Grant agreement for: Collaborative project*

Annex I - "Description of Work"

Project acronym: SEMEOTICONS

Project full title: " SEMEiotic Oriented Technology for Individual's CardiOmetabolic risk self-assessmeNt and Self-monitoring "

Grant agreement no: 611516

Version date: 2013-09-18

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Part A

Workplan Tables

A1:
Project summary

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

One form per project

General information			
Project title [3]	SEMEiotic Oriented Technology for Individual's CardiOmetabolic risk self-assessmeNt and Self-monitoring		
Starting date [4]	01/11/2013		
Duration in months [5]	36		
Call (part) identifier [6]	FP7-ICT-2013-10		
Activity code(s) most relevant to your topic [7]	:		
Free keywords [8]	Wellness self-monitoring; Cardio-metabolic Disease Prevention; Personalized Guidance System; Multisensory systems; Biometrics; Morphometrics; Digital Semeiotics; Virtual Individual's Model		

Abstract [9]

According to medical semeiotics, human face is a precious revealer of key information about the healthy or unhealthy status of individuals, as a combination of physical signs and expressive features. The central idea in SEMEOTICONS is to exploit the face as a major indicator of individual's well-being for the prevention of cardio-metabolic risk and cardiovascular diseases (CVD), for which healthcare systems are registering an exponential growth of social costs.

In accordance to a semeiotics viewpoint, face signs will be mapped to measures and computational descriptors, automatically assessed. To this end, SEMEOTICONS will design and construct an innovative multisensory system integrated into a hardware platform having the exterior aspect of a mirror: the so-called "Wize Mirror". This will easily fit into users' home or other sites of their daily life (e.g. fitness and nutritional centres, pharmacies, schools and so on).

The Wize Mirror will collect data mainly in the form of videos, images and gas concentration signals. These will be processed by advanced dedicated methods to extract biometric, morphometric, colorimetric, and compositional descriptors measuring individual's facial signs. The integration of such descriptors will provide a Virtual Individual's Model, which will be used to compute and trace the daily evolution of an individual's "wellness index".

A well-being diary based on this index will enable users to evaluate and personally correlate the lifestyle to their wellness and health status. Suggestions and coaching messages will be also provided to foster the maintenance of a correct lifestyle or reduce noxious habits. Moreover, users will be enabled to share data in their diary with health professionals so as to receive, when needed, direct expert guidance and support. In this frame, SEMEOTICONS will carefully focus on the development of user-friendly human-computer interactions so as to foster the perception of the system usefulness and reliability.

Medical experts will validate the system with respect to the reproducibility of measurements, the efficacy in detecting changes in well-being and cardio-metabolic status and the acceptability by the end-users.

The exploitation of the Wize Mirror will promote new aggregations between health and well-being actors including industry, fitness, and schools. Furthermore, significant effects towards the development of new CVD prevention strategies are expected, with positive impacts on the reduction of avoidable disease burden and health expenditures.

A2:
List of Beneficiaries

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

List of Beneficiaries

No	Name	Short name	Country	Project entry month[10]	Project exit month
1	CONSIGLIO NAZIONALE DELLE RICERCHE	CNR	Italy	1	36
2	FOUNDATION FOR RESEARCH AND TECHNOLOGY HELLAS	FORTH	Greece	1	36
3	LINKOPINGS UNIVERSITET	LIU	Sweden	1	36
4	UNIVERSITY OF CENTRAL LANCASHIRE	UCLAN	United Kingdom	1	36
5	NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU	NTNU	Norway	1	36
6	CENTRE DE RECHERCHE EN NUTRITION HUMAINE RHONE-ALPES	CRNH	France	1	36
7	INTECS SPA	INTECS	Italy	1	36
8	Hellenic Telecommunications & Telematics Applications Company	FORTHNET	Greece	1	36
9	DRACO SYSTEMS SL	DRACO	Spain	1	36
10	COSMED SRL	COSMED	Italy	1	36

A3:
Budget Breakdown

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

One Form per Project

Participant number in this project [11]	Participant short name	Fund. % [12]	Ind. costs [13]	Estimated eligible costs (whole duration of the project)					Requested EU contribution
				RTD / Innovation (A)	Demonstration (B)	Management (C)	Other (D)	Total A+B+C+D	
1	CNR	75.0	S	979,870.00	0.00	213,696.00	14,782.00	1,208,348.00	963,380.00
2	FORTH	75.0	A	368,400.00	0.00	10,320.00	5,560.00	384,280.00	292,180.00
3	LIU	75.0	T	466,080.00	0.00	15,200.00	2,400.00	483,680.00	367,160.00
4	UCLAN	75.0	T	371,464.00	0.00	12,003.00	5,600.00	389,067.00	296,201.00
5	NTNU	75.0	T	662,801.00	0.00	24,156.00	2,400.00	689,357.00	523,656.00
6	CRNH	75.0	T	280,200.00	0.00	12,800.00	4,800.00	297,800.00	227,750.00
7	INTECS	50.0	S	579,100.00	0.00	11,030.00	1,500.00	591,630.00	302,080.00
8	FORTHNET	50.0	A	474,920.00	0.00	11,460.00	3,500.00	489,880.00	252,420.00
9	DRACO	75.0	F	493,164.00	0.00	14,800.00	1,200.00	509,164.00	385,873.00
10	COSMED	75.0	A	322,480.00	0.00	10,440.00	7,000.00	339,920.00	259,300.00
Total				4,998,479.00	0.00	335,905.00	48,742.00	5,383,126.00	3,870,000.00

Note that the budget mentioned in this table is the total budget requested by the Beneficiary and associated Third Parties.

*** The following funding schemes are distinguished**

Collaborative Project (if a distinction is made in the call please state which type of Collaborative project is referred to: (i) Small of medium-scale focused research project, (ii) Large-scale integrating project, (iii) Project targeted to special groups such as SMEs and other smaller actors), Network of Excellence, Coordination Action, Support Action.

1. Project number

The project number has been assigned by the Commission as the unique identifier for your project, and it cannot be changed. The project number **should appear on each page of the grant agreement preparation documents** to prevent errors during its handling.

2. Project acronym

Use the project acronym as indicated in the submitted proposal. It cannot be changed, unless agreed during the negotiations. The same acronym **should appear on each page of the grant agreement preparation documents** to prevent errors during its handling.

3. Project title

Use the title (preferably no longer than 200 characters) as indicated in the submitted proposal. Minor corrections are possible if agreed during the preparation of the grant agreement.

4. Starting date

Unless a specific (fixed) starting date is duly justified and agreed upon during the preparation of the Grant Agreement, the project will start on the first day of the month following the entry info force of the Grant Agreement (NB : entry into force = signature by the Commission). Please note that if a fixed starting date is used, you will be required to provide a detailed justification on a separate note.

5. Duration

Insert the duration of the project in full months.

6. Call (part) identifier

The Call (part) identifier is the reference number given in the call or part of the call you were addressing, as indicated in the publication of the call in the Official Journal of the European Union. You have to use the identifier given by the Commission in the letter inviting to prepare the grant agreement.

7. Activity code

Select the activity code from the drop-down menu.

8. Free keywords

Use the free keywords from your original proposal; changes and additions are possible.

9. Abstract

10. The month at which the participant joined the consortium, month 1 marking the start date of the project, and all other start dates being relative to this start date.

11. The number allocated by the Consortium to the participant for this project.

12. Include the funding % for RTD/Innovation – either 50% or 75%

13. Indirect cost model

A: Actual Costs
S: Actual Costs Simplified Method
T: Transitional Flat rate
F :Flat Rate

Workplan Tables

Project number

611516

Project title

SEMEOTICONS—SEMEiotic Oriented Technology for Individual's CardiOmetabolic risk self-assessmeNt and Self-monitoring

Call (part) identifier

FP7-ICT-2013-10

Funding scheme

Collaborative project

WT1
List of work packages

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

LIST OF WORK PACKAGES (WP)

WP Number [53]	WP Title	Type of activity [54]	Lead beneficiary number [55]	Person-months [56]	Start month [57]	End month [58]
WP 1	Face Semeiotic Model of Cardio-Metabolic Risk	RTD	1	37.00	1	18
WP 2	Hardware and Software platform design	RTD	8	55.00	4	24
WP 3	Multispectral data analysis and sensors development	RTD	3	89.00	1	26
WP 4	3D Models construction and characterization	RTD	4	39.00	1	26
WP 5	Methods for face expression analysis and psycho-physical status evaluation	RTD	2	37.00	1	26
WP 6	Virtual individual's model and personalized guidance	RTD	1	62.00	1	36
WP 7	User centric applications and services	RTD	7	65.00	6	28
WP 8	Hardware platform development and Wize Mirror integration	RTD	9	92.00	6	36
WP 9	Wellness semeiotics validation	RTD	6	36.00	30	36
WP 10	Dissemination & Exploitation	OTHER	1	38.00	1	36
WP 11	Project Management and Coordination	MGT	1	40.00	1	36
			Total	590.00		

WT2:
List of Deliverables

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

List of Deliverables - to be submitted for review to EC

Delive-rable Number [61]	Deliverable Title	WP number [53]	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D1.1.1	Semeiotic model of cardio-metabolic risk	1	6	3.50	R	PP	3
D1.1.2	Final Semeiotic model of cardio-metabolic risk	1	6	2.50	R	PU	15
D1.2	Physical models for multispectral imaging of the cardio-metabolic signs of the face	1	5	10.00	R	PU	5
D1.3	Description of SEMEOTICONS reference dataset	1	1	19.00	R	PU	18
D1.4	Validation protocol	1	1	2.00	R	PU	5
D2.1.1	Initial specification of system requirement and functionalities	2	1	7.00	R	CO	6
D2.1.2	Revised specification of system requirement and functionalities	2	1	4.00	R	CO	15
D2.1.3	Final specification of system requirement and functionalities	2	1	4.00	R	CO	21
D2.2.1	Design of the Wize Mirror	2	9	5.00	R	CO	15
D2.2.2	Design of the Wize Mirror - updates	2	9	2.00	R	CO	24
D2.3.1	Design of the Wize Mirror ICT platform	2	8	13.00	R	PP	15

WT2:
List of Deliverables

Delive-rable Number [61]	Deliverable Title	WP number [53]	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D2.3.2	Design of the Wize Mirror ICT platform - updates	2	8	5.00	R	PP	24
D2.4.1	Data Management System design	2	7	11.00	R	PP	15
D2.4.2	Data Management System design - updates	2	7	4.00	R	PP	21
D3.1.1	MSI Hardware design and algorithms for monitoring endothelium function based on HSI	3	5	11.00	R	PP	15
D3.1.2	Algorithms for monitoring endothelium function based on MSI	3	5	8.00	P	PP	26
D3.2.1	MSI Hardware design and algorithms for monitoring cholesterol level based on HSI	3	3	10.50	R	PP	15
D3.2.2	Algorithms for monitoring cholesterol level based on MSI	3	3	8.50	P	PP	26
D3.3.1	MSI Hardware design and algorithms for monitoring AGE accumulation based on HSI	3	1	11.00	R	PP	15
D3.3.2	Algorithms for monitoring cholesterol AGE accumulation based on MSI	3	1	8.00	P	PP	26
D3.4.1	Eye image characterization	3	4	5.00	R	PP	15

WT2:
List of Deliverables

Delive-rable Number [61]	Deliverable Title	WP number [53]	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D3.4.2	Unobtrusive eye analysis system	3	4	3.00	P	PP	26
D3.5.1	Gas sensors for breath analysis	3	1	12.00	R	PP	15
D3.5.2	Design and integration of the Wize Sniffer	3	10	12.00	P	PP	22
D4.1.1	3D geometric reconstruction subsystem	4	4	13.00	R	PP	15
D4.1.2	3D geometric reconstruction subsystem – final release	4	4	7.00	P	PP	24
D4.2	Face detection and recognition	4	4	4.50	R	PP	12
D4.3.1	Methods for bio-morphometric and colorimetric face characterisation	4	1	5.00	R	PP	15
D4.3.2	Methods for bio-morphometric and colorimetric face characterisation – final release	4	1	4.00	P	PP	26
D4.4	General semeiotics signs of the face	4	2	5.50	P	CO	26
D5.1	In-depth analysis of state-of-the-art for facial expression analysis	5	2	3.00	R	PU	3
D5.2	Face normalization and alignment based on 3D data	5	4	8.00	R	PU	14
D5.3.1	Algorithms and methods for facial expression analysis and	5	2	13.50	R	CO	15

WT2:
List of Deliverables

Delive-rable Number [61]	Deliverable Title	WP number [53]	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
	psycho-physical status evaluation						
D5.3.2	Algorithms and methods for facial expression analysis and psycho-physical status evaluation - final release	5	2	12.50	P	PU	26
D6.1	User's profiling tools	6	2	11.00	R	CO	18
D6.2.1	Data Analysis and Fusion Strategies	6	1	15.00	R	CO	15
D6.2.2	Wellness index evaluation and risk correlation	6	1	12.00	P	PP	29
D6.3	Personalized guidance system	6	1	22.00	P	CO	29
D6.4	Model fine-tuning	6	1	2.00	R	PP	36
D7.1.1	User's requirements: first report containing the requirements of the SW applications	7	7	6.00	R	PP	9
D7.1.2	User's requirements: final report containing the requirements of the SW applications	7	7	5.00	R	PU	24
D7.2.1	SW Applications and Services: first Release of the applications and services	7	7	19.00	R	PP	18
D7.2.2	SW Applications and Services: final Release of the applications and services	7	7	14.00	P	PU	28

WT2:
List of Deliverables

Delive-rable Number [61]	Deliverable Title	WP number [53]	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D7.3.1	Data Management Infrastructure	7	7	12.00	R	PP	18
D7.3.2	Data Management Infrastructure - final release	7	7	9.00	P	PP	24
D8.1	Design of the Wize Mirror hardware platform	8	9	10.00	R	CO	9
D8.2	Wize Mirror platform prototype	8	9	4.00	P	RE	12
D8.3	Release of the first Wize Mirrow prototype	8	9	22.00	P	PU	18
D8.4	The Wize Mirror	8	9	11.00	P	PU	29
D8.5.1	Software integration Report	8	7	14.50	R	PP	29
D8.5.2	Software Integration and Wize Mirror user manual	8	7	13.00	P	PU	36
D8.6.1	First report on technical validation	8	1	9.00	R	PP	12
D8.6.2	Second report on technical validation	8	1	8.50	R	PP	20
D9.1	Reproducibility report	9	6	12.00	R	PP	36
D9.2	Validation report on system acceptability and efficacy in the practice setting	9	1	12.00	R	PP	36
D9.3	Validation report on Wize Mirror accuracy vs traditional measures	9	1	12.00	R	PP	36
D10.1	Website	10	1	5.00	P	PU	3

WT2:
List of Deliverables

Delive-rable Number [61]	Deliverable Title	WP number [53]	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D10.2.1	First Report on dissemination activities and initial exploitation plan	10	1	10.00	R	PU	12
D10.2.2	Second Report on dissemination and exploitation activities	10	1	10.00	R	PU	24
D10.2.3	Final Report on dissemination and exploitation activities	10	1	13.00	R	PU	36
D11.1	Project Presentation	11	1	0.30	R	PU	1
D11.2	Project Handbook	11	1	0.50	R	PP	3
D11.3	Report on Quality Assurance Process	11	1	0.70	R	PP	3
D11.4	1st Four-month Periodic Report	11	1	4.50	R	PP	4
D11.5	2nd Four-month Periodic Report	11	1	4.50	R	PP	8
D11.6	3rd Four-month Periodic Report	11	1	5.50	R	PP	12
D11.7	4rd Four-month Periodic Report	11	1	4.50	R	PP	16
D11.8	5th Four-month Periodic Report	11	1	4.50	R	PP	20
D11.9	6th Four-month Periodic Report	11	1	4.50	R	PP	24
D11.10	7th Four-month Periodic Report	11	1	6.00	R	PP	28
D11.11	8th Four-month Periodic Report	11	1	4.50	R	PP	32
			Total	590.00			

WT3:
Work package description

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

One form per Work Package

Work package number [53]	WP1	Type of activity [54]	RTD
Work package title	Face Semeiotic Model of Cardio-Metabolic Risk		
Start month	1		
End month	18		
Lead beneficiary number [55]	1		

Objectives

This work package is aimed at
a) identifying the requirements, imposed both by the medical aspects of the problem and the end-user interaction;
b) defining the functional specifications of the whole Wize Mirror system.
The activities needed by other WPs of the Projects will also be carried out in this Work Package.
Based on a thorough analysis of clinical and medical aspects of face semeiotics and a deepened investigation of multispectral imaging of facial district, the following points will be focused:
- Review of classical semeiotics in the light of modern imaging technology
- Modeling and collecting a reference dataset to be used for RTD activities in SEMEOTICONS, mainly in WP3-6.
The validation protocol needed for WP9 will be also defined and submitted to local ethical committees for approval.

Description of work and role of partners

Task 1.1 – Cardio-metabolic semeiotics
Task Leader: CRNH
Participants: CNR-IFC, CRNH
Duration: month 1-18
Medical semiotics will provide the starting point to individuate the signs that are: a) recognizable by face imaging and exhaled gas analysis and b) relevant to define individual cardio-metabolic risk-factors. Classical signs will be revised in view of the use of digital imaging techniques leading to quantitative face descriptions. Signs related to face aspect and expression will be identified and characterized with particular attention to physical and psychological status. Moreover, a detailed review of the state of the art will allow pinpointing the role of cholesterol and AGE accumulation in the skin. Assessment of subcutaneous flow will be analysed and procedures for the evaluation of endothelial function will be defined. CRHN unit will coordinate the task; the work being carried out in close cooperation with CNR-IFC unit.

Task 1.2 – Data modelling and investigation
Task Leader: NTNU
Participants: CNR-ISTI, CNR-IFC, LIU, UCLAN, CRNH
Duration: month 3-5
The activity will focus on investigating the physical aspect related to the following issues: subcutaneous flow and its changes during cardiac cycle, heart rate, haemoglobin concentration, cholesterol and AGEs accumulation in the skin by means of multispectral imaging. In addition the vasodilation on the face induced by a simple thermal stimulation will be evaluated and correlated with the endothelial function determined by peripheral arterial tonometry and laser Doppler flowmetry. NTNU unit will lead the work with the participation of CNR-ISTI, CNR-IFC, LIU, UCLAN, CRNH.

Task 1.3 – Reference data collection
Task Leader: CNR-IFC
Participants: CNR-ISTI, CNR-IFC, FORTH, LIU, UCLAN, NTNU, CRNH, COSMED
Duration: month 5-18

The aim of this task is building the reference data set to be used for other RTD activities. A group of volunteers (more than twenty) will be enrolled in the CNR campus of Pisa, Italy. Criteria for recruitment will be cover with sickness extremes in the different cardio-metabolic diseases. The clinical characterization of each volunteer will include anamnesis, physical examination, body weight and body composition by bioelectrical impedance; resting on energy expenditure by indirect calorimetry, peripheral venous blood sample for determination of lipid profile, glycemia, insulinemia, hemoglobin, glycated hemoglobin. Moreover, the following score will be calculated: Heart-Score, Fatty-Liver-Index, Finnish Type 2 Diabetes Risk Score (FINDRISC), Homeostasis Model Assessement (HOMA) index. The endothelium-dependent vasodilation will be tested by peripheral arterial tonometry. Psychological and nutritional tests will be also administered. Afterwards, images (still pictures and movies) will be acquired both in visible light and infrared band using a predefined laboratory set up. Exhaled gas samples will be also collected. Reference signals, such as ECG, Oxygen saturation, skin cholesterol, skin-flow data will be collected and stored simultaneously, whenever possible, with image data.

Task 1.4 – Definition of validation protocol.
Task Leader: CNR-IFC
Participants: CRNH
Duration: month 1-5
The protocol to be used in the validation phase (WP9) will be defined in this task. As the activity is planned to take place at CNR-IFC unit of Pisa, Italy, CNR-IFC unit in Milan, Italy, and at CRNH in Lyon, France, each unit will submit the protocol to the local ethical committee for approval.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	CNR	18.00
2	FORTH	2.00
3	LIU	3.00
4	UCLAN	1.00
5	NTNU	5.00
6	CRNH	6.00
10	COSMED	2.00
	Total	37.00

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D1.1.1	Semeiotic model of cardio-metabolic risk	6	3.50	R	PP	3
D1.1.2	Final Semeiotic model of cardio-metabolic risk	6	2.50	R	PU	15
D1.2	Physical models for multispectral imaging of the cardio-metabolic signs of the face	5	10.00	R	PU	5
D1.3	Description of SEMEOTICONS reference dataset	1	19.00	R	PU	18
D1.4	Validation protocol	1	2.00	R	PU	5

WT3:
Work package description

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
		Total	37.00			

Description of deliverables

D1.1.1) Semeiotic model of cardio-metabolic risk: This report will establish a semeiotic model of cardio-metabolic risk based on facial signs and exhaled gases analysis. This will identify a set of relevant features and the preferred observation conditions [month 3]

D1.1.2) Final Semeiotic model of cardio-metabolic risk: Update of D1.1.1. This update will integrate the results of investigation from other WPs with state of the art and the proposed semiotic model [month 15]

D1.2) Physical models for multispectral imaging of the cardio-metabolic signs of the face: This report will present physical models for multispectral imaging of endothelium function, cholesterol level, AGE product accumulation. This will include calculations and test protocols that either directly measure the tissue level such as cholesterol and AGE products or indirectly assess the function by a test procedure, such as endothelium function [month 5]

D1.3) Description of SEMEOTICONS reference dataset: This report will describe the generation of the reference data set that will be used from the activities of WPs 3, 4, 5 and 6 [month 18]

D1.4) Validation protocol: This report will define the validation protocol to be used in WP9 and the submission to local ethical committees [month 5]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead benefi-ciary number	Delivery date from Annex I [60]	Comments
MS1	First release of Semeiotics Model and system requirements	1	6	First semeiotic model released along with the requirements of system platform (D1.1.1, D2.1.1). Bases for face recognition and characterisation settled (D5.1).
MS3	1st release of the Wize Mirror related prototypes	1	18	Semeiotic model completed. First release of methods and sub-components from WP3-7. First partially integrated Mirror prototype released. Last updates to system requirements and design.

WT3:
Work package description

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

One form per Work Package

Work package number [53]	WP2	Type of activity [54]	RTD
Work package title	Hardware and Software platform design		
Start month	4		
End month	24		
Lead beneficiary number [55]	8		

Objectives

This WP will address the challenges associated with the design of all system components (HW, SW and DB) associated with the Wize Mirror development.

Description of work and role of partners

Task 2.1 - Specification of system requirements and functionalities
Task Leader: CNR-ISTI
Participants: CNR-IFC, FORTH, INTECS, DRACO, FORTHNET, COSMED
Duration: month 4-21
This task will mainly concern the definition of system requirements from the technological, methodological and medical points of view, in accordance to the semeiotic model defined in WP1. In particular, a first set of design requirements will be directly derived according to task 1.1 where the various signs and features to be observed are defined along with indications about substances to be detected /assessed. A second set of constraints will be derived analysing system integration and development. The specification of the system functionalities will then follow to obtain an overall description of the system operations.

Task 2.2 – Design of the Multisensory - Wize Mirror
Task Leader: DRACO
Participants: FORTHNET, INTECS
Duration: month 4-24
In this task the design of the Wize Mirror, integrated with all the sensors and devices, will take place. Trade-offs regarding non-intrusiveness, computational power, energy consumption, local storage capabilities, sensor placement, screen properties, cost, etc. will be taken into account in order to design the device according to the specifications defined in WP1.
The fundamental constraints in the design of the Wize Mirror are:
- Easy integration in a home environment;
- Non intrusiveness;
- Enable self assessment of well-being status through natural interaction.

Task 2.3 – Design of the ICT Platform
Task Leader: FORTHNET
Participants: INTECS, DRACO
Duration: month 4-24
This task will address the design of the ICT infrastructure for the Wize Mirror device, providing the design guidelines that will direct the development process carried out in WP3 and WP7 to meet the hardware and software specifications for Wize Mirror.
In the first phase of this task's activities, the work will focus on establishing the platform's required technological capabilities that will drive the platform design, and translating the system specifications (both hardware and software) defined in Task 1.3 into components (e.g. UML class diagrams) and interactions between them (e.g. UML interaction diagrams). The design for the software components will follow the agile software methodology and adhere to an iterative incremental development process.

The hardware design will focus on developing a dedicated hardware platform that will integrate the monitoring sensors comprising the pervasive sensor environment of Wize Mirror to collect and process environmental data and the subject's vital signs.
The software design will further focus on defining the necessary software layers to:
- interface with the various devices and sensors and provide unified access to the collected information for analysis and user output;
- define the procedures and rules assuring confidentiality, privacy and security;
- provide guidance towards improvements and maintenance of a healthy life style.

Task 2.4 – Design of the Data Management Solution
Task Leader: INTECS
Participants: CNR-ISTI, COSMED
Duration: month 4-21
In this task the data management system will be designed to store all data collected and computed by the Wize Mirror sensors. The main responsibilities of this task will be:
- To define the structure of the database for the various monitoring information;
- To define the structure of the database for the various descriptors;
- To define the structure of the database for the user profile;
- To provide unified access to all stored information;
- To define the modalities for data porting and sharing.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	CNR	5.00
2	FORTH	3.00
7	INTECS	12.00
8	FORTHNET	20.00
9	DRACO	9.00
10	COSMED	6.00
	Total	55.00

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D2.1.1	Initial specification of system requirement and functionalities	1	7.00	R	CO	6
D2.1.2	Revised specification of system requirement and functionalities	1	4.00	R	CO	15
D2.1.3	Final specification of system requirement and functionalities	1	4.00	R	CO	21
D2.2.1	Design of the Wize Mirror	9	5.00	R	CO	15
D2.2.2	Design of the Wize Mirror - updates	9	2.00	R	CO	24
D2.3.1	Design of the Wize Mirror ICT platform	8	13.00	R	PP	15

WT3:
Work package description

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D2.3.2	Design of the Wize Mirror ICT platform - updates	8	5.00	R	PP	24
D2.4.1	Data Management System design	7	11.00	R	PP	15
D2.4.2	Data Management System design - updates	7	4.00	R	PP	21
		Total	55.00			

Description of deliverables

D2.1.1) Initial specification of system requirement and functionalities: This report will draw the system requirements from the technological, methodological and medical points of view, in accordance to the semeiotic model defined in WP1. It will detail the functional specifications of the Wize Mirror hardware and software components as well as those of the methodologies and algorithms for data processing and output provision. Medical and technical requirements as well as users' needs will be taken into account to draw the guidelines for the development activities of the core project WPs. The report will be firstly issued at month 6 and updated after each intermediate verification activity (at month 15 and 21), since these can suggest slight changes and rectifications to requirements and functional specifications [month 6]

D2.1.2) Revised specification of system requirement and functionalities: Update of D2.1.1. This report will report on adjustments to system requirements and functional specifications as resulted from the interim verification activity at month 12 [month 15]

D2.1.3) Final specification of system requirement and functionalities: Update of D2.1.2. This report will report on adjustments to system requirements and functional specifications as resulted from the interim verification activity at month 18 [month 21]

D2.2.1) Design of the Wize Mirror: This report will present an analysis of the sensors and devices and how to integrate them into the platform design [month 15]

D2.2.2) Design of the Wize Mirror - updates: Update of D2.2.1 [month 24]

D2.3.1) Design of the Wize Mirror ICT platform: This report will address the analysis and design issues of the underlying ICT infrastructure for the Wize Mirror device, describing the design guidelines that will direct the development process carried out in WP3 and WP7, in order to meet the hardware and software specifications of the platform [month 15]

D2.3.2) Design of the Wize Mirror ICT platform - updates: Update of D2.3.1 [month 24]

D2.4.1) Data Management System design: This report will describe the design of the data management system to store all data acquired and computed by the Wize Mirror sensors. It will describe the structure of the database for: (i) the various monitoring information, (ii) the various computational descriptors; (iii) the user profile; (iv) the unified access to all stored information; (v) the modalities for data porting and sharing. The Data Base will be defined in term of Data Structure (Data types and relationship), Policies to Data Access and API interface [month 15]

D2.4.2) Data Management System design - updates: Update of D2.4.1. This deliverable will report updates and adjustments carried out, when needed, on the Data Management System according to the results of the interim technical validation [month 21]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead benefi-ciary number	Delivery date from Annex I [60]	Comments
MS1	First release of Semeiotics Model and system requirements	1	6	First semeiotic model released along with the requirements of system platform (D1.1.1, D2.1.1). Bases for face recognition and characterisation settled (D5.1).
MS3	1st release of the Wize Mirror related prototypes	1	18	Semeiotic model completed. First release of methods and sub-components from WP3-7. First partially integrated Mirror prototype released. Last updates to system requirements and design.
MS4	Wize Mirror design completed	1	24	Final version of the Wize Mirror technological and methodological design released.

WT3:
Work package description

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

One form per Work Package

Work package number [53]	WP3	Type of activity [54]	RTD
Work package title	Multispectral data analysis and sensors development		
Start month	1		
End month	26		
Lead beneficiary number [55]	3		

Objectives

This WP will mainly aim at:
i) Investigating a suitable hardware Multi Spectral Imaging (MSI) setup and developing efficient analysis algorithms, exploiting MSI, to quantify:
- endothelium function,
- skin cholesterol,
- AGE-product skin accumulation.
ii) Assessing suitability and developing methods for detection of abnormal cholesterol levels by means of iris and eyelid image analysis
iii) Developing a portable box (Wize Sniffer) for breath analysis.

Description of work and role of partners

Task 3.1 – Methods for analysing endothelium function
Task Leader: NTNU
Participants: LIU, CNR-IFC, DRACO
Duration: month 1-26
The quantification of the endothelium function using MSI will be explored based on reference data (collected in Task 1.3) from subjects with normal and abnormal endothelium function undergoing local and full-face heat provocation. Following the definition of a proper stimulation method, this task includes the design and evaluation of analysis algorithms for determining temporal variations in the tissue amount of blood and hemoglobin saturation, along with the heart rate, using imaging spectroscopy in the 400-2000nm range. An advanced HyperSpectral Imaging system (HSI) including white light illumination will be used for MSI hardware and algorithm development. The MSI hardware includes the camera setup with possible filters and the illumination by either white light or discrete light sources. As a reference, peripheral artery tonometry and probe-based forearm laser Doppler flowmetry during forearm skin heating will be used when collecting data in Task 1.3. As complementary method, blood flow/ perfusion imaging using laser speckle contrast analysis (LASCA) will be used.

Task 3.2 – Methods for analysing cholesterol level
Task Leader: LIU
Participants: CNR-IFC, NTNU, DRACO
Duration: month 1-26
Quantifying the skin cholesterol using MSI will be explored based on reference data (collected in Task 1.3) from patients with normal cholesterol level and those with hypercholesterolemia. The task includes the design and evaluation of analysis algorithms for determining the scattering level and the amount of lipid related absorption in skin and eye tissue. The algorithm will make use of MSI datasets in the 400-2000nm range. An advanced HyperSpectral Imaging system (HSI) including white light illumination will be used for MSI hardware and algorithm development. The MSI hardware includes the camera setup with possible filters and the illumination by either white light or discrete light sources. The HSI and MSI results will be compared to standard blood tests performed in Task 1.3.

Task 3.3 – Methods for analysing AGE-product concentration
Task Leader: CNR-IFC

Participants: LIU, NTNU
Duration: month 1-26
Quantifying the accumulation of AGE-products in tissue using MSI will be explored based on reference data (collected in Task 1.3) from both healthy patients and patients suffering from diabetes. This includes the design and evaluation of analysis algorithms for determining the amount of AGE-products using fluorescence with an excitation light source in the 300- 420nm range and imaging spectroscopy datasets in the 400-2000nm. The algorithm will need separate recordings of the backscattered UV-light intensity (a measure of excitation light intensity in tissue; <420 nm), and the backscattered fluorescence light intensity (> 420 nm). A modulated light source will be explored for ambient light suppression. The MSI result will be compared to measurements using an AGE reader, as performed in Task 1.3.

Task 3.4 – Iris image analysis for indicative detection of abnormal level of cholesterol.
Task Leader: UCLAN
Participants: CNR-ISTI, DRACO
Duration: month 9-26
The objective of this task will be the detection of arcus senilis (a white or gray ring in the corneal margin), alongside xanthelasmas (fat deposits on the eyelids).It is hypothesized that these may be used as indicators of possible abnormal levels of cholesterol. A number of feature spaces will be investigated including: entropy, co-occurrence, Fourier descriptors, shape histograms, Haar-like features and local binary patterns alongside number of classification algorithms including AdaBoost-SVM/RVM and random forests. The suitability of using detected arcus senilis and xanthelasmas for assessment of abnormal levels of cholesterol will be verified based on measurements preformed in Task 3.2 with data collected in Task 1.3. In case the validation of the method would show statistically significant discriminatory characteristic of abnormal levels of cholesterol detection a fully automatic non-intrusive eye scanning system will be developed based on the results obtained from Task 5.2.

Task 3.5 – Gas sensor for breath analysis
Task Leader: CNR-ISM
Participants: DRACO, COSMED
Duration: month 1-22
The objective of this task is to make ready a portable device, called Wize Sniffer, for the screening of the breath volatile components. The Wize Sniffer will be composed by an array of gas sensors and it will operate in three phases: gas collection, sampling and data analysis to measure the breath odor-print. The signals will be filtered, amplified, and sent to the Wize-mirror computing unit for further analysis. Commercial gas sensors as well as innovative, home built gas sensors, based on Electrospun nanofibers, will be explored and considered for the development of the Wize Sniffer. Electrospun nanofibers, made using conductive polymers (polyaniline and polypyrrole), will be used as sensing material and possible advantages with respect to commercial gas sensors will be analyzed, such as to efficacy of time response, sensitivity and reproducibility of measurements.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	CNR	21.00
3	LIU	27.00
4	UCLAN	6.00
5	NTNU	24.00
9	DRACO	1.00
10	COSMED	10.00
	Total	89.00

WT3:
Work package description

List of deliverables

Deliverable Number [61]	Deliverable Title	Lead beneficiary number	Estimated indicative person-months	Nature [62]	Dissemination level [63]	Delivery date [64]
D3.1.1	MSI Hardware design and algorithms for monitoring endothelium function based on HSI	5	11.00	R	PP	15
D3.1.2	Algorithms for monitoring endothelium function based on MSI	5	8.00	P	PP	26
D3.2.1	MSI Hardware design and algorithms for monitoring cholesterol level based on HSI	3	10.50	R	PP	15
D3.2.2	Algorithms for monitoring cholesterol level based on MSI	3	8.50	P	PP	26
D3.3.1	MSI Hardware design and algorithms for monitoring AGE accumulation based on HSI	1	11.00	R	PP	15
D3.3.2	Algorithms for monitoring cholesterol AGE accumulation based on MSI	1	8.00	P	PP	26
D3.4.1	Eye image characterization	4	5.00	R	PP	15
D3.4.2	Unobtrusive eye analysis system	4	3.00	P	PP	26
D3.5.1	Gas sensors for breath analysis	1	12.00	R	PP	15
D3.5.2	Design and integration of the Wize Sniffer	10	12.00	P	PP	22
		Total	89.00			

Description of deliverables

D3.1.1) MSI Hardware design and algorithms for monitoring endothelium function based on HSI: This deliverable will evaluate whether endothelial function can be measured using advanced HIS hardware and white light illumination. It will also be the basis for hardware and algorithm considerations for the simpler MSI system to be used in D3.1.2 [month 15]

D3.1.2) Algorithms for monitoring endothelium function based on MSI: Report and Prototype. This deliverable will evaluate the MSI system built from specifications in D3.1.1 that will be used in parallel with the HSI system on a new set of clinical measurements [month 26]

D3.2.1) MSI Hardware design and algorithms for monitoring cholesterol level based on HSI: This deliverable will evaluate whether cholesterol level can be measured using advanced HIS hardware and white light illumination. It will also be the basis for hardware and algorithm considerations for the simpler MSI system to be used in D3.2.2 [month 15]

D3.2.2) Algorithms for monitoring cholesterol level based on MSI: Report and Prototype.This deliverable will evaluate the MSI system built from specifications in D3.2.1 that will be used in parallel with the HSI system on a new set of clinical measurements [month 26]

D3.3.1) MSI Hardware design and algorithms for monitoring AGE accumulation based on HSI: This deliverable will evaluate whether AGE accumulation can be measured using advanced HIS hardware and white light illumination. It will also be the basis for hardware and algorithm considerations for the simpler MSI system to be used in D3.3.2 [month 15]

D3.3.2) Algorithms for monitoring cholesterol AGE accumulation based on MSI: Report and Prototype. This deliverable will evaluate the MSI system built from specifications in D3.3.1 that will be used in parallel with the HSI system on a new set of clinical measurements [month 26]

D3.4.1) Eye image characterization: this document will report on techniques developed for detection of arcus senilis and xanthelasmas from iris/eyelid images. Additionally it will provide suitability analysis for using arcus senilis and/or xanthelasmas for detection of abnormal levels of cholesterol [month 15]

D3.4.2) Unobtrusive eye analysis system: Report and Prototype. This deliverable will describe the implementation of a fully automatic non-intrusive eye scanning system which would be able to facilitate measurement techniques reported in D3.4.1 on the Wize Mirror platform [month 26]

D3.5.1) Gas sensors for breath analysis: This report will focus on: (i) the description of the volatile breath components to be detected; (ii) the gas sensors to be used and possible improvement with new sensing materials made of nanofibers; (iii) the accuracy of data processing [month 15]

D3.5.2) Design and integration of the Wize Sniffer: Report and Wize Sniffer Protyotype. The report will describe the architecture of the Wize Sniffer and its integration within the Wize Mirror. Accuracy and significance of Wize Sniffer data will be as well described [month 22]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead beneficiary number	Delivery date from Annex I [60]	Comments
MS3	1st release of the Wize Mirror related prototypes	1	18	Semeiotic model completed. First release of methods and sub-components from WP3-7. First partially integrated Mirror prototype released. Last updates to system requirements and design.
MS5	Release of the integrated Wize Mirror prototype	1	29	Integrated Wize Mirror completed. All methods and prototypes from WP3-7 finalized and integrated.

WT3:
Work package description

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

One form per Work Package

Work package number [53]	WP4	Type of activity [54]	RTD
Work package title	3D Models construction and characterization		
Start month	1		
End month	26		
Lead beneficiary number [55]	4		

Objectives

The overall aim of this WP is to investigate, design and develop tools and methods for capture and analysis of dynamic 3D facial data, and, as result, support tasks in WP3 and WP5. The main objectives are to:
- construct a novel hardware and software platform based on inexpensive of-the-shelf components for dynamic 3D facial reconstructions;
- create computational tools for modelling, analysis and categorization of the captured dynamic 3D facial data;
- design mathematical models for efficient data representation, meeting corresponding requirements from the WP3 and WP5 for real-time processing.

Description of work and role of partners

Task 4.1 – 3D geometric reconstruction and modelling of the face
Task Leader: UCLAN
Participants: CNR-ISTI, FORTH, DRACO
Duration: month 1-24
This task aims at developing an economically affordable system for 3D geometric reconstruction and modelling of faces. The system will be integrated with the Wize Mirror and is to be based on readily available vision and depth (Kinect–like) sensors. The depth sensor will be supplemented by more accurate dynamic 3D scanner. Number of different 3D-scan technologies will be investigated, including photometric stereo, with the final choice based on the best performance in terms of accuracy, computational efficiency and cost. The data output from the system will include co-registered high resolution (1Mpixels) colour video as well as range and dense facial surface data streams. The range data will be used for robust face detection, tracking, normalisation and alignment; video stream will be predominantly used for subject identification as well as stress, anxiety and fatigue assessment. The 3D data will be used for bio-morphometric and multispectral data analysis. An optimal parameterisation of facial data will be investigated to support efficient facial data analysis in the remaining tasks of this WP and relevant tasked in WP3 and WP5.
This task will be delivered in two phases. During the first phase a preliminary system will be developed and made available to the relevant project partners, so it can be evaluated and used for development of the relevant tasks in WP2, WP3 and WP5. Subsequently based on the feedback from the users in the second phase the system will be refined and delivered for integration (WP8) and validation (WP9).

Task 4.2 – Face detection and recognition
Task Leader: UCLAN
Participants: CNR-ISTI, FORTH
Duration: month 3-12
The principal objective of this task is to develop tools for robust subject recognition as to facilitate the concurrent usage of the system by multiple users. To this end, this task will also address the issues of face detection and tracking and, as such, will be executed in a close interaction with the task 5.2 - face normalisation and alignment. Although it is envisaged that the face recognition will be primarily based on the colour video stream data, the developed algorithms will take advantage of the 3D range data as to correct for the variability in the face pose and illumination. Additionally, the face recognition sub-system will also interrelate with the facial expression/articulation analysis tools both by providing digital identity of the subject and in this way facilitate subject specific facial expression analysis in WP5, and introducing facial expression variability corrections in

the face recognition task. Both landmarks and intensity based methods will be investigated and compared, based on computational complexity and accuracy criteria. The preliminary set of face recognition algorithms will be implemented during first eight months for the subsequent tests. These tests will provide data for the final subsystem tuning.

Task 4.3 – Bio-morphometric and colorimetric face characterisation
Task Leader: CNR-ISTI
Participants: FORTH, UCLAN
Duration: month 10-26
The objective of this task is to develop a set of software tools to perform bio-morphometric facial measurements based on dynamic 3D facial data resulting from tasks 4.1. It is envisaged that both landmark and dense facial features (e.g. surface local curvatures) will be used with Euclidian and geodesic distances utilising different data reduction schemes including multidimensional scaling, isomaps and diffusions maps. The overall objective of this task will be to detect and monitor over time, any facial changes due to weight, swelling, local growth, facial asymmetry or overall facial articulation changes. This would be subsequently used alongside colour information from the video camera to assess facial abnormalities.

Task 4.4 – Other General Semeiotics signs
Task Leader: FORTH
Participants: CNR-ISTI, UCLAN
Duration: month 12-26
This task will develop and optimize the necessary methods in order to measure a set of additional general semeiotics signs. In particular the heart rate, the heart rate variability, respiration patterns and the arteries pulsation (blood flow) will be monitored by implementing magnification of spatial and temporal variations occurring at different scales in the video streams. This is to be achieved by spatio-temporal analysis similar to the recently proposed Eulerian video magnification method. The accuracy of measurements is expected to be comparable to electrocardiography. This will be extensively tested.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	CNR	7.00
2	FORTH	6.00
4	UCLAN	25.00
9	DRACO	1.00
	Total	39.00

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D4.1.1	3D geometric reconstruction subsystem	4	13.00	R	PP	15
D4.1.2	3D geometric reconstruction subsystem – final release	4	7.00	P	PP	24
D4.2	Face detection and recognition	4	4.50	R	PP	12
D4.3.1	Methods for bio-morphometric and colorimetric face characterisation	1	5.00	R	PP	15

WT3:
Work package description

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D4.3.2	Methods for bio-morphometric and colorimetric face characterisation – final release	1	4.00	P	PP	26
D4.4	General semeiotics signs of the face	2	5.50	P	CO	26
		Total	39.00			

Description of deliverables

D4.1.1) 3D geometric reconstruction subsystem: Report and first prototype. This deliverable will detail results of the investigation on the 3D geometric reconstruction and modelling of faces. D4.1.1 will provide a standalone prototype of 3D geometric reconstruction subsystem with the software and hardware manuals to facilitate evaluation of the subsystem by project partners working on WP5 and Wize Mirror hardware platform development [month 15]

D4.1.2) 3D geometric reconstruction subsystem – final release: Report and Prototype. This deliverable will update D4.1.1. Based on the feedback from the users evaluating the standalone 3D geometric reconstruction subsystem, the prototype will be further refined. D4.1.2 will provide hardware and software specifications of the final subsystem for integration on the Wize Mirror platform (WP8) [month 24]

D4.2) Face detection and recognition: This document will report on the investigation of the image based face detection techniques. It will provide valuation matrix and implementation details for techniques deemed to be most suitable for the utilised on the Wize Mirror platform [month 12]

D4.3.1) Methods for bio-morphometric and colorimetric face characterisation: This deliverable will report on the first release of the methods developed for bio-morphometric facial measurements based on dynamic 3D facial data. These will be evaluated during the interim technological validation activity at month 18 and updated or adjusted accordingly, if necessary [month 15]

D4.3.2) Methods for bio-morphometric and colorimetric face characterisation – final release: Report and Prototype - updates of D4.3.1. This deliverable will detail the final release of the methods (the prototype) for bio-morphometric facial measurements [month 26]

D4.4) General semeiotics signs of the face: Report and Prototype. This deliverable will describe the methods (the prototype) used to measure the additional semeiotic signs (heart rate, HRV, respiration patterns, artery pulsation). The results of testing the accuracy of measurements will also be reported [month 26]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead benefi-ciary number	Delivery date from Annex I [60]	Comments
MS3	1st release of the Wize Mirror related prototypes	1	18	Semeiotic model completed. First release of methods and sub-components from WP3-7. First partially integrated Mirror prototype released. Last updates to system

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead benefi-ciary number	Delivery date from Annex I [60]	Comments
				requirements and design.
MS5	Release of the integrated Wize Mirror prototype	1	29	Integrated Wize Mirror completed. All methods and prototypes from WP3-7 finalized and integrated.

WT3:
Work package description

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

One form per Work Package

Work package number [53]	WP5	Type of activity [54]	RTD
Work package title	Methods for face expression analysis and psycho-physical status evaluation		
Start month	1		
End month	26		
Lead beneficiary number [55]	2		

Objectives

The main objective of this WP is to develop a coherent facial expression analysis module that uses the video captured by Wize Mirror. Through the analysis of rapid facial signals, the module will generate a quantitative representation of the subject's psycho-physical status, suitable for cardio-metabolic risk assessment. The representation will include metrics describing the likelihood of the individual or combined existence of stress, anxiety and fatigue in a given period of time.
WP5 aims at:
- developing methods for the assessment of stress, fatigue and anxiety, based on automatic facial expression analysis using video
- defining indices for the quantitative description of the above states
- integrating the above methods into one measurement module
- taking necessary provisions for ensuring reliability and reproducibility of the module.

Description of work and role of partners

Task 5.1 – In-depth analysis of relevant state-of-the-art
Task Leader: FORTH
Participants: CNR-ISTI, UCLAN
Duration: month 1-3
This task aims at supplementing Tasks 1.1 and 1.2 from WP1. It will cover the areas specific to WP5, offering an in-depth analysis of the existing methods and technology with respect to facial expression analysis, facial feature detection, motion analysis, face normalization, stress, fatigue and anxiety assessment. It will furthermore define a set of requirements in terms of necessary raw data for the development of the analysis algorithms, therefore providing input to Task 1.5. Furthermore, technical requirements on image acquisition devices will be set as a supplement to WP2.

Task 5.2 – Face normalization and alignment based on 3D data
Task Leader: UCLAN
Participants: FORTH, CNR-ISTI, DRACO
Duration: month 7-14
This task draws from the outcomes of Task 4.1. The aim of this task is to design and develop a set of necessary pre-processing steps facilitating objectives of Tasks 5.3 and 5.4 by providing reliable and robust data platform for subsequent relevant analysis. The main objectives are to design the required methods for eliminating variability due to face rotation, translation and illumination changes. It is necessary to compensate, or normalize, a face for position, orientation and illumination so that the data inconstancy due to these factors is minimized, allowing the detection of subtle changes due to muscle activation. As a result, a high degree of reproducible outcomes from the next two tasks is to be achieved.

Task 5.3 – Stress and Anxiety assessment
Task Leader: FORTH
Participants: CNR-ISTI, CNR-IFC, UCLAN
Duration: month 3-26
This task will focus on the analysis of facial expressions through captured video. The aim is to extract facial expression parameters for the quantitative description of stress and anxiety. For this, anatomic areas of the

face, which are dominant in the disclosure of any of the two states, will be localized and, if necessary, automatic detectors (e.g. Haar feature detectors) for these areas will be trained. The parameter extraction process will be based on analysing pixel motion between consecutive frames, resulting in time-varying signals, out of which quantitative features can be extracted in the time and frequency domains. The most eligible approach in terms of sensitivity/specificity and real-time execution will be elaborated. Furthermore, the suitability of the extracted parameters for the assessment of the psychological status and the cardio-metabolic risk will be evaluated and a valid set of such parameters will be offered for the development of the prototype platform.

Task 5.4 – Fatigue assessment
Task Leader: CNR-ISTI
Participants: CNR-IFC, FORTH, UCLAN
Duration: month 3-26
Similarly to Task 5.3, this Task will focus on the analysis of facial expressions through captured video with the aim to extract facial expression parameters for the quantitative description of fatigue and physical weakness. To this end, special detectors will be trained to locate and track anatomical areas relevant to fatigue assessment. In particular, an eye tracking technique will be developed in order to analyse both the area around the eyes and their movement. A good level of tracking robustness with respect to face orientation, illumination and head movements will be pursued. In this way, it will be possible to carry out analysis at a finer level. In particular, algorithms for quantitatively analysing the eyelid movements will be studied, including eyelid closure/open speed, percentage eye closure and presence of involuntary eye blinking. At an even higher and challenging level, gaze analysis will be investigated: by analysing pupil movements, it will be possible to derive quantitative parameters to be correlated with fatigue and lack of attention. Finally, facial expressions will also be studied in connection with fatigue e.g. by deriving methods for detecting nodding and yawing.
After having surveyed and tested such a wide group of features correlated to fatigue, the most promising ones will be selected and engineered for real time execution on the Wize Mirror platform.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	CNR	7.00
2	FORTH	21.00
4	UCLAN	8.00
9	DRACO	1.00
	Total	37.00

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D5.1	In-depth analysis of state-of-the-art for facial expression analysis	2	3.00	R	PU	3
D5.2	Face normalization and alignment based on 3D data	4	8.00	R	PU	14
D5.3.1	Algorithms and methods for facial expression analysis and psycho-physical status evaluation	2	13.50	R	CO	15
D5.3.2	Algorithms and methods for facial expression analysis and	2	12.50	P	PU	26

WT3:
Work package description

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
	psycho-physical status evaluation - final release					
		Total	37.00			

Description of deliverables

D5.1) In-depth analysis of state-of-the-art for facial expression analysis: This deliverable will report on the results of the in-depth analysis of existing methods and technology with respect to facial expression analysis, facial feature detection, motion analysis, face normalization, and stress, fatigue and anxiety assessment [month 3]

D5.2) Face normalization and alignment based on 3D data: This report will detail the results of the investigation of the face normalisation protocols. D5.2 will also document the software implementation details for the deployment of the face normalisation on the Wize Mirror platform [month 14]

D5.3.1) Algorithms and methods for facial expression analysis and psycho-physical status evaluation: This report will describe the methods devoted to quantitatively assess stress, fatigue and anxiety. It will present the elaborated parameters and preliminary results on evaluating the suitability of the proposed parameters for the assessment of the psycho-physical status [month 15]

D5.3.2) Algorithms and methods for facial expression analysis and psycho-physical status evaluation - final release: Report and Prototype. The report will update D5.3.1 describing the refined and optimized methods for parameter extraction, as well as the final parameter evaluation results [month 26]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead benefi-ciary number	Delivery date from Annex I [60]	Comments
MS3	1st release of the Wize Mirror related prototypes	1	18	Semeiotic model completed. First release of methods and sub-components from WP3-7. First partially integrated Mirror prototype released. Last updates to system requirements and design.
MS5	Release of the integrated Wize Mirror prototype	1	29	Integrated Wize Mirror completed. All methods and prototypes from WP3-7 finalized and integrated.

WT3:
Work package description

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

One form per Work Package

Work package number [53]	WP6	Type of activity [54]	RTD
Work package title	Virtual individual's model and personalized guidance		
Start month	1		
End month	36		
Lead beneficiary number [55]	1		

Objectives

The activities of this WP aim at the following objectives:
- Integrating all the descriptors for facial signs produced in the previous WPs, taking into account both individual baseline and the evolution of each of them, which is correlated to the cardio-metabolic status. The aggregated results will be conveyed into the definition of the “wellness index”. Such index will be optimized and fine tuned through the entire trial, in order to be a reliable and informative indicator for promoting the healthy lifestyle of the individual.
- Defining the visual representation of the virtual individual’s model: an expressive way to represent the wellness status will be designed and developed, possibly tailored on the subject’s preferences/attitude. (It could vary from a very simple and friendly visualization – like a comic; to a more ‘scientific’ one – a sort of augmented subject’s photorealistic visualization.)
- Studying and developing intelligent methods for user’s profiling on the basis of the collected medical, behavioural, and psychological data.
- Designing and developing the personalized support. The user profile definition is done in order to let the system recommend the user some choices concerning his/her interaction with the system, like feedback’s aspect (e.g. generic, friendly, professional), as well as the linguistic code to be used in messages.

Description of work and role of partners

Task 6.1 – User’s profiling
Task Leader: FORTH
Participants: CNR-ISTI, CNR-IFC, UCLAN
Duration: month 1-18
This task is devoted to the detailed user’s profiling. Its accurate definition is necessary to set, for each subject, a reliable starting point for the wellness status assessment. It will be comprehensive of many medical and behavioural data such as: age, height, weight, cholesterol level, phenotype, habits, sports, others. Also the psychological information, such as anxiety, stress, and attitude towards health issues should be taken into account because of their strong relevance in the choice of the support to be provided by the system. All these data will be collected through a simple preliminary questionnaire.

Task 6.2 – Wellness index definition and correlation to cardio-metabolic risk
Task Leader: CNR-ISTI
Participants: CNR-IFC, CNR-ISM, FORTH, CRNH
Duration: month 6-29
This task is devoted to the fusion of the data collected by the sensor suite integrated in the mirror into the virtual individual’s model. Suitable machine learning methods for analyzing, understanding and transforming the data laying in a high dimensional vector space, the cardio-metabolic wellbeing space, will be investigated. In this view, we will exploit correlations between the data collected by the mirror’s sensor suite and the data acquired via standard diagnostic tools used to compute well-established cardio-metabolic risk charts.
Computational paradigms, including non linear mappings, will be used to extract the most significant information to be conveyed into the wellness index. It is worth noting that the wellness index will not be built on the basis just of the last acquisition of data, but it will also encompass the temporal evolution of the computational descriptors of facial signs. Particular emphasis will be paid to the discovery of (possible hidden) correlations between the data collected by the mirror’s sensor suite and the data acquired via standard diagnostic tools used to compute

well-established cardio-metabolic risk charts (e.g., HEART SCORE, Fatty-Liver index, HOMA index, FINRISK index), e.g. for lipid-metabolic risk one expects to correlate skin cholesterol, obesity indicators (and any other relevant feature) to the fatty-liver index. To accomplish this task, efficient feature discovery/selection algorithms will be studied, together with robust (linear and non-linear) pattern association tools. In view of that, different methods, including classical statistics as well as machine learning paradigms able to discover significant relations and properly represent them, will be analyzed and compared. It is worth mentioning that the data analysis may also lead to reveal unknown/unexpected relations.
The wellness index will be devised to warn the user about improper lifestyles and possible CVD risks occurring during an observation time span, once the initial wellbeing state has been fixed. In this respect, the time evolution of the index is the most relevant source of information, while wellness index point values may offer limited discriminant power with respect to risk conditions, and may be unsuitable for inter-individual comparisons.

Task 6.3 – Personalized user's guidance
Task Leader: CNR-ISTI
Participants: CNR-IFC, FORTH, INTECS, FORTHNET, DRACO
Duration: month 13-29
Depending on the user's preferences and attitude, the system will provide an appropriate support. This will mainly consist in "coaching" messages according to the findings obtained from the virtual individual's model and the wellness index. Suggestions and contextual, educational information will be provided to foster correct life-style maintenance, such as dietary guidelines, diagnostic examination planning and so on.
To this end, a proactive decision support system will be set up, exploiting both procedural knowledge (formalized through ontologies and open standards provided by the semantic web communities) and computational models. A lightweight inference engine will be used to reason on the procedural knowledge and produce relevant suggestions, while computational models will be used to address less formalized and unstructured decisional tasks. Such core decision support system will natively provide personalized guidance; indeed the procedural knowledge will be designed to be adaptive and to best adhere to user's psycho-physiological status, attitude an inclination. To this end, the definition of a set of personalized user's support types will be addressed in this task: actually the system is intended to be used in different settings, for instance at home by the subject, or at the gymnasium by personal life-style trainers, or at the pharmacy by health workers. Then the system is meant to account either for a friendly or professional interaction. The diverse types of support could differ a lot from each other: in the level of detail for data that could be accessed by the user (from estimated quantities of substances in the cutaneous tissue, with errors, to simple trends visualized in graphics) or in the visualization itself.

Task 6.4 – Model Final Tuning
Task Leader: CNR-ISTI
Participants: CNR-IFC, CRNH
Duration: month 29-36
This task will run along the wellness semeiotics validation to verify the virtual individual's model in real cases within clinical settings. Clinician's feedbacks will be collected so as to carry out the required adjustments. The main goal is to fine tune the virtual individual's model and ensure its validity in terms of the significance of the wellness index. A strict cooperation with the clinicians involved in the validation will be sustained.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	CNR	40.00
2	FORTH	4.00
4	UCLAN	1.00
6	CRNH	4.00
7	INTECS	3.00
8	FORTHNET	9.00
9	DRACO	1.00
	Total	62.00

WT3:
Work package description

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D6.1	User's profiling tools	2	11.00	R	CO	18
D6.2.1	Data Analysis and Fusion Strategies	1	15.00	R	CO	15
D6.2.2	Wellness index evaluation and risk correlation	1	12.00	P	PP	29
D6.3	Personalized guidance system	1	22.00	P	CO	29
D6.4	Model fine-tuning	1	2.00	R	PP	36
		Total	62.00			

Description of deliverables

D6.1) User's profiling tools: This deliverable will resume the work performed in the context of T6.1 and will contain the list of the medical, behavioural and psychological parameters used for the definition of the user profile in order to provide each subject with a reliable starting point for the wellness status assessment. Methods for maintaining and updating the user profile will also be described in this deliverable [month 18]

D6.2.1) Data Analysis and Fusion Strategies: This report will introduce the methods devoted to process and fuse the data acquired by the Wize Mirror's sensor suite according to the medical semeiotic model defined in WP1. It will settle the basis for the production and evaluation of the user's wellness index and its correlation with well-established cardio-metabolic risk charts [month 15]

D6.2.2) Wellness index evaluation and risk correlation: This deliverable will move from the basis settled in D6.2.1 and will describe the methods and algorithms for the definition of the virtual individual's model and, hence, starting from the definition of a cardio-metabolic wellbeing space, the evaluation of the wellness index. It will also detail the strategies for cardio-metabolic risk analysis and hence the correlation between the computed wellness index and well-assessed cardio-metabolic risk charts [month 29]

D6.3) Personalized guidance system: Report and Prototype. This deliverable will summarize the work carried out in Task 6.3 and will detail the user's personalized guidance system that, through "coaching" messages, will support user's correct behaviour [month 29]

D6.4) Model fine-tuning: This report will describe the adjustments carried out, if necessary, on the virtual individual's model and the personalized guidance system according to clinicians' feedbacks collected during the wellness semeiotics validation phase [month 36]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead benefi-ciary number	Delivery date from Annex I [60]	Comments
MS3	1st release of the Wize Mirror related prototypes	1	18	Semeiotic model completed. First release of methods and sub-components from WP3-7. First partially integrated Mirror prototype released. Last updates to system

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead benefi-ciary number	Delivery date from Annex I [60]	Comments
				requirements and design.
MS5	Release of the integrated Wize Mirror prototype	1	29	Integrated Wize Mirror completed. All methods and prototypes from WP3-7 finalized and integrated.
MS6	Final Wize Mirror release and Validation data analysis finalized	1	36	Validated Wize Mirror released along with the analyses of data acquired during clinical validation.

WT3:
Work package description

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

One form per Work Package

Work package number [53]	WP7	Type of activity [54]	RTD
Work package title	User centric applications and services		
Start month	6		
End month	28		
Lead beneficiary number [55]	7		

Objectives

The aim of this Work Package is to design and develop
- the User Applications
- the relevant set of services related to the SW platform defined in the WP2
- the data management infrastructure to maintain, share and provide user's data.

The analysis of the data and the definition of the SW requirements will be the start-up activities of this WP. The development of the SW applications and services will follow this first phase. At the end, a test phase will be executed in order to validate the SW components in a dedicated test bed, before the start of the integration activity.

Description of work and role of partners

The activities of this Work Package are carried out in three tasks. The first one is related to the definition of the GUI and services requirements; the second one is dedicated to the development of the SW application and services; and the third one pertains to the development of the data management infrastructure.
The three of these tasks will be planned following an iterative process partitioned in two main phases. The first phase will be scheduled to define all basic requirements and features in order to permit the definition of a first SW release that can be delivered as input to the WP8. The second phase will add advanced SW features in order to have a complete coverage of the requirements.

Task 7.1 – Definition of user's requirements
Task Leader: INTECS
Participants: CNR-ISTI, CNR-IFC, FORTH, CRNH, FORTHNET
Duration: month 6-24
This task focuses on the definition of user and technical requirements of the SW applications. The analysis of the data types collected will be performed in order to define the GUI requirements and, at the same time, the input received by the WP2 will be considered in order to define technical requirements.
In the first phase, a first set of requirements and services will be defined. This first release shall be used to develop SW applications that implement the core of the SW features for its basic functionality.
In the second phase, the definition of requirements and services is extended to provide the whole set of user and technical requirements.

Task 7.2 – Development of User Centric Applications and Services
Task Leader: INTECS
Participants: CNR-ISTI, FORTH, FORTHNET, DRACO
Duration: month 7-28
This task receives input from the Task 7.1 and it entails the development of services and SW applications according to a two phases scheduling. In the first phase a SW version of services and applications will be developed and, after an execution of the technical validation test, it will be released in order to provide an input for the WP8.
The second phase will include the development and testing of a complete version of services and applications based on requirements made available by task 7.1.

Task 7.3 Development of data management and storage structure
Task Leader: INTECS

Participants: CNR-ISTI, FORTHNET
Duration: month 12-24
This task will focus on developing the infrastructure for collected data conservation, protection, retrieval and sharing among different devices. Starting from the design of Task 2.4, a suitable storage organization will be developed paying particular focus on user's profile definition and privacy data settings (e.g.: regulating data forwarding to General Practitioners and experts, limiting data accessibility by external services, etc.).

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	CNR	6.00
2	FORTH	4.00
6	CRNH	1.00
7	INTECS	38.00
8	FORTHNET	10.00
9	DRACO	6.00
	Total	65.00

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D7.1.1	User's requirements: first report containing the requirements of the SW applications	7	6.00	R	PP	9
D7.1.2	User's requirements: final report containing the requirements of the SW applications	7	5.00	R	PU	24
D7.2.1	SW Applications and Services: first Release of the applications and services	7	19.00	R	PP	18
D7.2.2	SW Applications and Services: final Release of the applications and services	7	14.00	P	PU	28
D7.3.1	Data Management Infrastructure	7	12.00	R	PP	18
D7.3.2	Data Management Infrastructure - final release	7	9.00	P	PP	24
		Total	65.00			

Description of deliverables

D7.1.1) User's requirements: first report containing the requirements of the SW applications: In this report the Semeoticons User Requirements will be identified and described in detail. In the first release at M9, a baseline description will be provided, which will be used for triggering the other technical activities in Task 7.2 and T7.3 [month 9]

D7.1.2) User's requirements: final report containing the requirements of the SW applications: Update of D7.1.1. This version of the deliverable at M24 will be a refined report, based on the feedback obtained from the technical activities in the other tasks [month 24]

D7.2.1) SW Applications and Services: first Release of the applications and services: This deliverable provides the first release of SW application and service facilities according to the user requirements defined in task T7.1 and designed the service and user application. This deliverable will be availabled for the WP8 in order to perform the integration phase [month 18]

D7.2.2) SW Applications and Services: final Release of the applications and services: Update of D7.2.1. This deliverable provides the complete set of service facilities and finalized users' application in order to integrate in the Wize Mirror the User GUI and the service platform [month 28]

D7.3.1) Data Management Infrastructure: This deliverable will report the infrastructure for the conservation, protection, retrieval and sharing among different devices of the collected and computed data, which will be developed according to the design of Task 2.4 [month 18]

D7.3.2) Data Management Infrastructure - final release: Update of D7.3.1.This deliverable will report the final release of the Data Management Infrastructure [month 24]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead beneficiary number	Delivery date from Annex I [60]	Comments
MS3	1st release of the Wize Mirror related prototypes	1	18	Semeiotic model completed. First release of methods and sub-components from WP3-7. First partially integrated Mirror prototype released. Last updates to system requirements and design.
MS4	Wize Mirror design completed	1	24	Final version of the Wize Mirror technological and methodological design released.
MS5	Release of the integrated Wize Mirror prototype	1	29	Integrated Wize Mirror completed. All methods and prototypes from WP3-7 finalized and integrated.

WT3:
Work package description

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

One form per Work Package

Work package number [53]	WP8	Type of activity [54]	RTD
Work package title	Hardware platform development and Wize Mirror integration		
Start month	6		
End month	36		
Lead beneficiary number [55]	9		

Objectives

This WP covers all the activities related to the hardware development and to the integration of the software modules designed and developed in WP3, WP4, WP5, WP6 and WP7 for the realization of the final Wize Mirror prototype.
In particular, the hardware development activities will include the design and actual manufacturing of a specific processing platform with dedicated input/output for cameras, sensors and user-interface in accordance with the requirements and specifications defined in WP2. To this end, a robust and efficient low level firmware will be integrated to guarantee real-time communications. The mechanical design of the Wize Mirror will also be taken into account towards the manufacturing and assembling of the whole prototype. The integration and technological validation of both sensors and software modules coming from WP3 to WP7 will be also carried out.

Description of work and role of partners

Task 8.1 – Development of Mirror Main Processing Platform
Task Leader: DRACO
Participants: COSMED
Duration: month 6-9
In this task, the design of the Wize Mirror hardware platform will be carried out in accordance with the requirements and functional specifications defined in WP2. In particular, advanced design techniques will be applied to develop a high performance platform for interfacing with sensors, cameras and touch-screen for smart multi-touch interaction. Special attention will be paid in the layout and selection of the chipsets to provide all the computational processing power needed for the prototype at a competitive cost. Moreover, placement and routing of all the components will be done from the design of the electronic schematics to generate the Bill of Material (BOM) and the Gerber files for manufacturing the printed circuit boards (PCB).

Task 8.2 – Manufacturing of the Mirror Main Processing Platform Prototype
Task Leader: DRACO
Participants: COSMED
Duration: month 8-12
In this task, all the activities related to the actual manufacturing of the Wize Mirror main processing platform will be carried out, including components compilation, PCB printing, components mounting and soldering.
A minimum number of 8 units will be realized, since –as they are prototypes– it is not guarantee that all the entire units manufactured will work properly. Once manufactured, the bring-up test and lab checking of all the prototypes of the main processor platform at signal level will be performed.

Task 8.3 – Development of Firmware for Mirror Main Processing Platform
Task Leader: DRACO
Participants: COSMED
Duration: month 12-19
After the test activities, the software environment will be set-up to develop all the low level firmware needed to boot the hardware platform. It is foreseen to use LINUX OS. In particular, custom boot loader, root file system and kernel will be developed together with the drivers needed to integrate all the hardware interfaces. Moreover, if necessary, some basic pre-processing tools will be included such as images co-registration at spatial and temporal level to facilitate the integration of some of the processing methodologies developed in other WP.

Task 8.4 – Manufacturing of the Mirror Structure
Task Leader: DRACO
Participants: CNR-ISTI, FORTH, LIU, UCLAN, NTNU
Duration: month 13-29
In this task, all the mechanical structure of the Wize Mirror will be designed so as to build a frame capable of accommodating all the components of the prototype and, in particular, the mirror itself, the touch-screen, the cameras, the sensors, the light sources and the main processor unit.
A major effort will be spent in integrating the suite of sensors behind or on top of a two-way mirror so as to be invisible to the individual subjects, who will use the system as a normal mirror to look at themselves. In addition, a special array of lights will be mounted on the mirror frame in order to ensure optimal illumination conditions. In particular, multi-colour light sources will be located at the four corners of the mirror for the exploration of the photometric 3D reconstruction.
A minimum number of 3 units of the whole system will be manufactured; in this way it will be possible to perform different pilot tests at the same time.

Task 8.5 – Integration of Software Components
Task Leader: DRACO
Participants: CNR-ISTI, FORTH, LIU, UCLAN, NTNU
Duration: month 14-36
In this task, the software integration will be done in a collaborative way among the main processing platform developers and the providers of the software modules outputting from WP3, WP4, WP5, WP6 and WP7. In a first step, a prototype of the main processing platform will be made available to each software provider and, with the assistance of the platform developers, their algorithms will be ported and run on the Wize Mirror main processing unit. Since the main processing platform has constrained memory and processing capabilities, benchmarking of computational times will be performed to guarantee high quality performances of each single algorithm. In a second step, all the developed software modules will be integrated together in the main processing platform and a second round of benchmarking will be performed for performance tuning. At the end a complete mirror system will be set up.

Task 8.6 Technological Validation
Task Leader: DRACO
Participants: all
Duration: month 14-29
This task will consist in the periodic verification of the methods and devices released in different stages of the project. Initially, the validation will mainly regard the different pieces separately. When the methods and the hardware platform will be consolidated, the software integration will start and the verification will concern the prototypes released. More specifically, the technological validation will consist in attesting if the methods and Mirror prototypes will (i) meet the requirements that guide design and development, (ii) work as expected, and (iii) satisfy the user's needs. In practise, this validation will verify, with clinicians' support, if, for each risk factor and for each modality, the computational descriptors are correctly extracted and correspond to the signs to be observed. Volunteer subjects will be involved in real settings, to this end.
A strict interaction with the clinical partners will be required since clinical feedbacks will be fundamental to understand accuracy and appropriateness of the project's methods.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	CNR	12.00
2	FORTH	3.00
3	LIU	6.00
4	UCLAN	2.00
5	NTNU	6.00
6	CRNH	1.00

WT3:
Work package description

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
7	INTECS	12.00
8	FORTHNET	8.00
9	DRACO	28.00
10	COSMED	14.00
	Total	92.00

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D8.1	Design of the Wize Mirror hardware platform	9	10.00	R	CO	9
D8.2	Wize Mirror platform prototype	9	4.00	P	RE	12
D8.3	Release of the first Wize Mirrow prototype	9	22.00	P	PU	18
D8.4	The Wize Mirror	9	11.00	P	PU	29
D8.5.1	Software integration Report	7	14.50	R	PP	29
D8.5.2	Software Integration and Wize Mirror user manual	7	13.00	P	PU	36
D8.6.1	First report on technical validation	1	9.00	R	PP	12
D8.6.2	Second report on technical validation	1	8.50	R	PP	20
		Total	92.00			

Description of deliverables

D8.1) Design of the Wize Mirror hardware platform: D8.1 will present the hardware architecture, main blocks description and manufacturing files list [month 9]

D8.2) Wize Mirror platform prototype: Prototype and report including some pictures and how to connect the different elements [month 12]

D8.3) Release of the first Wize Mirrow prototype: Electronic platform and report presenting software architecture, functionalities and communication protocols to help during the integration [month 18]

D8.4) The Wize Mirror: Mirrow structure prototype and report presenting the dimensions, sizes, and how to handle [month 29]

D8.5.1) Software integration Report: This report will detail the software integration activities carried out in Task 8.5. It will document the collaborative approach followed by the main processing platform developers and the providers of the software modules outputting from WP3, WP4, WP5, WP6 and WP7 [month 29]

D8.5.2) Software Integration and Wize Mirror user manual: Report and Prototype. This deliverable will report the last possible adjustments applied to the Wize Mirror during the clinical validation and will provide the user manual for the device [month 36]

D8.6.1) First report on technical validation: This deliverable will report the results of the first periodic verification of the methods and devices released by the core WPs of the project. It will be issued at month 12 and will regard

the assessment of the different separate methods in real settings. Results obtained from this evaluation will be inputted to WP1 and WP2 for updates and adjustments to the medical semeiotic model as well as to system requirements and design. Feedbacks obtained will serve also for the development of the activities of the core WPs [month 12]

D8.6.2) Second report on technical validation: This deliverable will report the results of the second periodic verification of the methods and devices released by the core WPs of the project. It will be issued at month 20 and will regard the assessment of the first prototypes of methods and algorithms as well as the hardware and software components of the Wize Mirror. Results obtained from this evaluation, carried out in real settings, will be inputted to WP1 and WP2 for updates and adjustments to the medical semeiotic model as well as to system requirements and design. Feedbacks obtained will serve also for the development of the activities of the core WPs [month 20]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead beneficiary number	Delivery date from Annex I [60]	Comments
MS2	Release of the Wize Mirror platform prototype	1	12	Prototype of the Wize Mirror platform completed. First interim verification of methods and sub-components concluded.
MS3	1st release of the Wize Mirror related prototypes	1	18	Semeiotic model completed. First release of methods and sub-components from WP3-7. First partially integrated Mirror prototype released. Last updates to system requirements and design.
MS5	Release of the integrated Wize Mirror prototype	1	29	Integrated Wize Mirror completed. All methods and prototypes from WP3-7 finalized and integrated.
MS6	Final Wize Mirror release and Validation data analysis finalized	1	36	Validated Wize Mirror released along with the analyses of data acquired during clinical validation.

WT3:
Work package description

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

One form per Work Package

Work package number [53]	WP9	Type of activity [54]	RTD
Work package title	Wellness semeiotics validation		
Start month	30		
End month	36		
Lead beneficiary number [55]	6		

Objectives

The main objectives of this Work Package are:
- To evaluate the reproducibility of the Wize Mirror measurements
- To evaluate system efficacy in detecting changes in well being and cardio-metabolic status
- To assess system acceptability by the end-users.

Description of work and role of partners

Task 9.1. Measurement reproducibility
Task Leader: CRNH
Participants: CNR-IFC, DRACO, COSMED
Duration: month 30-36
For the validation of the system, it is important to evaluate the accuracy and precision of the Wize Mirror as well as the influence of environmental conditions, such as changes in room temperature and effect of natural versus electric light. In particular, focus will be given to:
- intra assay validation : in one subject , ten measures in a stable state (two hours after breakfast to avoid long fasting period or early postprandial one)
- inter-assay validation : the measure should be repeated in the same subject during ten days in the same condition
- the influence of post prandial period will be checked in five subjects, in the fasting state and three times space of 15 min after breakfast and repeated three days.
- the influence of temperature and light will be checked in five subjects at two standardized room temperatures, under natural or electric light and repeated three days.

Task 9.2. Wellness Monitoring Validation
Task Leader: CNR-IFC
Participants: CRNH, DRACO, COSMED
Duration: month 30-36
We will recruit 60 subjects (20 subjects/centre: Lyon, Pisa, Milan) with the following eligibility criteria
- male or female
- age range 20-60 years
- interested and willing to change their lifestyle by decreasing body weight and/or increasing physical fitness and/or improving their well-being following medical advice
- no overt disease
- no chronic medical treatment (other than contraception)
At screening, subjects will undergo
- standardized clinical exam: measurement of weight, height, waist circumference, blood pressure, heart rate, ECG
- blood sampling for glucose, Hba1c, triglycerides, total, HDL and LDL cholesterol, ALAT,ASAT, GGT, insulin, bilirubine, complete blood count
- questionnaire for nutritional habits and physical activity.
- questionnaire for mood, quality of life and stress

Heart SCORE (www.heartscore.org) and the Fatty-Liver Index, Finnish Type 2 Diabetes Risk Score (FINDRISC), and Homeostasis Model Assessment (HOMA) index will be calculated.
Subjects will then undergo specific testing i.e.
- body composition analysis by Bod Pod (Cosmed)
- resting metabolic rate and fasted substrate oxidation by indirect calorimetry (using Quark, Cosmed)
- measurement of Endothelium-dependent vasodilation byperipheral arterial tonometry (PAT)
- AGEs by skin autofluorescence (AGE reader DiagnOptics)

Wize Mirror measurements will then be performed by a trained operator under standardized room temperature and light and with subjects in fasting state.
Lifestyle advices to achieve individual personalized well-being goals will be offered as medical prescription based on best practice evidence and subjects will be followed up for 3 months. During this period, subjects will be asked to come back for Wize Mirror evaluation every 10-15 days. At the end of follow up all subjects will repeat baseline evaluations. The changes in Wize Mirror measurements obtained at baseline and end of study will be correlated with changes in body weight, waist circumference and Fatty liver index. Relationship with quality of life, or other well being questionnaire SCORE, standard biochemistry and specific tests will be also assessed.

Subjects will fill in questionnaires to evaluate ease of use and acceptability of the Wize Mirror.
Coherence of coaching messages with the clinical characterization, the risk score index (Heart SCORE, the Fatty-Liver Index, FINDRISC and HOMA indices) and the diary features will be evaluated. The types of message (awareness, goals, feedbacks) will be also evaluated according to the psychological characterization and in relation to the objective need of a second opinion from health practitioners.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	CNR	12.00
6	CRNH	17.00
9	DRACO	1.00
10	COSMED	6.00
	Total	36.00

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D9.1	Reproducibility report	6	12.00	R	PP	36
D9.2	Validation report on system acceptability and efficacy in the practice setting	1	12.00	R	PP	36
D9.3	Validation report on Wize Mirror accuracy vs traditional measures	1	12.00	R	PP	36
		Total	36.00			

Description of deliverables

D9.1) Reproducibility report: Results of reproducibility tests aimed to evaluate accuracy and precision of the Wize Mirror and analyse the influence of environmental and operational conditions [month 36]

D9.2) Validation report on system acceptability and efficacy in the practice setting: Results from the acceptability test performed during wellness monitoring validation. Analysis of Wize Mirror efficacy observed during the validation in clinical sites [month 36]

D9.3) Validation report on Wize Mirror accuracy vs traditional measures: Results of comparison of Wize Mirror measurements with a predefined set of tests commonly used in clinical practice [month 36]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead benefi-ciary number	Delivery date from Annex I [60]	Comments
MS6	Final Wize Mirror release and Validation data analysis finalized	1	36	Validated Wize Mirror released along with the analyses of data acquired during clinical validation.

WT3:
Work package description

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

One form per Work Package

Work package number [53]	WP10	Type of activity [54]	OTHER
Work package title	Dissemination & Exploitation		
Start month	1		
End month	36		
Lead beneficiary number [55]	1		

Objectives

The overall aim of this WP is to design and deploy strategies for:
- Dissemination of the project results
- Definition of a commercial exploitation strategy.

Description of work and role of partners

Task 10.1 Dissemination activities
Task Leader: CNR-ISTI
Participants: All
Duration: M1 – M36
The task will promote the dissemination of project activities and results within the research and academia communities as well as to open social audience.In particular, dissemination will encompassed both traditional channels for scientific dissemination (e.g. through articles in scientific journal, newspapers and magazines) and unconventional methods to attract the interest of the general public. In this regard, audio-visual material and demonstrators will be produced for educational purposes to be shown in fairs and social events. Moreover, social networks (e.g., Facebook and Twitter) will be exploited to target a large audience.
The following activities are planned:
- Set-up of a Web Portal for dissemination, coordination and management: a Web Portal will be established to provide wide dissemination of general information about the project, public deliverables, papers, keynotes speeches, and projects results. A private section of the Portal will be reserved to the management activities and the upload of all the deliverable of the projects.
- Networking with the academia community: the research activities carried out in the project will be disseminated in national and international conferences, workshops and symposia;
- Social dissemination: project ongoing activities and outcomes will be demonstrated and publicized in open fairs, end-users meetings and social networks, so as to attract the attention of the general audience and rise social awareness of EU projects' significance;
- Liaison with ongoing National and European research projects: exchanges, cross-contributions, and synergies with similar projects will be promoted with a continuous networking activity;
- Promotion of two thematic workshops: two thematic international workshops will be organized to share, compare and discuss experiences, methods and results with academic and research institutions, end-user organizations, policy makers.

Task 10.2 Exploitation activities
Task Leader: INTECS
Participants: FORTHNET, COSMED, DRACO, CNR-ISTI, CNR-IFC, CRNH
Duration: M6 – M36
This task involves activities to conduct an investigation on potential markets in order to know the real needs and opportunities, and how project results can address such needs as real products or services. Additionally this task will provide strategic information in developing such products and services and a marketing plan.
List of task activities:
- market focus definition, to establish thematic and spatial priorities;
- market opportunities for products and services;
- products development plans;

- marketing plans and strategy.
This task will be done in collaboration with the Intellectual Property units of the research partners and the legal departments of the companies of the consortium. Exploitation plans are specified both for the project consortium as a whole and for each partner depending on its particular contributions in the project. The end result of this task is a marketing analysis document to be used in the following exploitation and dissemination activities.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	CNR	10.00
2	FORTH	2.00
3	LIU	4.00
4	UCLAN	2.00
5	NTNU	2.00
6	CRNH	1.00
7	INTECS	5.00
8	FORTHNET	5.00
9	DRACO	3.00
10	COSMED	4.00
	Total	38.00

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D10.1	Website	1	5.00	P	PU	3
D10.2.1	First Report on dissemination activities and initial exploitation plan	1	10.00	R	PU	12
D10.2.2	Second Report on dissemination and exploitation activities	1	10.00	R	PU	24
D10.2.3	Final Report on dissemination and exploitation activities	1	13.00	R	PU	36
		Total	38.00			

Description of deliverables

D10.1) Website: The Project Web Portal will be settled to provide wide dissemination of general information about the project, public deliverables, papers, keynotes speeches, and projects results. A private section of the Portal will be reserved to the management activities and the upload of all the deliverable of the projects [month 3]

D10.2.1) First Report on dissemination activities and initial exploitation plan: This report will summarize the activities on dissemination and exploitation for the first year of the project. It will describe in detail dissemination initiatives, events and publications as well as liaison with other similar research projects and initiatives. A preliminary exploitation plan describing the exploitation strategies and implementation will be included [month 12]

D10.2.2) Second Report on dissemination and exploitation activities: This report will summarize the activities on dissemination and exploitation for the second year of the project. It will describe in detail dissemination initiatives, events and publications as well as liaison with other similar research projects and initiatives. A detail description of the exploitation strategies and implementation will be provided [month 24]

D10.2.3) Final Report on dissemination and exploitation activities: This report will summarize the activities on dissemination and exploitation for the third year of the project. It will describe in detail dissemination initiatives, events and publications as well as liaison with other similar research projects and initiatives. A detail description of the exploitation strategies and implementation will be provided [month 36]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead beneficiary number	Delivery date from Annex I [60]	Comments

WT3:
Work package description

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

One form per Work Package

Work package number [53]	WP11	Type of activity [54]	MGT
Work package title	Project Management and Coordination		
Start month	1		
End month	36		
Lead beneficiary number [55]	1		

Objectives

A high quality management is a key objective of the SEMEOTICONS Project. This Work Package will cover the overall coordination and management of the Project, including administrative project's committments and supervision of its progress. The General Assembly (GAs), chaired by the Coordinator (see below), with the participation of the appointed Project Coordinator (TSC), and the Clinical Coordinator (CC), will be in charge of managing the Project. A detailed description of all the project management structures and procedures can be found in Section B.2.1.
The main objectives of this work package are to:
- Monitor work progresses and ensure that the Project runs successfully and achieves all its technical objectives.
- Control the budget and resources.
- Handle the coordination with the European Commission (EC), including on-time delivery of management reports, deliverables, and audits organisation.
- Ensure communications and coordination among Partners, including organisation of technical meetings and set up tools for remote collaboration (audio conferences, mailing lists, web groupware tools, instant messaging system, and so on).
- Organize and coordinate interface and relations with the external Experts Advisory Board (EAB), and organize meetings.
- Set up and manage the archive of the project to store internal information and relevant common documents.
- Set up and chair the Ethical Committee, and manage its working duties.
- Organize the Quality Control (QC) plans and quality procedures for the quality management of the project.

Description of work and role of partners

Task 11.1 – Coordination of the consortium technical activities
Task Leader: CNR
Participants: All
Duration: month 1-36
The task is carried out by the Technical-Scientific Coordinator (TSC) with the support of the PC. Management is carried out through general meetings and by supporting constant communication among the Partners. Organization and management of the meetings is ensured by the PC. Specific GAs meetings may also take place outside of general meetings. The TSC, supported by the PC, takes care of collecting and accepting technical reports from all partners. Regular (remote) conference meetings take place at short interval between (groups of) partners. Rules and roles are described in Section B.2.1, where the communication infrastructure is described below.

Task 11.2 – Overall management of the consortium
Task Leader: CNR
Participants: All
Duration: month 1-36
The overall management of the consortium is entrusted to the GAs. Periodic GAs sessions will take place during plenary meetings scheduled every 6 months in average. A kick-off meeting will start the activities of the project. Additional meetings may be organized for specific needs. The final meeting will conclude the activities of the project. Organization and management of the meetings is ensured by the Project Coordinator. Rules and roles are described in section Section B.2.1.

Task 11.3 – Management of project clinical procedures and Ethical committee
Task Leader: CNR
Participants: All
Duration: month 1-36
The appointed Clinical Coordinator (CC) is in charge of this task to supervise and control all the clinical activities carried out in the Project. In particular, the CC will supervise the set-up and chair an Ethical Committee whose consulting activities will define the appropriate research approach with respect to potential ethical questions. All the processes for the relations towards and with the Ethical Committee will be defined and put in place, as it is stated in the Management section of the Implementation of the proposal (Section B.2.1), and taking into account also the Ethical Issues raised in Section B.4.

Task 11.4 – Management of contractual, legal, financial and administrative procedure of the consortium
Task Leader: CNR
Participants: All
Duration: month 1-36
This task is carried out by the Project Coordinator, supported by all partners' administrative bodies and in particular by the administrative staff.
- A specific session of the kick-off meeting will be devoted to present all financial and administrative details and to set up common procedures. On such a basis, the PC will prepare a specifically tailored administrative and financial guide for each Partner.
- The PC co-ordinates the annual cost-statement activities in order to submit periodic financial reports to EC; it will take care of obtaining audit certificate by each of the participants; it manages the distribution of EC funds to partners.
Administrative and financial management are based also on brief periodic "outline" financial reports that provide a summary of expenditures, every 6 months, for internal use. Specific forms for financial reporting are set-up by the PC. The PC will provide a help-desk for legal, financial, administrative issues.

Task 11.5 – Internal communication infrastructure
Task Leader: CNR
Participants: All
Duration: month 1-36
For the sake of a transparent and effective communication among the Partners, a multiple communication channel is established. It is based on:
- a "reserved" part of the project web site equipped with an on-line archive, offering to authorized users: upload/download functions, commenting capabilities and versioning for all project documents, software modules and financial statements;
- a minimal on-line support for planning project meetings, conference calls, etc. and for recording meeting results (minutes, participants, etc.);
- support to audio/video conference meetings. Partners will be equipped for audio/video conference meetings, taking place at close intervals (monthly).
Support for the internal communication infrastructure is provided by the staff, recruited by the Project Coordinator, who will develop and manage the Project Web Site.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	CNR	31.00
2	FORTH	1.00
3	LIU	1.00
4	UCLAN	1.00
5	NTNU	1.00
6	CRNH	1.00
7	INTECS	1.00

WT3:
Work package description

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
8	FORTHNET	1.00
9	DRACO	1.00
10	COSMED	1.00
	Total	40.00

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D11.1	Project Presentation	1	0.30	R	PU	1
D11.2	Project Handbook	1	0.50	R	PP	3
D11.3	Report on Quality Assurance Process	1	0.70	R	PP	3
D11.4	1st Four-month Periodic Report	1	4.50	R	PP	4
D11.5	2nd Four-month Periodic Report	1	4.50	R	PP	8
D11.6	3rd Four-month Periodic Report	1	5.50	R	PP	12
D11.7	4rd Four-month Periodic Report	1	4.50	R	PP	16
D11.8	5th Four-month Periodic Report	1	4.50	R	PP	20
D11.9	6th Four-month Periodic Report	1	4.50	R	PP	24
D11.10	7th Four-month Periodic Report	1	6.00	R	PP	28
D11.11	8th Four-month Periodic Report	1	4.50	R	PP	32
		Total	40.00			

Description of deliverables

D11.1) Project Presentation: This report will summarize the main concepts and objectives of the project, including a project synopsis according to the EC formats [month 1]

D11.2) Project Handbook: This report will describe the overall structure of project, detailing the management organization, the scientific and technical activities, and the administrative and financial issues [month 3]

D11.3) Report on Quality Assurance Process: This report will track the status of compilation and submission of the deliverables and include general maintenance information on the project activities [month 3]

D11.4) 1st Four-month Periodic Report: Four-month report on project activity - months 1-4. The Four-month report will be in form of a condensed document reporting a summary of: the main achievements and concrete key outcomes of the reporting period; the project status; work started; work completed; work delayed; status of deliverables; remedial actions required, if applicable. This type of reports will be issued every four months, starting from M4 [month 4]

D11.5) 2nd Four-month Periodic Report: Four-month report on project activity - months 5-8 [month 8]

D11.6) 3rd Four-month Periodic Report: Four-month report on project activity - months 9-12 [month 12]

D11.7) 4rd Four-month Periodic Report: Four-month report on project activity - months 13-16 [month 16]

D11.8) 5th Four-month Periodic Report: Four-month report on project activity - months 16-20 [month 20]

D11.9) 6th Four-month Periodic Report: Four-month report on project activity - months 20-24 [month 24]

D11.10) 7th Four-month Periodic Report: Four-month report on project activity - months 25-28 [month 28]

D11.11) 8th Four-month Periodic Report: Four-month report on project activity - months 29-32 [month 32]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead benefi-ciary number	Delivery date from Annex I [60]	Comments

WT4:
List of Milestones

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

List and Schedule of Milestones

Milestone number [59]	Milestone name	WP number [53]	Lead beneficiary number	Delivery date from Annex I [60]	Comments
MS1	First release of Semeiotics Model and system requirements	WP1, WP2	1	6	First semeiotic model released along with the requirements of system platform (D1.1.1, D2.1.1). Bases for face recognition and characterisation settled (D5.1).
MS2	Release of the Wize Mirror platform prototype	WP8	1	12	Prototype of the Wize Mirror platform completed. First interim verification of methods and sub-components concluded.
MS3	1st release of the Wize Mirror related prototypes	WP1, WP2, WP3, WP4, WP5, WP6, WP7, WP8	1	18	Semeiotic model completed. First release of methods and sub-components from WP3-7. First partially integrated Mirror prototype released. Last updates to system requirements and design.
MS4	Wize Mirror design completed	WP2, WP7	1	24	Final version of the Wize Mirror technological and methodological design released.
MS5	Release of the integrated Wize Mirror prototype	WP3, WP4, WP5, WP6, WP7, WP8	1	29	Integrated Wize Mirror completed. All methods and prototypes from WP3-7 finalized and integrated.
MS6	Final Wize Mirror release and Validation data analysis finalized	WP6, WP8, WP9	1	36	Validated Wize Mirror released along with the analyses of data acquired during clinical validation.

WT5:
Tentative schedule of Project Reviews

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

Tentative schedule of Project Reviews

Review number [65]	Tentative timing	Planned venue of review	Comments, if any
RV 1	12	-	First Review
RV 2	24	-	Second Review
RV 3	36	-	Final Review

WT6:
Project Effort by Beneficiary and Work Package

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

Indicative efforts (man-months) per Beneficiary per Work Package

Beneficiary number and short-name	WP 1	WP 2	WP 3	WP 4	WP 5	WP 6	WP 7	WP 8	WP 9	WP 10	WP 11	Total per Beneficiary
1 - CNR	18.00	5.00	21.00	7.00	7.00	40.00	6.00	12.00	12.00	10.00	31.00	169.00
2 - FORTH	2.00	3.00	0.00	6.00	21.00	4.00	4.00	3.00	0.00	2.00	1.00	46.00
3 - LIU	3.00	0.00	27.00	0.00	0.00	0.00	0.00	6.00	0.00	4.00	1.00	41.00
4 - UCLAN	1.00	0.00	6.00	25.00	8.00	1.00	0.00	2.00	0.00	2.00	1.00	46.00
5 - NTNU	5.00	0.00	24.00	0.00	0.00	0.00	0.00	6.00	0.00	2.00	1.00	38.00
6 - CRNH	6.00	0.00	0.00	0.00	0.00	4.00	1.00	1.00	17.00	1.00	1.00	31.00
7 - INTECS	0.00	12.00	0.00	0.00	0.00	3.00	38.00	12.00	0.00	5.00	1.00	71.00
8 - FORTHNET	0.00	20.00	0.00	0.00	0.00	9.00	10.00	8.00	0.00	5.00	1.00	53.00
9 - DRACO	0.00	9.00	1.00	1.00	1.00	1.00	6.00	28.00	1.00	3.00	1.00	52.00
10 - COSMED	2.00	6.00	10.00	0.00	0.00	0.00	0.00	14.00	6.00	4.00	1.00	43.00
Total	37.00	55.00	89.00	39.00	37.00	62.00	65.00	92.00	36.00	38.00	40.00	590.00

WT7:
Project Effort by Activity type per Beneficiary

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

Indicative efforts per Activity Type per Beneficiary

Activity type	Part. 1 CNR	Part. 2 FORTH	Part. 3 LIU	Part. 4 UCLAN	Part. 5 NTNU	Part. 6 CRNH	Part. 7 INTECS	Part. 8 FORTHNE	Part. 9 DRACO	Part. 10 COSMED	Total
1. RTD/Innovation activities											
WP 1	18.00	2.00	3.00	1.00	5.00	6.00	0.00	0.00	0.00	2.00	37.00
WP 2	5.00	3.00	0.00	0.00	0.00	0.00	12.00	20.00	9.00	6.00	55.00
WP 3	21.00	0.00	27.00	6.00	24.00	0.00	0.00	0.00	1.00	10.00	89.00
WP 4	7.00	6.00	0.00	25.00	0.00	0.00	0.00	0.00	1.00	0.00	39.00
WP 5	7.00	21.00	0.00	8.00	0.00	0.00	0.00	0.00	1.00	0.00	37.00
WP 6	40.00	4.00	0.00	1.00	0.00	4.00	3.00	9.00	1.00	0.00	62.00
WP 7	6.00	4.00	0.00	0.00	0.00	1.00	38.00	10.00	6.00	0.00	65.00
WP 8	12.00	3.00	6.00	2.00	6.00	1.00	12.00	8.00	28.00	14.00	92.00
WP 9	12.00	0.00	0.00	0.00	0.00	17.00	0.00	0.00	1.00	6.00	36.00
Total Research	128.00	43.00	36.00	43.00	35.00	29.00	65.00	47.00	48.00	38.00	512.00
2. Demonstration activities											
Total Demo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Consortium Management activities											
WP 11	31.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	40.00
Total Management	31.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	40.00
4. Other activities											
WP 10	10.00	2.00	4.00	2.00	2.00	1.00	5.00	5.00	3.00	4.00	38.00
Total other	10.00	2.00	4.00	2.00	2.00	1.00	5.00	5.00	3.00	4.00	38.00

WT7:
Project Effort by Activity type per Beneficiary

Total	169.00	46.00	41.00	46.00	38.00	31.00	71.00	53.00	52.00	43.00	590.00

WT8:
Project Effort and costs

Project Number [1]	611516	Project Acronym [2]	SEMEOTICONS

Project efforts and costs

Beneficiary number	Beneficiary short name	Estimated eligible costs (whole duration of the project)						Requested EU contribution (€)
		Effort (PM)	Personnel costs (€)	Subcontracting (€)	Other Direct costs (€)	Indirect costs OR lump sum, flat-rate or scale-of-unit (€)	Total costs	
1	CNR	169.00	625,300.00	10,000.00	147,844.00	425,204.00	1,208,348.00	963,380.00
2	FORTH	46.00	184,000.00	0.00	47,560.00	152,720.00	384,280.00	292,180.00
3	LIU	41.00	266,500.00	0.00	35,800.00	181,380.00	483,680.00	367,160.00
4	UCLAN	46.00	207,092.00	0.00	36,075.00	145,900.00	389,067.00	296,201.00
5	NTNU	38.00	388,474.00	3,000.00	40,500.00	257,383.00	689,357.00	523,656.00
6	CRNH	31.00	155,000.00	0.00	31,125.00	111,675.00	297,800.00	227,750.00
7	INTECS	71.00	390,500.00	0.00	21,500.00	179,630.00	591,630.00	302,080.00
8	FORTHNET	53.00	249,100.00	0.00	41,500.00	199,280.00	489,880.00	252,420.00
9	DRACO	52.00	377,000.00	2,500.00	45,220.00	84,444.00	509,164.00	385,873.00
10	COSMED	43.00	206,400.00	0.00	20,000.00	113,520.00	339,920.00	259,300.00
Total		590.00	3,049,366.00	15,500.00	467,124.00	1,851,136.00	5,383,126.00	3,870,000.00

1. Project number

The project number has been assigned by the Commission as the unique identifier for your project. It cannot be changed. The project number **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

2. Project acronym

Use the project acronym as given in the submitted proposal. It cannot be changed unless agreed so during the negotiations. The same acronym **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

53. Work Package number

Work package number: WP1, WP2, WP3, ..., WPn

54. Type of activity

For all FP7 projects each work package must relate to one (and only one) of the following possible types of activity (only if applicable for the chosen funding scheme – must correspond to the GPF Form Ax.v):

• **RTD/INNO =** Research and technological development including scientific coordination - applicable for Collaborative Projects and Networks of Excellence

• **DEM =** Demonstration - applicable for collaborative projects and Research for the Benefit of Specific Groups

• **MGT =** Management of the consortium - applicable for all funding schemes

• **OTHER =** Other specific activities, applicable for all funding schemes

• **COORD =** Coordination activities – applicable only for CAs

• **SUPP =** Support activities – applicable only for SAs

55. Lead beneficiary number

Number of the beneficiary leading the work in this work package.

56. Person-months per work package

The total number of person-months allocated to each work package.

57. Start month

Relative start date for the work in the specific work packages, month 1 marking the start date of the project, and all other start dates being relative to this start date.

58. End month

Relative end date, month 1 marking the start date of the project, and all end dates being relative to this start date.

59. Milestone number

Milestone number:MS1, MS2, …, MSn

60. Delivery date for Milestone

Month in which the milestone will be achieved. Month 1 marking the start date of the project, and all delivery dates being relative to this start date.

61. Deliverable number

Deliverable numbers in order of delivery dates: D1 – Dn

62. Nature

Please indicate the nature of the deliverable using one of the following codes

R = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

63. Dissemination level

Please indicate the dissemination level using one of the following codes:

• **PU =** Public

• **PP =** Restricted to other programme participants (including the Commission Services)

• **RE =** Restricted to a group specified by the consortium (including the Commission Services)

• **CO =** Confidential, only for members of the consortium (including the Commission Services)

• **Restreint UE =** Classified with the classification level "Restreint UE" according to Commission Decision 2001/844 and amendments

• **Confidentiel UE =** Classified with the mention of the classification level "Confidentiel UE" according to Commission Decision 2001/844 and amendments

• **Secret UE =** Classified with the mention of the classification level "Secret UE" according to Commission Decision 2001/844 and amendments

64. Delivery date for Deliverable

Month in which the deliverables will be available. Month 1 marking the start date of the project, and all delivery dates being relative to this start date

65. Review number

Review number: RV1, RV2, ..., RVn

66. Tentative timing of reviews

Month after which the review will take place. Month 1 marking the start date of the project, and all delivery dates being relative to this start date.

67. Person-months per Deliverable

The total number of person-month allocated to each deliverable.

PART B

COLLABORATIVE PROJECT

Project acronym: SEMEOTICONS

Project full title: "SEMEiotic Oriented Technology for Individual's CardiOmetabolic risk self-assessmeNt and Self-monitoring"

Version date: 2013-09-18

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B1.1. Concept and objectives

B1.1.1. Project Concept

Human face has been always considered to be a mirror of emotions and mood. During the Pythagorean and Socratic period, physiognomy used to consider the face as a descriptor of human character, intended as the result of a circular interaction between psyche and soma. One of the first scholars particularly concerned with physiognomy was Leonardo da Vinci, who published some fundamental observations in his "Trattato della pittura" (Paris, 1651); later, René Descartes carefully investigated ocular saccades, face gesture, colour variations and breath rhythms, in order to establish their relationship with the emotional and pathological status of an individual. In the modern age, Charles Darwin contributed to the study of face and expressions with his book titled "The expressions and emotions in man and animals" (1872). Later on, the study of the face has been mainly addressed within anthropologic, criminological and psychiatric fields of research.
Currently, Medical Semeiotics deems the face as an important revealer of precious information about the healthy or unhealthy status of individuals, produced by the combination of physical signs and expressive features. Each *semeiotic portrait* results, indeed, from the association of multiple signs that form a specific pattern, named "*facies*", peculiar of a certain pathology. The physical signs usually considered are the colour of skin and mucous, the distribution of subcutaneous fat, perspiration, facial gesture and expressions, and alterations of mild and bony zones. Some examples of facies are the *Hippocratic* (mechanical or paralytic ileum), *febbrilis*, *tuberculosis*, *tetanic*, *parkinsonian*, *basedowian* (from hyperthyroidism), and *acromegalic*.
Beyond these well-defined semeiotic pictures, experienced medical doctors acquire a personal and typical ability in reading and interpreting the complex and composite semeiotic signs of patients' face. These signs usually suggest how to steer the medical examination and may contribute to suggest which diagnostic investigations are to be prescribed. So far, although its evident great value, the semeiotic evaluation has not raised a systematic scientific interest, and no attempt has yet been done to support such a type of medical analysis through Information and Communications Technology (ICT) applications.
The idea behind the SEMEOTICONS[1] Project is to exploit human face as an indicator of individual's health status and translate the semeiotic code of the face into measurements and descriptors automatically evaluated by a computerized application. In particular, the eligible application field is the one of cardio-metabolic diseases prevention, for which healthcare systems are registering an exponential growth of social costs, especially due to expensive diagnostic resources, often improperly prescribed.
The principal aim of the Project is to move the semeiotic analysis from the office of medical doctors closer to individual's normal-life settings and enable normal people to self-assess their personal well-being status, particularly concerning their cardio-metabolic risk. To this end, we will design and construct a **multisensory system**, to be easily integrated, as a piece of house ware, at home, or at different levels of the health care delivery chain, including fitness centres, nutritional centres, pharmacies, and so on. This system will supply a contactless evaluation of face signs by acquiring and processing **heterogeneous, multimodal data**. Such data will provide a rich set of relevant information for the medical staff, useful to contribute to diagnostic processes or to remote patient monitoring, if necessary.
The core idea is, therefore, to develop an ***interactive smart mirror***, easily deployable in normal-life settings, which will seamlessly integrate contactless sensors, such as three-dimensional (3D) optical sensors, a multispectral camera, gas detection sensors, and microphones. A touch-screen interface will be also included for user's interactions and output visualization. The resulting device will be a kind of "*wise wizard*" mirror, called ***Wize Mirror***, which will collect data mainly in the form of videos, images and gas concentration signals, and will apply dedicated methods to extract a number of biometric, morphometric, colorimetric, and compositional descriptors to measure individual's facial signs. The opportune integration of such descriptors will constitute a **virtual individual's model** used to compute and trace the daily evolution of an ***individual's wellness index***. A health diary about this index will be created so as to enable the individual to **evaluate and personally relate** his/her **lifestyle to** his/her **well-being**. Suggestions and coaching messages will be also provided, in relation to the evolution of the wellness index and each descriptor. A **personalized user's guidance** will be supplied according to **user's profiling** so as to provide useful suggestion on correct

[1] The acronym SEMEOTICONS derives from the fusion of the word SEMEiotics with emOTICON'S, the well-know

lifestyle self-monitoring. Moreover, only if agreed with the individual, the diary will be shared with a General Practitioner (GP), via a secure messaging system, so as to receive, when needed, a direct medical guidance and support. In this frame, we will carefully concentrate on the development of user-friendly human-computer interactions: a rich set of **user-centric applications and services** will foster the perception of the system usefulness and reliability.
Three main features characterize the resulting semeiotics-based well-being evaluation: it will (*i*) be non-invasive, (*ii*) require just a natural interaction between the subject and the system, (*iii*) support and guiding personal choices towards improvements and maintenance of a healthy life style.
The outcomes of the Project will represent a challenging step forward in both research and technology: we will set up methods to process, analyse and integrate numerous physical signals, as well as optimize the quantity and quality of information extracted from the semeiotics and the biometrics of the face.
Moreover, through a careful clinical validation activity, we expect interesting results that will correlate iconic features of the face, and psychometric signs with well-known factors of cardio-metabolic risk. Indeed, some of the descriptors that will be automatically extracted are well established and well known in the literature; others will be specifically explored in the Project. For this reason, the descriptors computed and the resulting semeiotic evaluation will be compared, during a clinical validation phase, with simple diagnostic examinations (e.g., blood analysis, Advanced Glycation End-product (AGE) reader, nutritional tests, and psychometric questionnaires) that the involved subjects will periodically do. System validation and verification will encompass the transversal (i.e., an individual with respect to an entire population) and longitudinal (i.e., an individual with respect to his/her temporal evolution) evaluation of a group of healthy individuals.

B1.1.2. Background and Motivations

Atherosclerotic cardiovascular diseases (CVDs), including heart disease and stroke, are the leading causes of mortality worldwide [1] (World Health Organization. The Global Burden of Disease: 2004 Update. Geneva, Switzerland: World Health Organization, 2008). The atherosclerotic illness develops insidiously, and clinical manifestations often become evident in its advanced stages. Altogether, frequently, the major events, such as serious health complications, disability and death occur between 40 and 60 years of age. Moreover, the majority of patients who survive a myocardial infarction do not fully recover the ventricular function, and many stroke survivors have physical limitation in the daily activities. This explains why CVDs represent one of the major challenges to the health systems and considerable efforts are profuse to treat clinical manifestations of CVDs. These efforts have granted significant advances with actual improvements in patients' outcome, *quod ad vitam and valitudinem* [2].
Despite the success of the pharmacological, interventional, and surgical treatment of the CVDs, it is obvious that all these therapies cannot modify the epidemiological impact of the disease. Moreover, the cost of current health systems grows exponentially with the widespread use of complex, and often inappropriate, diagnostic procedures, as well as with population aging. At present, the strategy of prevention, which attempts to modify some patho-physiological factors related to the genesis of the disease, seems to be the only way to limit the epidemic growth of CVDs [3].
Cardio-metabolic risk is a cluster of risk factors indicative of a patient's overall risk for CVD and type-2 diabetes. These risk factors include obesity, physical inactivity, smoke, alcohol abuse, abnormal lipid metabolism, hyper-glycaemia and arterial hypertension [4]. Educational programs and lifestyle interventions represent effective tools for reducing cardio-metabolic risk profile and incidence of CVDs [5]. However, maintaining a healthy lifestyle frequently needs the counselling and supervision of various health professionals such as dieticians, physical trainers, psychologists and behaviourists. Such a prevention strategy is individually tuned and requires an expensive organization of the health systems. A rationale alternative to this kind of intensive individual coaching is the development of systems for self-learning and self-monitoring. These systems are expected to help people to change and maintain their lifestyle providing tailored suggestions about nutrition, weight, physical activity, fatigue, and stress according to daily surveys. Moreover, data collected by such coaching systems could be analysed and interpreted by health care professionals so as to support decision making targeted to the specific individual conditions. This approach has the potential to result highly cost-effective and might foster the diffusion of self-coaching systems with favourable impact on social, physiological, and environmental factors that, at present, remain barriers for the success of large-scale preventive intervention on CVD and diabetes.

Medical semeiotics, in the era of magnetic resonance, computed tomography and molecular biology, is still a valuable resource that may be useful in every condition and location independently of other structural facilities; it can provide valuable information for clinical decision making and action planning. The basics of semeiotics blend with the history of medicine; many signs are coded and represent fundamental issues of medical practice. Moreover, in his/her professional career the physician refines the ability to detect and integrate signs so as to improve the assessment of the health status of individuals. The development of imaging and biological diagnostic techniques has probably attenuated the interest for developing technological tools based on data obtained from simple semeiotics. The face, for example, is a fine descriptor of a person's well-being state and, in the everyday life, people, not only doctors, derive from the observation of the face clues about physical condition. Evidence on the state of nutrition, fitness, and mental condition can be obtained. In addition, states affecting the colour or the appearance of the skin (anaemia, high blood pressure, hypercholesterolemia, thyroid disease, etc.) can be also revealed. Furthermore, the use of advanced detection tools (multispectral cameras and electronic sensors) could allow obtaining data on the cardio-respiratory system (heart rate, blood saturation, endothelial function, respiratory rate), on presence of products of glucose and lipid metabolism in the skin and on lifestyle habits (smoking and alcohol consumption). This suggests that detection and integration of signs derived from the semeiotics of the face could be used to build a sensitive equipment to self-monitor the psychophysical state and to elaborate suggestions useful for optimising the personal life style and to trap the major cardio-metabolic risk factors.

B1.1.3. The Proposed Solution

In SEMEOTICONS, we propose the definition of the *digital semeiotics* of the face, i.e. the computerized evaluation of facial signs, focused on those signs that relate to some widely-recognized risk factors of CVDs. A ***semeiotic model of the face*** will be defined taking into account signs concerning (*i*) Obesity; (*ii*) Diabetes; (*iii*) Hyper-cholesterolemia; (*iv*) Endothelial dysfunction; (*v*) Psychological status. Other general semeiotic signs will be added to gain more general information about the overall individual's conditions.
Each of the above mentioned risk factors has several observable manifestations that can be evaluated by suitably imaging the face:

(i) Obesity: the general appearance and several features of the face are relevant index of overweight and obesity. A computerized reconstruction of face shape from images and videos and its characterization through a detailed morphometric analysis can, then, serve to localize and evaluate a fatty physiognomy (see Fig. 1).

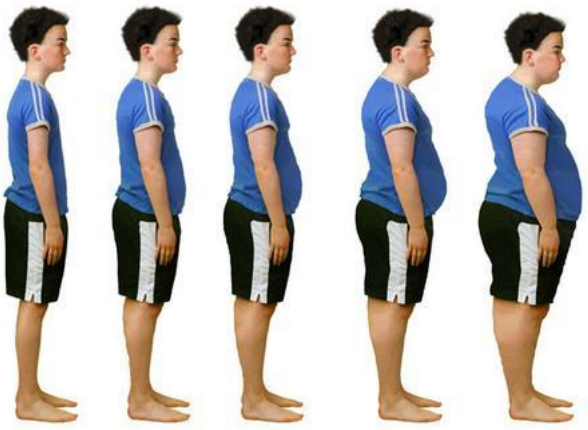


Fig. 1. Face and body changes in obesity

(ii) Diabetes: the metabolic alterations due to diabetes foster the glycation of proteins and the accumulation of Advanced Glycation End-products (AGE) in the skin. According to recent results in AGE diagnosis, autofluorescence is a viable solution to detect AGE in sub-cutaneous layer.

(iii) Hyper-cholesterolemia: high level of cholesterol could result in some typical signs in the periocular region (i.e., xanthelasmas) as well as in the iris border (i.e., *arcus cornealis*). Both these signs could be detected by a morphologic analysis of face oval. Furthermore, it is reasonable to expect that visible - near infrared (NIR) spectroscopy and imaging may be used to assess the accumulation of cholesterol in the skin of the face and in the iris.

(iv) Endothelial dysfunction: Endothelial dysfunction is a major physio-pathological mechanism that leads towards coronary artery disease. Broadly speaking, the endothelium function can be seen as the capability of the endothelium to balance between vasodilating and vasoconstricting substances produced by (or acting on) the endothelium. Endothelial dysfunction can result from and/or contribute to several disease processes (e.g. hypertension, hypercholesterolemia, and diabetes) and it can also result from environmental factors (e.g. smoking tobacco, exposure to air pollution). In clinical practice, a simple non-invasive evaluation of endothelium function is based on peripheral artery tonometry. Another

method is based on studying microcirculatory blood flow after local heating. Since variations in blood supply to sub-cutaneous districts result in variations of skin colour, an accurate analysis of face images in the red and near-infrared bands is a practicable way to evaluate elementary hemodynamic parameters. These can relate to heart rate, oxygen saturation, peripheral resistances and endothelial function. Actually, after providing a controlled thermal stimulus to trigger a vasodilatation, the evaluation of such hemodynamic response gives a measure that can be correlated to the endothelial function. Moreover, the analysis of heart rate variability can serve to the characterization of the autonomous nervous system.

(v) Psychological status: the morphological appearance of human face can reveal useful information about an individual's mood, anxiety, and status of fatigue. Facial expression recognition and facial biometrics in 3D space serve this scope.

(vi) Other semeiotics: other signs can be related to well-being in a more general sense. These include:

a. Face colorimetry (pallor, jaundice)
b. Heart rate
c. Regional skin surface temperature in the face
d. Respiratory rate
e. Exhaled composition. In particular, O2, CO, CO2, alcohols, nicotine may allow the evaluations of respiratory quotient, energy expenditure and give feedbacks about alcohol intake and smoking.

SEMEOTICONS will evaluate all the above mentioned signs by assessing a number of ***computational descriptors*** that will be extracted from different observation modalities. These descriptors will cover:

i. the morphometric, biometric, colorimetric, gestural and emotional analyses of the face;
ii. the spectroscopic analyses of skin and iris, sub-cutaneous substances and the function of sub-cutaneous tissues;
iii. the compositional analysis of breath and exhaled.

We will extract such computational descriptors through innovative methods able to analysis and correlate heterogeneous data of an individual. Such data mainly consist of videos and multispectral images of human face, gas detection signals, and other general data about individual's history and preferences. The multisensory *Wize Mirror* will acquire these heterogeneous data, seamlessly and unobtrusively, according to an ambient intelligence philosophy. The *Wize Mirror* will, actually, capture, track and analyse face and breathe of the individual standing in front of it. To this end, the Mirror will integrate a suite of sensors and facilities including:

a 3D optical sensors (colour cameras, 3D depth sensors)
b multi-spectral cameras for acquisition of visible and NIR spectra
c gas sensors
d touch-screens for user's interactions and output visualization
e arrays of lights, heat sources and microphones.

The suite of sensors will be integrated behind or on the top of a two-way mirror so as to be invisible to the individual subjects, who will use the system as a normal mirror to look at themselves.

Fig. 2 sketches a possible organization of the sensorized structure of the mirror, which will be investigated during the Project, to find out the optimal configuration. In particular, the development of an integrated *Main Processing Unit* will be tackle so as to foster the optimal control of data acquisition as well as the execution of the computational methods for data analysis.
The 3D optical sensors, integrated with a suitable array of lights, will serve the acquisition of videos for the 3D reconstruction of the individual's face. Advanced methods will be studied, compared and integrated (e.g., structure-from-motion, stereo techniques, photometric stereo) for a faithful modelling of face morphology. The use of light sources of different emission will be investigated to find out the best organization to reach the envisioned outcome. Accuracy will be a fundamental pursue since the 3D reconstruction will serve the morphological and textural characterization of the face by extracting morphometric and colorimetric descriptors of a face oval. The idea is to obtain important information about the size and location of subcutaneous fat (e.g., cheeks, neck, earlobes…), the colour of the face, the presence of cholesterol accumulations, and so on.

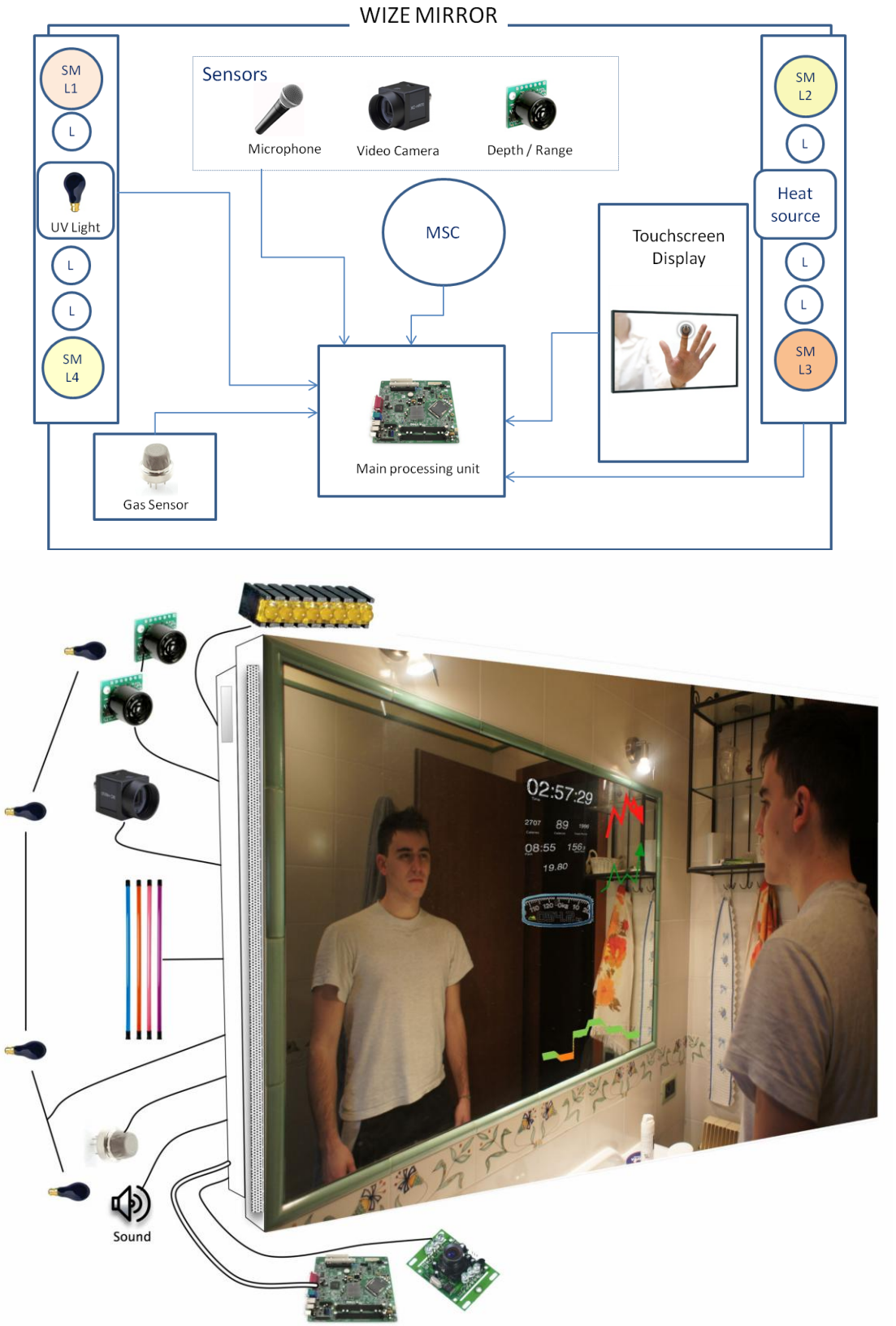


Fig. 2 On the top, a schematic representation of the Wize Mirror suite of sensors, processing unit, display and accessories. SMLi (i=1,…,4) are multicolour lights used to explore photometric 3D reconstruction. On the bottom, the Mirror appearance: the user will be only aware of the touch-screen, of the lights, which will appear as normal lights, and of the gas sensors, called *Wize Sniffer*, which will have a small "protrusion" to better "sniff" user's breath.

The 3D model will also allow the analysis of face expressions. In this frame, a suite of methods will be developed to recognize face expressions and correlate these as well as other face signs to an individual's

psychophysical status. A particular array of lights will be mounted to ensure the best illumination conditions. In particular, multi-colour light sources located at the four corners of the mirror will serve for the exploration of the photometric 3D reconstruction.

The Multi-Spectral Camera (MSC) will acquire images at different wavelength in the visible and NIR spectral range. An experimental activity will be carried out to identify the most suitable lighting source with tuned spectral emission so as to optimize the detection of different compounds in face skin tissue. Innovative methods will then be devised to analyse the multispectral images and extract descriptors that measure (*i*) the concentration of different chemical substances located in and under the skin, i.e. cholesterol and AGE products; (*ii*) the endothelium function; (*iii*) iris morphometric and colorimetric characteristics; (i*v*) pigmentation characteristics; (*v*) simple hemodynamic information, endothelium function measurement, along with blood oxygenation data. In particular, as the evaluation of the endothelium function will require a thermal stimulus to be given to the individual, the mirror will incorporate an ad-hoc remote heat source, monitored and controlled by a non-touch thermometer. Similarly, the inclusion of a suitable light source to explore skin auto-fluorescence will be investigated.

The gas detection sensors will record the concentration of specific substances for a breath analysis: this will be particularly beneficial as far as substances as O2, CO, CO2, alcohols, and nicotine are concerned. The use of ad-hoc devised sensors based on Electrospun nanofibers will be investigated and an innovative device, the *Wize Sniffer*, will be produced.

Computing all these descriptors via a contact-less device will be a very innovative and challenging achievement. Actually, so far, there have been very few investigations aiming at this goal. Technology-enhanced mirrors are being developed, but only few solutions attempt to compute individuals' vital signs (i.e. simple parameters such as heart rate - see the section about the state of the art for some examples).
In SEMEOTICONS, we will precisely investigate the possibility to record facial signs and evaluate the cardio-metabolic risk. This will be achieved by analysing not only the external appearance of the face, but also going further to assess the compositional and functional signs of skin tissues. This challenging outcome will be pursued from both technological and methodological innovative solutions.
Facial signs will be translated in computational descriptors, which will be combined into a *virtual individual's model*. This will comprise a 3D colour reconstruction of the individual's face, augmented with a map of skin substances concentrations and with morphometric, colorimetric and homeostasis descriptors. By relating all this information with the major risk factors, the model will constitute a synthetic and comprehensive basis to measure a *wellness index* of individuals with respect to the cardio-metabolic risk. In particular, well-established risk charts (such as the *Fatty-Liver Index* [6-8], Heart SCORE [9], the *Finnish Type 2 Diabetes Risk Score* [10, 11] and *Homeostasis Model Assessment* - HOMA index [12]) will be taken as reference to correlate the wellness index to routine evaluation of cardio-metabolic risk.
Daily acquisitions and measurements of this index will be tracked and recorded into a personal diary, which will be useful to self-assess improvements and deteriorations of the personal individual's well-being and put these changes in relation to proper or improper lifestyle. The main idea is to provide an instrument that let normal people self-monitor their wellness by following the trends of the computed descriptors. In particular, the system will explicitly and clearly report and signal, through user-adaptive messages, when any of the descriptors improves or deteriorates.
It is important to stress that the system is not meant to be a diagnostic tool, but a self-monitoring device based on reproducible and controlled evaluation of some important psycho-physical signs, which will provide suggestions about the trends that these signs have over time. The usefulness of such a device is evident on the impact that self-monitoring and self-assessment can have in the daily life of normal people.
Usability and simplicity will be two main features of the Wize Mirror. Microphones will be included to explore the possibility of vocal interaction. Moreover, a touch-screen facility, embedded into the Mirror, will serve for both input and output of the system. In particular, it will display, in a portion of the Mirror, the outcome of the wellness evaluation, according to an attractive visualization that will show a *user avatar* and its evolution over time. The system will also provide, on screen, suitable suggestions as well as counselling and contextual information aimed at a personalized guidance so as to foster a good lifestyle, reduce the cardio-metabolic risk and, hence, prevent cardio-metabolic diseases.
The output will differ in accordance to the types of users. Actually, the system will be a multi-user device, which can afford usage in different environments:

- Normal people home settings
- Institutional health environments, such as health centres, GP offices or pharmacies
- Lifestyle and fitness centres.

In the former of these three cases, individual subjects will self-assess and self-monitor their wellness index and decide to report their evolution to a GP. In the latter two cases, a health professional will use the Mirror to collect an overall evaluation of individual's wellness status related to cardio-metabolic risk and adopt correct measure to tackle this. More detailed information will be provided when the Mirror will be used by professional users; while a suitable summary and presentation of the information will be devoted to normal people. In particular, since individuals can hear, understand and react differently from one another to an evaluation of their wellness status, the system will include user *profiling* based on any individual's characteristics of being anxious, hypochondriac or sensitive. Psychometric tests will be specifically carried out and incorporated to this aim.
A set of user-centric applications and services will enhance the Mirror usability and foster its profitable adoption. Multiple interfaces (e.g., mirror, tablet, smart-phone) will grant the data access and exploration, enabling the individual user to share information (e.g., with experts, on social networks).

The system will have several innovative features: starting from the suite of sensors for heterogeneous and multimodal data acquisition, moving to the contactless estimation of several descriptors of skin morphology and composition, and ending up with the assessment of a customized user- adaptive wellness index specific for cardio-metabolic risk and the provisioning of personalized guidance and services.

For the Mirror assembly, off-the-shelf, cheap sensors will be considered, when possible (e.g., by considering Kinect-like solutions), so as to ensure cost containment. For the MSC part of the mirror, an accurate hyper-spectral camera system will be used initially to identify the most suitable wavelength for multispectral inspection. Based on this evaluation a cheaper solution, presumably built on a standard CMOS/CCD camera, will be implemented. If wavelengths above 900nm will be needed, an additional InGaAs camera will be included.

The development of the system will go through several phases of a cycle that will define, develop, test and validate the virtual individual's model. The cycle will end with a validation activity that will verify if the computed descriptors are meaningful and relevant to the evaluation of the cardio-metabolic risk. This validation will be performed by comparing the descriptors computed for each risk factor with routine investigations that can be summarized as follows:

- Obesity: basic reference indexes are Body Mass Index, waist circumference, Lean Body Mass, Fatty Free Mass. Further details about individual dietary habits can be collected by nutritional questionnaires.
- Diabetes: blood tests for insulin resistance, AGE-reader tests.
- Hyper-cholesterolemia: blood tests.
- Cardiovascular homeostasis: non–invasive tests based on peripheral arterial tomography finger pulse oximeter.
- Face expression: psychometric tests.

The main idea is to estimate well-established risk scores and, then, correlate and compare the computed descriptors to these. These correlation and comparison will ensure that the wellness index correspond to an evaluation of the cardio-metabolic risks and can be then used effectively to warn users about improper lifestyles.

B1.1.4. ICT Challenges

This Project is highly innovative basically from two viewpoints: medical semeiotics and ICT.
On the one hand, the main medical challenge is the assessment of AGEs and cholesterol with a contact-less device, such as a camera operating from visible to NIR, or customized light sensors and sources. For the aims of our Project, the constraints on measurement precision can be relaxed with respect to the case of diagnostic devices. Indeed, the most stringent requirement is good repeatability: we demand just for a kind of

coarse estimation, which will be enough to trace the evolution of the skin substances concentration and, then, the variation of the cardio-metabolic risk.
On the other hand, several challenges and innovations can be identified as far as the ICT methods are concerned:

- all the morphometric, colorimetric, compositional and homeostatic analyses of human face will be detailed enough for encoding a useful face description, and should be carried out in almost real-time, at a low computational cost. This will also demand for an efficient co-registration among the diverse imaging data (RGB and spectral imaging, for instance).
- all the descriptors will be summarized in the key definition of a wellness index. This is actually a critical point of the Project, since, so far, this will be the first attempt in literature to let very heterogeneous data flow into an index, representative of the cardio-metabolic status in an almost automated way. In addition, the same index representation will be a novelty: it should fit in with the user's preferences, and it should take into account the user's attitude (laziness vs. hypochondria) towards his/her health and lifestyle.
- all the different functionalities will be integrated in one device, the *Wize Mirror*. This device will have a processing unit and a set of sensors, seamlessly integrated, so as to obtain the lightest impact on the user's environment. Even more remarkably, the Mirror surface will not just mirror but it will also
  - display personalized information and feedback depending on the user profile (measures, trends, elaborated data, augmented visualization of the user, or simple recommendations);
  - include a touch-screen for user-system interaction.

B1.1.5. Project Outcomes

An overview of the Project activities is sketched in Fig. 3. Three main types of activities can be distinguished:

a. the development of the technological instrument, the *Wize Mirror*, with its sensory, hardware and software components. These will result in the technological outcome of the Project;
b. the scientific investigation devoted to the analysis and interpretation of multimodal data, and their integration into the virtual individual's model. This will result in the scientific outcome of the Project.
c. the clinical validation which will evaluate and verify both the above mentioned outcomes in real cases. These will lead to the clinical outcome of the Project.

Each of the expected outcomes will represent a challenging step forward with respect to the state of art.
From the technological viewpoint, we will set up methods to

- touch-less data acquisition;
- temporal and spatial synchronization of data acquisitions;
- real-time process multimodal data;
- integrate each sub-component (i.e. for data acquisition, data processing, users' interaction) in one smart object: the *Wize Mirror*.

From the scientific viewpoint, we will set up innovative and intelligent methods to:

- translate facial physiological signs into repeatable and measurable computational descriptors with adequate accuracy, efficiency and reliability;
- analyse, establish correlations, and integrate heterogeneous computational descriptors;
- optimize the quantity and quality of information.

From the clinical viewpoint, through a careful experimentation, we expect interesting results that will correlate iconic features of the face and psychometric signs with the well-known factors of cardio-metabolic risk. Indeed, some of the descriptors that will be automatically extracted are well established and well known in the literature; others will be specifically explored in the Project. For this reason, the descriptors computed and the resulting semeiotic evaluation will be compared with simple diagnostic examinations (e.g., blood analysis, AGE reader, nutritional tests, and psychometric questionnaires) that the involved subjects will periodically do, to validate and evaluate how to improve the system during the testing, to the last version at the end of the Project.

The overall high-level outcome of the Project is the development of a personalized system for lifestyle management and cardio-metabolic disease prevention. The main features of this system are:

(i) a friendly integration in the user's environment, making "intelligent" a familiar and common object;
(ii) a detailed user profiling and the creation of a *virtual individual's model*, resulting by the fusion of the user's characteristics (such as preconditions, unhealthy behaviours, physical activity, sleep, mental status) with the several heterogeneous data acquired by the system sensor suite;
(iii) the supportive character of the feedback provided to the user, tailored on the individual's overall status (psycho-physical) and/or preferences.

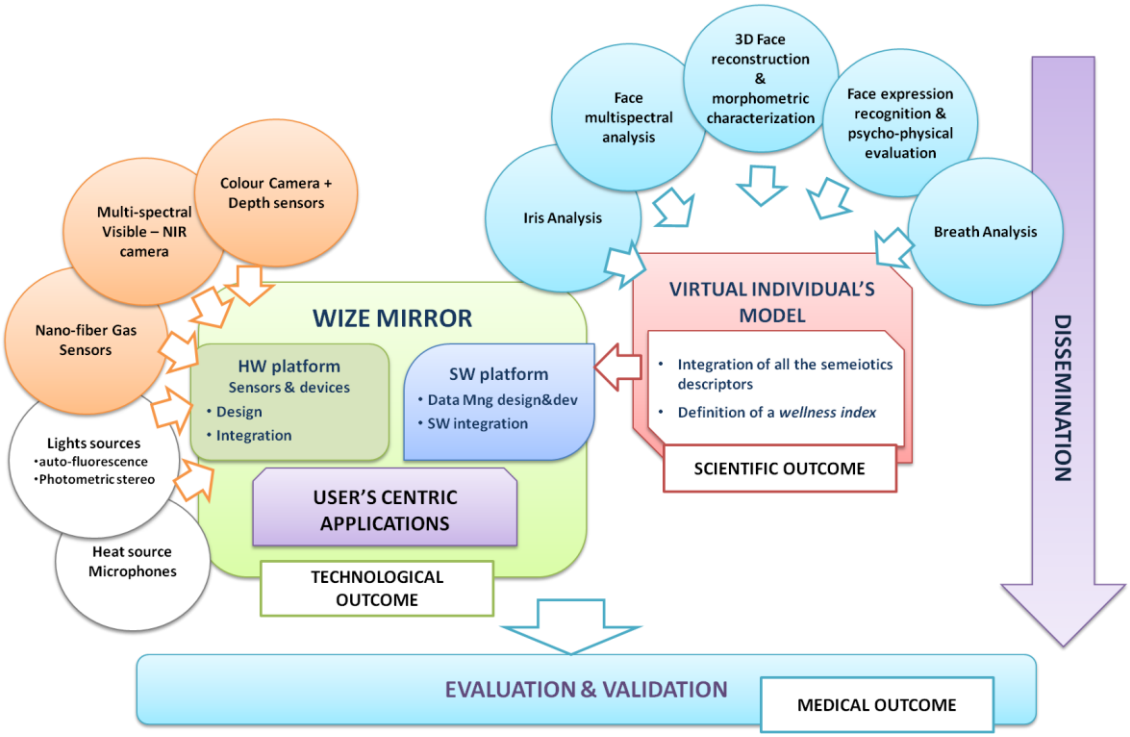


Fig. 3 A logical organization of the SEMEOTICONS activities

B1.1.6. Scientific and Technological Objectives

SEMEOTICONS will target the following objectives:

Objective 0 - To develop a *face semeiotic model* of the face and map this on advanced imaging and sensing strategies for the acquisition and processing of facial signs

SEMEOTICONS will formulate a *semeiotic model* of the face that will account for the cardio-metabolic risk of an individual. This will rely on a large collection of semeiotic clusters of the face, which can be grouped in:

- Morphological features;
- Emotional and expression features;
- Appearance of skin and its changes in response to light and heat stimuli;
- Eye related features;
- Exhaled gas compositions.

Several features in these groups may be linked to specific cardio-metabolic risk factors, other signs may be less specific and may be indicative of improper habits or other risk conditions. Such a combined use of a broad spectrum of specific and partly complementary signs is expected to help an accurate and repeatable assessment of individual's well-being. In the view of that, the acquisition of different physical signals must be considered, including:

- Imaging and depth sensing of the face to build a 3D model for morphological analysis. Imaging will also serve for face expression recognition/analysis.
- Multispectral imaging of the face skin to explore "colorimetric" properties and its changes;
- Gas sensing to examine exhaled breath.

In general, the extraction of these features clusters is a challenging task. Therefore, we plan an extended investigation of physical and biophysical factors affecting signal generation processes. That should assist to

clearly define the constraints on sensor devices, the meaning and usefulness of the pieces of information conveyed by each signal, the related processing methods and algorithms.
Milestones: MS1 (month 6), MS3 (month 18)
Measure of success:

- High repeatability, adequate sensitivity and specificity in detecting and measuring single quantities in comparison to standard reference methods, as those used in clinical practice;
- High repeatability, adequate sensitivity and specificity of morphological analysis with respect to reference data;
- Agreement of morphological and face expression recognition analysis with medical Partners expectances according to semi-quantitative analysis

Objective 1 - To define the virtual individual's model based on several descriptors of facial semeiotics
SEMEOTICONS aims to build an innovative virtual individual's model, which is based on a set of objective signs, closely related to cardio-metabolic risk, derived from external physical examination of the face. The model should serve to evaluate a subject well-being status over time and allow early detection of improper lifestyles as well as potentially dangerous conditions mainly related to cardio-metabolic risk. The model is expected to be useful for transversal and longitudinal observations. End-users will be individual's and health professionals. The model will integrate the clues from data using up-to-date ICT methods.
The model construction is based on the following sub-objectives:

Sub-obj 1.1 The definition and validation of descriptors for facial signs of obesity. Obesity produces well-known morphological signs, "roundedness", affecting virtually all the body. Morphological descriptors based on a 3D model of the face will be investigated and tuned to provide sensitive clues of individual ponderal and body-composition changes. These are expected to be useful both to warn the subject about weight increase and to monitor the progress of lifestyle improvements. Computed obesity descriptors will be analysed and correlated with standard obesity tests and measurements including: dietary questionnaire, body mass index, waist circumference, lean body mass, fatty mass and Fatty Liver Index.
Milestones: MS3 (month 18), MS5 (month 29)
Measures of Success

- high repeatability, adequate sensitivity and specificity in comparison to standard reference methods in clinical use.

Sub-obj 1.2 The definition and validation of descriptors for facial signs of alterations of glucose metabolism. Deposit of AGEs is strongly correlated with disorders of glucose metabolism. We aim at detecting AGEs in the skin district of the face using multispectral imaging of tissue autofluorescence during ultraviolet (UV) exposure. The spectral range of both the emitting light source and the detector will be optimized for AGE detection. The basic requirement is the computation of a highly repeatable AGE descriptor that is monotonically related to skin AGE content. Validation of AGEs will occur by correlation with data from AGE-readers employed in clinical practice. Correlation analysis with standard clinical test for glycated haemoglobin and insulin resistance (Homeostasis Model Assessment - HOMA index) will be also performed.
Milestones: MS3 (month 18), MS5 (month 29)
Measures of Success

- high repeatability, adequate sensitivity and specificity in comparison to AGE-reader test and other standard clinical references.

Sub-obj 1.3 The definition and validation of descriptors for facial and eye signs of hypercholesterolemia. Hypercholesterolemia is one of the major cardiovascular risk factor that is included in traditional risk score such as HEART SCORE. Different effects of high levels of blood cholesterol may be visible in the face. Classical semeiotic signs are xanthelasmas and arcus cornealis, which are cholesterol depots in the eyelid skin and the periphery of the iris respectively. Furthermore, skin cholesterol can potentially be assessed by multispectral analysis. We will investigate the power of multispectral imaging to reveal changes of skin cholesterol.

A compact cholesterol descriptor will result by integrating morphological and multispectral data. The relationship between cholesterol descriptor and blood cholesterol will be assessed.
Milestones: MS3 (month 18), MS5 (month 29)
Measures of Success
- correlation of cholesterol descriptor with blood cholesterol.

Sub-obj 1.4 The definition and validation of descriptors for facial signs of cardiovascular homeostasis. Imaging the face in the red and NIR bands is known to carry information about the blood found in tissue. We will, based on hyper spectral images, present algorithms that are capable of quantifying both blood amount and saturation. Heart rate will be estimated from NIR data and validated by electrocardiogram (ECG).
Moreover, both standard laser Doppler flowmeter (LDF) tests and peripheral arterial tonometry (PAT) tests will be utilized to evaluate the ability of NIR imaging to appraise vasodilating blood flow effects during local heating as a measure of endothelial function.
Milestones: M3 (month 18), M5 (month 29)
Measures of Success
- high correlation of heart rate with reference measurement;
- high correlation of thermal stimulation test with PAT and LDF.

Sub-obj 1.5 The definition and validation of descriptors for facial signs of psycho-physical status. Morphological description and analysis of the face using 3D modelling will be the basis for evaluating the individual psycho-physical status with particular emphasis on mood, anxiety and fatigue. An overall psycho-physical status descriptor will be derived according to clinical psychology standards. The capabilities of developed descriptors in recognizing face expressions and other specific clinical signs will be tested on available reference database. A global validation of such a descriptor will be based on standard psychological tests and questionnaires.
Milestones: MS3 (month 18), MS5 (month 29)
Measures of Success
- agreement with standard clinical reference.

Sub-obj 1.6 The definition and validation of breath analysis.
The analysis of face and neck motion will be used for estimating the respiratory rate. Validation will be done using a respiratory rate sensor.
Exhaled gases will be analysed by an innovative gas sensor able to detect carbon dioxide, oxygen, and other substances, such as nicotine and alcohol, related to improper lifestyle. Validation will be done using indirect calorimetry and with questionnaires about tobacco and alcohol intake.
Milestones. MS3 (month 18), MS5 (month 29)
Measures of Success
- high agreement with indirect calorimetry;
- agreement with questionnaire on tobacco and alcohol intake.

Sub-obj 1.7 The definition and validation of descriptors for other facial signs. Several additional signs may be useful to detect conditions related to individual's general status. We aim at building descriptors able to capture:
a) face colour appearance. It may be related to different factors including, environmental conditions (e.g. low or high temperature, sunlight exposure), ethnicity, personal care habits (e.g. face make up), alcohol effects, colour changes related to pathological conditions such jaundice. Colour changes possibly related to pathological conditions will trigger a proper message warning.
b) manifestation of unusual facial movements such as eye blinking, involuntary winking. These data will be related to anxiety and fatigue scores.

Milestones: MS3 (month 18), MS5 (month 29)
Measures of Success
- high repeatability, adequate sensitivity and specificity at recognizing colour changes,
- agreement of unusual facial movements descriptor with anxiety and fatigue scores.

Sub-obj 1.8 Integration of all the descriptors into the virtual individual's model and computation of individual's well-being index. The computation of individual well-being status will rely on the integration of all the previous descriptors. Integration will account for standard risk scores (HEART SCORE, Fatty liver-index, *Finnish Type 2 Diabetes Risk Score*, waist circumference, body max index) and nutritional, psychological tests. User's profiling will be a fundamental premise to this evaluation, so as to incorporate information about user's peculiarities.

Milestones: MS3 (month 18), MS5 (month 29), MS6 (month 36)

Measure of success:

- capability of the virtual model to describe individuals well-being as compared to models used in medical practice and agreement with physician's evaluation;
- agreement of the well-being index with the most relevant medical scores.

Objective 2 - To provide personalized guidance and user centric services

The development of Wize Mirror will take into account the most important factor for the successful implementation of this objective: the final user who will benefit from this technology.

The mirror device will be able to build a comprehensive representation of the well-being status of an individual, while being not intrusive and seamlessly integrated with a generic living environment (home, fitness centres, pharmacies etc.). This peculiar aspect of the system, which increases the usability factor of the multisensory device, represents a significant step forward with respect to existing solutions, which often require the user to wear obtrusive electronic systems to gather data and build a representation of the user's monitored parameters. The requirement of providing an effective solution to build a useful representation of the individual's well-being status and the associated risk factors, with an object that the user is already accustomed to see in his environment and use, is an important guideline coming from the attention to the user needs. The Wize Mirror application will see the user at the centre of each design and development stage. The non-invasiveness of the system and the natural interaction pattern (looking into a mirror) strongly encourages the profitable adoption of this device.

When used by individual users in their private premises on periodical basis, the Mirror will display the results of the semeiotic computational analysis according to an intuitive and easy-to-read representation of a set of comprehensive indicators and a wellness index. The Graphical User Interface (GUI) will display well-being descriptors with colour-based, intuitive graphical objects which will be further expandable to provide more detailed information. This will be complemented with the provision of pertinent information and suggestions that will support and supervise individual's self-monitoring. The personalized guidance, based on user-profiling in terms of preferences and attitudes, will supply advices and counselling messages. Educational materials will be conveying to help relating individual's signs with correct behaviours and life-style. Tracking user's progresses in the improvement of his/her well-being descriptors and highlighting the successes that a user has achieved will motivate the individual to use the device and keep his/her well-being index high, thus leading to a better style and quality of life.

Data collected from the users will be stored locally and will be used to compose a diary to track the user progress in time and his/her adherence to suggested measures.

The Wize Mirror will also support remote transmission and cloud storage of user data. This capability will be regulated by a simple and clear GUI option by means of which the user will be able to deactivate or limit this functionality.

The availability of user data on a remote cloud system will significantly enrich the user experience with a set of new interaction paradigms, including also a social perspective, to further stimulate the user towards a proficient and beneficial employment of the device. In this regards, the user may want to explicitly share some of his achievements with his friends on a social platform, e.g., graphs showing that, when following the guidance of the Wize Mirror, the health parameters have improved.

Remote and cloud storage of data can also enable mobile services implemented on Smartphones or Tablets, with which the user could remotely revise his progresses and check the adherence to the guidance and suggestions coming from the semeiotics analysis performed by the Wize Mirror. This aspect adds new interfacing options (Smartphones and Tablets) in addition to the one directly offered by the mirror.

Data sharing can also facilitate interactions between the person using the Wize Mirror and a General Practitioner supervising the user's progresses.

When used in social premises, Wize Mirror will provide to professional users a detail portrait of an "inspected" individual with an in depth analysis of the inspection outcomes. In this case, support will be provided in terms of how to guide corrections and tips to improve the individual's life-style.
Particular care will be taken in the protection of the user data. A single *smart interactive mirror* will potentially serve multiple users. Protected access will prevent the visualization of the well-being descriptors belonging to different users. The data collected by the device will be properly encrypted to avoid any unauthorized access to a user profile, whether local or remote.
Milestones: MS3 (month 18), MS5 (month 29)

- end user's acceptance:
  - easy to use, intuitive interaction
  - lifestyle guidance consistency.

Objective 3 - To set-up and validate the non-invasive multisensory device

Sub-obj 3.1. Development of the Wize Mirror

SEMEOTICONS is aimed at designing and implementing a multisensory device to enable and ease individual's self-monitoring and well-being awareness. It will be a highly innovative device and will incorporate original data-acquisition strategies and procedures aimed to exploit different kinds of face signs in a systematic way. To this end, we will integrate different sensors including imaging and depth sensors, a multispectral/hyperspectral imager, a gas-sensing device, and acoustic sensors into an interactive Wize Mirror. User interaction will exploit touch and voice devices, besides imaging.
The Wize Mirror will be the core of a system able to acquire data on users' physical and psychophysical status, record significant events in their personal history, and integrate the different pieces of information based on the virtual individual's model. Wize Mirror will incorporate properly developed user' centric applications and will be the physical interface able to provide a friendly lifestyle guidance at users' home.
The user will be also enabled to send, if desired, data stored in the Wize Mirror system to personal trainers, nutritionists, and medical advisors. Connectivity with home and external computer networks will be ensured to ease further developments and exploitations of the system and its integration in users' daily life.
The Project will achieve the objective by a close integration and fine tuning of sensing and interaction devices into a specific hardware and software platform. Thorough investigations of the physical and biological factors affecting observable quantities will pilot the design and development phases.
Milestones: M2 (month 12), MS3 (month 18), MS4 (month 24), MS5 (month 29), MS6 (month 36)
Measures of Success

- end-users acceptability;
- capability to detect signs related to cardio-metabolic risk and track changes of measured parameters;
- coherence and safety of guidance advices.

Sub-obj 3.2. Validation of the wellness model assessed by the Mirror

As the system will be essentially user-centric, it should be easily accepted by end-users and should provide reliable feedback to generic end-users in their daily life environments. To appraise those capabilities, it will be validated by a population of healthy volunteers enrolled by the clinical units in SEMEOTICONS.
Milestones: MS6 (month 36)
Measures of Success

- the acceptability by end-users;
- the repeatability of the observations in standard conditions;
- the impact of environmental conditions;
- the capability to detect signs related to cardio-metabolic risk and track changes of measured parameters,
- the coherence (and safety) of guidance advices.

B1.1.7. Resulting benefits

Societal Benefit

From the citizen point of view: Knowing health status, understanding risk, preventing and assessing the results of lifestyle guidance

SEMEOTICONS is strongly characterized by a user-centric approach. The Wize Mirror will be the core of a platform aimed at building a natural bridge between the user and his/her body, in order to strengthen the awareness of people on prevention and healthy lifestyle.

The mirror will support the users in self-assessing the quality of their lifestyle and self-monitoring their physical and psycho-physical status over time, providing a stimulating framework in which the users may share their experience with positive effects on family and social aspect of daily life. Therefore, the smart mirror system will represent also a valid education and behavioural rehabilitation tool, capable to broaden people knowledge about the factors affecting their health and empowering them with efficient strategies to counteract related risks.

From the institutional side: Renewed health models, new policies and prevention-induced economic burden relief

SEMEOTICONS addresses a strategic challenge in preventing cardiovascular diseases by empowering people. The approach followed in the Project is expected to pave the way to new health models in which prevention has a key role. Indeed, SEMEOTICONS will provide a proactive personal guidance system able to warn the user whenever potentially unhealthy behaviours are detected. In this way, a familiar and unobtrusive coaching will be enforced aimed at maximizing the effectiveness of lifestyle guidance. SEMEOTICONS will renew also the way in which communication between users and healthcare operators is managed, with benefits for both actors. In particular, practitioner will have the possibility to gather (with the consensus of the patient) quickly and with a no time-consuming procedure more precise, complete and structured information on the status of the individual and related trends. SEMEOTICONS system is also planned as an instrument for transversal observations and could be relevant for clinical investigations, helping clinician to discover and understand new correlations among sign, risk factors and actual diseases. It might be foreseen that due to prevention, the economic burden of CVD and especially of chronic CVD will be relieved by the solution proposed in SEMEOTICONS.

Business--oriented benefits

SEMEOTICONS is expected to offer significant way to favour new aggregations between health and well-being actors including industrial ones. Exploitation of SEMEOTICONS achievements will bring thus benefits at various socio-economic levels. In particular, the Wize Mirror will fit in domestic and daily-life environments (e.g. schools and fitness centres). This should give a push to the growth of new actors in the field of well-being management, also derived by a strengthened involvement of citizens, encouraged to become co-producers of their health. The user-centric applications to be developed in the Project will also be an interesting starting point for the market of e-Health services, exploiting novel channels in business. In particular, some services might be provided only to subscribers, with a wide choice of personalized subscription plans.

B1.1.8. Relevance to the topics addressed by the call

As already described in the previous section, SEMEOTICONS addresses the Objective ICT-2013.5.1 Personalized health, active ageing and independent living, aiming at target outcome a) Personalised Guidance Services for lifestyle management and disease prevention.

Indeed, SEMEOTICONS main aim is the development of **personalized services** for individual's cardio-metabolic self-assessment and self-monitoring. By using the Wize Mirror, **people of different ages, from the youngest to the eldest**, can become active actors both in *i*) **maintaining a good health status** by keeping at a minimum level cardio-metabolic risk factors and *ii*) following a **proper lifestyle** for CVD prevention, thanks to the **supportive guidance** supplied by the system.

To this end, a **virtual individual's model** will be constructed and constantly updated by aggregating, thanks to advanced machine learning methods, both personal baseline profile and semeiotic descriptors related to several risk factors, unhealthy behaviour and psycho-physical status. Indeed, advanced sensors will be used to derive descriptors for facial signs of hypercholesterolemia, cardiovascular homeostasis, breath pattern etc. Sensors will include imaging devices in several bands (in visible and NIR spectra) and range sensors for constructing detailed 3D models in combination with photometric stereo. Gas sensor will be also included to analyze both exhaled breath and the air in the surrounding environment.

The descriptors extracted from such a sensing framework will be fused and aggregated into **novel global indices for wellbeing**. These will be correlated with well-established cardio-metabolic risk charts. Indices analysis will **allow for the recognition of behavioural trends and for the early detection of increased cardio-metabolic risk**, thus **empowering patients with an innovative tool for effective prevention**.

Besides, methods for computing the raw numerical values of such well-being indices, user centric applications will be designed and developed, in order to give personalized and adaptive **guidance** to people

(according to their inclinations, education and psycho-physical status), with the goal of optimally fostering behavioural change.
The Wize Mirror, developed in the Project activities, will constitute a product with reduced time-to-market; since it is deployable in several contexts (home, hospital premises, fitness centre, schools,…), it can attract the attention of new actors such as **fitness industry, schools, health insurances and media**.
The services offered by the Wize Mirror are not confined to the mirror itself, but can be extended to the provision of new, additional services. Indeed, thanks to cloud technologies, many applications and services can be built to fully deploy the richness of information contained in the semeiotic descriptors and well-being indices: from remote consulting of health professionals to external computational models for the fine analysis of collected data and extra individual support and coaching. In particular, **new business models in the form of novel services are enabled by the technologies to be developed in SEMEOTICONS**.

Finally, the proposed Project shows a strong attitude in **multi-disciplinary research**: it can be inferred clearly by the diversification of the envisioned outcomes, and by the Consortium structure. The research areas mainly involved in the Project could be grouped in three main families: (i) signal processing, imaging and multimodal data fusion; (ii) development of hardware and software for contactless data acquisition, processing and storage; (iii) detection and understanding of facial signs and their evolution with respect to standard diagnostic method. In each of this family, the Project activities will address challenging problems. Nevertheless, thanks to the clinical Partners in the Consortium, a realistic implementation and thorough validation plan will be carried out, since the settling of Project activities. In addition, an agile structure of the work plan will ensure **frequent feedbacks from clinicians and users**, enrolled in the testing stages, in order **to guide the scientific and technological advances**. At the end of the Project, **the validation stage will assess the value and effectiveness of the proposed solution. Quantitative indicators for the achievements of** the aforementioned Project objectives will be previously **defined in the first steps of the Projects and then evaluated at several points during validation phases**. In this way, it will be possible to quantitatively **demonstrate the proof of concept** and evaluate the improvements in quality of life and prevention.
The Project Consortium is well aware of ethical and privacy issues and will pay constantly attention to their safeguard, as explained in Section B4.
Last but not least, in order to let the Wize Mirror to happily coexist with other technological tools and in order to guarantee adaptability, re-usability, extensibility and **interoperability** of the produced virtual individual's model, **standards and open architectures, including those for semantic web, will be always preferred**.

B1.2. Progress beyond the state-of-the-art

SEMEOTICONS aims at building an innovative virtual individual's model, which is based on a set of objective signs, closely related to cardio-metabolic risk profile and derived from external physical examination of the face. The model should serve to evaluate a subject well-being status over time and allow early detection of improper lifestyles as well as potentially dangerous conditions mainly related to cardio-metabolic risk.
SEMEOTICONS tool will be a self-monitoring system mainly based on the Wize Mirror device. This architecture will be absolutely non-intrusive and will be able to use personal data for coaching and learner-adaptive messages.
This objective appears innovative in the field of computer vision where the main applications based on face recognition and characterization are related to anthropology, psychology and neuroscience [13].

B1.2.1. Medical Semeiotics

Face semiotics has been used since the time of Aristotle; Hippocrates already described aspects of pathological conditions related to face, becoming common heritage to associate face traits with character, psychological dispositions and health status. In modern medicine signs, derivable from face observation, are an important part of the physical examination that, together with the anamnesis, constitutes the basis for a rational decision-making.
The appearance and features of the face allow the distinction among ethnicity, gender, age and psycho-physical condition (happiness, sadness, fear, anxiety, and pain). Face changes can be due to alterations of skeletal and/or muscular structure, subcutaneous tissue, skin colour and eyeballs appearance. Chronic

endocrinological diseases (achondroplasia, acromegaly) and congenital anaemia (thalassemia) may produce characteristic bone structures alterations. Diseases of the nervous system (Parkinson, myasthenia, tetanus) may cause typical alterations of the muscular structures. Other local and systemic illness may induce alterations of the superficial tissues due to changes of water content, growth of adipose tissue, and deposition of mucoproteins such as in myxedema (hypothyroidism).
Haemoglobin concentration, oxygen saturation, vasodilation or vasoconstriction affects the colour of facial skin (pallor, redness, and cyanosis); moreover the deposit of other substances may be responsible of pathologic appearance of the skin, as bilirubin in jaundice. Local accumulation of cholesterol may become evident with the appearance of xanthelasmas in the eyelid and arcus cornealis, a white ring in front of the periphery of the iris. Moreover some clusters of characteristic features of the face are considered pathognomonic of specific medical conditions such as mitral face (mitral stenosis), Hippocratic face (sepsis), lunaris face (Cushing's syndrome, obesity), face poliglobulica etc.
Thus face semiotics may be considered as a potential source of information for obtaining surrogate markers of obesity, metabolomics, cardiovascular homeostasis and psychophysical status. However, despite the face represent a naturally pre-eminent means for communication among human beings and modulating inter-personal interaction, at present the valuable pieces of information conveyed by human face are not systematically used nor integrated in smart systems able to help people in their daily life.

Cardio-metabolic risk and metabolic syndrome
Cardio-metabolic risk comprises a cluster of risk factors that are good indicators of patient's overall risk for CVD and type-2 diabetes. These risk factors are classified in two groups: modifiable and non-modifiable.

Modifiable factors		Non-modifiable factors
overweight/ obesity	high blood glucose	age
high LDL cholesterol	low HDL cholesterol	race/ethnicity
high triglycerides	hypertension	gender
hyper-coagulation	inflammation	family history
smoking	physical inactivity	
unhealthy eating	psychosocial issues	
health disparities		

The metabolic syndrome is characterized by a clustering of clinical and metabolic features that include high triglycerides, low HDL cholesterol, high blood pressure, impaired glucose tolerance, visceral adiposity, and insulin resistance [14]. Epidemiological studies have shown that persons with metabolic syndrome have morbidity and mortality for cardiovascular disease 3-4 times increased as compared to control population [15].
The importance of primary prevention for the decrease of cardiovascular epidemic is well documented by epidemiological studies [16]. Moreover the impact on mortality of prevention is judged higher in comparison with the effects of evidence-based therapies such as medical and interventional treatments [2, 17] (Fig. 4).
According with this observation some clinical trials and observational studies have shown a rapid decline in the risk for cardiovascular disease mortality after individual or population-wide changes in diet and/or smoking and in general following an healthy life-style [18]. In addition the favourable impact of prevention on human wellbeing and economic have been estimated by committees of several countries [18, 19]. Unfortunately, the adherence to the recommended lifestyles and the proportions at goal for blood pressure, lipids, and blood glucose in patients at high risk resulted less than 50% in European surveys [20, 21].
This evidence suggests the need for new strategies aiming to directly involve people and families in this important task [22].

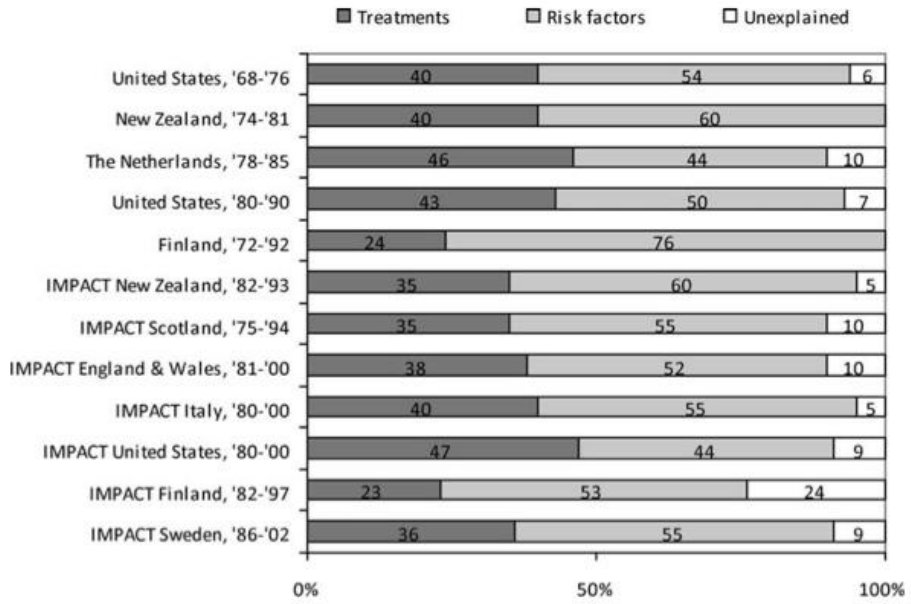


Fig. 4 Percentage of the decrease in deaths from coronary heart disease attributed to treatments and risk factor changes in different populations (2)

Charts for Cardiovascular and metabolic risk estimation

The evaluation of cardiovascular risk in healthy person is traditionally done using validated risk charts (Framingham, Procam, Score etc). These tools have been developed for clinicians that use these chart scores for assessing risk rapidly and with sufficient accuracy to allow logical management decisions.

Since SEMEOTICONS is intended for self-monitoring of apparently healthy individuals, as indicators of cardiovascular and metabolic risk we will use the HEART SCORE, Fatty-Liver Index (FLI), Finnish Type 2 Diabetes Risk Score (FINDRISC) and the HOMA index.

FLI algorithm is based on body-mass-index (BMI), waist circumference, triglycerides and gamma-GT. Although FLI was originally developed for the diagnosis of non alcoholic fatty liver disease, we have recently demonstrated that FLI is highly correlated with insulin resistance, visceral fat accumulation, metabolic syndrome and atherosclerosis in apparently healthy subjects and thus it can be considered a cardio-metabolic risk score [6-8]. Moreover, it has been recently shown in the Cremona study that high values of FLI are associated with increased morbidity and mortality in the general population [23].

Cardiovascular risk will be assessed using the HEART SCORE that is a risk chart based on data from 12 European cohort studies; it included 205178 subjects examined at baseline between 1970 and 1988 with 2.7 million years of follow-up and 7934 cardiovascular deaths. The SCORE risk function has been externally validated and it allows a computation in relation to the relative risk of the population examined [9, 24]. The FINDRISC is a validated questionnaire to predict the presence of any glucose homoeostasis abnormalities and the metabolic syndrome [10, 11].

HOMA is based on fasting glucose and insulin concentrations and gives an estimation of insulin resistance [12].

Self-monitoring and well-being

Self-monitoring is an effective tool to stimulate individual awareness of physical cues and/or behaviours and to identify the barriers to changing behaviour. It may allow the recognition of goals and may provide direct feedbacks guarantying discretion and confidentiality. At the same time, people may choose to activate external communication with prompts such as personal digital assistant or health care professionals [25-27].

Ward *et al*. analysed clinical trials that used self-monitoring in the area of cardiovascular risk management [28]. They indicated 4 major interventions obtainable with self-monitoring strategies: a) education b) self-measurement c) adjustment of (or adherence to) behaviour d) contact with health professionals.

In SEMEOTICONS Project all these interventions will be activated in order to optimise the performance of the Wize Mirror.

B1.2.2. Smart Mirrors

Recent progresses in material science and great ICT advances are more and more fostering the vision of mirrors as viable instruments to enact the ubiquitous and pervasive ambient assistance. Indeed, in the last years, mirrors are no longer simple reflecting surfaces, but are being transformed into more powerful, functional and dynamic instruments. New functionalities are being provided to these modern, technology enhanced mirrors, including (see Fig. 5, for some examples):

- interactive multimedia playback, from music playing to video displaying
- augmented reality
- interactive activity support.

Actually, several companies are currently marketing mirrors able to play music, through a built-in sound system that incorporates speakers, radios, small displays and touch-screen consoles for interactive control and, also, a plugged or Bluetooth connection for personal mp3 players[2]. Others advertised mirrors are able to control ambient lighting and connect to a weighting scale[3]. In these solutions, the advanced features of the mirror are mainly connected to ambient intelligent facilities.
In other cases, the mirror has been endowed with highly interactive touch-screen functionalities[4] and the possibility to show different kinds of media content whenever standing in front of it. In this case, the device incorporates the Philips mirror TV technology and Microsoft Kinect. The enhanced features of such a solution are currently devoted just to "entertainment" purposes.
In other cases, the mirror has been endowed with augmented reality functionalities mainly devoted to enhance shopping premises[5], such as dressing rooms and shops. In many cases, the mirror is actually a large touch-screen monitor equipped with a digital camera.
Finally, some attempts to use the mirror to interactively support normal-life activities have been reported, such as an application aimed at monitoring and guiding tooth brushing[6,7].
Recently, a so-called "medical mirror" has also appeared[8] which is able to compute some vital parameters such as heart rate and breathing rate. It is under development at the Massachusetts Institute of Technology as a two-way mirror that hides a monitor and a camera.

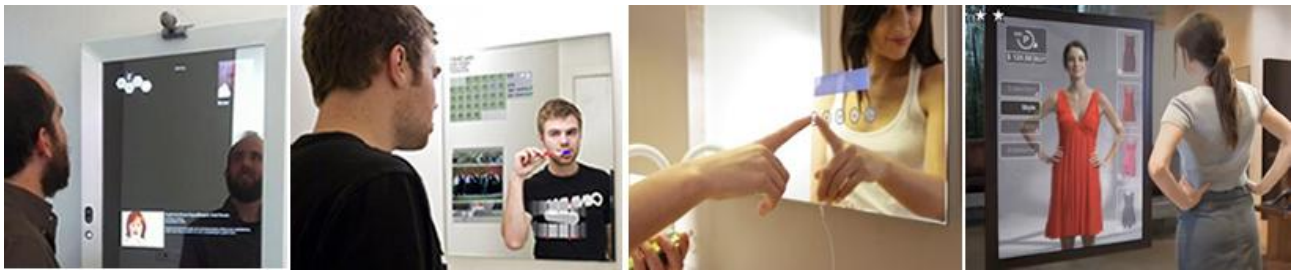


Fig. 5 Some examples of advertised smart mirrors

Beyond the State of the Art

The Wize Mirror to be developed in SEMEOTICONS differs from the above reported prototypes since it will incorporate in one device all the features of the others: it will (*i*) include a complete suite of heterogeneous sensors that will enable the analysis not only of the individual's appearance but will go a bit further, with the analysis of skin composition; (*ii*) enable an effective, contactless evaluation of physical and psychological signs (*iii*) supply interactive support, in particular a reasoned and competent user guidance to life-style monitor; (*iv*) provide a touch-screen for interaction and smart data management and sharing facilities. Although not being a diagnostic tool, it will incorporate an effective and medical knowledge and bring this closer to user's normal life settings.

[2] See, for instance http://www.stocco.it/scheda_collezione_eng.php/IdCollezione=14/NomeCollezione=Specchi sets number 9, also online at http://www.mytechnology.eu/2009/06/08/specchio-da-bagno-con-comandi-audio-integrati-e-stocco-maitre/ or also http://www.alkesmartmirror.be/
[3] http://www.youtube.com/watch?v=qqFcaewtBJA
[4] http://www.youtube.com/watch?v=dAI9mF_cBu0
[5] http://www.youtube.com/watch?v=_X2-_t5f_IA
[6] http://realitypod.com/2011/12/brushing-teeth-and-diagnosing-problem-made-easy/
[7] http://www.youtube.com/watch?v=Cvoy4deM-VQ
[8] http://www.youtube.com/watch?v=LyWnvAWEbWE

B1.2.3. Gas Sensors

Many kinds of materials such as polymers, semiconductors, carbon graphites, and organic/inorganic composites have been used as sensing materials to detect the targeted gases based on various sensing techniques and principles. It is worth noting that the sensitivity of chemical gas sensors is strongly affected by the specific surface of sensing materials [29-30]. A higher specific surface of a sensing material leads to a higher sensor sensitivity, therefore many techniques [31-33] have been adopted to increase the specific surface of sensing films with fine structures, especially to form the nanostructures, taking advantage of the large specific surface of nanostructured materials.
There are many classes of commonly used gas sensors, different from each other with respect to materials and principles used: metal-oxide, solid electrolyte, capacitive, calorimetric, gravimetric, optical, ionization gas sensors.
Gas Sensors for Breath Analysis. In recent years, there were increasing concerns about the applications of breath analysis in medicine and clinical pathology as a diagnostic tool and a monitor for evaluating the progress of therapies. Breath analysis is non-invasive, real-time, and harmless to the subjects and the personnel who collect the samples. The two widest methods used for analysing the human exhaled are: gas chromatography, very accurate but expensive and not portable; the electronic nose (e-nose), cheaper, more portable, easy to use, and faster. E-nose has already been used for many applications such as in environment, security, fragrances analysis, food and chemistry, while in medicine the E-nose has been used for diagnosis of renal disease, diabetes, lung cancer and asthma [34-36]. Since there is not a commercial e-nose designed for the breath analysis specifically, breath analysis requires the development of new strategies and new ad-hoc instrumentation. Table 1 reports the breath compounds associated to various diseases.

Table 1 Some breath compounds and associated diseases. Readapted with permission from [37]

Breath compounds	Possible disease associated
Acetone	diabetes
carbonyl sulphide, isoprene	liver diseases
naphtalane, 3-heptanone, methylcyclododexane	pulmonary tuberculosis
nonane, tridecane, 3-methyl, 5-methyl,	breast cancer
Benzene	lung cancer
Ammonia	renal disease
octane, decane, 4-methyl, hexane	unstable angina
propane, octadecane, octane, 5-methyl	heart transplant rejection
Pentane	acute myocardial infarction, acute asthma, cystic fibrosis, rheumatoid arthritis
nitric oxide	asthmatic inflammation

Electrospun Nanofibers. Electrospinning is an efficient, relatively simple and low cost way to produce polymer and composite fibers with diameters ranging from several nanometers to a few micrometers. Electrospun fibers with controllable membrane thickness, fine structures, diversity of materials and large specific surface can be ideal candidate as sensing materials. Gas sensors based on electrospun fibers have been successfully applied to detect vapors of NH3, CO, NO2, O2, CO2 and alcohols or amines at room temperatures and with a detection limit varying from 1ppm to 100ppm [38].
In this Project, we will focus on the detection of O2, CO, CO2, alcohols, nicotine, and nitrogen oxides by sensors made of conductive polymers fibers, such as polyaniline (PANI), poly-diphenylamine (PDPA), polypyrrole, polythiophene. They show chemical selectivity, which allows them to act as excellent materials for the immobilization of gas molecules, and exhibit highly reversible redox behavior with a distinguishable chemical memory.

Beyond the State of the Art

In the SEMEOTICONS Project, we will study how to analyse the user's exhaled gas in order to detect the breath compounds associated to cardio-metabolic risk factors. We will combine commercial chemical gas sensors with a new system of breath sensors made of Electrospun nanofibers, the Wize Sniffer. The

advantage is given by the possibility to obtain high sensitivity to the biomarkers and compounds in human breath. The sample is injected into the Wize Sniffer using an auto-sampler at a fixed injection rate to guarantee a uniform sampling. The sensor's response will be a kind of odour-print that should be associated with a given cardiac condition or disease. Finally the signals are processed, and statistical criteria applied to the data to ensure the repeatability and reproducibility of the method.

B1.2.4. Spectral Data Analysis for Colorimetric and Compositional Cutaneous, Subcutaneous and Iris Characterization

Skin Imaging for AGE evaluation

Recent findings [39] have demonstrated the possibility of detecting changes in AGE product accumulation in tissue by analysing autofluorescence (AF) in the 300-600nm range that is emitted during exposure of UV light (300-420nm). A commercial device (AGE reader, Diagnoptics Technologies B.V., Groningen, The Netherlands) has been developed based on these findings. In this design a probe is positioned in direct contact to the tissue [40]. Changes in AF as a marker for AGE product accumulation have proven to be a clinically useful parameter when studying pathological conditions such as diabetes [41], cardiovascular diseases and renal diseases [42]. The use of AF as a marker has great advantages compared to other competitive methods as it is non-invasive, fast and cheap. These advantages make the technique attractive as a possible solution for a mirror implementation as described in this Project.

To make a functional imaging application, using a multispectral imager (MSI) for detecting AF, some difficulties need to be addressed. The level of skin pigmentation, the amount of ambient light and the sensitivity of the MSI detector are important parameters in this context. The skin pigmentation issue can potentially be overcome by either evaluating low-pigment lip tissue or by estimating the amount of skin pigmentation. The mirror implementation proposed in this Project will obviously allow for the evaluation of lip tissue, while the later can be done using MSI combined with a white light source [43] as planned in the other MSI activities (WP3.1 and WP3.2) in this Project. Further, the sensitivity and the ambient light issues can potentially be overcome by averaging repeated measurements over large tissue areas while subtracting ambient light images captured while the excitation light source is turned off. If successful, an MSI-based AF detector could prove to be an attractive tool for studying AGE product accumulation in tissue.

Skin Imaging for cholesterol evaluation

When imaging skin tissue, the vast majority of the detected light will originate from photons that are diffusely backscattered from deeper tissue layers. To fully describe how these photons propagate through tissue one need to address both the amount and location of scattering and absorbing compounds. In human skin, the level of scattering (i.e. the scattering coefficient) is strongly dependent on the amount of cell membranes, a structure that beside other lipids and proteins can consists of nearly 50% cholesterol. The skin tissue also naturally contains light absorbing chromophores such as oxygenized and reduced haemoglobin, melanin, water and lipids. In addition, substantial amounts of chromophores such as bilirubin and betacarotene can be present in pathological conditions.

To design efficient and accurate state-of-the-art algorithms for quantifying the tissue compounds one typically need to be able to model how photon propagation and the backscattered intensity is affected by tissue scattering and absorption. This is commonly done for single or multi layered skin tissue using empirical expressions [44], diffusion theory [45] or Monte Carlo simulations [46], where Monte Carlo is considered the most accurate but slowest one. With any of these photon propagation models the detected spectrum can be modelled with knowledge on tissue absorption and scattering. However, for these models to be useful in a data analysis algorithm one need to solve the inverse problem – quantifying the absorption and scattering properties based on a measured spectrum. For some simple empirical models and some diffusion approximation models [47] this can be done analytically, which will result in fast algorithms. For other more complex models non-linear optimization algorithms are needed. These iterative algorithms are however computationally demanding, but with massive parallelization using GPUs (Graphics Processing Unit) this can potentially be overcome.

By solving the inverse problem using a multi-layered tissue model it is possible to quantify both tissue scattering and amount of chromophores, and potentially also structural information such as layer thickness and depth discrimination of scattering and absorption. This has partly been demonstrated using spectral datasets acquired using either probe based [48] or imaging devices with either homogeneous [43] or structured illumination [49]. In this Project we plan on implementing such an algorithm, based on either

diffusion theory or Monte Carlo simulations, to try to quantify changes in tissue scattering and lipid concentration that are related to skin cholesterol.

Skin Imaging for Endothelial Function

Multispectral imaging provides a powerful tool for non-invasive non-contact monitoring of blood oxygenation and vascular changes in skin. Changes in these parameters are linked to endothelial function. Changes in the endothelium have been seen as a precursor, or even a cause of more severe cardiac symptoms. It has also been linked to development of preeclampsia [50]. A significant effort has been put into this field over the last years, and several techniques have been developed to evaluate endothelial function [51-55]. In vivo non-invasive techniques have been successfully developed. These methods are based on a variety of techniques ranging from ultra sound to peripheral artery tonometry. Optical assessment of endothelial function is based on the assumption that the microcirculatory blood oxygenation and perfusion in the face are affected by endothelial changes. Turner et al [56] showed that endothelial function in the microcirculation can be estimated using Laser Doppler Imaging. They argue that the state of the microcirculation in the skin is closely related to the endothelial function in other vascular compartments. Laser Doppler based techniques will in this Project be used as verification of the MSI technique [57]. Hyperspectral imaging has previously been used to assess local skin oxygenation [58, 59], tissue fluorescence, and other parameters [60-63].

The idea in SEMEOTICONS is to use MSI to evaluate changes in blood concentration and oxygenation during local heating as an indicator for endothelial function.

Light penetration in skin is a function of the tissue properties and will depend strongly on the wavelength [64]. Thorough knowledge about the optical properties of the skin is essential to monitor the endothelial function, as every patient should be their own control. Inverse photon transport modelling can be used to extract the optical properties and correct for background chromophores [65, 66]. The probing depth can thus be estimated individually in each patient. Control of the probing depth will allow probing of the deep- and superficial vascular plexus and the response to external stimuli can thus be measured. This is a high risk approach which, if successful, will simplify the identification of endothelial malfunction. Algorithms and data processing approaches have to be in focus for this diagnostic modality to be fast enough for consumer use. A combination of statistical image analysis and physical models based on Monte Carlo and diffusion theory will be used for the extraction of data. This will be done using high speed processing techniques to achieve as close to real time results.

Beyond the State of the Art

A non-contact MSI-technique for determining AGE-related products in facial skin using autofluorescence has not yet been presented. The main challenge lies in the presence of non-standardized ambient light which will affect the readings of a weak fluorescent signal.

Furthermore, it is more technically challenging to determine chromophore concentrations in a non-contact setup as compared to a contact method due to the difficulty of standardizing the illumination settings in a non-contact mode. A method that is independent of illuminated light intensity should thus be developed.

A non-contact MSI-technique for determining cholesterol content in facial skin by assessment of light scattering and lipid concentration will presumably need to be based on both scattering effects (indirect method) as well as on lipid concentration. Lipid light absorption is rather weak and similar to that of water in the NIR wavelength range.

A non-contact MSI-technique for determining endothelial function will be developed by studying the vascular response to facial remote heating. Development of standardized remote heating of skin to controlled temperature using a feedback system is new. It is also novel to study blood concentration changes during heating rather than the more common method using microcirculatory perfusion.

We will develop novel real time inverse models to describe photon transport in skin and extract chromophore concentrations from multi spectral data. Such models have to our knowledge so far only been presented for single spectra, and not for use on image data. This is challenging due to the large amount of data collected within a short time period. Handling of movement artefacts and variations in illumination during the image capture will be included in the implemented software.

Iris Image Analysis for cholesterol detection

Arcus cornealis (which can be *senilis* or *juvenilis*) is a white or grey ring around the outer edge of the cornea (see Fig. 6). It represents deposits of lipid particles, which are trapped in the extracellular matrix in the stroma of the cornea. Presence of arcus cornealis could be due to number of reasons, one of them,

particularly for people under 40 is thought to be due to higher cholesterol level [67]. This though is currently disputed [68]. Ramlee [69] has previously proposed an image analysis system for detection of arcus cornealis. The novel approach proposed on this Project will aim to design and build a fully automatic non-intrusive eye scanning system to be integrated within the mirror for iris image analysis and detection of the arcus cornealis. Additionally the results from the iris analysis system will be correlated with the xanthelasma (yellowish flat plaques on the eyelids) to be detected by the 3D bio-morphometric and colorimetric face characterisation subsystem and results from the multispectral sensor.

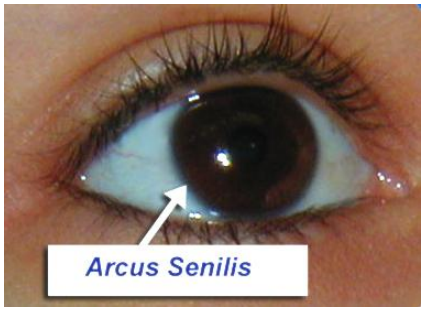


Fig. 6. A case of arcus senilis. The arrow points to the ring around the cornea

Beyond the State of the Art

In SEMEOTICONS, we will study and develop methods and algorithms to recognize and quantify arcus cornealis and to analyze the components and the presence of cholesterol in the iris by textural analysis. Multi-spectral images should ensure better cholesterol discrimination.

B1.2.5. 3D Face Reconstruction and Bio-morphometric Characterization

3D Reconstruction

Acquiring 3D digital representation of human faces is of importance in a wide range of applications, including: human computer interactions, security, video conferencing, virtual reality, entertainment and last but not least biometrics and medicine. As the result there has been a steady progress in terms of methods and technology applied to the 3D face reconstruction.

The 3D facial data is usually represented as a set of 3D points or surface patches and is normally captured by 3D imaging systems. Such devices scan a real-world object generating point cloud corresponding to samples taken from the observed 3D surface. Apart from surface geometry, 3D scanners can often provide additional information about the corresponding 3D point as surface normal or appearance e.g. colour.

The main methodologies currently used to acquire 3D facial data include: shape-from-shading [70], geometric stereo [71], laser triangulation [72], structured light [73] and photometric stereo [74]. Commonly these methods use a combination of lighting and sensing devices placed at different positions and orientations around subject enabling recovery of the "missing" depth information.

Currently, the most widespread technology for facial scans is geometric stereo, where 3D points are reconstructed based on estimated correspondence in two or more images taken by the cameras at different positions and orientations. Such systems come in two variants: with [75] and without [76] additional structural illumination supporting correspondence search. Both these technologies can produce highly accurate 3D dynamic scans but are expensive and don't operate in real time due to high computational cost of the point correspondence search.

From the perspective of real-time acquisition an attractive alternative for geometric stereo is Time-of-Flight (ToF) camera where the distance information is recovered from the analysis of the time between the emitting and receiving the reflected light, most commonly measured through the phase analysis of the interference between these two signals. ToF cameras contrary to the LIDAR-like devices captures entire scene at each light pulse. There are number of commercial products currently available on the market including SwissRanger from Mesa Imaging [77] and Photonic Mixer Device (PMD) from PMD Technologies [78]. Such devices can operate at the very fast frame-rate (up to 100 frames per second) in changing ambient-illumination conditions, but have low spatial resolution, of up to about 200x200 pixels, have comparatively low depth sensing accuracy, and effectively provide range scans rather than true 3D.

From the point of view of the simplicity of the row data acquisition and the low cost of the scanner, an attractive option for reconstruction of 3D shapes is to reconstruct directly from a single image. In [79], it is achieved by using morphable 3D face model with model parameters (shape, texture, pose and illumination) iteratively estimated by minimising the pixel colour difference between the image and the rendered morphed model. This 3D reconstruction framework has been automated in [80] by introducing SVM face detector with automatically detected facial features generating list of likely features configuration which are subsequently evaluated using linear projections with morphable model. Numerous approaches utilising similar methodology have been also proposed including [81], where the cost function is based around facial landmarks or [82] where the cost function is defined in the illumination subspace. Similar category of

methods uses range data rather than images to estimate parameters of the morphable model. In [83] a target mesh is represented by an implicit function and the parameters of the morphable model are estimated by minimising the distance between the current model and the depth scan. Li *et al* [84] proposed a method for deformable surface registration with simultaneous estimated correspondence and confidence weights. The adopted cost function enforces the local mesh rigidity and the global smoothness. Yet another group of methods [85, 86, 87] combine both texture and range data to define cost function minimising texture and mesh distance simultaneously. Zollhöfer *et al.* [87] described a system utilising Kinect device for acquiring both the texture and the range data and therefore eliminating the need for expensive correspondence search between these two modalities and making it attractive solution from the cost point of view. The main drawback of the methods based on the morphable model is the high computational cost of the 3D reconstruction. Additionally although these techniques can produce very impressive results in terms of rendering realistically-looking 3D faces they cannot currently provide required 3D reconstruction accuracy for bio-morphometric facial measurements.
To reduce computational requirements, a possible option is to use structure from motion (SfM) methodology [88]. Contrary to the morphable model approach the SfM generally does not use explicitly 3D model of the face but rather estimates 3D facial geometry based on a sparse set of characteristic landmarks extracted from a sequence of images. The classical rigid SfM model has been extended by Bregler *et al.* [89] to deal with reconstruction of 3D deformable objects by introducing to the factorisation algorithm a low rank shape model to represent deformable shapes. As a time-varying object usually cannot arbitrarily deform, the idea of this model is to represent a deformable shape as a linear combination of basic shapes. Due to their simplicity, shape basis model has been widely used in this research field [90-92].
However in the non-rigid structure from motion (NRSfM), inherently high number of degrees of freedom together with motion degeneracy may fail to provide meaningful reconstruction. To counter this effect, it is commonly admitted to use prior information defined as new additional constraints rather than optimise the unknowns only using 2D observation and minimising re-projection error. Torresani *et al.* [93] employed a form of Probabilistic Principal Components Analysis to provide Gaussian distribution on deformation coefficients as prior knowledge. Del Bue [94] proposed an alternative approach introducing a single shape prior coupled with a bundle adjustment refinement. Departed from the shape basis model, a trajectory based algorithm was proposed Akhter *et al.* [95] who described a duality theorem in 3D structure representation which models independent 3D point trajectories. The main advantage of this representation is that the basic trajectories can be predefined, thus removing a large number of unknowns from the estimation.
Although the NRSfM methods are much more computationally efficient than morphable model methods and some recent progress has been reported with on-line implementation of this methodology [96], in general neither of these two methods provides adequate computational efficiency and 3D reconstruction accuracy to support objectives of the proposed Project.

One of the most promising methodologies enabling accurate, effective 3D reconstruction using relatively inexpensive hardware is photometric stereo [73]. In this technique the surface is reconstructed from image(s) captured by a single camera with different light source directions. The light source direction can be encoded in: (i) time domain with multiple images captured with different light sources being activated [97] or (ii) spectral domain with each light source emitting different wavelength with single captured image [98]. For these methods to work number of assumptions is usually made including: Lambertian reflectance model, presence of distant and uniform light sources, static camera and/or subject, no shadows. Additionally the method requires careful calibration often preformed independently for each subject. Although in recent years there has been a significant progress in addressing some of these problems [99], with the range data or NRSfM used to aid the calibration process, the technology is not fully matured yet.

Another attractive option is the structured light scanning technique. Such systems are inexpensive and can operate in real time, though most of the proposed techniques [100] so far are too intrusive due to projection of visible structural light patterns. Recently proposed solution to this problem, use the near-infrared structured light. Indeed this technique is being used in the Kinect device [101] which is fast becoming one of the most widely used 3D range sensor. It should be mentioned though that although it is likely that such device will be used on the Project on its own Kinect does not provide sufficient 3D reconstruction accuracy.

Progress beyond the state of the art

The objective is to develop a non-contact, embedded 3D facial reconstruction system, which is to be integrated within the Wize Mirror. The main characteristics of the system are such that it should provide an ubiquitous 3D scanning facility within only a partially controlled environment. This imposes a number of constrains on the 3D facial reconstruction system. Such system should be: (i) inexpensive (ii) operating in real time (ii) fully automatic, (iii) non-intrusive and (iv) accurate to enable 3D facial bio-morphometric analysis. From the review given above it should be evident that such system is beyond the current state of the art. It is envisaged that the developed systems will combine near-infrared structural light (Kinect-like), photometric stereo and non-rigid structure from motion 3D reconstruction methodologies to combine their complementary strengths and combat their inherent weaknesses. It is therefore expected that the Project will deliver novel technological solutions for 3D facial reconstruction. Additionally the integration of the 3D facial information within the specific area of interest of the Project have not been previously investigated in detail and therefore it is expected that the cooperation with the health practitioners will provide valuable new scientific outcome for evaluations of the human wellbeing.

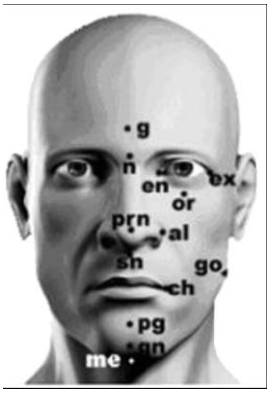
Face Bio-morphometric Characterization

The many areas of feasible applications contributed to make Face Detection and Recognition very charming topics for the ICT research community. Moreover the industry introduced the use of real time technologies applied to the three dimensional reconstruction of the human body or parts of it (e.g. Microsoft Kinect technology). The most important research areas that will be addressed within the Project are: face detection and recognition, face morphology and facial expression recognition.

Particular attention will be paid to the morphological and facial biometric aspects, in order to perform the analysis of the face evolution over time and extract meaningful information (e.g. ratios of distances, evolution of the oval face shape as well as skin colour or surface variations).

A detailed review concerning landmark measures and geometrical features for 3D human face description was published in 2012 by Vezzetti and Marcolin [102].

The discipline that deals with the facial morphology study is named Anthropometry. Leslie G. Farkas enhanced the existing methods for the measurement of the surfaces of the head and neck [103] by exploiting anatomical landmarks. This allowed him to quantify the effects on faces of various types of illnesses and syndromes [104-107]. Anthropometric facial landmarks (see Fig. 7) lie in zones of the face that exhibit peculiar features. The goal is to carry out accurate geometric face measurements (e.g., the Euclidean or geodesic distances between landmarks, angle measurements) and distinguish between different faces by the comparison of the measurements.



In anthropometry applications, these measures are called morphometric. Euclidean and Geodesic distances involve two landmarks, while angle measurements involve three landmarks. It is also possible to take into account the curvature or shape information. In the following a more thorough description of these measurements is provided.

Euclidean Measure. It is possible to analyse changes in facial morphology through the Euclidean measurements concerning two points in a three-dimensional space. Stereo-photogrammetry methods (see e.g. [109]) provide an accurate three-dimensional reconstruction of facial morphology. The estimated 3D coordinates can be exploited to calculate the Euclidean distances for a set of suitably chosen landmarks.

Fig. 7 Anthropometric soft-tissue landmarks (for landmark names see [108])

Geodesic Measure. A geodesic is the shortest distance between two points on a surface [110]. In SEMEOTICONS, the reference surface will be the reconstructed 3D face model; hence the geodesic distance will be defined between two facial landmarks. For further details the reader should refer to Bronstein et al. [111-115], who proposed to model facial expressions as isometries of the facial surface, which is described as a compact connected two-dimensional Riemannian manifold with specific smoothness properties.

Ratios of Distances. In the last decades, the interest in the study of ratios of facial landmark distances for face classification purposes has significantly increased. These ratios are defined by means of Euclidean or geodesic distances among landmarks and they are usually normalized distances, obtained by dividing a length between points by a face width. In the framework of SEMEOTICONS, the work by Mao *et al.* [116]

will be considered for the Project purposes. In that work the ratio between the geodesic and Euclidean distances has been exploited to obtain information about the curvature asymmetry.
Curvature and Shape. Several techniques have been developed to estimate the curvature information related to a point cloud. Interesting curvature representation was proposed by Koenderink *et al.* [117] and Calignano [108].
Another valuable result is based on 3D SIFT, fairly employed as face descriptors. Zhang *et al.* [118] focused on local feature based 3D face recognition, and proposed a Faceprint method. They extracted SIFT features from texture and range images and matched them. The matching number of key points together with geodesic distance ratios between models are used as matching scores, while the likelihood ratio based score level fusion is conducted to calculate the final matching score. Thanks to the robustness of SIFT, shape index, and geodesic distance against various changes of geometric transformation, illumination, pose and expression, the Faceprint method is inherently insensitive to these variations. Experimental results proved that this method achieves consistently high performance comparing with commonly used SIFT on texture images.

Commercial devices
Device and software currently in use are able to produce a real time 3D reconstruction of the entire body, and sometimes rich in details, such as colour, texture and so on. Among these, one of the most famous is the Microsoft Kinect device, for which a nice set of applications is already developed.
Kinect device uses a depth sensor that consists of an infrared laser projector combined with a monochrome CMOS sensor (640x480 pixels, 30fps). The depth map is then analyzed by the proprietary software drivers, which obtains the 3D positions of the skeleton joints. Microsoft supplies the Kinect SDK as a standard packet that can easily be integrated in C++ and C# projects in quite smooth way. Recently, in his current version of the SDK, Microsoft introduced the Face Tracking SDK. "The Face Tracking SDK's face tracking engine analyzes input from a Kinect camera, deduces the head pose and facial expressions, and makes that information available to an application in real time. For example, this information can be used to render a tracked person's head position and facial expression on an avatar in a game or a communication application or to drive a natural user interface (NUI)" (from Microsoft Web Site). Kinect outputs consist in a set of 121 3D points, enough to describe the facial features with reasonably good precision.
More than that, we mention that there are many other options for the 3D real-time reconstruction, such as ASUS Xtion PRO LIVE, with different features but similar in functional capabilities in 3D real-time reconstruction of human face and body.
As a consequence of the previous considerations about the Kinect resolution, we might need to use other optical sensors to get higher resolution data for more complex elaboration (such as iris detection and analysis).

Beyond the State of the art
The face bio-morphometric characterization nowadays is an open problem because is much more than face detection: it is the extraction of the meaningful bio-morphometric data from a set of face images.
In computer vision, actually, the extensive use of face biometrics has lead to a lot of efficient methods and algorithms for face recognition. At a preliminary stage, we should use the medical knowledge about biometrics to better profiling the observed subject and to better define the wellness starting point; note that this stage needs the close interaction between the clinical and the ICT researchers. Then, another important achievement of the Project will be the identification and extraction of the ratios (of distances, Euclidean or geodesic, among facial landmark points) which could be more sensitive to the subject's variations that are related to the cardio-metabolic and/or psychophysical status assessment, like fattening and losing weight, eye socket's variations; more than this, in the Project we will study a method for the tracking during the time of singularities detected over the face cutaneous or subcutaneous tissues (using triangulation of such singularity, starting from recorded landmark points of the enrolled subject).
One of the most innovative issues in this part of the Project is the definition of bio-morphometric descriptors which are closely related to the cardio-metabolic status assessment and their tracking during the time; moreover, in order to get an attractive and expressive output of the bio-morphometric analysis, it is necessary to fuse these with the other features investigated in the virtual individual's model, representative not only of the geometric appearance of the subjects, but of the wellness status evolution associated with the period of tracking/investigation.

B1.2.6. Face Expression Recognition and Psycho-physical Evaluation

The facial expression is a visible manifestation of the affective state, cognitive activity, intention, personality, and psychopathology of a person [119]. The human face can be seen as a multi-signal IO system, able to convey information via four kinds of signals [120]: i) ***static facial signals*** related to permanent features of the face (bony structure, overall proportions); they are usually exploited for person identification tasks; ii) ***slow facial signals*** associated with features that are slowly varying over time (wrinkles, texture changes); these signals can be employed to assess the age of an individual; iii) ***artificial signals*** i.e. exogenous features of the face (glasses, cosmetics) that might enhance or weaken some facial features; these signals are typically used in gender recognition; iv) ***rapid facial signals*** related to visually detectable changes in facial appearance due to neuromuscular activity; these signs may communicate messages about the affective/attitudinal state and mood of an individual (e.g. fear, disbelief, interest, dislike, stress).

Many applications benefitting from automatic analysis of expressions exist today. The most intensively studied area is that of natural ***human-computer interfacing***, where computer, machine or robot interfaces are supplied with tools (e.g. ***gaze trackers***, ***lip readers***, ***face-based command listeners***) in order to interpret facial expressions and relate them to the individual needs. Beyond that, the recognition and interpretation of a person's affective state is the topic of the emerging research area of affective computing, with the primary purpose of providing a better human-computer interaction [13]. Other applications can be found in the rendering of human avatars in the movie industry or in the assessment of fatigue and stress in crucial tasks, such as air traffic control, surveillance or driving. In the medical domain facial expression analysis has been performed to examine facial neuropathy [121], as well as facial paresis and paralysis [122] or other motor disorders [123]. It has been used also for emotion expression assessment in neuropsychiatric diseases such as schizophrenia [124, 125], as well as for the detection and objective description of epileptic seizures [126].

Automatic systems for facial expression recognition usually take the form of a sequential configuration of processing blocks (Fig. 8). The main blocks are: image acquisition, pre-processing, feature extraction, classification, and post-processing. [127]

Facial expression and Emotion

Classical emotion recognition theory aims at the detection and classification of six basic emotions [121]: surprise, sadness, disgust, fear, and anger. The measurement of emotion is performed by following two major approaches [128]: the first aims at detecting and classifying the six basic emotions by extracting features from the face, while the second uses predefined signs/parameters to describe the facial surface and decode the corresponding emotion. These signs can be described by the Facial Action Coding System (FACS) [129], an index of facial expressions based on the action units (AUs). Action units are defined as the fundamental actions of individual muscles or groups of muscles. According to that system a facial expression can be represented as a combination of action units [130]. An alternative to FACS deriving from neurophysiologic and psychological studies is the MPEG-4 metrics [131] that is mainly focused on facial expression synthesis and animation.

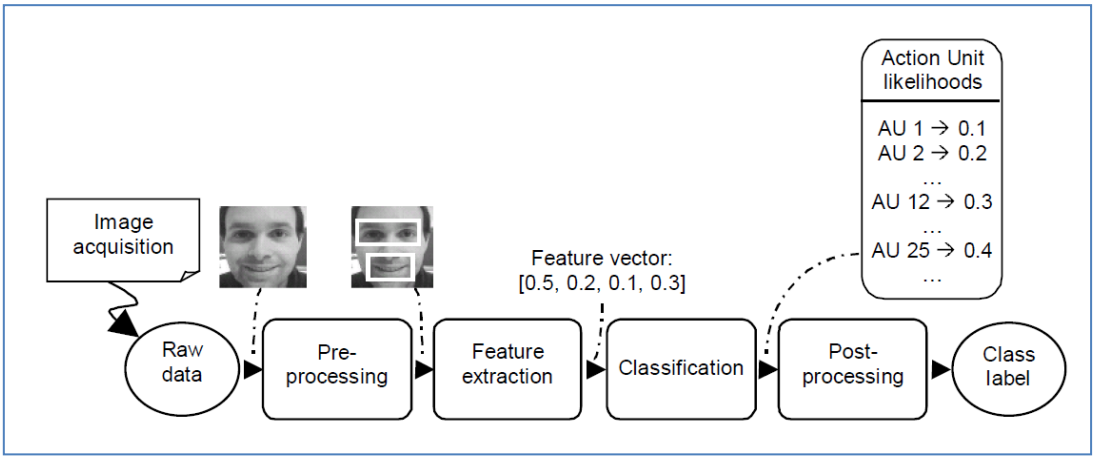


Fig. 8 The classical pattern recognition model for facial expression analysis [127]

In more recent years, there have been attempts to recognize more complex expressions than the six basic ones. One of the existing techniques aims at directly identifying the individual AUs, in order to recognize finer changes in expressions [132].
The aforementioned methods exploit features related to shape or appearance, without providing any description of the temporal dynamics of the face. Temporal dynamics refers to the timing and duration of facial activities, articulated in three steps (*temporal segments of the expression*): onset, apex and offset. For a detailed description of these parameters we refer to [133]. Following this approach Pantic and Patras have been able to recognize a wide range of expressions [134].

Facial expression and Stress, Fatigue and Anxiety
The following paragraphs are based on the review concerning objective measures for stress, fatigue and anxiety published in 2012 by Sharma and Gedeon [135].

Stress
Facial expressions can be used to recognize stress. When responding to stressors, facial expressions indicate biological responses reliably. This is commonly used to assess stress. Facial muscle hyper-activity, e.g. related to head and mouth motion, has been used as a stress indicator. Machine learning techniques (e.g. SVM, PCA, and decision tree-based classifiers) can be used for facial expression recognition in that area.
Eye gazing and frequent focusing actions can be considered as stress indicators. In this case the estimation of gaze spatial distribution and measurement of the percentage of saccadic eye movement have been employed as stress measurement indicator. Pupil dilation has been examined for stress detection by evaluating the mean values for pupil diameters. It has been observed that the growth of these mean values over a time period is coupled with an increase in stress intensity. Also eye blinks are sensitive to stress. Some reports suggest that higher frequency of blinks is related to stressful conditions. In addition, higher eye closure speed has been suggested as a characteristic for higher stress levels.

Fatigue
Automatic fatigue detection has been intensively studied in the context of preventing accidents when a driver loses attention as a cause of drowsiness. All vision-based systems are mainly based on eye tracking and closure detection [136]. The ocular cue known as "percentage eye closure" has strong capability in identifying the fatigue state [137-139]. The eye blink rate can also be a measure for fatigue [140- 143].
A commonly used method for eye detection is the Hough Transform [144]. In 2007, Liang and Houi developed an eye tracking system by combining colour segmentation and Hough Transform techniques [145].

Anxiety
There are many studies that analyse the capability of recognizing facial expressions and emotions of a person suffering from anxiety [146, 147]. There is evidence that suggests that anxiety can be determined by detecting features relating to specific affective states such as facial characteristics of fear and arousal [148]. In [149] the author incorporated implementations of Active Appearance Models, Gabor Wavelet Transforms and Support Vector Machines in order to analyse anxiety and depression through facial expressions.

Progress beyond the state of the art
The goal is to generate a digital representation of the user's psycho-physical state based on the analysis of facial characteristics. In the review given above it is noticeable that a holistic approach efficiently fusing the descriptors of each separate expression, namely fatigue, stress and anxiety, is missing. Moreover a system that detects these multiple descriptors at once is beyond the current state of the art, especially if combined with the measurement of another critical factor for the cardio-metabolic risk assessment, namely the heart rate variability. The latter will be measured in a non-contact manner via the same video camera that captures the facial expressions. Moreover the application of current facial expression analysis methods in the specific field of interest of the Project has been sparsely studied and the development of a novel reliable system forms a considerable challenge. The collaboration with the clinical Partners of the Project, which will provide high quality annotated data, as well as valuable feedback, will produce scientifically valid research outcomes adding value to the current state of the art.

B1.2.7. Personalized guidance for people empowerment and self-efficacy

In the field of decision support systems for health, there is a growing demand of smart services oriented not only to health care operators but also to people self management and empowerment. In this context, conventional clinical decision support systems are evolving, trying to encompass also adaptive and

personalized services dedicated to the users, as also witnessed by reference publications (see e.g. [150]). When the systems are target at general people and not just to patients, they are usually named personalized guidance systems. For maximizing self-efficacy (i.e. the person's level of confidence that he or she can perform a specific task or health behaviour in the future), the inclusion of user preferences is recognized as a key point in tailoring information to user and in providing adequate decision support. Indeed, tailored information has been proved to be more effective in giving consumer information and is generally preferred by patients [151]. As is generally understood, tailoring involves a combination of strategies and information intended to reach *one specific person* based on characteristics that are *unique* to that person, related to the *outcome* of interest, and derived from an *individual assessment*. Computerized personalized guidance in smoking cessation, physical activity, dietary practices and mammography screening is surveyed in [152]. It is argued there that tailoring can be effective for supporting health-related changes across a number of behaviours linked to chronic diseases. In addition, dynamic tailoring using iterative assessment and feedback is an important intervention strategy. Multiple behaviours can be targeted simultaneously without hindering intervention effectiveness. However, regardless of tailoring method, intervention effects overall were found to decline after intervention completion, suggesting the need for innovative techniques to help participants maintain changes.
Under the hood, personalized guidance system can employ technologies coming from a blending of conventional decision support and tele-monitoring systems. In particular, there is the need of proactive methods able to aggregate data from advanced sensing framework, to recognize trends, to alert care providers in case of worsening and to support constantly people. Some attempts to tackle these points have been just reported in the literature [153-155], as this is an emerging decision support domain.

Progress beyond the state of the art
In SEMEOTICONS, novel methods for providing personalized guidance will be investigated; in particular, accurate user profiling will be performed using data mining methods with the aim of understanding people attitude and inclinations. Then, the behaviour of the personal guidance system will be governed by adaptive procedural rules, to be instantiated on the individual automatically, by extending the methods presented in [156]. Feedbacks from the user will also be incorporated for greater effectiveness and personalization. Presentation, visualization and linguistic style of suggestion and coaching messages will also be addressed and personalized, since they are important moderators of effect in communication modalities.
Finally, in SEMEOTICONS, personalized guidance services will be provided continuously and on a daily basis, thanks to the user centric applications, helping people to maintain achieved changes and, thus, overcoming the limits in endurance of previous attempts.

B1.2.8. User-centric Interactions and Services

ICT applications to monitor the well-being status of an individual typically require a user to carry electronic sensors on his/her body. Applications that monitor users' vital parameters during a fitness session (heart-rate, oxygen saturation, body temperature) constitute an example of a whole class of applications that are implemented according to this paradigm.
With the proposal carried out in Project SEMOTICONS, we argue that this intrusiveness is not necessary in order to provide a well-being indicator as the effect of the measurement of different parameters related to the health status of an individual.
A significant progress that this Project represents is indeed the way in which the smart interactive mirror will be able to collect data to build a representation of the user well-being status and associated cardio-metabolic risk factors, that is, through semeiotics recognition.
From the user perspective, the possibility of using a device which can provide information on his/her current health status, without the need to wear additional sensing devices, is a strong encouragement for the effective adoption of this system.
Another important innovation that this Project brings is the natural interaction pattern between the user and the Wize Mirror device. The multisensory device will seamlessly integrate with the user environment, and the collection of semeiotics signs will be the result of a common gesture which is already part of people's everyday life: looking one's own face through a mirror.
The user experience will be further enriched thanks to the touch-screen display on the mirror surface, with which the individual will be able to interact.

B1.3. S/T methodology and associated work plan

SEMEOTICONS will combine multiple specialities and expertise to engineer facial semeiotics, make it available to normal people and enable them self-assess and self-monitor their wellness status with respect to CVDs. The starting point is obviously the medical knowledge which will be modelled, translated into computational methods and provided to end-users in the form of wellness evaluation and personalized guidance. To make this possible, SEMEOTICONS will concentrate on the development of

a. a sensor infrastructure to acquire multimodal data about an individual, and
b. a suite of scientific methods to analyse and interpret such data, assess individual's wellness and provide personalized support.

The overall result will be the Wize Mirror.

B1.3.1. Overall Strategy and general description

As already introduced in Section B1.1.5, the Project activities can be grouped in two lines:

a. a *technological* line, which will investigate suitable sensor configurations, develop the hardware platform and prototype the Wize Mirror;
b. a *methodological* line, which will study and define innovative methods to translate facial signs into computational descriptors, integrate these into a computational individual's model and provide user's guidance.

These two lines melt together in the core activities of the Project, since the selection of the sensors configuration for data collection cannot be uncoupled from the methods that analyze such data.
More in detail, the overall work strategy organizes the Project activities in a *modelling-development-integration-testing* cycle. Such a cycle will break down in the following phases:

- *Modelling – Definition of a facial-based semeiotic model of cardio-metabolic risk*. First of all, for each risk factor, the list of signs to be evaluated will be defined along with the modalities of their observation (i.e., visible, multispectral, gas signals) and the criteria of their interpretation.
- *Development – Methods and technologies to estimate, integrate and interpret facial computational descriptors*. For each risk factor and for each observation modality, the work will concentrate on defining the most suitable solutions to extract and evaluate descriptors corresponding to those facial signs included in the model. These solutions will be in terms of sensors configuration and processing methods. Intelligent methods will be also studied and developed for the *semantic* integration of extracted descriptors into the virtual individual's model and their interpretation as a wellness index;
- *Integration – Assembly and prototyping*. Configured sensors and defined methods will constitute sub-components (kind of *tools for data analysis and integration*) that need to be integrated into the Wize Mirror prototype. Since Wize Mirror will embed a dedicated processing board, this integration will be preceded by design and manufacturing of the board.
- *Testing –Technological validation.* The system and its data processing methods will be tested for verifying their functional correspondence to the medical semeiotic model. This will be a technological validation because it will consist in attesting if they will *(i*) meet the requirements that guide its design and development, *(ii*) work as expected, and *(iii*) satisfy the user's needs. In practise, this validation will verify, with clinicians' support, if, for each risk factor and for each modality, the descriptors are correctly extracted and correspond to the signs to be observed. Volunteer subjects will be recruited to test the system in real scenarios. The main goal is to promptly identify and correct any possible fault and requirements misalignment.

These four phases will be organized in a cycle as shown in Fig. 9, so that periodic testing and refinement steps will occur.
At the end of this cycle, when a consolidated system will be available, a *Final Validation* phase will start for the **proof-of-concepts** of the system. This will involve a number of healthy subjects that will be monitored over time. This activity will consist in a *wellness semeiotics validation* since its main goal is to verify (*a*) the significance of the virtual individual's model in assessing the wellness status of individuals and (*b*) its effectiveness in supporting their self-monitoring. This phase will collect feedbacks to adjust and refine the virtual model.

Summing up, starting from the medical semeiotic model, for each identified risk factor and observation modality, the methods for the computational evaluation of signs will be developed, integrated and periodically tested. When the methods will be consolidated into a tested prototype of Wize Mirror, the proof-of-concepts will start and the virtual individual's model will be tested and finally refined.

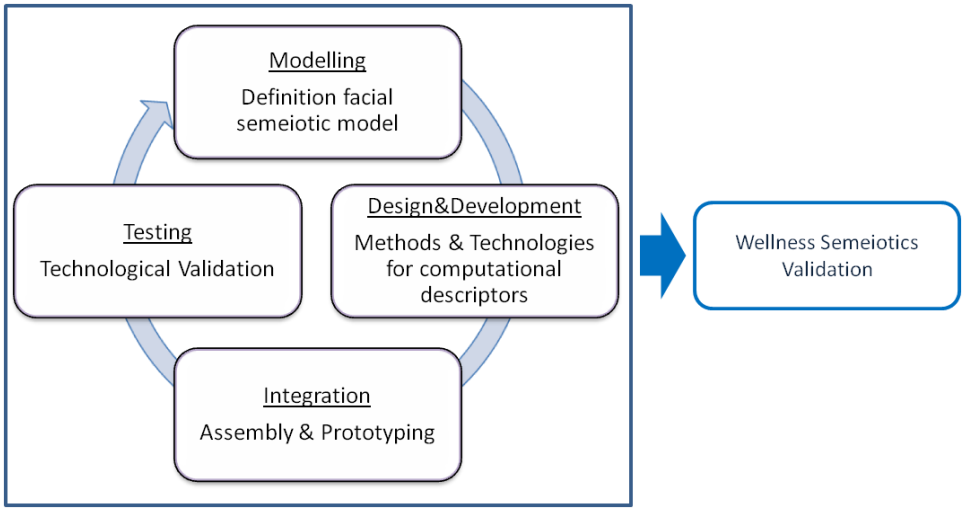


Fig. 9 The main phases towards the Project objectives

By mapping the cycle of Fig. 9 onto the activities in Fig. 3, the SEMEOTICONS activity plan is obtained as shown in Fig. 10.
The work is break down in eleven Work Packages (WPs), numbered from WP1 to WP11. WP11 (*Project Management and Coordination*) will deal with Project management activities (MGT, WP11). The others can be briefly introduced as follows.

WP1 (*Face Semeiotic Model of Cardio-Metabolic Risk*) comprises the definition of the medical semeiotic model of the face. In addition, since an effective translation of facial signs into computational descriptors requires working on real data, WP1 will comprise the collection of a reference data set, obtained by enrolling a number of volunteer subjects. WP1 will, then, produce a "hypothesis zero" of the virtual individual's model to be implemented and evolved in the core WPs of the Project.
Additionally, to speed up the final validation activity, WP1 will also include the definition of the validation protocol to be followed in WP9 (*Wellness Semeiotics Validation*), so as to be promptly submitted to the ethical committees of each validation site.
Once obtained a first release of the semeiotics model, the specification of system requirements and functionalities will be tackled in WP2 (*Hardware and Software Platform Design*). This will regard the design of all the sub-components of the system resulting from the technological and methodological activities lines: i.e. (*i*) the hardware platform; (*ii*) the sensor configuration coupled with the methods for data analysis and interpretation; (*iii*) the data management infrastructure and the user's applications.
The output of WP1 and WP2 will be used as an input for the core research and developments activities. The main methodological activities coupled with sensors configuration will be carried out in the following WPs:

- WP3 (*Multispectral Data Analysis and Sensors Development*) will handle (*i*) the definition and implementation of multispectral data analysis for descriptors related to skin tissues composition and function as well as iris and breath characterization, (*ii*) the configuration of the necessary sensors and, in particular, the prototyping of the gas sensors for breathe analysis.
- WP4 (*3D models construction and characterization*) will address the definition and characterization of a face 3D model, through colorimetric and morphometric descriptors. It will also include the extraction of the other general semeiotics descriptors, such as heart rate and its variability.
- WP5 (*Methods for face expression analysis and psycho-physical status evaluation*) will focus on the definition of new methods for the recognition of individual's mood and psycho-physical status through the analysis of face expressions.

- WP6 (*Virtual individual's model and personalized guidance*) will tackle the *semantic* integration of all the extracted descriptors into the virtual individual's model and the definition of the *wellness index*. This WP will also address the definition of methods for user's profiling, system customization and the core facility of user's guidance in self-assessment. This WP will see a strong participation of clinical Partners so as to support modelling and implementation.
- WP7 (*User Centric Applications and Services*) will focus on the definition of the user requirements, the development of user's interface and the data management infrastructure.

Each of these WPs will take care of the software implementation of the scientific methods.

In order to avoid jeopardizing activities, WP8 (*Hardware Platform Development and Wize Mirror Integration)* will take care of the technological activities not coupled with the methodologies. WP8 will, then, cover:

(a) the electronic design of the main processing board embedded in the Mirror.
(b) the HW/SW integration of all the outcomes of WP2, WP3, WP4, WP5, WP6 and WP7, by merging together both the sub-components in one innovative instrument.
(c) the periodic technological validation activity, aimed at verifying the effectiveness of the developed methods before release the consolidated system.

In such an organization, WP8 requires the involvement of the clinical Partners to verify the work done.

The validation of the wellness semeiotics model will be, finally, carried out in WP9 (*Wellness Semeiotics Validation*), which will see the involvement of the clinical sites of CNR-IFC unit of Pisa, Italy, CNR-IFC unit in Milan, Italy, and at CRNH in Lyon, France.

WP10 (*Dissemination & Exploitation*) will take care of the dissemination and exploitation activities. The former will involve all the Partners, while the latter will mainly implicate the effort of the industrial Partners.

All these activities will be carried out taking advantage of a strict cooperation among clinical, bioengineering, medical engineering and computer scientists. A suitable organisation and management schema will be conceived to enable this interaction and foster understanding the diverse backgrounds and the development of new knowledge and tools.

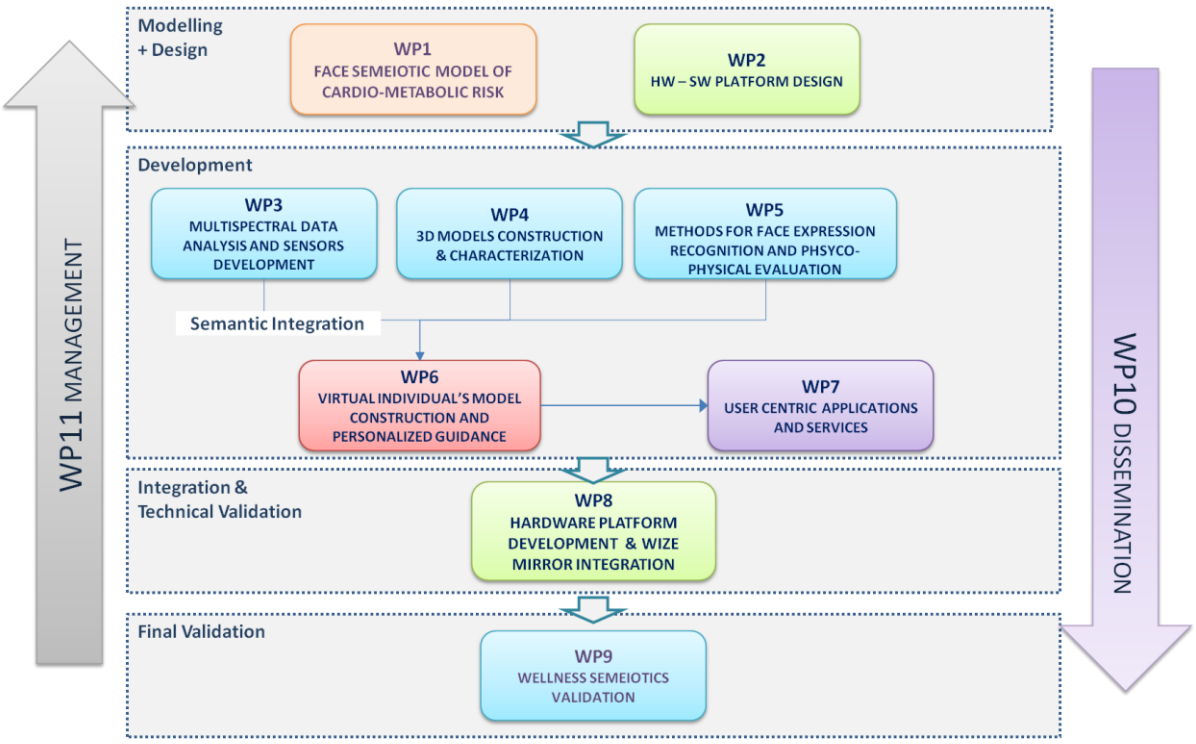


Fig. 10. SEMEOTICONS Work Packages

B1.3.2. Work Packages Overview

A brief overall description of the core WPs is reported below. WP11 *Management and Coordination* as well as WP10 *Dissemination and Exploitation* are discussed respectively in sections 2 and 3, and hence skipped here.

WP1- Face Semeiotic Model of Cardio-Metabolic Risk

The Work Package is aimed at a) identifying the requirements, imposed both by the medical aspects of the problem and the end-user interaction, and b) defining the functional specifications of the whole Wize Mirror system, b) carrying out other activities relevant to the whole Project.
Medical semiotics will provide the starting point to individuate the signs that are: a) recognizable by face imaging and exhaled gas analysis and b) relevant to define individual cardio-metabolic risk-factors. Classical signs will be revised in view of the use of digital imaging and sensing techniques leading to quantitative face descriptions. Signs related to face aspect and expression will be identified and characterized with particular attention to physical and psychological status. Moreover, a detailed review of the state of the art will allow pinpointing the role of cholesterol and AGE accumulation in the skin. Assessment of subcutaneous flow will be analysed and procedures for the evaluation of endothelial function will be defined.
In this way a set of "high level" design requirements will be directly derived and integrated with the constraints imposed by end-users interaction with the Wize Mirror system. Particular attention will be paid to friendliness deriving from touch-less interaction.
In WP1, additional activities necessary for the completion of other WPs will be also carried out. Based on the defined semeiotics model of cardio-metabolic risk and resulting medical requirement, we will investigate relevant physical aspect of image and signal acquisition. The activity will focus on subcutaneous flow and its changes during cardiac cycle, heart rate, haemoglobin concentration, cholesterol, and AGEs accumulation in the skin, as observed by multispectral imaging. In addition, the vasodilatation on the face induced by thermal stimulation will be analyzed and compared to the endothelial function assessment by Peripheral Arterial Tonometry (PAT). In this WP, the functional specifications of the laboratory set-up to be used for RTD activity will be also defined.
We will collect a reference dataset from 20 volunteers that will be enrolled in the staff of CNR campus of Pisa. These subjects will be clinically characterized according to: anamnesis, physical examination, body weight and body composition by bioelectrical impedance; energy expenditure by indirect calorimetry, peripheral venous blood sample to assess lipid profile, glycaemia, insulinemia, haemoglobin, glycated haemoglobin. Moreover, the following scores will be calculated: Heart-Score, Fatty-Liver-Index, Finnish Type 2 Diabetes Risk Score (FINDRISC) and Homeostasis Model Assessment (HOMA) index. The endothelium-dependent vasodilatation will be tested by peripheral arterial tonometry. Psychological and nutritional tests will be also administered. Afterwards, images (still pictures and movies) will be acquired both in visible light and infrared band using a predefined laboratory setup. Exhaled gas samples will be also collected. Reference signals, such as ECG, oxygen saturation, skin cholesterol, laser Doppler flowmetry and Laser Doppler imaging will be collected and stored simultaneously, whenever possible, with image data. The reference subjects will be selected so as to provide data both normal condition and advanced cardio-metabolic risk (e.g. hypercholesterolemia, diabetes, and hypertension).
In this WP, the protocol to be used in the validation phase (WP9) will be defined and submitted the local ethical committees for approval by CNR units in Pisa and Milan, and CHRN unit in Lyon.

WP2- Hardware and Software Platform Design

This Work Package will derive and establish the system requirements and the functional specifications. These will then lead to the design of all system components that will devise a system that meets requirements and delivers the expected functionality.
The first goal of this WP will be the design of the smart mirror, incorporating all sensors and devices. With regards to the hardware aspect, the Wize Mirror device is an engineering artefact involving computation that is subject to physical constraints. The physical constraints arise through the two ways that computational processes interact with the physical world: reaction with the physical environment and execution on a physical platform. The design of the Wize Mirror device will thus need to address both reaction constraints (e.g. non-intrusiveness, compactness, screen size, sensor placement, etc.) and execution constraints (processing power, hardware failures, etc.).

With regards to software there are several different aspects to consider, including communication interfaces, touch-screen interaction, usability, etc. To ensure a strong user experience the design will also need to consider how the user will be interacting with the mirror; e.g. if users are expected to be tapping, flicking, and swiping their way around, the device needs to be designed in such a way as to allow users to access it easily with these physical movements.
A crucial aspect of the software design will be the middleware that will provide a bridge for interconnecting the various sensor devices, providing support for the communication interfaces that will be used for data acquisition. These communication interfaces will be carefully defined, paying attention to existing standards, off-the-shelf sensor availability and interoperability. The Wize Mirror middleware must be able to integrate the various heterogeneous components/sensors and provide transparent access to the collected information, hiding any communication complexity. Furthermore, the OS must support user interaction with a touch-screen interface, allowing navigation to the information that will be displayed to the user.
Finally, this WP will also address the design of the Data Management solution which deals with modelling the information collected and processed by the mirror device, defines the overall data flow and provides data access services to system processes. The information that is collected by the Wize Mirror sensors involves videos, images as well as gas concentration signals. This data will be merged and stored in a structured format that best suits the processing methods that will access it to extract the various descriptors required to predict the individual's health status. These descriptors will also be stored by the Data Management system in an appropriate format so they can be accessed on demand to provide the necessary output to the user.

WP3 – Multispectral Data Analysis and Sensors Development

The objective for WP3 is to assess Multi Spectral Imaging (MSI) hardware (including camera, light and heat sources) and algorithms (including illumination schemes), for the evaluation of endothelium function, skin cholesterol and AGE-product concentration. It is also the aim to develop a gas sensor for breath analysis.
Reference dataset recorded in WP1 with an advanced hyperspectral imaging spectroscopy (HSI) system with a high spectral resolution and a white light illumination, and other modalities, will be analyzed. The aim is to assess the feasibility of contact-less measurements of the desired physiological functions with a simplified MSI system (camera, light and heat sources and illumination scheme). Focus will be on reducing the algorithms to as few discrete wavelengths as possible and an illumination scheme that reduces the effect of ambient light. This will give MSI hardware and algorithms specifications for the Wize-mirror set-up.
Quantitative description of the endothelium function will be explored based on data from subjects with normal and abnormal endothelium function undergoing local and full-face heat provocation and evaluated with reference methods. This includes the planning of a proper stimulation method and the design and evaluation of MSI algorithms for assessing the tissue fraction of blood haemoglobin saturation, along with the heart rate, and presumably blood flow.
Quantification of the skin cholesterol using MSI will be explored based on data from subjects with normal cholesterol level and those with hypercholesterolemia. The task includes the design and evaluation of analysis algorithms for determining the scattering level and the amount of lipid related absorption in skin and eye tissue. Algorithms to detect and measure arcus cornealis and localized fat depots on the eyelid (xanthelasmas) will be also developed in this task.
Quantification of the accumulation of AGE-products (Advanced Glycation End-products) will be explored based on data from both normal subject and subjects suffering from diabetes. The method will involve fluorescence induced with an excitation light source in the 300-420nm range, and include the design and evaluation of specific algorithms.
This WP will also focus on the development of gas sensors for the analysis of user's exhaled gas. The objective is to make ready a portable device, called *Wize Sniffer*, for the screening of the breath volatile components associated to cardio-metabolic risk factors. The Wize Sniffer will be composed by an array of gas sensors and it will operate in three phases: gas collection, sampling and data analysis aimed at providing the breath *odor-print*. Besides the evaluation of existing, commercial gas sensors, a major activity will focus on the development of innovative gas sensors based on Electrospun nanofibers. The use of conductive polymers (such as polyaniline and polypyrrole) as sensing materials will be explored in order to improve Wize Sniffer efficacy and effectiveness in term of sensitivity and reproducibility of measurements. The integration of Wize Sniffer in tools such as the Bodpod will be also investigated.

WP4 - 3D models construction and characterization

The objective of this WP is to investigate, design and develop hardware and software platforms for the acquisition and analysis of dynamic vision-based data to support objectives of the WP3 and WP5. The data streams made available by the developed platform will include the time-synchronised and the spatially co-registered video, range and dense 3D surface information. Apart from these data streams the software developed in this WP will detect the identity of the subjects using the Wize Mirror, as to facilitate concurrent usage of the device by the multiple users, and assist in the facial expression analysis by enabling the use of subject specific facial expression models in WP5. This WP will also aim to develop facial data segmentation algorithms with corresponding information about local facial surface characteristics to support multispectral data analysis in WP3. The dense 3D facial reconstructions will be used to perform bio-morphometric and colorimetric characterisation as to monitor, detect and quantitatively assess temporal changes in the face morphology and appearance to facilitate early detection of inflammations, abnormal growths or neurological events.

To further utilise the available vision data streams additional general semeiotics signs will be computed. In particular the heart rate variability, respiration patterns and the arteries pulsation will be monitored by implementing magnification of spatial and temporal variations occurring at different spatial and temporal frequencies in the vision streams.

WP5 - Methods for face expression analysis and psycho-physical status evaluation

This Work Package aims at developing a coherent facial expression analysis module that generates a quantitative representation of the subject's psycho-physical status, suitable for cardio-metabolic risk assessment. The module will process the video captured from the integrated camera inside the Wize Mirror by using advanced computer vision and pattern recognition techniques in order to analyse rapid facial signals. These signals represent temporal changes in neuromuscular activity that lead to visually detectable changes in facial appearance. These (atomic facial) signals underlie facial expressions and communicate, among other, messages of affective state or attitudinal states and moods. In this context, WP5 will focus on the detection and quantification of stress, anxiety and fatigue, since the evaluation of these three states provides information necessary for feeding the virtual individual's model of WP6, therefore resulting in the final cardio-metabolic risk assessment. In achieving its goals, WP5 will identify and subsequently analyse specific areas of the face (e. g. the eyes) that are dominant in the disclosure of stress, anxiety and fatigue. Motion in these areas will be captured in terms of pixel movement between consecutive frames. The ultimate objective is to define indices for the quantitative description of the above states and to integrate the methods for gaining these indices into a single measurement module. The chosen algorithms will be optimized in terms of sensitivity/specificity and real-time execution, while taking the necessary provisions for ensuring reliable and reproducible indices. With respect to the latter, methods for elimination of the variability induced by facial rotation, translation and illumination changes will be studied. The underlying research challenge related to the development of the methods is to expose the subtle changes in facial appearance.

WP6 - Virtual individual's model and personalized guidance

This Work Package will tackle the integration of all the extracted descriptors into the virtual individual's model and the definition of a wellness index. Generally the cognitive and also the social well-being are assessed considering several payoffs with respect to individual aspirations; actually, a complete and general definition of the well-being status must not leave out the evaluation of the individual health status.

This WP will address the integration of all the facial data analysed in the previous WPs (such as expressions, facial biometrics and general shape), taking into account the individual's starting point, so as to correlate the evolution of semeiotic signs to individual's cardio-metabolic status. As a matter of fact, there is no reason to stress the point-wise data, or set of data: it seems sounder to analyse the set of data as a whole, and to stress more the importance of their temporal evolution. This should result in the construction of a proper multidimensional space, the *cardio-metabolic wellbeing space*, in which the relevant measurements are tracked, and in which it is possible to extract a meaningful index representing the wellness status. This point is quite innovative, and, even if the wellness index extracted is not intended as a diagnostic tool, it requires to be well defined at the beginning of the testing, and to be fine tuned through the entire trial, in order to use it as a reliable indicator promoting the healthy lifestyle of the individual.

The procedure will include a personalization phase to account for the individual variability and the initial cardio-metabolic wellbeing status. The reference dataset will drive the setup of this *calibration* phase. In

fact, in the reference dataset the initial status is defined by baseline subject evaluation carried out by medical experts. In the final configuration of *Wize* prototypes calibration will be based on user-provided data.
Another very important issue to be addressed in this WP is the visual representation of the virtual individual's model: the potential in 'compelling' healthy lifestyle in the individual's behaviour relies in its clearness and expressivity. It will be studied an expressive way to represent the well-being status, tailored on the subject's preferences/attitude. (It could vary from a very simple and friendly visualization – like a comic; to a more 'scientific' one – a sort of augmented subject's photorealistic visualization).
This WP will also address the definition of methods for user's profiling, system customization and the core facility of user's support in self-assessment. The user's profile is necessary to set for each subject a reliable starting point for the wellness status assessment. It will be comprehensive of many medical and behavioural data (such as age, height, weight, phenotype, habits) and also other psychological data (such as anxiety, stress, laziness, hypochondria,…). As a consequence, a range of opportunities for the system customization and the definition of the user's support choices will be studied and defined.
User's support will mainly consist in coaching messages for the provision of pertinent suggestions and educational materials. In accordance to evaluated wellness index, the system might (i) either suggest to contact the GP due to the worsening trend of the index or (ii) reward and encourage the individual subject that is maintaining a good wellness index or (iii) display dietary suggestions and/or workout plans, and so on. This personalized user's guidance, strictly coupled with the correlation of the wellness index to established cardio-metabolic risk charts, will be specifically tuned to foster the prevention of cardio-metabolic diseases..

WP7 - User Centric Applications and Services

The WP7 deals with the design and development of User Centric Applications and related Services in order to give the person a feedback on his/her well-being status. The SW applications will be able to show the real-time wellness status of the person in front of the mirror as well as to display the collection of data stored in the past (progress analysis, tracking of improvements and achievements, etc.). For enhancing usability, the use of vocal interactions will be explored.
Data storage will happen locally to the Wize Mirror device, but, in order to provide a mechanism for data exportation, the application will allow the storage of data on an external support or, upon the approval of the user, data transmission to a personal cloud.
The option enabling remote storage of data and remote data transmission shall be in total control of the user and, if activated, will provide for the following extensions to the user experience:

- Multiple interfaces: third party services implemented on tablets or smartphones will allow the user to remotely revise his progresses and the guidance coming from the Wize Mirror analysis on his data
- Data sharing on social platforms (e.g.: to advertise achievements and progresses to friends)
- Data sharing with General Practitioners and experts.

The Work Package activities will include the development of a set of services that allow the management of data acquired by the multisensory devices and its storage in the SW platform. These activities will be performed while taking care of the activities carried out in the Work Packages dealing with SW application and service platform requirements definition.

WP8 - Hardware Platform Development and Wize Mirror Integration

WP8 deals with all hardware related components from the development of a specific hardware platform to the manufacturing of the Wize Mirror, going through the integration and validation of all the software components from WP3 to WP7.
The Work Package activities may be break down into four main groups: (*i*) group 1 will be in charge to tackle with the development of a novel hardware platform with high performances, low power consumption and low cost as a main target; (*ii*) group 2 will deal with the manufacturing of the Wize Mirror, which include the assembling of all the sensors and elements in a nice friendly package for the end-users; (*iv*) group 3 will tackle the development of the data management structure; (*iv*) group 3 will consist in the periodic technical validation of the methodological and technological components of the system. This will consist in both a technical and functional verification of Project's intermediate releases to explore requirements fulfilment and obtain feedbacks from clinical Partners and volunteer user's specifically involved.
At the end of the Work Package, we will have 3 prototype units of the Wize Mirror ready to be evaluated in clinical settings.

WP9 - Wellness Semeiotics Validation

The aim of this WP is to evaluate the reproducibility of the measurement by the Wize Mirror, to evaluate system efficacy in detecting changes in well being and cardio-metabolic status and to assess the system acceptability by the end-users

The validation studies will be performed in all three clinical centres (i.e., Pisa, Milan and Lyon). The characteristics of the subjects that will participate are age 25- 60, male and female in similar proportion, without any patent disease or chronic medical treatment. The validation studies will be performed in two steps.

In first set of experiments we will validate the use of the Wize Mirror by evaluating the intra and inter assay precision of these measures as well as the influence of environmental conditions such as changes in room temperature and effect of natural vs electric light. In a second set of experiments we will enrol 60 subjects (20 subjects/centre) that will be followed for 3 months with the Wize Mirror. The goal is to evaluate if changes in body composition and/or metabolism are reflected by changes in the parameters measured using the Wize Mirror. To accomplish this we will enrol subjects aiming to change their life style either for decreasing their BW or to increase their fitness or improving their well-being.

At screening, subjects will receive a basic clinical examination by a trained clinician with measurement of weight, height, waist circumference, blood pressure, heart rate. Psychological and nutritional tests will be administered. A venous blood sample for determination of routine tests (glycemia, Hba1c, TG, Cholesterol HDL, LDL, ALAT, ASAT, GGT, insulin, complete blood count) will be drawn. We will also evaluate body composition by Bod Pod (Cosmed) resting metabolic rate and fasting substrate oxidation by indirect calorimetry (using Quark, Cosmed), endothelial function measured as Peripheral Arterial Tonometry (PAT), and the skin accumulation of AGEs (AGE reader, DiagnOptics). HEART SCORE, Fatty-Liver Index, FINDRISC score, and HOMA index will be calculated. After individual evaluation each subject will be given a clinical advice for lifestyle change and a recommendation to up-date a food and physical activity diary. Subjects will be followed for 3 month with Wize Mirror evaluation every 10-15 days. At the end of follow up, subjects will repeat all screening tests, including blood tests, body composition, indirect calorimetry, endothelial function and AGE accumulation, psychological and nutritional tests. The changes in Wize Mirror measurements obtained at baseline and end of study will be correlated with changes in body weight, waist circumference and Fatty liver index. Relationship with quality of life, or other well-being questionnaire SCORE, standard biochemistry and specific tests will be also assessed.

Subjects will fill in questionnaires to evaluate ease of use, acceptability and satisfaction with the Wize Mirror.

Coherence of coaching messages with the clinical characterization, the risk score index (HEART SCORE, Fatty-Liver Index, FINDRISC score, and HOMA index) and the diary features will be evaluated. The types of message (awareness, goals, feedbacks) will be also evaluated according to the psychological characterization and in relation to the objective need of a second opinion from health practitioners.

B1.3.3. Timing and interdependencies of Work Packages

In Fig. 11 the timing of WPs is shown in a GANTT chart, while Fig. 12 illustrates the relations between WPs. Here, arrows represent one (or more) deliverables being passed from one WP to another. Only major iterations are depicted. When such relations occur, the milestones are also indicated in the chart. We envisage that additional minor iterations will occur spontaneously during the Project, involving any group of WPs.

An *agile-like* approach to system development will be adopted to implement the cyclic strategy introduced in section B1.3.1. This means that the activities will be organized in an iterative and incremental process in which the core WPs will run in parallel exchanging intermediate releases. Each cycle ends with a technical validation phase that will collect results of functional test as well as clinical and user's feedback. Changes according to the outcomes of such a validation will be performed in the succeeding cycle.

In particular, in SEMEOTICONS, we will have (*i*) an "*internal*" cycle, which will comprise the *technological validation* meant to verify methods and systems with respect to the suitability and effectiveness of the extracted and integrated descriptors; (*ii*) an "*external*" cycle, which will use the consolidated prototype to verify (*a*) the significance, reproducibility and accuracy of the virtual individual's model to assess the wellness index and (*b*) its effectiveness in user's guidance.

In the internal cycle, both the methodological and technological activities will evolve in parallel to each other and in strict cooperation through the following phases:

1. *Semeiotics model definition and system specifications*: the process will start from WP1, where the semeiotics model will be defined in terms of the signs to be extracted, and from WP2, where the methods and device will be designed. These WPs will periodically broadcast their outcomes to the WPs devoted to *(i)* the computational evaluation of these signs, i.e. WP3, WP4, WP5, *(ii)* to the integration of the extracted descriptors, i.e., WP6, and *(iii)* to user applications, i.e. WP7. WP2 specifications will serve also to WP8 for the activity related to the hardware platform of the Mirror.
2. *Methods and system development*: for each sub-component, research and development will occur within any of WP3, WP4, WP5, WP6, and WP7.
3. *Methods and system integration*: two levels of integrations will occur. WP6 will realize a *semantic* integration of the outcomes of WP3, WP4 and WP5, while a *syntactic* integration of all the sub-systems will occur in WP8.
4. *Methods and system technical validation*: this will occur in WP8 and will have an increasing level of complexity.

The output of each phase will be inputted to the subsequent one and will be used by the previous one as a feedback.
The three cycles will consist in the following activities:

(i) After the first release of the semeiotic model and system requirements (Milestone MS1), the core methods and sub-components of WP3-5 will be studies, developed and verified separately along with parts of the methods of WP6 and 7 (Milestone MS2).

(ii) Then, according to feedback of the preceding cycle, the semeiotic model, system requirements and design as well as the core methods will be refined. The semantic integration will start and a partial integration of the Wize Mirror will be released. At the end of the second cycle, the semeiotic model cannot be modified anymore and a first prototype of the Wize Mirror sub-components as well as a partially integrated Mirror will be available (Milestone MS3).

(iii) In the end, last adjustments to the Mirror design are applied (Milestone MS4) and all the sub-components, updated accordingly, will be integrated into a consolidate Wize Mirror, which will be released after a concluding, internal testing (Milestone MS5).

At the end of these three cycles, the "external" cycle will start for the wellness semeiotics validation. During this period, the prototype will be employed in a small clinical trial to test its features in terms of reproducibility and to obtain a proof-of-concepts of the model. Feed-back will be collected for a final fine-tuning of the system. This will specifically concern the virtual individual's model and the evaluation of the wellness index. Obviously, integration activities of WP8 will take place to apply last refinements. At the end, the validated Wize Mirror will be available (Milestone MS6).

This organization of activities is reflected in the timing of the Work Packages: these do not follow a sequential waterfall approach, but they run in parallel, exchanging intermediate results, to produce the final outcome by cyclical refinements.
Fig. 13 shows in more details WP relations at task level.

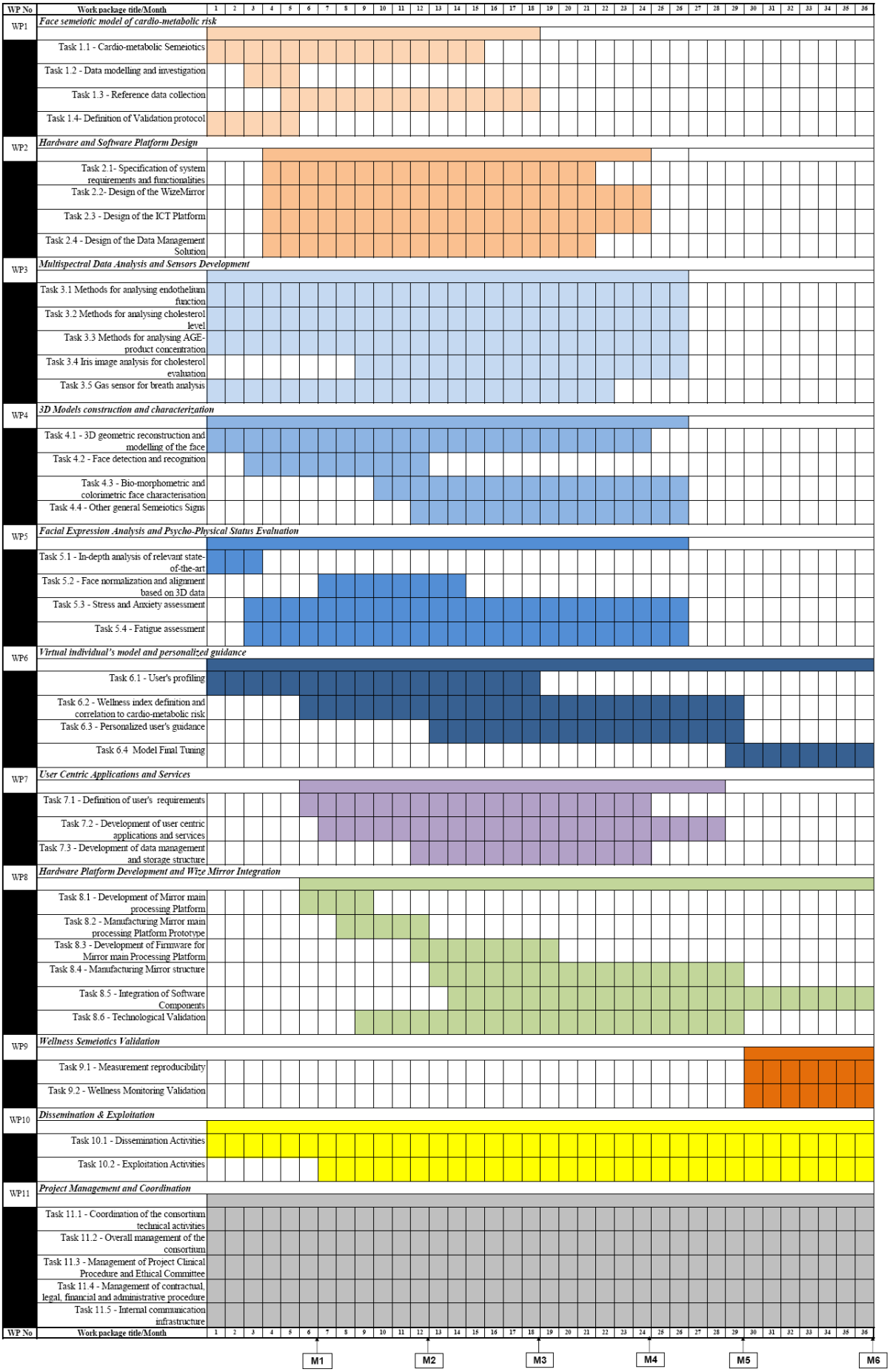


Fig. 11. Project GANTT chart

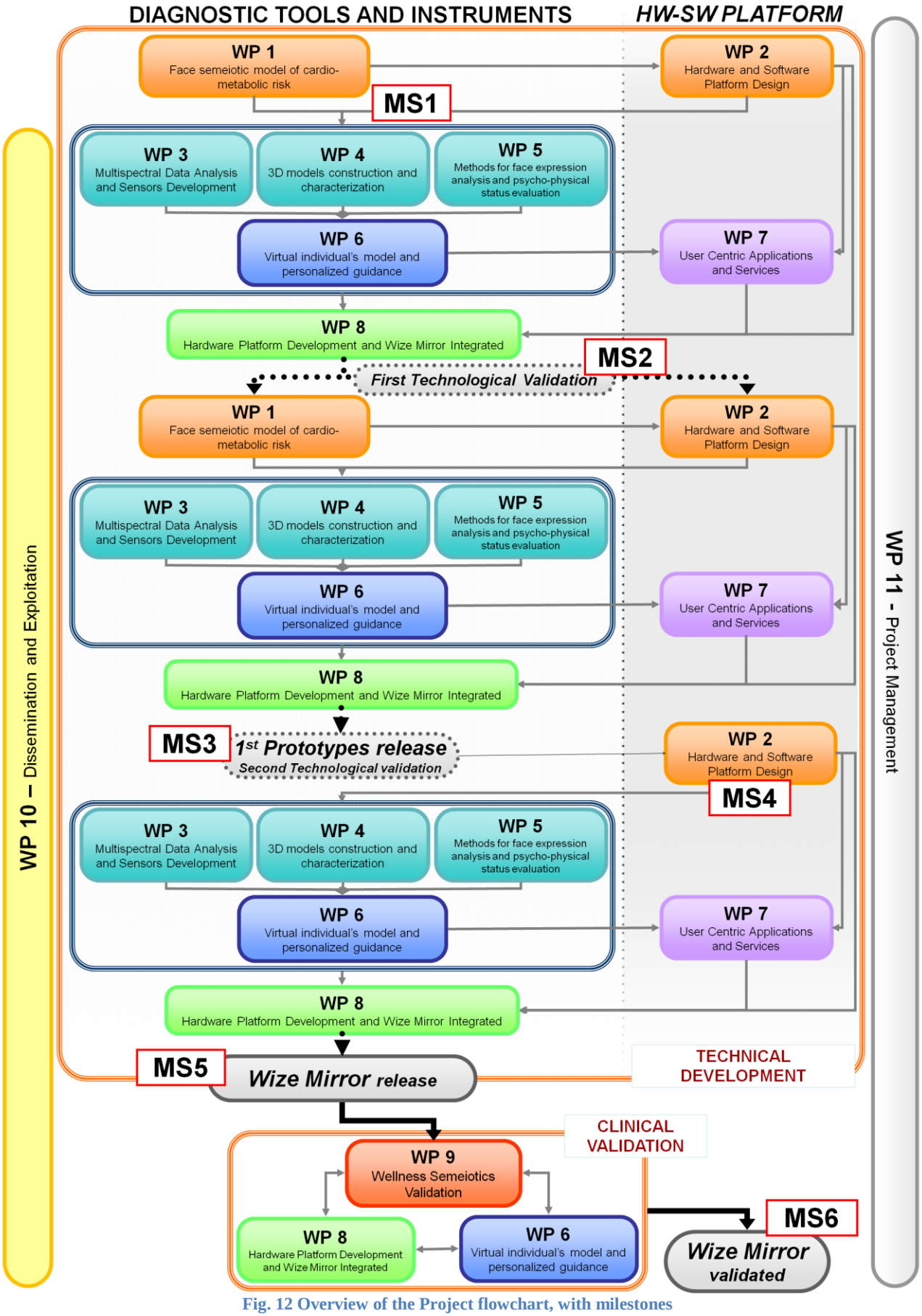


Fig. 12 Overview of the Project flowchart, with milestones

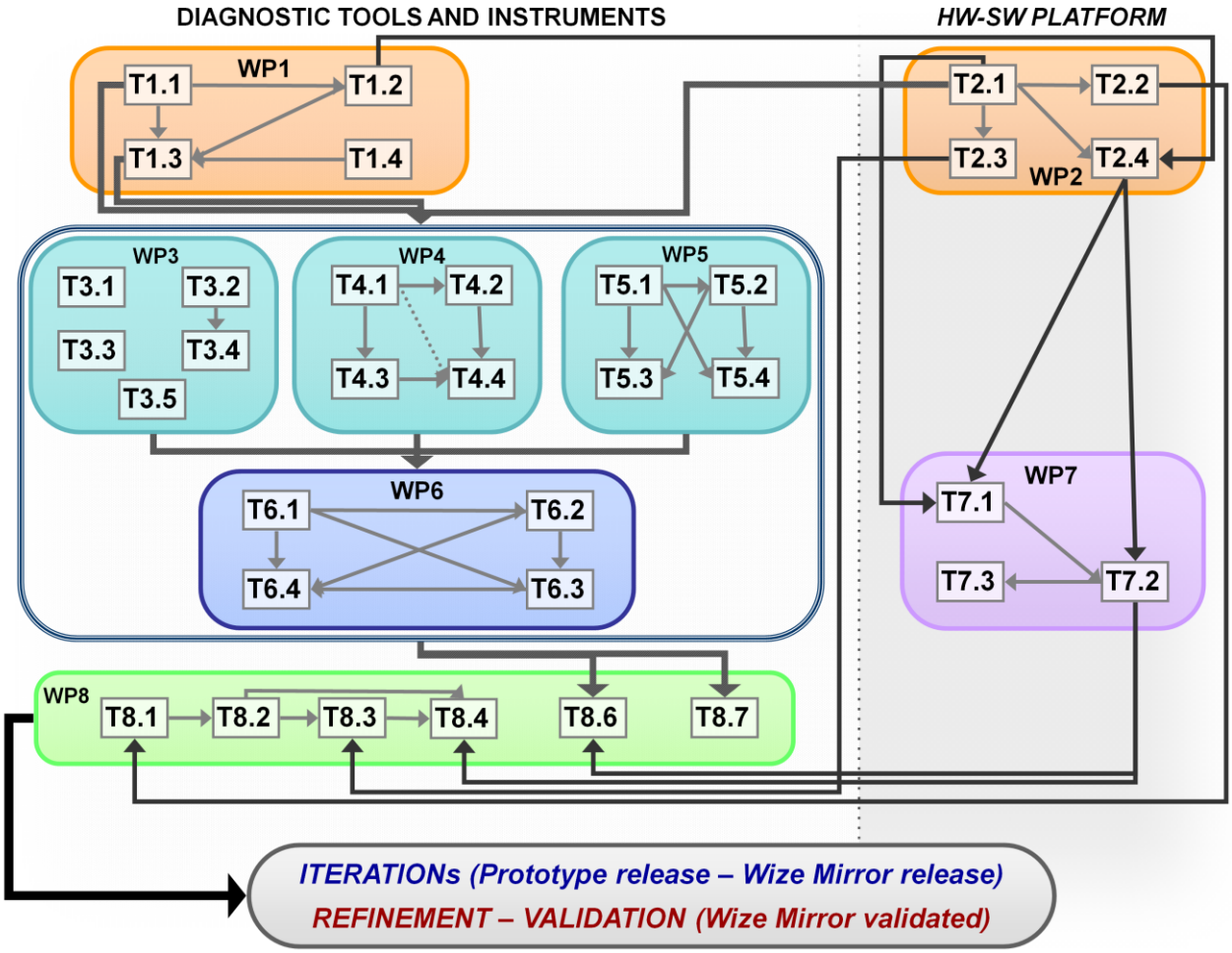


Fig. 13. Flowchart of task interrelation

B1.3.4. Effort Distribution

The following figures (Fig. 14, Fig. 15) highlight the effort distribution among WPs and partners, respectively.

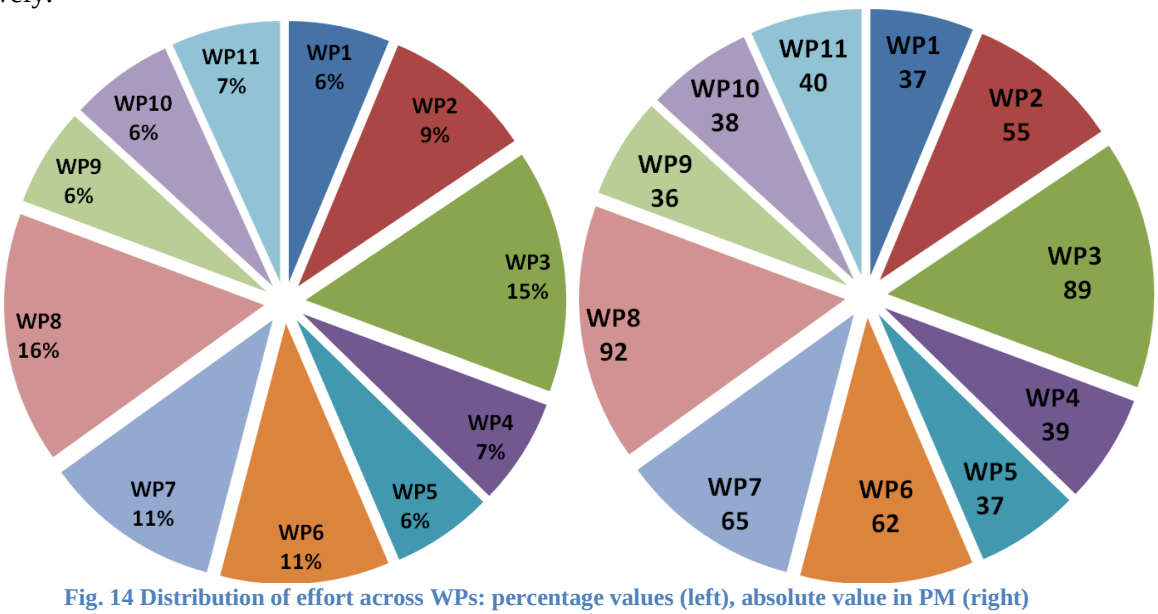


Fig. 14 Distribution of effort across WPs: percentage values (left), absolute value in PM (right)

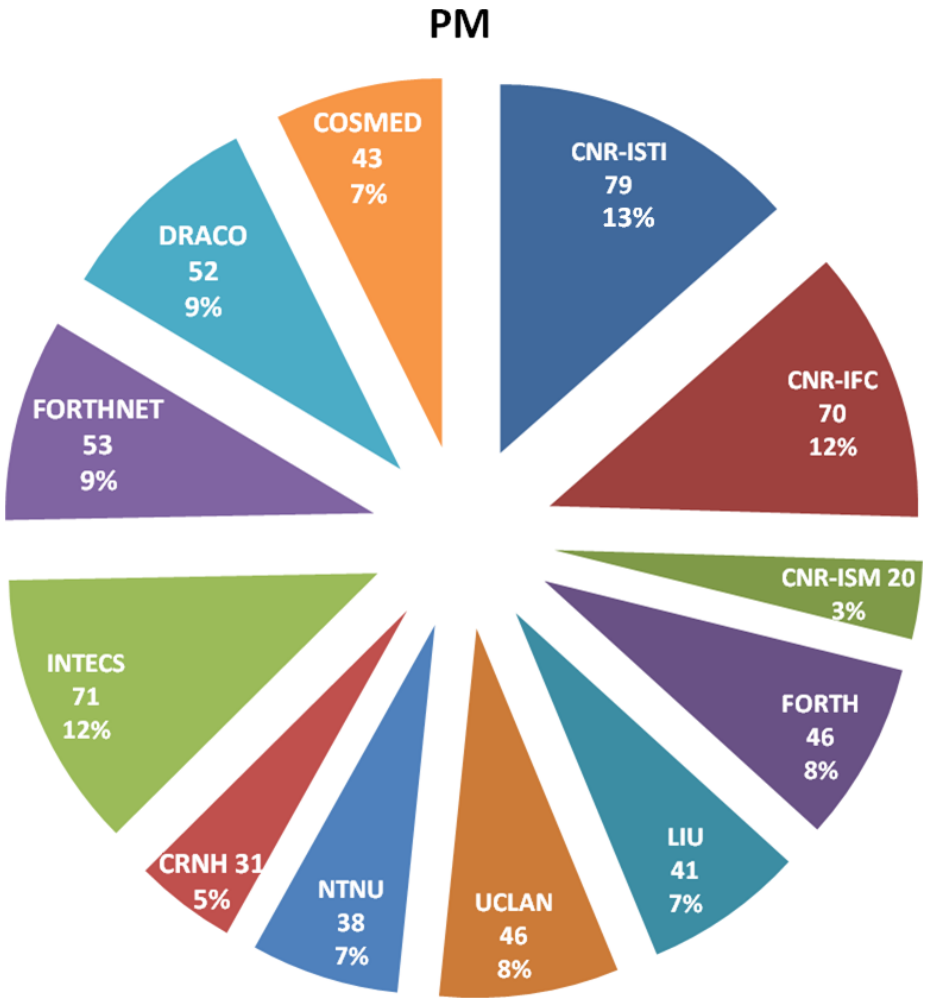


Fig. 15 Distribution of effort per Beneficiary in total PM and relative percentages

B1.3.5. Technical risks analysis and associated contingency plans

Each of the Work Packages has been carefully planned and the Partners are committed to minimise risks that milestones or deliverables will be delayed or not achieved. However, some uncertainties are intrinsically related to the research nature of the Project, since the topics and methodologies addressed are still live research themes. Table 2 shows the technical risks identified and the contingency plans. Nontechnical risks are analysed in Section B2.1.9.

Table 2. Analysis of risks and mitigation actions

Technical Risks	Prob.	Severity	Risk summary and contingency plan
Data collected from the volunteers in task 9.2 are insufficient to describe clinically evident improvement of physical, psychological and metabolic scores thus limiting the power of the data analysis	low	medium	This is a very low risk because we expect that, on the basis of clinical trials, about the 50% of volunteers may reach the target of their programs. This outcome may be useful for differentiating cohort of results in the validation analysis.
Changes on the design throughout the Project duration	low	low	The hardware and software design that will be used for the implementation of the proposed SEMEOTICONS device should be defined at the early stages of the Project within the WP2 framework. This will assist the Consortium in having a more clear view of what is important and what needs to be implemented, as well as how all the components are interconnected. Despite the above, it should be considered that a small number of already defined and designed components might be altered during the development stages, in order to comply better with the desired Project results.
Multispectral data analysis shows that AGE-related products cannot be detected	medium	low	Detecting AGE-related products in skin by using autofluorescence in the presence of ambient light could be very difficult. Existing technique utilizes optical methods but when shielding ambient light due to a weak signal. The cameras ability to integrate light from larger areas will be a benefit. Choosing a sensor with high sensitivity and large dynamic range will be important to minimize this risk. Moreover, the Project comprises an accurate investigation activity aimed at assessing the best sensor apparatus to multispectral analysis.
Facial heating causes too little temperature increase to be useful for multispectral data analysis	medium	low	Distant heating will impose a technical difficulty in order not to overheat the skin. Local heating during skin contact utilizes feedback to regulate heating to e.g. 44 ^{o}C. Distant heating focusing and remote detection and control of skin temperature can possibly solve the problem.
Some of the computational descriptors does not consistently comply with the expected semeiotic face model	low	low	The overall strategy of the Project will consist of a continuous cycle develop-test-refine which will ensure the prompt identification of missing correspondence to medical requirements and expected outcomes of the methods. An erroneous or inaccurate outcome will only partially impair the overall development, since it will be timely detected and suitably corrected thanks to a strict interaction between the clinical and ICT Partners. Furthermore the strict cooperation among technical and clinical Partners will ensure the low probability that this risk will happen.

Technical Risks	Prob.	Severity	Risk summary and contingency plan
Some of the face signs cannot be evaluated with the sensor suite or estimation is not reproducible or not effective	medium	low	This risk can mainly concern the descriptors extracted from the face multispectral images. Indeed, multispectral analysis of cutaneous and sub-cutaneous skin tissues is a challenging research activity of the Project. However, the consolidated expertise of the Partners involved in this activity ensures that interesting and effective results will be obtained. Moreover, an extensive research activity will be carried out in WP3 and, preliminary in WP1, to define the best conditions to obtain successful results. Finally, in the worst case, the lack of one or few descriptors will compromise neither the evaluation of the virtual individual's model nor the validity of the wellness index. Since, thanks to the Partners' expertise in the main methodologies involved, the majority of the descriptors will be easily estimated. This that risk will have a very low impact on the overall structure.
Wize Sniffer device: Trouble for repeatability, classification and comparison of performance between commercial and Electrospun nanofibers sensors	low	medium	The overall strategy of the design of Wize Sniffer is based on a cluster of sensors any one selected for sensing a specific volatile gaseous species. Errors could be given by the inaccurate association of selected gas species to cardio-metabolic risk factors.
Presentation of personalized guidance messages will be a critical one for friendless and acceptance of Wize Mirror	low	low	Personalised Coaching messages will be generate according to Wize Mirror findings interpretation. They represent the communication channel for self-monitoring the failure of this target may compromise the functionality of the device. The global risk is probably low, thanks to the accurate designed and development of but in this case a recursive tuning activity may be request for obtaining the best result. In this case a suitable resources reallocation and an extension of time need for complete the WP9 might be required.
Unavailability of suitable SW interface of HW devices during the start-up phase of the SW development	low	low	To reduce this risk, we will make accurate estimations of the SW interface complexity taking into account the HW constraints and we will keep track of the progress through several checkpoints during the design flow.
Verification platform hardware not functional	low	medium	The risk that the verification platform PCB does not work is considered very low due to the Partner experience. Any problems can be identified in due time. If necessary, Project resources will be relocated in order to fix the problem.
Delays due to allocation of electronic components	low	medium	Due to the electronic component market, there is a risk due to manufacturers does not want to keep stock of components. We will do our best to find the component and use equivalent components in case of allocation.
Delays due to integration problems	low	medium	There is a risk that all the inputs for the integration do not arrive on time. If necessary, Project resources will be relocated in order to fix the problem.
Problems with test applications	low	medium	There is a risk that during the test and validation something breaks. Partners are committed to act and replace parts or modify mirror applications to perform test without problems.
Volunteer drop-out during the wellness semeiotics validation which may cause an insufficient number of observations	medium	low	We foresee that this is a low risk because the trial is totally non-intrusive; the time requested for experiment is short and achievable in out-patient laboratory. This risk may be compensated by an increase of number of subjects. In this case a suitable resources reallocation and an extension of time need for complete the WP9 might be required.

B2. IMPLEMENTATION

B2.1. Management structure and procedures

The SEMEOTICONS management structure is designed to drive the efficient implementation of the Project's activities as defined in the work plan, to foster the achievement of its objectives, and to ensure the completion of its contractual obligations vis-à-vis the European Commission and among the Consortium members.

We recognise that for Projects involving geographically separated participants, a major risk for failure is the lack of coordination. Accordingly, our approach to Project management consists of a comprehensive organizational plan together with clear reporting procedures to ensure efficient Project quality and cost control, as well as visibility for all Project Partners and external contacts throughout the lifetime of the Project. Special attention is brought into linking all Project components and maintaining smooth communication between the Partners.

A management structure that ensures close control has been established and well-defined objectives have been set for all Partners to ensure agreement even before the Project begins. This structure has been successfully applied in other projects.

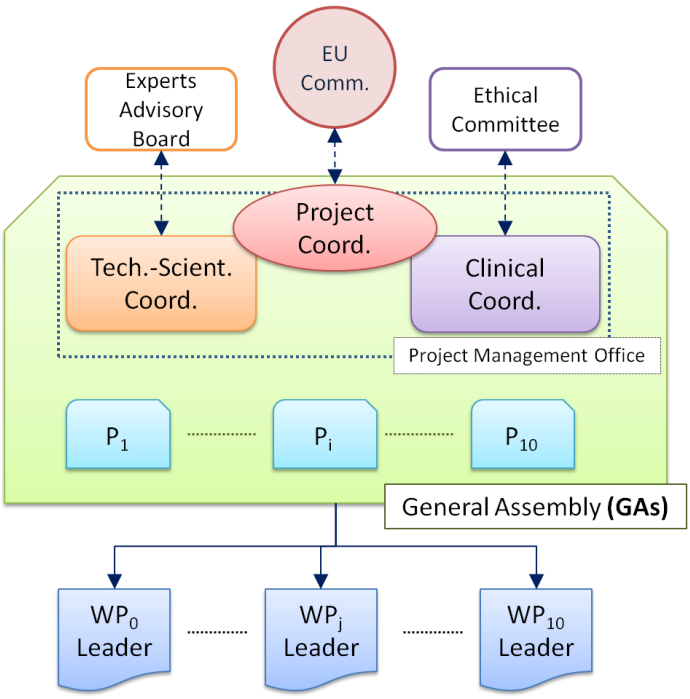


Fig. 16 SEMEOTICONS Management Structure

Project management in SEMEOTICONS relies on three principles:

- The creation of a simple and effective management structure, which incorporates technical, scientific, administrative and financial coordination, and allows for quick decisions;
- The establishment of efficient mechanisms based on state of the art management instruments and on a good information flow for the entire team, to anticipate problems and quickly resolve potential conflicts;
- The definition of clear responsibilities for self-contained subsets of work to minimise overall risks.

In Fig. 16 the overall structure of SEMEOTICONS Management Structure is reported. The responsibility of each body or role in the organisation is defined in the following paragraphs.

B2.1.1. The General Assembly and the Management Office

The Project's overall management structure is based on different entities, the main one is the General Assembly (GAs), who will manage the SEMEOTICONS Project and is chaired by the Project Coordinator (PC). The GAs consists of representatives from all Partners. Each Partner group, including the Coordinator, will be represented by his Principal Investigator (or his deputy).

The *Project Management Office* consists of a team grouping the Project Coordinator, the Scientific Coordinator and the Clinical Coordinator.

In order to ensure that the Project activities, conducted at the various sites, are fully coordinated into a coherent whole, the Consortium appoints as Project Coordinator Drs. Sara Colantonio (CNR); the PC will be administratively and organizationally in charge of the overall management of the Project. The PC will be responsible for the correct execution of the contract, is a member of the GAs, and is the main interface to both the European Commission and the outside world. Her tasks comprise in the definition, according to the specifications identified in the Project work plan (further ratified in the Technical Annex of the EC Contract) of strict procedures for problem approaching and solutions, system integration and overall management, with particular care to orchestrate Project outcomes and demonstrations, even in their early version.

In details, the PC will be responsible for:

- Chairing the General Assembly;
- Monitoring compliance by the Partners with their obligations;
- Setting-up a collaborative work environment (including e-Conferencing) accessible to all Partners;
- Keeping the address list of Members and other contact persons updated and available;
- Organising a quality review process and submitting reports and other deliverables (including financial statements and related certifications) to the European Commission;
- Transmitting documents and information connected with the Project to and between Work Package Leaders, as appropriate, and any other Partner concerned;
- Organising the Project review meetings in coordination with the EC Project Officer;
- Administering the Community financial contribution and executing the payments to Partners;
- Providing, upon request, the Partners with official copies or originals of documents that are in the sole possession of the Coordinator when such copies or originals are necessary for the Parties.

Along with the PC, a Technical-Scientific Coordinator (TSC) will be in charge of the planning, management and monitoring of the research and technological development activities, including the coordination of scientific and technical work between Work Packages. The Consortium appoints Dr. Giuseppe Coppini (CNR) as Technical-Scientific Coordinator. In particular, the TSC will be responsible for:

- Monitoring the Project progress on a day-to-day basis for continuous rating of the achievements, objectives, tasks, Work Packages, and the entire Project;
- Assessing the scientific contribution of each individual Project Partner;
- Ensuring a smooth and efficient collaboration of all Partners;
- Chairing the Management Office;
- Chairing the SEMEOTICONS External Experts Advisory Board;
- Leading the scientific dissemination activities;
- Running the quarterly risk management activity;
- Checking the delivery of documents and information regarding the SEMEOTICONS Project within the agreed time;
- Driving the process for updating the description of work according to Project, science and technology evolution.

Finally, the Clinical Coordinator (CC) will be in charge of the integration between technical activities and user and medical requirements in order to optimize the results in each field in relation with objectives and ethical issues. Moreover the CC closely collaborate with the TSC for the management of scientific and dissemination activities. In particular, the CC will be responsible for:

- Monitoring the Project progress in order to evaluate the impact of the achievements on the expected results and ethical issues;
- Monitoring the coherence between data analysis and coaching messages;
- Monitoring the integration between the technical and clinical Partners;
- Close collaboration with TSC for risk management activity, particularly, in relation to user safety and privacy;
- Charing of the SEMEOTICONS Ethical Committee;
- Close collaboration with TSC for updating the description of work according to state of the art and emerging clues in cardio-metabolic risk prevention and self-monitoring.

The Consortium appoints M.D. Paolo Marraccini (CNR) to act as the Clinical Coordinator.

The GAs role is to make high-level management/scientific decisions concerning every aspects of the Projects life, in reference to strategic and technical issues.
The GAs is responsible for:

- ⇒ monitoring the progress toward the objectives of the Project;
- ⇒ dissemination decision;
- ⇒ important technical decisions and options;
- ⇒ reviewing or amending the work plan;
- ⇒ interfacing with Work Package leaders.

The GAs will meet at least six times during the Project, coinciding with the organization of Project meetings. It will be called at the Project start for the first time, coinciding with the Kick-off Meeting. Extraordinary

meetings will be called if required. It may also be called together at the request of the PC or one of its members. The Partners commit to authorize their delegates to make decisions.

B2.1.2. Work Package Leaders

Each Work Package will be led by the WP leader (i.e. identified in each WP Table), who is responsible on the work associated with the relevant Work Package as have been identified within the Project. Each Work Package Leader will be the main interface of its WP towards the GAs, and will be responsible of the leadership and coordination of the tasks activities involve in the WP.
Decision-making is under the GAs responsibility; its role is to decide on the high level management issues, including mainly technical, financial, exploitation, dissemination, planning and control issues. The GAs will cope with the collective responsibility of the Consortium for the strategic implementation of the Project, including where the Partner financial liability is concerned.

B2.1.3. External Expert Advisory Board

Considering that the current Project has the potential to deeply impact society and industry, it is important to accurately organise the activities so as to maximise the chances for a successful exploitation of results. The SEMEOTICONS Consortium believes that it is particularly important to pursue scientific excellent, since the beginning of the Project. In this view, SEMEOTICONS will set up an external Experts Advisory Board (EAB) whose mission will be:

- To monitor the progresses (and help assessing the risks) with respect to the major Project objectives and the scientific quality of the work carried out, acting as a peer-review council,
- To foster innovation, by advising the Management Office for facilitating the adoption of SEMEOTICONS resulting technologies by the different target industrial sectors, and,
- If needed, to suggest improvements in the work plan for maximal impact.

The EAB will interact directly with the GAs with an external.
The following candidates have confirmed their availability and will be part of the EAB:

- Prof. **Paolo G. Camici**, Professor of Cardiology and Headmaster of the High-specialization School of Cardiology at Università Vita Salute San Raffaele, Milan
- Prof. **Hans J.A. Romijn**, Professor of Internal Medicine at the Faculty of Medicine of the University of Amsterdam. He is particularly focused on Endocrinology and Metabolic Disorders
- Prof. **A. Enis Cetin**, full Professor of Electrical and Electronics Engineering, at the Bilkent University, expert in image and signal processing, Human-Computer Interaction using vision and speech
- Prof. **Tamás Szirányi**, Scientific Adviser with the Computer and Automation Institute of Hungarian Academy of Sciences, Head of Distributed Events Analysis Research Group, Professor with the Péter Pázmány Catholic University, Department of Information Technology. He is particularly expert in image analysis, biometrics in identification, multiple camera systems, and pattern recognition.

The main purpose of this board will be to provide long-term vision and guidance for the Project. In this frame, the TSC will receive and request suggestions from the EAB and act as an interface between the EAB itself and the GAs. A memorandum of Understanding will be put in place, defining the rights, duties and expectations between the EAB members and the SEMEOTICONS Consortium. No remuneration is planned for the EAB members, but travel expenses will be covered. Furthermore the GAs will organize at least two plenary meetings inviting also the EAB using a specific budget for this scope; those meetings will serve also as an important dissemination activity

B2.1.4. Consortium Agreement

The Consortium Agreement will cover the relationship as well as the rights and obligations of the different Partners with respect to each other. These may include (but not exhaustively) the liability of Partners, Partner withdrawal procedures, the settlement of disputes, the responsibilities of Partners regarding accurate and timely reporting of difficulties, confidentiality (including the difference between foreground and background information), IPR (ownership and exploitation of results, including arrangements for licensing). The CA will be in force at the starting date of the Project.

B2.1.5. Ethical Committees

The research that we will be carried out in SEMEOTICONS may lead to questions that are related to Ethics. The SEMEOTICONS Consortium will set up an Ethical Committee as a consulting body to help defining an

appropriate research approach related to potential ethical questions. The Ethical Committee will also address possible legal issues. The overall treatment of ethical issues is reported in Section 4.
Moreover, for the Wellness Semeiotics Validation activity (WP9), the Consortium will apply to local Ethical Committees of each validation site in order to require the necessary approval of the validation protocol that will be followed.

B2.1.6. Communication strategy management

A Project Archive will be set up and maintained at the Coordinator's site, and Partners will be asked to deliver a copy of all relevant documents to this archive.
Concerning management activities, in order to cover all aspects related to these issues as well as quality assurance, the following procedures have been identified for the achievement of a proactive Consortium activity management:

- Describe in detail the quality assurance methodology and guidelines; define the quality objectives;
- Define roles and responsibilities to ensure successful progress of the Project;
- Check the interaction between the Consortium members during the work execution;
- Check the progress of the work, on a regular basis;
- Provide a detailed and consensual Project plan;
- Allocate works and tasks and detailed dependencies and outputs, as milestones and deliverables;
- Assist the maintenance of process quality by increasing the visibility of Project progress to the Partners;
- Detail the documents work flow between the Partners;
- Set out editorial standards for Project deliverables contents.

B2.1.7. Information Flow

The information flow among Partners will be facilitated through a number of means:

- There will be a **website** established and maintained for the Project, also including a private section that can be accessed only by the Project members. All the Partners will be given read/write access to both the public and the private sections of the website.
- The Coordinator will establish a **Project database** for internal reports, deliverables, publications and relevant reports accessible by all Project Partners through the website.
- Private **mailing lists** will be created and maintained by the Coordinator: a general low-traffic list for institutional and urgent communications, one list for each technical WP for technical discussions, one list for financial and reporting issue.
- Project **meetings**.

WP meetings will be held every two months in order to review the progress of the Project, evaluate its conformance with the contractual obligations and plan future activities. In addition, smaller Work Package meetings focused on specific Work Packages may be also organized by the task leaders, if required. Meetings will be combined with milestones and deliverables to obtain the optimum performance evaluation mechanisms. To minimize unnecessary travelling, teleconferences will be used as a time and cost efficient alternative to physical meetings. The decision on whether to hold a teleconference or physical meeting will be taken during the previous meeting by the WP leader, depending on the actual status of the technical activities in the WP and criticality of deliveries. In any case, we foresee at least two physical meetings per year per WP.
The location of WP physical meetings will be selected in accordance to the principle of even distribution of hosting activities. The kick off meeting will take place in the Coordinator's premises. To foster collaboration between WPs, physical meetings will be hosted in the same premises and overlapping dates, whenever possible, as facilitated by the General Assembly.
This requirement will be mandatory for the physical meetings associated to milestones with multiple WPs involved. To improve the efficiency of meetings, an agenda with all necessary documentation or other items will be provided to all the participants by the WP leader. After every meeting the minutes will be circulated by the WP leader and reviewed by all the participants.

B2.1.8. Quality management and reporting

As far as the Quality Control (QC) is concerned, the PC will act as the Quality Assurance Manager (QAM). The QAM will handle the specific task of quality assurance of the Project results. The QAM will establish and maintain close liaisons with the TSC. The QAM will have the tasks of formulating the appropriate prototype evaluation scenarios and compiling the results of the technical evaluation scenarios, describing the faults encountered and the measures taken to rectify or overcome them. While the Work Package leaders are responsible, internally, for the production of the deliverables, the ultimate responsibility lies with the PC to ensure that properly QA deliverables are submitted on time.
The SEMEOTICONS Project Quality Management is a key objective. A Quality Management Report will be produced at the beginning of the Project to ensure overall quality of activities and reporting.
Project Reporting: In addition to any ad-hoc correspondence which may be necessary due to special circumstances, the following periodic report shall be submitted to the EC Project officer:

1 Four Month Monitoring Reports (from the Project start onwards)
2 Periodic Progress Reports (submitted with each cost statement)
3 Review Reports (submitted on EC request)
4 Final Report and Quality Assurance Reports.

B2.1.9. Non-technical risks and associated contingency plans

Every advanced research Project will have to live with uncertainty and cope with it to a greater or lesser degree. Whilst we can identify risks using our experience and imagination, getting those risks into proportion proves to be difficult. It becomes more challenging when there are solutions that deal with more than one risk, or risks that need more than one mitigation action. Consequently, a quarterly risk management activity will be developed within the Project.
Risk items in the deliverables will be identified and described. The risk items are first classified according to probability of occurrence (low, medium, high) and to severity (low, medium, high). The quarterly risk management cycle is found in the diagram shown in Fig. 17. The result of this activity is a continuously revised risk management report assessed at every Management Office meeting. The mitigation plan (see Fig. 17) will feed into the re-planning activities.
Thus, while the analysis of the technical risks can be found in Section 1.3, the following Table 3 shows the identified non-technical risks and the envisaged contingency plans.

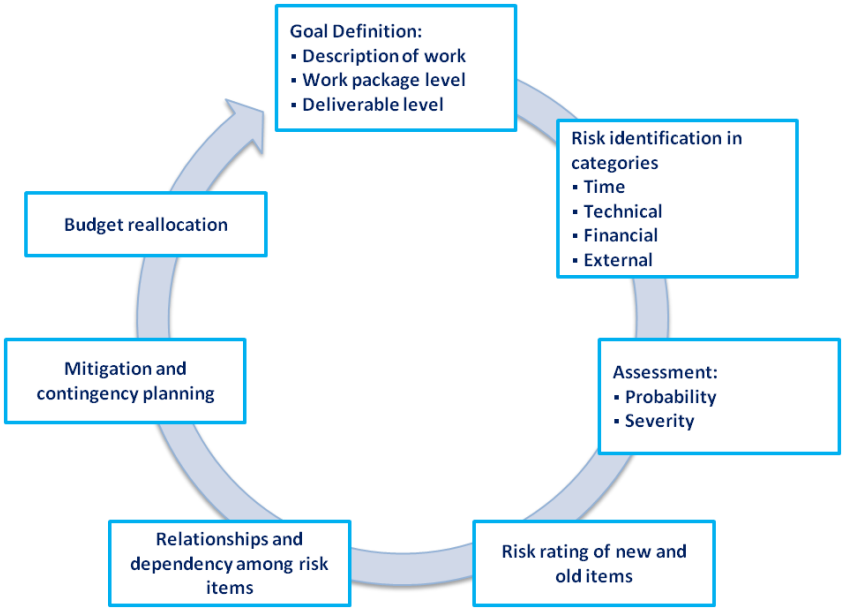


Fig. 17. Mitigation plan for technical risks

Table 3 Analysis of non-technical risks and mitigation actions (Prob stays for Probability, Sev for Severity)

Risk	Prob	Sev	Summary and contingency plan
A Partner leaves the Project	low	medium	If a Partner leaves the Project, this would not have a disruptive effect since the Consortium is well balanced and tasks allocated to a Partner can be carried out by other Consortium members. Actually, for each activity, two or more Partners share similar competences. Furthermore, the Consortium and the management structure are flexible, in order to include new Partners, if necessary.
Partners cannot agree on specific	low	low	Management procedures for decision making and conflict resolution will be applied. However, the target is to achieve consensus among Consortium members for all unresolved issues.

Risk	Prob	Sev	Summary and contingency plan
issues			
Key staff member leaves or is temporarily unavailable	low	low	Consortium Partners are involved in the related areas with more than one staff member, which ensures an efficient substitution of a participating expert. Furthermore, the Project has a strategy of technical excellence in given disciplines spread across the Partners, ensuring immediate substitution the staff member
Personnel working on the Project reallocated to other activities	low	low	Along the duration of the Project, it might happen that the people working on the Project are allocated to different tasks. If this happens, we can reallocate new people into the Project. This will take some overhead time to get new people familiar with the work, but the impact on the Project should be minor.
Key milestones or deliverables delayed	low	low	The technical expertise and high international Project management expertise of the Consortium make it highly unlikely that this risk will materialize. If the problem occurs, the management team will make adjustments in the work plan, in order to make sure that crucial elements of the Project work are not affected.
Failing to meet technical and quality (high impact) results	low	low	Apply and continuously refine risk, quality and Project management procedures defined in Section 2 of the present document. The impact of this risk is significantly reduced since the Consortium is well balanced with the needed skills, know-how and competences, and the Project structure consists of clear objectives and well defined interfaces and responsibilities
Insufficient equipment, tools and resources	low	low	We will do our best to find the component and use equivalent components in case of allocation.
Delivery of required hardware or equipment suffering long delays	low	low	The public institutions like Universities and Research Centres are regulated under different law frameworks at each EU national state, as far as purchases of hardware equipment are concerned. Depending on the amount that is due to be spent, this could imply a direct purchase after receiving a number of different offers or a public tender if the amount exceeds a certain limit. A public tender is typically a lengthy process that also requires a certain administration overhead for the people that are involved. Therefore, in the case of public institutions, it has to be studied from the beginning of the Project the law framework that regulates the purchases of hardware equipment in each EU country. It has also to be analysed the projected cost of the hardware that has to be acquired by receiving informal offers from different providers. Whenever a public tender is required by law, a careful planning has to be deployed to fit the Project milestones. An early commencing of the hardware purchase process is a way to resolve this issue.
Delays in recruiting research and technical staff	low	low	Due to internal policies, call for recruiting can be issued only after the funds are transferred to the institutional Partner. This may cause delays in issuing the calls and thus in recruiting the personnel needed for carrying out Project activities. In this case, more effort will be initially charged on permanent staff so as to fulfil the contract agreement.
Changes of requirements during the Project	low	low	The functional and non-functional requirements for the implementation and integration of the proposed SEMEOTICONS components should be defined at the early stages of the Project. This will assist the Consortium in having a more clear view of what is important and what needs to be implemented for the Project. Despite the above, the agile methodology to system development ensures that requirements can be altered at a certain extent, to comply better with the desired Project results. The cyclical development and refine approach will take care of these adjustments

B2.2. Individual participants

Name	**ITALIAN NATIONAL RESEARCH COUNCIL**						
Country	Italy	**Type**	Academic	**Short Name**	CNR	**Partner N.**	1
Organization description	The Italian **National Research Council** (**CNR**) is the main public research organisation of Italy, whose aim is to perform, promote, spread, transfer and improve research activities in the main sectors of knowledge. The CNR consists of about 100 different research institutes that span from human sciences to engineering sciences. In SEMEOTICONS, three CNR units are involved belonging respectively to: 1. Institute of Information Science and Technologies (ISTI), Pisa 2. Institute of Clinical Physiology (IFC), Pisa 3. Institute of Structure of Matter (ISM), Rome The units have very distinctive role in the activities of the Project. For this reason, details on each unit are given below.						
UNIT 1: CNR-ISTI							
UNIT Name	**Institute of Information Science and Technologies**						
Unit Description	The CNR-ISTI unit is led by the "Signals & Images" Lab, a research group working in the fields of signal acquisition and processing, image understanding, artificial intelligence, medical imaging, knowledge representation and modelling, high performance and distributed computing. The general goal of the Lab is to increase the knowledge in the above mentioned fields, in both theoretical and applicative contexts. This is achieved by studying and developing models, computer-based methods and machines for the formation, elaboration, analysis and recognition of images and signals, and by applying these methods and techniques to several sectors of the public and private society having strategic, scientific and technological interests. Around 30 people are working at the SI Lab, both researchers and technologists and engineers, covering expertise in computers science, engineering, physics and mathematics. The lab aims at developing its activities dynamically, fully becoming a part of the national and international, academic and industrial network in the field of automated vision and information technologies.						
Unit Relevant skills and previous experiences	The Lab has actively participated in several EU Projects since the 80's (both as Partner and coordinator) (BRITE, ESPRIT, CRAFT, INTAS, FP4, 5, 6 and 7). During the last years, the Lab has been involved in three Projects related to the provision of decision support services, namely FP6 Heartfaid, FP7 Chronious (www.chronious.eu/) and FP7 Argomarine (www.argomarine.eu). In connection with these activities, the Lab has gained strong expertise in designing, developing, integrating and validating decision support systems for disparate applicative contexts. In particular, in Chronious, decision support services were developed for the provision of personalized health system monitoring in the COPD and Renal Insufficiency domain. In addition, methods for medical-clinical knowledge representation, formalization and authoring have been studied and are current research fields of the lab. Great attention has always been paid to interoperability and semantic web technologies, also actively participating to W3C initiatives. Other core activities of the Lab include information systems, sensor networks for home and environmental monitoring, as well as interactive multimedia environments for rehabilitation and education.						
Relevant Publications	- Colantonio S., Esposito M, Martinelli M, De Pietro G, Salvetti O. A Knowledge Editing Service for Multisource Data Management in Remote Health Monitoring. IEEE Transactions on Information Technology in Biomedicine 16(6): 1096-1104, 2012 - Coppini G., Favilla R., Moroni D., Salvetti O., D'Errico L., Salituri F., Ciardetti M., Schlueter M., Faggioni L., Coceani M., Mazzarisi A., Bianchi M., Bartolozzi C., Marraccini P. Epicardial fat volume assessment in cardiac CT. In: International Journal of Computer Assisted Radiology and Surgery. Abstract, vol. 7 (Supplement 1) pp. 40 - 40. Springer, 2012 - Chiarugi F, Colantonio S, Emmanouilidou D, Martinelli M, Moroni D, Salvetti O. Decision Support in Heart Failure through Processing of Electro- and Echocardiograms. Artificial Intelligence in Medicine, 2010, vol. 50, issue 2, 95-104						
Key personnel	**Sara Colantonio** M.Sc. (Hons.) in Computer Science and Ph.D. in Information Engineering from the University of Pisa, Italy, researcher at SI-Lab, CNR-ISTI. In 2004 and 2006, she received a grant from Finmeccanica for studies in the field of image categorization with applications in medicine and quality control. Her research interests include machine learning, image understanding and decision support theory. She is co-author of more than 40 scientific papers and co-editor of a special issue on "Intelligent signal and image processing in eHealth." She is currently involved in a number of European research						

	Projects regarding image mining, information technology, and clinical and environmental decision support systems. **Ovidio Salvetti**, Director of Research at CNR-ISTI, is working in the fields of image analysis and understanding, multimedia information systems, spatial modeling and intelligent processes in computer vision and information technology. He is co-author of four books and monographs and more than three hundreds technical and scientific articles and also owner of ten patents regarding systems and software tools for real-time signal and image acquisition and processing. He has been scientific coordinator of several National and European research and industrial Projects, in collaboration with Italian and foreign research groups, in the fields of computer vision, multimedia semantics and high-performance computing for diagnostic imaging. Member of the Editorial Boards of the International Journals Pattern Recognition and Image Analysis and Forensic Computer Science, of IEEE and of the Steering Committee of a number of EU Projects. He is Head of the ISTI 'Signals and Images' Lab. **Davide Moroni**, M.Sc. in Mathematics honours degree from the University of Pisa in 2001, dipl. at the Scuola Normale Superiore of Pisa in 2002, Ph.D. in Mathematics at the University of Rome 'La Sapienza' in 2006, is a researcher at the Institute of Information Science and Technologies of the National Research Council of Italy, in Pisa. His main interests include geometric modelling, computational topology, image processing and medical imaging. At present he is involved in a number of European research Projects working in discrete geometry and scene analysis. He is co-author of more than 30 scientific papers. **Gabriele Pieri**, M.Sc. in Computer Science from the University of Pisa in 2000, is researcher at the "Signals and Images" Laboratory at CNR-ISTI working in the field of image acquisition and analysis, tracking systems, internet and communication protocols management. His main interests include machine learning, industrial diagnostics and imaging, surveillance automatic systems and real-time process control. He was member of organizing committees of workshops in the field of advanced infrared technologies and applications. He is co-author of more than 30 scientific papers. **Francesca Pardini** has been responsible for the administrative management of various EU 7FP Projects, including CHRONIOUS, ARGOMARINE and ARROWS, and various regional Projects (e.g., IPERMOB, THESAURUS). In SEMEOTICONS, she will carry out the administrative management work.
UNIT 2: CNR-IFC	
Unit Name	**Institute of Clinical Physiology**
Unit Description	CNR-IFC is a centre for basic, clinical, technological and epidemiological research. This multidisciplinary translational approach has been the key strategy driving years of collaborations operating on a flexible and problem-solving basis. The main interest of the Institute is in the field of cardiovascular diseases, which are dealt with through a multi-organ and multisystem prospective, covering associated pathologies of the lungs, kidneys, and the neuro-endocrine and metabolic systems. Research is mainly developed in the area of physiopathology and methodology, in which multidisciplinary Projects merge in the fields of experimental and clinical medicine, in line with the tradition of the Institute.
Unit Relevant skills and previous experiences	The Institute actively participated in several EU Projects in the last 20 years. During 2012 CNR-IFC have involved in 27 European Grants, in 4 of them CNR-IFC has the role of coordinator (EVINCI, SENSORART, ARTREAT, DORIAN). The most significant fields of research and expertise of CNR-IFC are: - epidemiology and prognosis of coronary artery disease, - study on insulin resistance and its relationship with cardiovascular disease, - investigation of coronary and multi-distrectual blood flow in animal models and in man, - study on the kinetics of plasma proteins and hormones, - study on relationships between thyroid and heart with particular reference to heart failure - imaging development and clinical research on CT, MRI and PET CNR-IFC is a key clinical user and will participate in all user activities. Their participation is also foreseen to all technical tasks, to ensure the acceptability of the designed solutions and applications.
Relevant Publications	- **Gastaldelli A**, Morales MA, **Marraccini P**, Sicari R. The role of cardiac fat in insulin resistance. Curr Opin Clin Nutr Metab Care. 2012 Nov;15(6):523-8. - Basta G, Del Turco S, Navarra T, Mazzarisi A, Cocci F, Coceani M, Bianchi M,Schlueter M, **Marraccini P**. Inverse Association between Circulating Levels of Soluble Receptor for Advanced Glycation End-Products and Coronary Plaque Burden. J Atheroscler Thromb. 2012 Oct 29;19(10):941-8. - Diciotti S, Lombardo S, **Coppini G**, Grassi L, Falchini M, Mascalchi M. The LoG characteristic scale: a consistent measurement of lung nodule size in CT imaging. IEEE Trans Med Imaging. 2010

	Feb;29(2):397-409.
Key personnel	**Paolo Marraccini, MD,** was born in 1954, in Italy. He graduated in 1978 and post-graduated in cardiology and radiology. His scientific fields of interest are: coronary artery disease, physiopathology of coronary circulation, biotechnology and cardiac imaging. He is currently Research Director of the CNR-IFC, head of cardiopulmonary radiology unit and director of the CNR-IFC site of Milan. He is the author of 85 papers and co-inventor of 4 international patents. **Giuseppe Coppini** was born 1954. He graduated in Electronic Engineering in 1980. He is currently a senior researcher at the CNR-IFC. He has been a contract professor in Biomedical Engineering at Padua and Florence universities. He has been involved in several research Projects in the field of Bioengineering. He is the author of 100 scientific papers. **Amalia Gastaldelli, PhD.** She graduated in Electronic Engineering in 1990, and has 2 Ph.D. degrees (Biomedical Engineering, Human Metabolism). She is a staff researcher of CNR-IFC and the head of the Cardiometabolic Risk Laboratory. She is also an adjunct associate professor of the Division of Diabetes of University of Texas Health Science Center (USA) and Director of the European Chapter of the Am. Coll. of Nutrition. She is the author of more than 200 publications. **Riccardo Favilla** was born in 1966. He earned a MSc degree in Geology at the University of Pisa. He is a staff researcher of the CNR Institute of Clinical Physiology. His scientific fields of interest are in biomedical imaging and Computer Aided Diagnosis systems. He is also an experienced C/C++,Obj-C/C++, DICOM programmer. **Renata De Maria, MD**, born in 1957, Cardiologist Research assistant at CNR-IFC Milan. She graduated in 1978 and post-graduated in cardiology and nuclear medecine. Her main scientific fields of interest are heart failure. She is currently collaborating with several international and national clinical Projects. She is author of 87 papers. ***Technical staff:*** **Alessandro Mazzarisi**: computer science technician expert in data collection systems for identification of new clinical indicators and prognostic protocols. **Mirko Passera**: computer science technician expert in construction and management of the internet Web sites. **Luca Serasini:** computer science technician, expert in multimedia design and production. **Demetrio Ciociaro**: laboratory technician, in charge for biochemical analysis.
UNIT 3: CNR-ISM	
Unit Name	**Institute of Structure of Matter**
Unit Description	The Institute of Structure of Matter of the Italian National Research Council, established on 13.09.2000, located in the Area della Ricerca di Tor Vergata, (Rome) and located in the Area della Ricerca di Roma 1 - Montelibretti (Rome). There is also a third institute section located in Trieste, at the Area Science Park of Basovizza, focused on synchrotron radiation research. The scientific activity of the Institute for Structure of Matter (ISM) originates from the integration of the traditional activities of the former Institute for Structure of Matter (ISM) and the Institute for Materials Chemistry (ICMAT) in the field of synthesis and characterization of innovative materials, which are produced and studied in the different institute locations with particular attention to their functionalities and their applications in the field of advanced devices.
Unit relevant skills and previous experiences	The scientific activity of the CNR-ISM group involved in the Project is focused in the field of synthesis and characterization of innovative materials, which are produced and studied with particular attention to their functionalities and their applications in the field of advanced devices to be used in materials science, biology, medicine and nanoscale science CNR-ISM has several previous experiences in cooperative national and international Projects. The main scientific activity relevant to SEMEOTICONS are concerned with bioengineering and biomaterials: - the physical and chemical study of the matter at all scales; - development of new instrumentation for characterization of matter on nanoscale, as Scanning probe Microscopies, X-ray spectroscopy, Nanostructured magnetic materials, Nanoelectronics; - development of integrated devices with new functionalities for application in medicine, biomaterials and biochemistry, - imaging development for clinical research on CT, MRI and PET CNR-ISM will focus the scientific activity to build the Wize Sniffer but its participation is also foreseen to all technical tasks, to ensure the acceptability of the designed solutions and applications.
Relevant Publications	- S. Napolitano, **M. D'Acunto**, P. Baschieri, E. Gnecco, P. Pingue. Ordered Rippling of Polymer Surfaces by Nanolithography: Influence Of Scan Pattern And Boundary Effects. Nanotechnology, 23, 475301, 2012. - M. D'Acunto Atomic-Scale Wear In Uhv: Connection between AFM Induced-Abrasion and Debris Recrystallization. Tribology Letters 45, 161-175, 2012 - M. D'Acunto, S. Napolitano, P. Pingue, P. Giusti and P. Rolla Fast Formation of Ripples Induced By AFM. A New Method for Patterning Polymers On Nanoscale.. Materials Letters, 61, 3305, 2007

Key personnel	**Mario D'Acunto.** Laurea degree (M.S.degree) in Physics by the Institute of Physics "Enrico Fermi", 1994, University of Pisa, Italy. PhD degree in nanoTribology (Mechanics of Surfaces) 1999 by the Department of Mechanical and Nuclear Engineering, University of Pisa, Italy. He is co-author of more than 50 papers published in international journal and peer-reviewed journal. His main interests are in AFM imaging of Single-Walled and Multi-Walled Carbon NanoTubes interacting with Cells; Electric Force Microscopy and Kelvin probe based techniques; nano-fiber sensors.

Name	**FOUNDATION FOR RESEARCH AND TECHNOLOGY – HELLAS (FORTH), INSTITUTE OF COMPUTER SCIENCE, COMPUTATIONAL MEDICINE LABORATORY**						
Country	GR	**Type**	RES	**Short Name**	FORTH	**Partner N**.	2
Organization description	The **Foundation for Research and Technology – Hellas** (**FORTH**) is one of the largest research centres of Greece under the supervision of the General Secretariat for Research and Technology of the Hellenic Ministry of Development. The Institute of Computer Science (FORTH-ICS) established in 1983, is conducting basic and applied research, developing applications and products, providing services, and playing a leading role in Greece and internationally, in the fields of Information and Communication Technologies. FORTH-ICS's activities cover important research and development areas, taking into consideration new perspectives, emerging fields of research and technological challenges.						
Relevant skills and previous experiences	The CML at FORTH-ICS has been involved in several Projects and initiatives at EU level related to the topics of this Project. REACTION aims at developing an integrated approach to improve long term management of diabetes, by continuous monitoring, complemented by education on life style factors such as obesity and exercise. REMOTE was a pan-European research Project concerned with the needs of elderly and individuals with chronic conditions, to support independent living. HEARTFAID was another successful Project aimed at devising, developing and validating an innovative knowledge based platform of services, able to improve early diagnosis and to make more effective the clinical management of heart failure diseases within elderly population. In addition, our laboratory has been involved in several Virtual Physiological Human (VPH) related Projects ACGT and ContraCancrum - aiming at the development of the European Biomedical Informatics Grid for cancer research, INTEGRATE - focusing on model and collaborative tools development, pMedicine - to bring together international experts for creating an infrastructure that will facilitate the translation from traditional practice to personalized medicine, etc.).						
Relevant Publications	- M Pediaditis, M Tsiknakis, N Leitgeb. Vision-based motion detection, analysis and recognition of epileptic seizures - A systematic review. Computer Methods and Prog in Biomedicine, online 4 September 2012, ISSN 0169-2607, 10.1016/j.cmpb.2012.08.005. - M Pediaditis, M Tsiknakis, L Koumakis, M Karachaliou, S Voutoufianakis, P Vorgia. Vision-Based Absence Seizure Detection. In Proc. 34th Annual International Conference of the IEEE EMBS, San Diego, California USA, 2012. - M Pediaditis, M Tsiknakis, V Bologna, P Vorgia. Model-Free Vision-Based Facial Motion Analysis in Epilepsy. 10th IEEE Int Work on Biom Eng, 2011.						
Key personnel	**Franco Chiarugi** is a senior staff member at the CML of FORTH-ICS. He holds a M.Sc. and a B.Sc. in Electronic Engineering from the University of Pisa, Italy and the qualification to practice as an engineer. He has been working in the field of biomedical engineering for more than 20 years with main focus on communication protocols, implementation and development of interoperability standards in the health domain, bio-signal processing, and clinical decision support systems. He has contributed to several ICT R&D, being scientific responsible for FORTH's He has published more than 70 papers in international journals and conference proceedings related to his fields of expertise. **Matthew Pediaditis** received the engineer's degree in electrical engineering - biomedical engineering from Graz University of Technology (TUG), Austria in 2008. He is currently a PhD candidate at the Institute of Health Care Engineering, TUG, in collaboration with the Computational Medicine Laboratory, FORTH. His has experience in numerical electromagnetic field dosimetry, image and signal processing, as well as vision-based human motion analysis for medical applications, especially in epilepsy diagnosis. Dr. **Manolis Tsiknakis** is an associate professor of biomedical informatics and eHealth technologies and Head of the BMI and eHealth lab at TEI-Crete and an affiliate researcher at the CML of FORTH-ICS. His research is focused on various computational aspects of biomedical informatics, such as high performance computational approaches to demanding biomedical applications; and the semantic interoperability (SIOp) of health information systems. He acted as technical manager of a large nationally Project in Crete, called HYGEIAnet, which received an EU eHealth award in 2003. He is a member of the Editorial Board of the Open Medical Informatics Journal, and a member of the programme committee in numerous high-profile conferences.						

Name	**LINKÖPING UNIVERSITY – DEPARTMENT OF BIOMEDICAL ENGINEERING**						
Country	SWEDEN	**Type**	Academic	**Short Name**	LIU	**Partner N.**	3
Organization description	**Linköping University (LIU)** is one of Sweden's larger academic institutions, a multi-faculty university where research and education are equally important. At LIU there are 27000 students, 3900 employees and more than 100 educational programmes**.** The LIU campuses are situated in Linköping and Norrköping in East Sweden. The university is an important driving force for regional development. World-class research is conducted within cutting edge domains such as new materials, IT and disability research. Students from Linköping University are among those who first obtain jobs and have the highest income average one year after graduation. The openness between different subjects and faculties has contributed to the creation of strong research environments at Linköping University. World-leading research is carried out within several areas such as materials science, bioelectronics and migration, economy and society. LIU has exceptionally strong connections with the surrounding society The Department of Biomedical engineering at LIU, (LIU-BME), is one of 14 Departments of LIU. It is a national centre for research and education in Biomedical Engineering. The research is motivated by the requirements in healthcare and takes place in close collaboration with the biomedical industry and hospital clinics.						
Relevant skills and previous experiences	LIU is a pioneer in the development of point-wise and imaging Laser Doppler Flowmetry for assessment of microcirculation perfusion since more than 30 years. We have worked with diffuse reflectance spectroscopy for more than 10 years, mainly point-wise measurements but recently also with imaging. Recent contributions are using tissue optics for advanced light transport modelling in realistic tissue models.						
Relevant Publications	- Fredriksson I, Larsson M, Strömberg T. Model-based quantitative laser Doppler flowmetry in skin. J Biomedical Optics 15(5), 2010, doi: 10.1117/1.3484746 - Fredriksson I, Larsson M, and Strömberg T. Inverse Monte Carlo method in a multilayered tissue model for diffuse reflectance spectroscopy. Journal of Biomedical Optics 17(4), (April 2012), 047004 (12 pp)) - Draijer, M.J., E. Hondebrink, M. Larsson, T.G. van Leeuwen and W. Steenbergen, Relation between the contrast in time integrated dynamic speckle patterns and the power spectral density of their temporal intensity fluctuations. Optics Express, 2010. **18**(21): p. 21883-21891						
Key personnel	Professor **Tomas Strömberg**, PhD, MSEE. Activities and interests: Biomedical optics , tissue optical properties, diffuse reflectance spectroscopy, laser Doppler Flowmetry, Monte Carlo simulations. Senior lecturer **Marcus Larsson**, PhD, MSEE. His research is focused on theoretical and applied biomedical optics for tissue characterization. Research interests and competences: Theoretical light scattering in tissue applied to laser Doppler blood flowmetry (LDF) techniques and spectroscopic applications. Junior lecturer **Ingemar Fredriksson**, PhD, MSEE. He is currently working with research and development of laser Doppler flowmetry and diffuse reflectance spectroscopy at Perimed AB and at the Department of Biomedical Engineering, Linköping University. Activities and interest: Laser Doppler Flowmetry, diffuse reflectance spectroscopy, Monte Carlo simulations, tissue optical properties.						

Name	**UNIVERSITY OF CENTRAL LANCASHIRE**						
Country	UK	**Type**	Academic	**Short Name**	UCLAN	**Partner N.**	4
Organization description	The **University of Central Lancashire** (**UCLAN**) is one of the largest universities in the UK with more than 35,000 students, 500 undergraduate courses and 180 postgraduate courses. University employs 3,000 people, has a turnover of £120m a year and contributes £300m to the regional economy. In the latest Research Assessment Exercise the University submitted 17 subject areas for rigorous review and was rated as having produced research of international excellence in all of them. No fewer than 11 areas were assessed as containing research which is world-leading.						
Relevant skills and previous experiences	Based within the school of Computing, Engineering and Physical Sciences, the Applied Digital Signal and Image Processing Research Centre (ADSIP) is well known for cross-disciplinary collaborative research on the development and deployment of innovative signal and image processing techniques as well as computer vision and 3D/4D technologies in various sectors, such as aerospace, environment, manufacturing, medical and nuclear. There is an extensive collaboration with around 100 Project partners from 20 countries and a wide range of externally funded research Projects with substantial support from EU government bodies (6 major Projects starting from FP4), national research councils, charities and industry. In the UK it has close collaborative links with several hospitals and clinics More recently the Centre has been leading the "Engineering and Computational Science for Oncology Network-ECSON" where it has engaged with 24 leading clinical and academic centres from 6 European countries. The Centre was involved in two major Projects related to radiation therapy namely: MEGURATH, and TeRaFS, both funded by the UK EPSRC. Over the years the Centre has developed several areas of expertise relevant to the SEMEOTICONS Project. More specifically the Centre is active in developing deformable surface models, matching techniques, and deformation recognition/classification tools. The work in this area is supported by state-of-the-art facilities available in the Centre which include: multiple dynamic surface scanners using active and passive stereo, fringe projection and time of flight scanning principles, with scanning frequency of up to 60 full 3D frames per second as well as comprehensive dynamic 3D facial expression database. Other areas of expertise relevant include: (i) deformable segmentation using active contours implemented using level set PDE formalism with focus on incorporating prior knowledge about expected object shape and image appearance as well as utilising combinatorial optimisation methods; (ii) uni-modal and multi-modal deformable image registrations (iii) robust object tracking including human articulated tracking (iv) image denoising and reconstruction; (v) face and facial articulation recognition and (vi) facial dysfunction detection and quantification.						
Relevant Publications	- W. Quan, B. J. Matuszewski, L-K. Shark, Facial Asymmetry Analysis Based on 3-D Dynamic Scans, IEEE Int. Conf on Systems, Man, and Cybernetics, October 14-17, Seoul, Korea, 2012. - B. W, Papiez, B. J. Matuszewski, "Symmetric Image Registration with Directly Calculated Inverse Deformation Field", Annals of the British Machine Vision Association, 2012. Invited paper - B. J. Matuszewski, W. Quan, L-K. Shark, A. S. McLoughlin, C. E. Lightbody, H. C. A. Emsley, C. L. Watkins, "Hi4D-ADSIP 3D Dynamic Facial Articulation Database" Elsevier, Image and Vision Computing, Vol. 10, No. 10, pp. 713-727, October 2012.						
Key personnel	Dr **Bogdan Matuszewski** gained PhD in 1996 for the work on inverse problems from the Wroclaw University of Technology (Poland). He holds position of Reader in Computer Vision and heads the Robotics and Vision Laboratory at UCLAN. He has published over 100 research papers in different areas of computer vision and image processing and successfully supervised to completion 12 PhD students. He has been leading major research Projects in the health ICT area, funded by the UK EPSRC Research Council. He has the extensive experience working on a collaborative research Projects funded by the industry, UK Research Councils and the European Programmes. Prof **Lik-Kwan Shark** is the Professor of Signal and Image Processing and the head of ADSIP at UCLAN. He is a fellow of IET, an associate editor of two international journals and an evaluator of European Research Council and Research Executive Agency. He has received external funding around £8M, published around 150 papers/books/book chapters including two best conference papers and 8 invited journal papers, and won several awards including two from BAE for technology innovation						

Name	**NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY**						
Country	Norway	**Type**	Academic	**Short Name**	NTNU	**Partner N.**	5
Organization description	The **Norwegian University of Science and Technology** (**NTNU**) is Norway's second largest university in number of students. NTNU has a staff of about 5000, with over 3000 in academic and scientific positions. More than 300 PhD degrees are awarded yearly, within the fields of technology, science, arts and humanities, social sciences and medicine. NTNU has a broad range of contacts with International R&D actors, in academia as well as in industry. The annual budget of NTNU is around € 600 million, 25% of which is externally funded. NTNU is an active participant in the EU R&D Framework Programs and participates in 75 FP7 Projects. NTNU recognizes medical technology and ICT as two of its strategic areas.						
Relevant skills and previous experiences	The group at NTNU has expertise within tissue optics, modelling of light transport in tissue, clinical use of lasers, optical spectroscopy and optical diagnostics. Over the last 8 years the group has been working on diagnostic hyperspectral imaging and development of algorithms for analyzing such data. Ongoing and previous studies include hyperspectral fluorescence imaging of atherosclerotic lesions, development of a diagnostic system for skin ulcers, and forensic applications (aging of skin bruises).						
Relevant Publications	- L.L. Randeberg, J. Hernandez-Palacios, M. Lilleeng, L.T.N. Nilsen, A. L. Krogstad, UV doses and skin effects during psoriasis climate therapy, Proceedings of SPIE, Vol. 7883, 2011 - L.L. Randeberg, E.L.P. Larsen, L.O. Svaasand, Characterization of vascular structures and skin bruises using hyperspectral imaging, image analysis and diffusion theory, J. Biophot., 3(1): 53-65, 2010 - L.L. Randeberg, A.M. Winnem, N.E. Langlois, E.L.P. Larsen, R. Haaverstad, B. Skallerud, O.A. Haugen, L.O. Svaasand, Skin changes following minor trauma, Lasers Surg Med, 39(5):403-413, 2007 - L.L. Randeberg, O.A. Haugen, R. Haaverstad, L.O. Svaasand, A novel approach to age determination of traumatic injuries by reflectance spectroscopy, Lasers Surg Med, 38(4):277-89, 2006						
Key personnel	**Professor Lise Lyngsnes Randeberg**, PhD. PhD in Biomedical Optics (2005). Professor of photonics and biomedical optics at NTNU since 2011 (Associate professor 2009-11). She has been a visiting professor at the Wellman Center of Photomedicine (Harvard Medical School/Massachusetts General Hospital) in Boston, USA (2009-2011). Main fields of competence are light-tissue interactions and optical diagnostics (spectroscopy and imaging). Her research within optical forensics has awarded her both the Young innovator award from the Norwegian government (2007) and a research grant from American Society for Laser Medicine and Surgery (2006). **Lukasz Paluchowski,** MSc **and Martin Denstedt,** MSc are specializing in hyperspectral imaging. Their background is within image processing and experimental physics.						

Name	**CENTRE DE RECHERCHE EN NUTRITION HUMAINE RHÔNE-ALPES**						
Country	France	**Type**	Research Inst.	**Short Name**	CRNH	**Partner N.**	**6**
Organization description	**CRNH- Rhône-Alpes** gathers researchers working either in clinical teams or in research laboratories and has an in-patient unit for healthy volunteers and patients and a mass spectrometry laboratory. The main research axes are prevention and treatment of mal nutrition (over and under nutrition) and functional properties of food (carbohydrate and lipids). CRHN-RA is well recognized at the international level for its research works on the physiological and molecular basis of obesity and diabetes (mechanism of insulin resistance and adaptation to nutritional changes at physiological and molecular level), of lipid metabolism and vascular risks with experimental approaches focusing on fatty acids of nutritional value, especially omega-3 ones, and on Cancer and Nutrition through the link with the International Agency for Research on Cancer (IARC, WHO-UNU organisation),. It also has an important role in developing and disseminating new strategies in the prevention and the treatment of these diseases.						
Main attributed tasks in the project	Leader of Work Package 9-Clinical validation studies to test the reliability and the feasibility of the facial semeiotics device Partner in Work Package 1-Medical/clinical requirements and system functional specifications (definition of the medical and user requirements, definition of the validation protocol)						

Relevant skills and previous experiences	The current program of CRNH- Rhône-Alpes spans the human nutrition from molecular level to investigating the role of nutrients, to examining the impact of dietary interventions, to conducting research on over-nutrition diseases (overweight, obesity, diabetes, cancer, cardiovascular diseases) and to studying patient nutrition through all stages of life. In particular, a multidisciplinary approach is followed to (i) explore the relationship between food and genetics in the medical context and contribute to the emergence of new therapies, (ii) improve the understanding of diabetes, obesity and cardiovascular disease, identify new markers and implement early treatment, (iii) prevent the malnutrition associated with chronic disease and extreme old age; (iv) to write new nutritional recommendations and help develop functional foods. The methodologies used are: (*a*) nutritional intervention; (*a*) metabolic phenotyping (insulin sensitivity, body composition,…), (*a*) substrate turnover and food bioavailability determination using stable isotopes; (*a*) energy expenditure with doubly labelled water; (*a*) mass spectrometry analysis (GCMS, GCIRMS); gene expression in muscle and adipose tissue biopsies. Expertise in clinical validation and monitoring
Relevant Publications	- Alligier M, Meugnier E, Debard C, Lambert-Porcheron S, Chanseaume E, Sothier M, Loizon E, Ait Hssain A, Brozek J, Scoazec Jy, Morio B, Vidal H, Laville M. Subcutaneous Adipose Tissue Remodeling during the Initial Phase of Weight Gain Induced by Overfeeding in Humans. J Clin Endocrinol Metab. 2012 Feb;97 (2):E183-92. - ALLIROT X, SAULAIS L, DISSE E, ROTH H, CAZAL C, LAVILLE M. Validation of a buffet meal design in an experimental restaurant. Appetite. 2012 Feb 17;58(3):889-897 - BLOND E, MAITREPIERRE C, NORMAND S, SOTHIER M, ROTH H, GOUDABLE J, LAVILLE. M. A new indirect calorimeter is accurate and reliable for measuring basal energy expenditure, thermic effect of food and substrate oxidation in obese and healthy subjects; e-SPEN, the European e-Journal of Clinical Nutrition and Metabolism (2011), 6 (1): e7-e15
Key personnel	**Pr.Martine Laville** is head of CRNH Lyon since 1996 and of CRNH Rhône-Alpes from 2006. She graduated in medicine from the University of St Etienne in 1986, specialized in Endocrinology, Diabetes and Nutrition in 1987, Doctor of Medical Science in 1990. She was Associate Professor of the Dept of Endocrinology of the University of Lyon from 1987 to 1992. She was a researcher at the INSERM U 449 in Lyon from 1992 to 1997 and appointed as Professor of the Nutrition in Lyon in 1997. She is at the head of the CENS project (Centre for European Nutrition Safety and Health). She has participated to the creation of the research center of Institute Paul Bocuse, which has an experimental restaurant core, and she is the president of its scientific committee. She and is co-leader with Hubert Vidal of the team: nutritional adaptations, environment and diabetes of research unit CarMeN /UMR INSERM 1060 /INRA. She has set up the clinical research core and the mass spectrometry core of the Rhône-Alpes CRNH. **Pr Joelle Goudable**, graduated in Pharmacy from the Uni of Lyon in 1977, specialized in Biology in 1981, PhD in 1985, is professor in Public Health and Nutrition in the faculty of Pharmacy (Uni Lyon1) since 2003. She is a member of CRNH since 1990 and a researcher member of CarMeN (Cardiovasculaire, Métabolisme, Nutrition diabètes). Her areas of specialization are clinical chemistry, critical care testing and biological methods to obtain the accreditation of biological laboratories. **Dr Stéphanie Lambert Porcheron**, graduated in Medicine from the Uni of Lyon in 2001 and specialized in Endocrinology, Diabetes and Nutrition in 2001, is a project manager at CRNH since 1997. Missions within CRNH are the drafting and submission of research protocols, coordination and implementation of the study, reporting of results and publications. **Dr Emilie Blond** is biologist, graduated in pharmacy from the University of Lyon in 2009, PhD in 2012. She works in the Lyon Sud University Hospital since 2009 as assistant in chromatography department specialized in vitamins and oxidative stress measurements. Since 2012, she teaches in the nutrition and Biochemistry Dpt of the Inst. of Pharmaceutical and Biological Sciences (Uni. Lyon 1). She belongs to the research unit CarMeN and works on glucolipotoxicity, metabolic stress and diabetes. **Dr Sylvie Normand** has a nutrition engineering degree from Agrosup Dijon, a MSc in Nutrition and Metabolism and a PhD in human nutrition and metabolism from the University Lyon1. She got a position as staff engineer at INSERM Unit in Lyon from 1988 to 2003, and then joined the Lyon1 University as research engineer at CRNH. At present she works especially as scientific coordinator. Her major research interest is about physiology and stable isotopes techniques. She is involved in research projects on metabolic fate of food, measurement of metabolic flux using stable isotopes analyzed by mass spectrometry (isotopic and organic) and bioavailability of substrates (carbohydrates and fat), measurement of body composition and energy metabolism. **Christine MaitrePierre** received her nursing degree status in 1980 and graduated as clinical research in 1997. From this date, she was placed as research nurse at CRNH

Name	**INTECS**						
Country	Italy	**Type**	IND	**Short Name**	INTECS	**Partner N.**	7
Organization description	**INTECS** is a leading company in Italy for providing software and consultancy services in many safety-critical domains, for which it obtained important certifications (e.g., CMMI level 3, Automotive SPICE level 2 by Volkswagen, CENELEC SciroTÜV and TÜV Rheinland Berlin). The typical customers of INTECS are big manufacturers or system integration companies, mostly based in Italy. The company is also expanding in Europe, and recently opened an affiliate company based in Paris, i.e., Intecs France SA, while the long-established office in Toulouse is also experiencing growth. The Smart City market is of strategic interest for INTECS, which, in 2012, created a new Business Unit (BU) called "Smart Systems" to follow more closely the customers and market needs. The Smart Systems BU operates on many sub-domains of Smart City, such as Intelligent Transport Systems (ITS), Smart Grids, eHome, eHealth. As an ETSI member, INTECS participates to Technical Committee on M2M, which is defining a standard for M2M telecommunications. INTECS also joined the OneM2M partnership Project, which had its first plenary session on September 2012. The OneM2M pursues the objective of defining a common M2M Service Layer, also aiming at involving organizations from M2M-related business domains in the standardization process. As part of its activities on the IoT and M2M, INTECS developed an SDK for M2M which has been used to develop ETSI-compliant M2M applications, in cooperation with an international partner. INTECS M2M applications have been showcased at various events, more recently, at the 3rd ETSI Workshop on M2M (Oct 2012).						
Relevant skills and previous experiences	The company has wide and solid experience of both participation and coordination of industrial and R&D Projects at a national and international level. The recent R&D Projects which are most relevant to the objectives of the proposal follow: (*a*) EU FP7 Project BETaaS (coordinated by INTECS) proposes a platform for the execution of M2M applications, which is built on top of services deployed in a "local cloud" of gateways, the latter being the devices which provide the smart things with connectivity to the Internet (e.g., smart phones, home routers, road-side units); (b) EU FP7 project ICSI (coordinated by INTECS) addresses the challenges of more efficient, safer and energetically sustainable intelligent transportation systems (ITS) and thus give a qualitative leap towards the future mobility. This raises the implementation of a platform to merge and integrate heterogeneous data sources into a common system and provide a set of advanced tools for control, monitoring, simulation and prediction of traffic, that achieves a more safe, sustainable and uncongested road; (*c*) POR-CReO 2007-2013 IPERMOB project achieved the goal of designing and implementing a urban-scale ITS, using low-cost innovative technologies. A prototype implementation have been installed and operated in the area of the Pisa International Airport "G. Galilei". In 2011 IPERMOB has been reported by the Regione Toscana as an "excellence project" to the European Union.						
Relevant Publications	- C. Cicconetti, L. Lenzini, A. Lodi, S. Martello, E. Mingozzi, M. Monaci, "A fast and efficient algorithm to exploit multi-user diversity in IEEE 802.16 BandAMC", Computer Netw 55, 3680–3693, 2011 - C. Cicconetti, F. Galeassi, R. Mambrini, "IEEE 802.11p: Laboratory Measurements and Analysis", 50th Fitce Conference, Palermo, Italy, Aug. 31-3, 2011 - Cicconetti, C.; Galeassi, F. & Mambrini, R., "Network-Assisted Handover for Heterogeneous Wireless Networks", IEEE Globecom Workshop on Seamless Wireless Mobility, 2010						
Key personnel	**Raffaella Mambrini** received her MS degree in Telecommunications Engineering in 1998 from the University of Pisa. She is currently the Telecommunications and Smart Systems Business Unit Leader at Intecs S.p.a., Italy. She is a member of Verification & Validation and Model Driven Engineering Intecs Excellence Teams. She has been involved in leading roles in many national and European R&D projects (currently: IPERMOB, SANDRA). Her main activities include software modelling, development, verification & validation for automotive and telecommunications systems. She co-authored several scientific papers. Her last research interests include short and long range wireless networks, next generation network, Software Defined Radio (SDR) and applications for Intelligent Transportation Systems (ITS). **Elena Cordiviola** graduated in Computer Science in 1990 at University of Pisa, has now accrued more than 20 years of experience in the Information and Communications Technology. Starting off developing software in several domains and different languages, she has acquired the highest level of skills of analysis, design, and validation for any kind of software embedded projects. She has been managing and coordinating research projects since 2010 (IPERMOB, DSPACE). At the moment she is the project leader of important R&D projects such as BETaaS and ICSI.						

Name	**FORTHNET S.A.**						
Country	Greece	**Type**	Industry	**Short Name**	FORTHNET	**Partner N.**	8
Organization description	**FORTHNET** S.A. is a leading provider of broadband network services in Greece. The company was established in 1995 to be the first commercial Internet Service Provider in the country. Starting from the Internet access services arena in 1995 up to today, FORTHNET has entered both the telecommunications and network services business, being a convergent services provider offering from voice telephony to Internet and value-added services. The company has a total of 450.000 subscriber lines and FORTHNET customer base comprises a major part of the Greek Internet community and the market of alternate voice telephony & network providers. FORTHNET utilizes and integrates technological solutions on the basis of the latest telecommunications prototypes to develop and provide new services on the Network. FORTHNET has established its Research & Development department in the Science & Technology Park of Crete. It designs, develops and evaluates the application of modern services management through operation support systems, as well as security management systems. It also develops information systems for the SMEs and for the realization and provision of eServices. Core server technology, integration capability and web interface customization are within the technological skills of the R&D team, based upon object-oriented development with C++, Java/J2EE on various operating platforms. The approach of R&D in FORTHNET is market-driven, aiming at (*i*) delivering prototypes, experimental results and proofs of concept for application of innovative technologies into eServices and networking, and (*ii*) transferring know-how and facilitating the transition of production and commercial activities to modern technologies and services. FORTHNET, through its R&D activity, has 10 years of experience in European projects, either as a coordinator or a contractor.						
Relevant skills and previous experiences	FORTHNET utilises and integrates technological solutions on the basis of the latest telecommunications prototypes to develop and provide new services on the Network. It also utilises various software technologies (Java/J2EE, .Net, Linux, open source, database systems) for the development of information systems for the SMEs and for the realisation and provision of eServices. Main interests of R&D department include Broadband communications, Next-Generation networks, Wireless & Ad-Hoc networks, E-Content & Networked Media management & distribution, eTourism, eHealth, eLearning, eGovernment, Advanced Messaging Systems and EWS, User mobility and Mobile Internet. System & network technology and software engineering are within the technological skills and know-how of the R&D team, based upon object-oriented development with C++, Java/J2EE on various operating platforms. FORTHNET R&D department has participated in several European research projects in the past, related to synthesis and interoperability of services, mobile application and personalised services within the eHealth, tourism and transportation domain. FORTHNET has a strong participation in EC funded projects in the areas of eHealth, such as IST FP6 HEARTFAID which aimed at the development of a knowledge based decision support system for improving the medical-clinical management of heart failure within the elderly population. FORTHNET is also participating in FP7 IP REACTION project, where it is mainly involved in the implementation and provision of server and network infrastructure and integrates advanced network and edge communication technologies as well as the underlying security modules.						
Relevant Publications	- M. Stratakis, S. Louloudakis Validation of a Flexible and Innovative Platform for the Home Monitoring of Heart Failure Patients: Preliminary Results — Comp. in Cardiology 2009 - M. Stratakis, S. Louloudakis Adopting Dynamic Declarations and Rule-based Executions in SOA-oriented Remote Patient Monitoring Platform using an Alarms and Alerts GUI - MobiHealth 2012 workshop, Paris						
Key personnel	**Stelios Fragakis** holds a BSc in Computer Science from the University of Indiana, USA. He is experienced with several programming languages such as Pascal, C/C++, 80x86, Scheme, Perl, Java and Visual Basic. Since December 1998 he is managing the development of FORTHNET Billing-Provisioning System. His main activities are the Design and Development of billing application as well as the Design and Development of a system for the elaboration of phone calls data (Call Detail Records). **Manolis Stratakis** holds an MSc by research in Computer Networks and Digital Communications and a BSc in Electronic Computer Systems, both from the University of Salford, UK. He is currently the Head of Research Projects in the R&D department of FORTHNET S.A., where he is managing several European and National research projects, primarily related to Internet and web applications and the development of Value Added Services in the areas of Mobile Internet, Advanced Messaging Systems, mobile Learning, Electronic Commerce, Teleworking, eHealth, Telemedicine and 3G Technologies.						

Name	**DRACO SYSTEMS**						
Country	SPAIN	**Type**	SME	**Short Name**	DRACO	**Partner N.**	9
Organization description	**DRACO SYSTEMS** was founded in January 2004, as a result of the enthusiasm and vision of a group of engineers with extensive experience in technical and scientific projects of hardware and software development. Draco solutions provide to his customers with the state-of-the-art in highest-quality, reliability, cost effective, fastest time-to-market, reusable, real-time developments. Draco solutions are at the core of a number of worldwide new generation devices. While their list of product experience continues to grow, their skills and technologies know how evolves continuously to offer their customer the cutting-edge technologies easily. Draco has a wide experience in ARM/DSP processors, analogue design, sensor integration, motors control, communication protocols, development of complex filters and algorithms for vision, video and audio codecs integration and embedded system solutions that require ultra low power, flexibility, small sizing and easy to use friendly interfaces. Our technology enables a broad array of next generation smart devices and embedded applications such as Hand Held Appliances, Medical Devices, Industrial Automation, Wireless Products, Smart Screens, Point of Sale Terminals, IP encoding, IP Smart Cameras, Digital Recorder Platform, Remote Monitoring systems and Sensor networks.						
Relevant skills and previous experiences	Expertise resulting from previous work is highly relevant to the proposed SEMEOTICONS project. In particular, image processing capabilities and medical devices developed for the electromedicine sector such a portable electrocardiograph device, remote rehabilitation sensors, tiny wireless camera for arthroscopy, smart robot for kids with face recognitions capabilities, etc. Some links about the products developed: Electrocardiograph: http://www.gem-med.com/electrocardiografos-gem-heart-one.php Robot for kids: http://www.aisoy.com/?page_id=4742&lang=en						
Relevant Publications	Camera for arthroscopy: Sports Injuries, Springer-Verlag Berlin Heidelberg 2012 pag. 1201-1207, Wireless Arthoscopy: the wireless arthroendoscopy device (Dr. Guillen's WAD invention)						
Key personnel	**Meritxell Gimeno** was born in Barcelona, Spain. Her enthusiasm for space-related fields, lead her to obtain an Engineering degree in Electronics, a M.Sc. in Remote Sensing, a Ph.D. in SAR satellite image processing and to attend to the Summer Session Program 2003 of the International Space University, as well as other Managing Programs. At the present, she is the general manager at DRACO SYSTEMS. **Jordi Posas** was born in Sant Feliu de Codines, Spain. His passion for image processing, 3D world, and artificial intelligence, brought him to obtain his degree in Informatics and a M.Sc. in Computer Vision. During the year 2000 and 2001, the Catalan government and television, and SUN Microsystems awarded him for his virtual game to promote the use of internet. At the present, he is co-founder and software manager at DRACO SYSTEMS. **Joan Puig** was born in Barcelona, Spain. Following his interest in electronics as well as in robotics, he received his M.Sc. in Electronics Engineering. In 2000, he received the honours of being the best European Engineer thanks to his innovative robotic hand controlled by a wireless virtual glove. At the present, he is co-founder and hardware manager at DRACO SYSTEMS.						

Name	**COSMED Srl**						
Country	ITALY	**Type**	SME	**Short Name**	COSMED	**Partner N.**	10
Organization description	**COSMED** is an ISO 9001 certified company, leader in the design, development and manufacturing of Cardio Pulmonary and Metabolic Diagnostic Equipment. Founded in 1980, with headquarters in Rome, Italy and branches in USA and China PR, COSMED applies the latest technologies to provide solutions and technology in the field of Sport Science, Health Prevention as well as in the Clinical and Hospital markets. COSMED products are aimed for either professional or medical use for many different applications like: Hospital, Clinics, Primary Care, University & Education in Human Physiology, Clinical Nutrition, Commercial Weight Management, Sport Institutions and Health Club Industry. Currently, COSMED products range from complete line of spirometers, modular Pulmonary Function equipment, Cardio Pulmonary Exercise Testing systems to Gold Standard Body Composition for adults, paediatric and infants.						
Relevant skills and previous experiences	The key expertise that COSMED will spend in the project relates to: Gas exchange technology, Nutritional assessment, Indirect calorimetry, Functional aerobic capacity, Metabolic Testing for Sport Science. Concerning the **Nutritional Assessment**, COSMED provides the most complete range of solutions and diagnostic equipment for measuring metabolism and energy requirements of either spontaneously breathing or mechanically-assisted patients. Accuracy and reliability of COSMED technology has been confirmed by several scientific validation studies. COSMED is now also a leader in body composition diagnostic equipment based on Gold Standard Air Displacement Plethysmography for accurate measurements of adults, children and infants. The group has been involved in various research projects, such two FILAS project aimed at developing (i) a device for the analysis of respiratory fraction of nitric oxide as a marker of inflammatory asthma phenomena; and (ii) modular solutions to measure the cardiopulmonary and metabolic function.						
Relevant Publications	- Cecchini, Schena, Marianotaro, Carassiti, and Silvestri, "Non-invasive Estimation of Cardiac Output in Mechanically Ventilated Patients: A Prolonged Expiration Method", Annals of Biomedical Engineering, Vol.40, No.8, August 2012(2012) pp.1777–1789 - Cecchini, Schena, Di Diodoro, Silvestri "Uncertainty evaluation of a calibration method for metabolic analyzer in mechanical ventilation", 978-1-4244-9337-1/11/$26.00 ©2011 IEEE,						
Key personnel	**Emanuele Pagliei**, received the degree in electrical engineer and bioengineering from the Rome University "La Sapienza", Italy in 1996. Position in COSMED: R&D Project Management & engineering. His role involves managing R&D Project team members and its organization by monitoring and controlling progress of projects and providing technical oversight. Functional aerobic capacity and Metabolic Testing for Sport Science represent his main working fields and special experience. Roles: Project Manager **Alberto Di Pietro** is a R&D engineer with electrical engineering background and engineering degree obtained from the University Tor Vergata of Rome, Italy, in 2003. Position in COSMED: R&D Product Manager, design & validation. His main responsibilities at COSMED are managing and leading the development of new products within the company, leading new projects and coordinate final validations and trials on the products. Gas exchange technology, Nutritional assessment and Indirect calorimetry represent his main working fields and special experience. Role in the project: Development of single steps of project.						

B2.3. Consortium as a whole

A particular strength of the SEMEOTICONS Project is its well-balanced Consortium with complementary expertise and background to fulfil all the RTD, Innovation, Integration, Dissemination and Exploitation activities, which is necessary to run a successful project. The SEMEOTICONS Consortium has been constituted by a group of research centres and international industries, offering wide capability and technical excellence of working cooperatively. The Consortium consists of 10 Partners with high technical skills and broad research experience, which guarantee that the overall project objectives can be achieved.

B2.3.1. Consortium overview and role of the participants

The project's Consortium brings together a unique variety of professional and research competence and experience. This is a very good example of the European collaboration practice for producing R&D results out of wide European collaboration schemes and also by establishing synergies with other countries. Having broad coverage in the European geographical area the SEMEOTICONS results start with a promising opportunity of wider uptake and successful exploitation. The Partners were selected in such a way to synthesize the best possible solutions and achieve best results. The research Partners spam a broad wealth of methodological expertise that covers all the required investigations. Moreover, their professionalism stands as a definite insurance to reach the Project goals. The industrial Partners have each international experience in bringing reliable systems to the market and together they have the skills to integrate the complete system and produce this to a competitive price. The participation of six research organizations (CNR, FORTH, LIU, UCLAN, NTNU, CRNH), two industrial Partners (INTECS and FORTHNET), two SMEs (DRACO and COSMED) guarantees a perfect balance of innovation and technology-driven research that is required to realized the SEMEOTICONS vision. In particular, the Consortium brings together Partners experienced in different markets and together they are able to exploit the results in both Europe and globally. Furthermore, the Partners have been and are collaborating in other projects and have consolidated and fruitful relationships (e.g., CNR and FORTH, UCLAN, CRNH, INTECS, FORTHNET; NTNU and LIU; FORTH and FORTHNET; INTECS and FORTHNET). This "run in" collaboration will surely ease and speed up all the cooperative activities of Project.
All the Partners have a significant and focused role within the Project, which is summarized in Table 4.

Table 4 Main roles of Partners

Partner	Type	Main role within the Project
CNR	RES	CNR will coordinate the organization, financial, scientific and clinical activities of the Project as well as the dissemination of Project results. CNR-IFC will lead the activities of semeiotics model definition. The clinical team will also strictly collaborate with CNRH for the realization of the wellness semeiotics validation. The engineering team will contribute to the activities of multispectral data acquisition and analysis. CNR-ISTI will lead the activities of virtual individual's model construction and user guidance provisioning, and will work on the problem of 3D face reconstruction and characterization as well as face emotion recognition and correlation to individual's psycho-physical status. CNR-ISM will lead the activities of gas sensors development and contribute to breath analysis.
FORTH	RES	FORTH's main task in this Project will be related to the design and development of methods & algorithms for facial expression analysis, for psycho-physical status evaluation and other facial signs evaluation. FORTH will also contribute to methods & algorithms for 3D face models and biometric characterization and to the virtual individual's model construction. Finally, FORTH will also contribute to the requirement phase and to design the technological platform and the software for data processing and data management.
LIU	RES	LIU will lead the activities on multispectral data analysis for the evaluation of compositional and functional descriptors of face cutaneous and sub-cutaneous tissues. They will work on the set up of the hardware apparatus as well as on the development of algorithm for data and image analysis

Partner	Type	Main role within the Project
UCLAN	RES	UCLAN will lead the activities of 3D face reconstruction and biometric, morphometric and colorimetric characterization of face and iris. They will also contribute to face expression recognition and evaluation of psycho-physical status.
NTNU	RES	NTNU will contribute to the development and testing of the multispectral imaging system and algorithms for data analysis focusing on endothelial function, monitoring of skin cholesterol, connective tissue and other skin parameters. This includes giving input on and evaluating system specifications based on the expected optical properties of the tissue, and development of fast and efficient algorithms for data analysis based on physical modelling, known chromophore signatures and statistical image analysis.
CRNH	RES	CRNH will lead the activity of validation protocol definition and wellness semeiotics validation studies to test the reliability and the feasibility of the facial semeiotics device. They will be also involved in the definition of the semeiotics model and the definition of the medical requirements of the system.
INTECS	IND	INTECS will lead the development of user-centric application and services and the exploitation activities of the Project. They will support SW integration activities and will lead the activities of design and development of the Data Management Solution.
FORTH NET	IND	FORTHNET's primary contribution will be leading the design activities of the system components associated with the development of Wize Mirror. FORTHNET will also contribute in the specification of system requirements, in the integration of system components and the dissemination and exploitation of the Project's results.
DRACO	SME	Draco Systems will have a key role in the design and integration of the Wize Mirror solution. In particular, know-how relating to hardware processors, sensor capture and video processing technique will be used to develop a new hardware solution. This will involve close cooperation with the entire Partner Consortium that will assist the implementation of the software algorithms. Draco Systems will, then, be responsible for the following activities: (i) development of novel processing hardware platform; (ii) integration of the algorithm; (iii) Project exploitation / disseminations
COSMED	SME	COSMED will be mainly involved in (i) the electronic design (HW and SW) of the system; (ii) the engineering and prototyping activities and in (iii) the provision of equipment for validation of the system. COSMED will be also strongly involved in the exploitation activities of the Project.

B2.3.2. Complementarity of participants

Partners have complementary skills as appropriate to fulfil the scientific objectives of the Project, as demonstrated by the skills matrix in Table 5.

Table 5 Complementarities among participants: Partners vs. S/T objectives

SEMEOTICONS Objectives	CNR-ISTI	CNR-IFC	CNR-ISM	FORTH	LIU	UCLAN	NTNU	CRNH	INTECS	DRACO	FORTH NET	COSMED
Objective 0- To define a semeiotics model of the face with respect to cardio-metabolic risk and study advanced imaging and sensing strategies for the acquisition and processing of facial signs	X	X	X	X	X	X	X	X				

SEMEOTICONS Objectives	CNR-ISTI	CNR-IFC	CNR-ISM	FORTH	LIU	UCLAN	NTNU	CRNH	INTECS	DRACO	FORTH NET	COSMED
Sub- obj 1.1. The definition and validation of descriptors for facial signs of obesity	X	X		X		X						
Sub-obj 1.2 The definition and validation of descriptors for facial signs of alterations of glucose metabolism		X			X		X					
Sub-obj 1.3 The definition and validation of descriptors for facial and eye signs of hypercholesterolemia	X	X				X						
Sub-obj 1.4 The definition and validation of descriptors for facial signs of cardiovascular homeostasis		X			X		X					
Sub-obj 1.5 The definition and validation of descriptors for facial signs of psycho-physical status	X	X		X		X						
Sub-obj 1.6 The definition and validation of breath analysis			X									X
Sub-obj 1.7 The definition and validation of descriptors for other facial signs	X	X		X								
Sub-obj 1.7 Integration of all the descriptors into the virtual individual's model and computation of individual's well-being index	X	X		X		X						
Obj 2 - To develop user centric applications and services	X								X		X	

SEMEOTICONS Objectives	CNR-ISTI	CNR-IFC	CNR-ISM	FORTH	LIU	UCLAN	NTNU	CRNH	INTECS	DRACO	FORTH NET	COSMED
Sub-obj 3.1 – Development of the Wize Mirror[9]			X						X	X	X	X
Sub-obj 3.1 - Validation of the wellness model assessed by the Mirror	X	X						X	X	X		X

For each objective, at least two Partners of the Consortium possess the relevant expertise.
This replication of expertise is intentional due to the following reasons:

- contingency planning, such as poorly performing technology components or even Partners leaving the Project
- ensuring marginal diversity towards safeguarding the Project development against specific integration problems/risks
- in several cases different Partners may excel in complementary aspects of the same technology.

B2.3.3. Industrial involvement and exploitation of the results

SEMEOTICONS is mainly a research-driven R&D proposal, since it mainly aims at exploring innovative methods for well-being self-assessment and self-monitoring. The distribution of the RTD effort, the total cost and the EC contribution between research and industry Partners is also reported in Fig. 18.
However, an important outcome of the Project will consist in an innovative device, the Wize Mirror, which suites well to exploitation. In particular, the Consortium includes two large enterprises and two SMEs that see in the Mirror a good business opportunity.

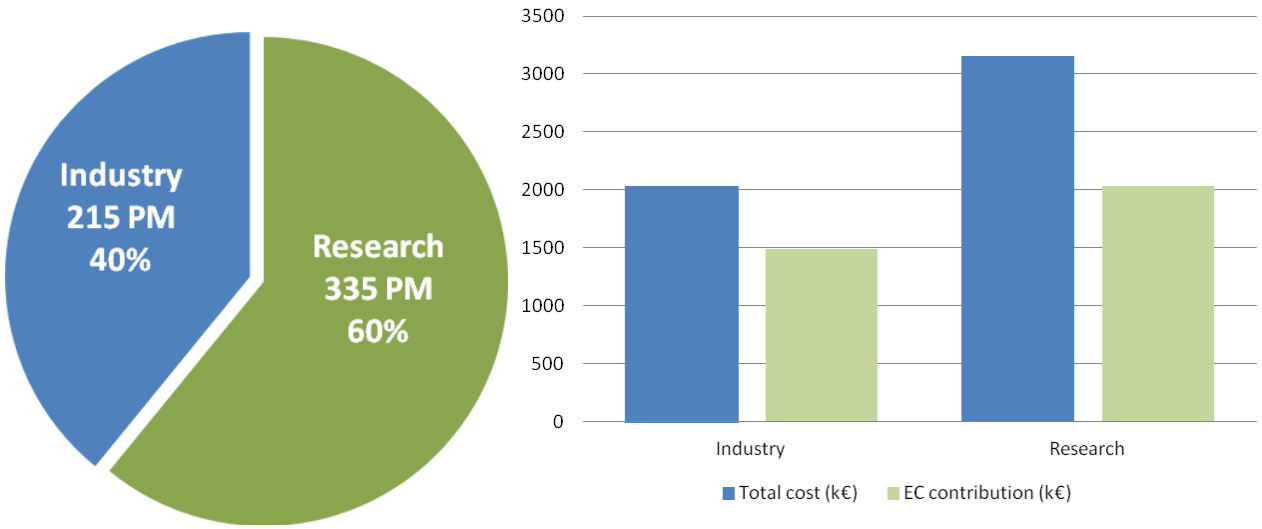


Fig. 18 Total effort, cost and EC contribution distribution per Partner's type (industry or research) for RTD activities

B2.3.4. Subcontracting

MNG subcontracting is included to account the expenses for the Certificate on the Financial Statements for those Partners that exceed the threshold of 375,000€ of funding, i.e. CNR, NTNU and DRACO.

[9] This objective is here intended from a technological point of view, and hence as the HW/SW integration of the device

B2.3.5. Third Parties

During the *Wellness Semeiotics Validation* phase (in WP9), CRNH needs to hire nurses to carry out laboratory activities. This is because CRNH is an autonomous public entity which employs directly only research staff; the medical and nurse staff is hired by the **Hospices Civils de Lyon** (**HCL**), a constitutive member of CRNH. This has been decided by the Administration Council of CRNH to avoid staff's insecurity.
HCL will be, then, involved in SEMEOTICONS as a Third Party which will make part of its resources available to CRNH, in particular nurse personnel. The cost of HCL personnel will be submitted by CRNH in its own Financial Statement. CRNH will reimburse HCL after the Form C has been approved by the European Commission. The effort is estimated as nurses' ten person/months for a total amount of **40,000**€.

B2.3.6. Other countries

All Partners are based in EU Member States.

B2.4. Resources to be committed

B2.4.1. Equipment

The need for new durable equipment to be acquired for SEMEOTICONS is summarized in Table 6, together with the justification of costs. The total cost of equipment is **85,250**, which is **1.6**% of the total Project cost.

Table 6. Equipment

Partner	Equipment costs	Justification
CNR	18000	Optical sensors and instrumentation will be needed for the study and investigation activities on 3D face reconstruction and characterization. Some diagnostic tools will also be acquired for the validation activities.
FORTH	12000	Optical sensors will be needed for testing face expression recognition algorithms. FORTH is also planning to buy some new workstations, servers and software licenses.
LIU	12000	Modification of existing hardware for laser Speckle Contrast Imaging and probe based integrated laser Doppler Flowmetry and diffuse reflectance spectroscopy
UCLAN	13250	Software licenses, light sources, image and range sensors and associated software and hardware peripherals will be acquired to build sub-system for 3D facial reconstruction
NTNU	12000	Existing hyperspectral cameras will be used for collection of reference data. The system will be adapted to fit the needs of this Project. Adaption costs, light sources and computers needed for real time analysis will be charged to the Project.
CRNH	10000	The acquisition of an AGE reader DiagnOptics will be required for the validation activities
INTECS	2000	Equipment costs for development and demonstration activities
FORTHNET	6000	Software and hardware related to profiling, user centric application development and data management
DRACO		Equipment costs for research, development and demonstration will be covered by the company's R&D budget.
COSMED		Equipment costs for research, development and demonstration will be covered by the company's R&D budget.

B2.4.2. Travel costs

The travel budget per Partner is computed based on the following estimates[10]:

- Average cost of Project meeting per person: 1,000 €. This estimate is based on the geographical distribution of the Partners and on their previous experience of participation to FP7 Projects.

[10] The travel costs of FORTH, FORTHNET and NTNU are increased by 35% due to their geographical position (Crete Island and Norway), which requires at least one additional flight connection for virtually every destination. Moreover, for the main meetings, costs for CNR-ISTI and CNR-IFC are doubled since two persons will travel: one will take care of the management and one for R/T.

- Average cost of Project management travels per person: 1,000 €. This estimate is based on previous experience of participation to FP7 Projects.
- Average cost of conferences and industrial fairs per person: 2,000 €, which also includes conference/fair registration fees.

Based on the involvement of each Partner in multiple WPs and the overall contribution expected in the Project, we estimated average numbers of travels per Partner, reported per category in Table 7. The resulting total travel costs in the Project are **254,030** €, which account for the **4.7**% of the total Project cost.

Table 7. Indicative number of travels per Partner

Travel type	Average number
Project meetings	9/10
Project management travels	3
Conferences or industrial fairs	3

B2.4.3. Management costs

The following management costs are planned:

- Expenses for Project management travels (e.g., reviews, coordination of Project management activities) (see Section 2.4.2), total **38,000** €, classified as other direct costs for each respective Partner.
- Subcontracting costs for the CFS of all Partners with EC contribution exceeding 375,000€, total **15,500**€.
- Personnel costs, total **165,175** €. In accordance with the ECGA Article II.16.5, the costs above will include (non-exhaustive list): maintenance of the CA, the overall legal, ethical, financial and administrative management. These costs will not include any technical coordination and development activities.
- Indirect costs, total **115,231** €.

The total management cost is **335,906** which is **6**% of the total Project cost.

B2.4.4. Other costs

For each Partner, expenses for dissemination activities, such as workshop/fair organization, dissemination materials, open-access journal publication, have been included as "Other costs".
Direct costs of these expenses account for **42,840**€; indirect costs on these amounts are **5,900**€, for an overall cost of **48,740**€, which is the **1.86**% of the total Project costs.

B2.4.5. Sub-contracting costs

The subcontracting costs and their justification are reported in Section 2.3.4.
The total sub-contracting cost of the Project is **15,500** €, which is **0.003**% of the total Project costs.

B2.4.6. Resources employed in the Project

The resources that will be employed in the Project for each Partner are reported in Table 8.

Table 8 Resources to be employed in the Project

Partner	Resource to be employed
CNR-ISTI	In addition to the Project Coordinator, who will be employed full-time on the Project for the whole duration, CNR-ISTI team will include two researchers, who will be employed full-time for the Project duration, one research fellows that will work on the methods study and development and the part-time supervision of a senior researcher and a part-time management of a director of research.

Partner	Resource to be employed
CNR-IFC	In addition to the Scientific Coordinator, who will be employed full-time on the Project for the whole duration, and the Clinical Coordinator, who will spent most of his time on the Project, CNR-IFC will employ two senior researchers (one technical and one medical). Three research fellows (one technical and two medical or biologist) will be work with the supervision of a senior researcher. A technical staff of 4 persons will be involved in the Project for data management, biochemistry assays, web-site implementation and maintenance.
CNR-ISM	CNR-ISM team will mainly consist in a researcher that will work full-time on the development of the gas sensors
FORTH	FORTH will involve two full-time engineers for the development and test activities, one part-time senior engineer and one part-time researcher for supervision and dissemination
LIU	LIU will employ an almost full-time Ph.D. student, who is going to be recruited, a part-time senior lecturer and a professor for supervision
UCLAN	UCLAN team will employ a full-time post-doc who will work on the allocated tasks for the whole duration of the Project with the part-time support of a professor and occasional additional support from the full-professor
NTNU	NTNU will employ a full-time post-doc (who is under recruitment) for all the activities of study and development, and a small percentage of a professor's time for activities supervision, management and dissemination
CRNH	CRNH team will employ a part-time MD and a full-time research nurse for the clinical study. A part-time supervision will involve two professors (one clinician, one biologist), one engineer and one assistant professor (biologist)
INTECS	INTECS team will include one senior researcher, who will be employed full-time for the Project duration, and two-three developers or junior researchers for development, integration, and testing activities
FORTH NET	The Project team will include a) two full-time ICT experts who are developing and adapting network management solutions, as well as a senior research manager with significant experience in European Project management and coordination of tasks related to evaluation and assessment, exploitation planning and dissemination
DRACO	DRACO will employ a full-time senior engineer, and a part-time junior engineer with the supervision of a Project manager. The team will also comprise administrative personnel
COSMED	Four engineers will work on the Project in the activities of hardware electronic design, software integration and system development.

B2.4.7. Budget breakdown

In the Table below the breakdown of the budget for the resources to be committed is reported. Two main sections are identified for the Management and RTD costs. Moreover, the three units composing the Partner CNR (i.e. ISTI, IFC and ISM) are reported, both separately and combined (the grey column).

Table 9 Budget Breakdown

	1-CNR-ISTI	1-CNR-IFC	1-CNR-ISM	1-CNR TOT	2-FORTH	3-LIU	4-UCLAN	5-NTNU	6-CRNH	7-INTECS	8-FORTHNET	9-DRACO	10-COSMED	Total
RTD														
Personnel	€ 225.700	€ 214.600	€ 70.300	€ 510.600	€ 180.000	€ 260.000	€ 202.590	€ 378.251	€ 150.000	€ 385.000	€ 244.400	€ 369.750	€ 201.600	€ 2.882.191
Subcontracting	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Other direct	€ 43.002	€ 41.560	€ 37.500	€ 122.062	€ 39.000	€ 31.300	€ 29.575	€ 36.000	€ 25.125	€ 17.000	€ 35.000	€ 41.220	€ 10.000	€ 386.282
Indirect	€ 153.476	€ 145.928	€ 47.804	€ 347.208	€ 149.400	€ 174.780	€ 139.299	€ 248.550	€ 105.075	€ 177.100	€ 195.520	€ 82.194	€ 110.880	€ 1.730.006
Funding	75,00%	75,00%	75,00%	75,00%	75,00%	75,00%	75,00%	75,00%	75,00%	50,00%	50,00%	75,00%	75,00%	
Total Budget	€ 422.178	€ 402.088	€ 155.604	€ 979.870	€ 368.400	€ 466.080	€ 371.464	€ 662.801	€ 280.200	€ 579.100	€ 474.920	€ 493.164	€ 322.480	€ 4.998.479
Requested EC Contrib	€ 316.634	€ 301.566	€ 116.703	€ 734.902	€ 276.300	€ 349.560	€ 278.598	€ 497.100	€ 210.150	€ 289.550	€ 237.460	€ 369.873	€ 241.860	€ 3.485.353
MANAGEMENT														
Personnel	€ 66.600	€ 44.400	€ 3.700	€ 114.700	€ 4.000	€ 6.500	€ 4.502	€ 10.223	€ 5.000	€ 5.500	€ 4.700	€ 7.250	€ 4.800	€ 167.175
Subcontracting	€ 10.000	€ 0	€ 0	€ 10.000	€ 0	€ 0	€ 0	€ 3.000	€ 0	€ 0	€ 0	€ 2.500	€ 0	€ 15.500
Other direct	€ 5.000	€ 3.000	€ 3.000	€ 11.000	€ 3.000	€ 3.000	€ 3.000	€ 3.000	€ 3.000	€ 3.000	€ 3.000	€ 3.000	€ 3.000	€ 38.000
Indirect	€ 45.288	€ 30.192	€ 2.516	€ 77.996	€ 3.320	€ 5.700	€ 4.501	€ 7.933	€ 4.800	€ 2.530	€ 3.760	€ 2.050	€ 2.640	€ 115.230
Funding	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	
Total Budget	€ 126.888	€ 77.592	€ 9.216	€ 213.696	€ 10.320	€ 15.200	€ 12.003	€ 24.156	€ 12.800	€ 11.030	€ 11.460	€ 14.800	€ 10.440	€ 335.905
Requested EC Contrib	€ 126.888	€ 77.592	€ 9.216	€ 213.696	€ 10.320	€ 15.200	€ 12.003	€ 24.156	€ 12.800	€ 11.030	€ 11.460	€ 14.800	€ 10.440	€ 335.905
OTHER														
Personnel														
Subcontracting														
Other direct	€ 6.750	€ 6.750	€ 1.282	€ 14.782	€ 5.560	€ 1.500	€ 3.500	€ 1.500	€ 3.000	€ 1.500	€ 3.500	€ 1.000	€ 7.000	€ 42.842
Indirect	€ 0	€ 0	€ 0	€ 0	€ 0	€ 900	€ 2.100	€ 900	€ 1.800	€ 0	€ 0	€ 200	€ 0	€ 5.900
Funding	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Total Budget	€ 6.750	€ 6.750	€ 1.282	€ 14.782	€ 5.560	€ 2.400	€ 5.600	€ 2.400	€ 4.800	€ 1.500	€ 3.500	€ 1.200	€ 7.000	€ 48.742
Requested EC Contrib	€ 6.750	€ 6.750	€ 1.282	€ 14.782	€ 5.560	€ 2.400	€ 5.600	€ 2.400	€ 4.800	€ 1.500	€ 3.500	€ 1.200	€ 7.000	€ 48.742
TOTAL COSTS	**€ 555.816**	**€ 486.430**	**€ 166.102**	**€ 1.208.348**	**€ 384.280**	**€ 483.680**	**€ 389.067**	**€ 689.357**	**€ 297.800**	**€ 591.630**	**€ 489.880**	**€ 509.164**	**€ 339.920**	**€ 5.383.126**
TOTAL EU FUNDING	**€ 450.272**	**€ 385.908**	**€ 127.201**	**€ 963.380**	**€ 292.180**	**€ 367.160**	**€ 296.201**	**€ 523.656**	**€ 227.750**	**€ 302.080**	**€ 252.420**	**€ 385.873**	**€ 259.300**	**€ 3.870.000**

In the following Fig. 19, the budget distribution and requested EU contribution per beneficiary are reported, taking into account only the RTD activities.

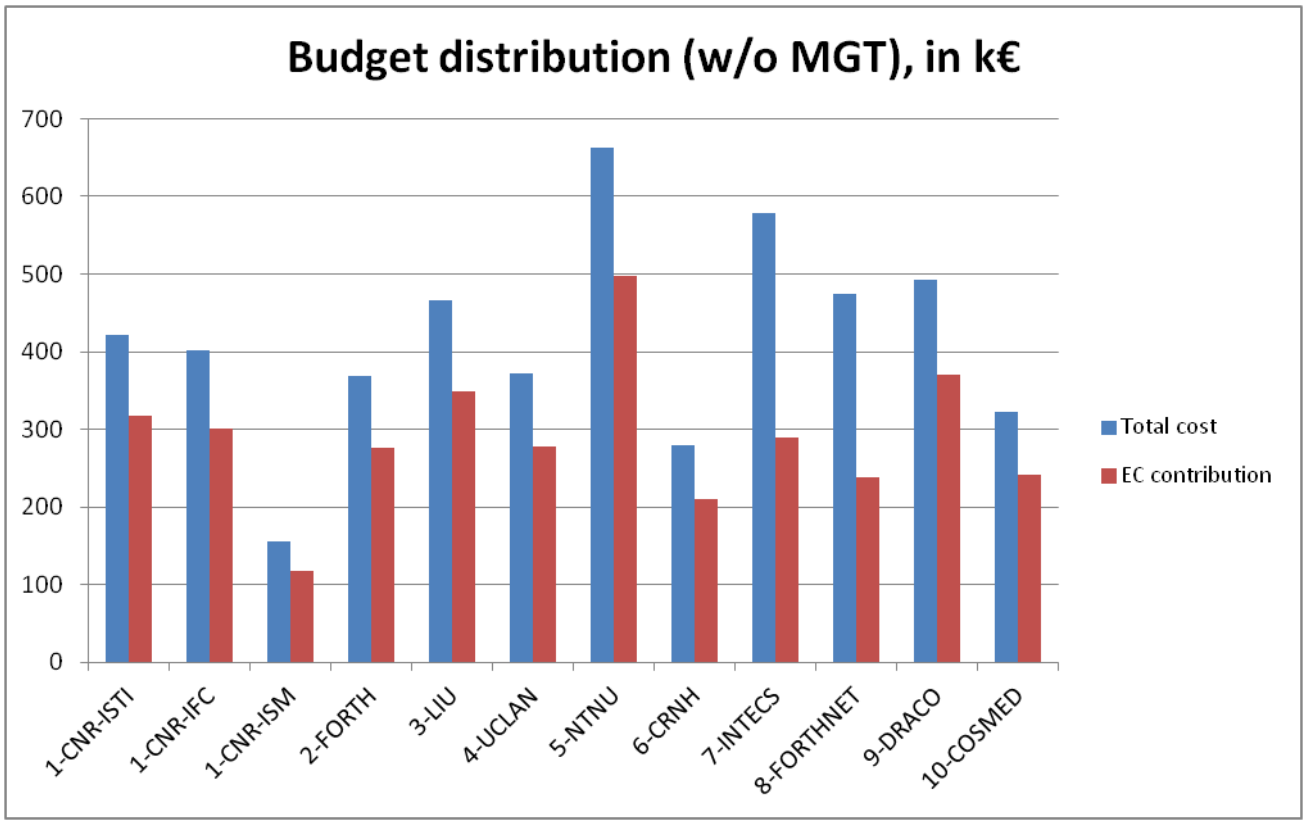


Fig. 19 Budget distribution over beneficiary for RTD activities

B3. IMPACT

B3.1. Expected impacts listed in the work programme

This section clarifies and summarizes the relevance of SEMEOTICONS Project towards Objective ICT-2013.5.1 and it will discuss, from a European perspective, its strategic impacts in terms of well-being. This point of view is relevant for the disease prevention strategy. Besides direct impact on heath and health systems, it has also social, economic and cultural implications that will be discussed in the following subsections.

B3.1.1. Relevance toward impacts of Objective ICT-2013.5.1a

This proposal is in line with the expected impact of topic ICT-2013.5.1 "Personalised health, active ageing and independent living - Target Outcomes (a) Personalised Guidance Services for lifestyle management and disease prevention" of the Work Programme 2013, as analyzed in the following sections.
Actually, SEMEOTICONS, through the creation of a user-centric multisensory device, the Wize Mirror, allows the following main strategic, economical and social impacts:

- Reduction of the national health expenditure due to the prevention of at-risk individuals. An individual, stimulated to improve his/her well-being, pursues a healthy lifestyle that allows him/her to minimize the risk of disease outbreaks.
- Reduction of the national health expenditure due to the prevention of people not at risk. Data collection on the state of well-being supports the medical staff.
- Reduction of cases of hospitalization of patients at risk. The data collection carried out allows the medical staff to carry out continuous monitoring of subjects at risk and intervene proactively.
- Move the individual use of e-Health technologies. Through the use of User-Centric multisensory system mirrors an individual uses a non-invasive system to monitor his/her well-being and can choose to share this information with his/her medical team.

It is a matter of time that specific hardware platforms with high performances, low cost and low power consumption will replace conventional PC for novel applications like the one developed in that Project. There is a number of challenges in that Project that we expect to tackle and address efficiently to obtain a substantial impact for future applications.

Expected impact	SEMEOTICONS *contributions*
Strengthened evidence of the impact of healthy behaviours on health and wellbeing.	SEMEOTICONS framework relies on a model that captures a wide spectrum of individual signs and characteristics. Besides personal history, habits and preferences, they include the evaluation and monitoring of personal physical and psycho-physical status and risk factors. Such an integrated virtual individual's model will be a powerful tool to manage individuals' lifestyle, discover unhealthy situations, and also improve interaction with health professionals. The latter will be favoured the rich set of detailed personal data that may be sent to doctors. In addition, the Wize Mirror will ease self-education and produce a more convinced and specific understanding of potential risks affecting individual's health. The Wize Mirror is also conceived to assist longitudinal and transversal medical investigations. The analysis of collected data is estimated to enrich medical knowledge on cardio-metabolic risk factors, leading to improved personalized prevention strategies.
Strengthened evidence on the impact of disease prevention on health and expenditure.	The SEMEOTICONS multisensory device will help the person in keeping his well-being indicators to a positive level. Improving the individual lifestyle should allow an optimized management of cardio-metabolic risks and enhanced disease prevention. A successful exploitation of the Wize Mirror in CVD prevention will also have a significant impact towards health

Expected impact	SEMEOTICONS *contributions*
	expenditure
Contribution to a more sustainable European healthcare system through reduction of avoidable disease burden.	Improved management of CVD risks is deemed an effective step to reduce morbility and mortality. Reduction hospitalization is also expected. All that would lead to more effective organization of healthcare system with significant economic benefits.
Validated programmes and good practices for health promotion and disease prevention.	SEMEOTICONS includes a validation phase carried out by the medical Partners of the Project. That should provide both an optimized deployment of the Wize Mirror and the gathering of significant data to be shared with medical community. That would enable health professionals to take advantage of personalized strategies to counteract cardio-metabolic risk. On the other hand, improvement of individuals' awareness about their well-being through self-monitoring will strengthen the link between doctors and citizens, easing the communication among individuals and medical and other "well-being" operators. All that will ease good practice in CVD prevention.
Business ecosystem and new business models for promotion and co-production of health.	The relevance of the SEMEOTICONS Project is to be found both at the clinical and ICT level. Wize Mirror will be designed taking into account its potential impact to primary and secondary prevention. Therefore, SEMEOTICONS platform is expected to offer significant way to favour new aggregations between health and well-being actors including industrial ones. Exploitation of SEMEOTICONS achievements should impact at various socio-economic levels. In particular, one has to consider that, thanks to its design strategy; the Wize Mirror will fit in domestic and daily-life environments (e.g. schools and fitness centres). That should prompt the growth of new actors in the field well-being management, also derived by a strengthened involvement of citizens, encouraged to become co-producers of health. In view of that, involvement of educational services (e.g. schools) will be stimulated and facilitated.

B3.1.2. Impact towards individuals

SEMEOTICONS is strongly characterized by a user-centric approach. Wize Mirror will be the core of a platform aimed to support the users in self-assessing the quality of their lifestyle and self-monitoring their physical and psycho-physical status over time. At the same time, it will offer a natural interface between the users and their body, which should help to strengthen their awareness about personal well-being. That should be valuable in assisting people to detect unhealthy behaviours connected to diet, psycho-physical stress conditions, physical inactivity and sedentary lifestyle.

The Wize Mirror is expected to be located at user home and/or in environments involved in daily life such as fitness centres and other similar sites. In this way, SEMEOTICONS platform will assume a familiar and friendly role easing its acceptance as well as its effectiveness towards user. In addition, that is expected to stimulate and ease the users in sharing their experience with positive effects on family and social aspect of daily life.

A further point to be considered is related to reliability of the given feedbacks and, in general, of information and data provided to the user. The overall design strategy, exploiting the integration of advanced multisensory devices and the development of specialized intelligent processing systems should ensure the coherence and the reliability of all the pieces of information offered to individuals. In addition, the results coming from Wize Mirror validation, which will be carried out by specialized clinical centres in the final phase of the Project, is expected to provide the generic users a firm and authoritative reference, thus enforcing their confidence in the system.

A noteworthy SEMEOTICONS aspect is the educational and communicational impact. Besides direct advising, the smart mirror system will be an important education tool to broaden people knowledge about the

factors affecting their health and the strategies to counteract the related risks. In addition, the smart mirror platform will offer a semeiotics-based link between health professionals and individuals. That will help the transfer of medical knowledge on cardio-metabolic risk and related prevention strategies towards the users. At the same time it is expected that users will be encouraged and guided in their communications with physicians and other health professionals and agents.

B3.1.3. Impact towards health and health systems

The empowerment of the individuals to improve and manage personal life conditions through active participation is a strategic challenge in current policies for preventing cardiovascular diseases. Proper adaptation of personal lifestyle allows influencing many modifiable cardio-metabolic risk factors. SEMEOTICONS will provide a directing system able to warn the user whenever potentially unhealthy behaviours are detected. This will be achieved by integrating personal data and sensor measurement using a specific "virtual individual" model. Following initial user profiling, users will be able to track their status and receive advices in a personalized way taking into account their preferences, desired detail level and graphical data display modalities. This will enforce a familiar and unobtrusive coaching aimed at maximizing the effectiveness of lifestyle guidance. Furthermore, improvement in communication between users and health agents will be also beneficial for doctors and other health professionals. As a matter of fact, the latter will be able to gather more detailed and precise information about individual status and related trends. From the medical point of view, SEMEOTICONS platform is also planned as an instrument for transversal observations and could be relevant for clinical investigations. Though it is not conceived as a diagnostic tool, it allows the non-invasive monitoring of several physical quantities and the measurement of important physiological parameters. That may occur for long lasting periods also allowing the monitoring of effects of prevention measures and therapeutic actions for diseased subjects.

B3.1.4. Impact towards Economic Burden

According to medical literature, personalized continued monitoring and advising is expected to produce significant beneficial effects in contrasting CVD morbility and mortality. These have major economic costs for health systems.

According to 2012 reports by the US National Centre for Health Statistics [157], 46.5% of Americans adults (about 102.5 million adults) have at least one risk factor for heart disease. And more than 1 of 3 (83 million) U.S. adults currently lives with one or more types of cardiovascular disease. Death rates for heart disease and stroke have decreased in the United States in recent years from 341.3 in 2000 to 244.8 every 100000 peoples in 2008 [158]. However, rates for incidence and death continue to be high, especially among some populations, including members of certain racial and ethnic groups, people with low socioeconomic status, and those living in the south-eastern United States.

In 2010, the total costs of cardiovascular diseases in the United States were estimated to be $444 billion. Treatment of these diseases accounts for about $1 of every $6 spent on health care in this country. As the population ages, the economic impact of cardiovascular diseases on nation's health care system will become even greater.

At the European level, the CVD costs for health care systems were just under €105 billion [159]. This represents a pro-capite cost of €230 per annum, around 12% of the total health care expenditure across the EU. However, the overall CVD cost, including production losses due to premature mortality and illness, is estimated to cost the EU economy €169 billion a year.

The evaluation of the economic burden of CVD should also account for trends observed in recent years. A report issued by the Institute of Medicine (IOM) [160] revealed that more than 80 per cent of deaths worldwide related to cardiovascular disease now occur in developing countries. Furthermore, nearly 30 per cent of all deaths in developing countries are caused by cardiovascular disease. Since cardiovascular disease reduces productivity, it would certainly threaten the economic growth of developing countries in the long run.

B3.1.5. Technological innovation

Wize Mirror will have several innovative features: starting from the suite of sensors for heterogeneous and multimodal data acquisition, moving to the contactless estimation of several descriptors of skin morphology

and composition, and ending up with the assessment of a customized user-adaptive wellness index specific for cardio-metabolic risk and the provisioning of personalized guidance and services.
The development of an integrated device has inherent technological innovative features, related to (i) the development and integration of advanced sensors and sensing methodologies, (ii) the implementation of an intelligent system able to efficiently and effectively exploit the variegated pieces of information provided by integrated sensing, (iii) development of user-centric applications able to provide a friendly and familiar user interaction and allowing the user to develop personalized strategies to behavioural changes.

B3.1.6. Added value of carrying out the research at European Level

There two main compelling reasons to carry out the proposed work at European level rather than at a national or local level. Firstly, SEMEOTICONS needs the integration of many different skills and capabilities including, scientific, medical, technological and industrial competences. A multinational European Consortium is the key to bring the required knowledge and expertise together to succeed in the challenging activities proposed by the Project. On the other hand, the involvement of European R&D establishments and academic institutions is necessary to create innovation at the leading edge of the worldwide research. The Consortium combines European Partners from different ICT sectors that will work in close contact with medical Partners having differentiated competence, covering cardiology, metabolomics, nutrition and lifestyle management, that are necessary to the proposal aims.

A second important reason is related the EU cardio-metabolic risk prevention. SEMEOTICONS aims at realizing instruments and services targeted to "global users" independently of their culture, language and ethnicity. The EU framework is a natural and stimulating environment to fruitful overcome these barriers and encourage the progress toward a unified view of cardio-metabolic risk and related management strategies.

Thus, the establishment of an international cooperation between leading centres from various EU countries may significantly contribute to optimize the impact of Wize Mirror to global market.

B3.1.7. Initiatives relevant to the proposal

Among the various national and international research and medical initiatives relevant to SEMEOTICONS, the actions of medical associations and organizations for cardio-metabolic risk and lifestyle management will be closely analysed in SEMEOTICONS. These include guidelines and CVD prevention actions by:

- European Society of Cardiology (ESC);
- European Association for Cardiovascular Prevention & Rehabilitation (EACPR);
- European Atherosclerosis Society (EAS);
- International Society of Behavioural Medicine (ISBM);
- European Stroke Organisation (ESO);
- European Society of Hypertension (ESH);
- European Association for the Study of Diabetes (EASD);
- European Society of General Practice/Family Medicine (ESGP/ FM/WONCA);
- International Diabetes Federation Europe (IDF-Europe);
- European Heart Network (EHN);
- American Heart Association;
- American Diabetes Association;
- American Society for Nutrition;
- The Obesity Society;
- Association for Weight Management and Obesity Prevention;
- World Health Organization.

B3.1.8. Steps needed to bring about these impacts

The first step of course is to ensure that the Research leads to a system that is technically feasible and acceptable to the users. SEMEOTICONS ensures this by the participation into the Consortium of high expertise Partners in the respective knowledge fields.
Prototype implementation of Wize Mirror will rely on a development process that exploits the expertise of industrial Partners in close interaction with academic, both ICT and medical, units. The final validation

activity, led by medical Partners, will provide a significant assessment of end-user functionalities of the Wize Mirror, including user's acceptance tests.
In order to achieve the expected impacts people need to know about the system we are developing. This will be accomplished through extensive dissemination of our results both during and after the Project has completed. Our dissemination plan is described in more detail in Section B3.3.

B3.2. Exploitation of Project results

SEMEOTICONS main technological objectives involve the development of new devices and software tools as well as their integration into a complex system, the Wize Mirror. All of them are expected to offer significant application areas in the academic context as well as from the industrial point of view.

Different SEMEOTICONS outcomes are expected to be worth of industrial/commercial exploitation. In fact, the Wize mirror will be an integrated and flexible multisensory system incorporating highly innovative devices being aimed to assist individual's self-monitoring in daily-life environments. As planned, these include individuals' home, pharmacies, fitness centres and schools. On the other hand, operation in other sites, e.g. workplaces, seems readily feasible. In addition, following proper software updates and hardware extensions, different applications and uses of the system look reasonable. Just as an example, the system could offer a powerful platform for monitoring chronically diseased subjects in their living environment.

All the aforementioned features are crucial to define and optimize successful exploitation strategies of SEMEOTICONS results. On these ground, the following exploitation ideas will be investigated and developed during the project.

a) Single components or processing modules of the Wize mirror are expected to offer significant stand-alone functionalities and could be commercially exploited in "simple", non-integrated, devices. Similarly to the *Wize-sniffer*, already included in SEMEOTICONS work plan as a stand-alone device, other *Wize-devices* are practicable, e.g. for the assessment of skin cholesterol or skin AGE concentration. Among the other, methods developed for monitoring stress and fatigue conditions also deserves attention for their practical uses.
b) The internal hardware and software architecture of the Wize mirror will be modular and flexible. This will be a key point to ease the integration of additional hardware components (such as sensors and communications links) and software tools and applications.
c) A particular attention will be paid to cost-related issues. They will be evaluated and carefully taken into account since the beginning of the project (i.e. software and hardware specification and design activities in WP2). In this perspective, it is worth considering that, though the mirror is conceived for a personal use, a fruitful exploitation plan might be based on a "top-down" strategy. Institutional sites, such as schools, or commercial ones, such as fitness centres and pharmacies, can be strategic points to reach individuals even in the case of relatively high initial prices. This will be advantageous to promote the Wize mirror usage and will offer an interesting mean to gradually reduce initial costs.

The Consortium will start from the very beginning of the Project to study possible exploitation strategies. Particularly, industrial-commercial partners will be involved in maximizing the impact and exploitation potential of the system and/or its sub-components.
Joint exploitation opportunities will be investigated as part of WP10 activities. Specifically, an initial exploitation plan will be released at M12 and will be updated throughout the duration of the project as defined in the work-plan, leading to the final exploitation report at M36. In order to match the above ideas, the SEMEOTICONS exploitation plan will take care of the following topics: target market need and potential target user groups/customers, SWOT analysis, market penetration plan. This is a useful approach to have a clear vision of the target market; it allows defining an appropriate decision-making process.
In this frame, a schedule for the elaboration of the plan will include the following steps: 1) identification of the end user segments; 2) detailed SEMEOTICONS platform distribution plan; 3) detailed identification of the relative competitive environment; 4) assessment of benefits by end-users; 5) establishment of a commercial agreement among partners on the joint commercialization and exploitation after Project end; 6) development of the prototype into an integrated product, following the successful completion of the SEMEOTICONS project.

Based on this plan, the consortium will promote SEMEOTICONS to its contacts' network.

Task 10.2 will, then, provide guidance for the process of registering IPR; especially in cases where joint ownership is involved. It will also address any issues concerning access rights, including cases where partners join or leave the project during its execution, and exploitation of IPR.

INTECS – *exploitation strategy*:

INTECS has a strong interest in the Health Systems, as confirmed by the recent creation of a new business unit (Smart Systems) to follow more closely the customers' needs and business opportunities in this domain. The domains in which the Smart Systems business unit operates are eHealth, Smart Grids, eHome, Intelligent Transport Systems.
INTECS will exploit the SEMEOTICONS' results by appropriately transferring internally the knowledge acquired during the execution of the R&D activities. This process will be facilitated by the use of the Centres of Excellence mechanism that has been used successfully in the last years by INTECS for this purpose. The new skills and experiences will make INTECS a more competitive player for providing turn-key solutions and consultancy services to its customers, and will allow the company to expand its business towards market segments that are only partially addressed today, including the integration of the European guideline on the healthcare domain (e.g. http://ec.europa.eu/digital-agenda/en/about-health).

FORTHNET – exploitation strategy:

FORTHNET S.A. is a leading provider of broadband network services in Greece. FORTHNET has entered both the telecommunications and network services business, being a convergent services' provider, offering from voice telephony to Internet and value-added services over its private broadband network. The company has more than 270.000 enterprise customers using leased lines and broadband access services; more than 320.000 voice telephony lines and 500 data centre customers. FORTHNET customer base comprises a major part of the Greek Internet community and the market of alternate voice telephony & network providers. The extended technological research throughout the duration of the SEMEOTICONS Project, along with the expected outcomes will provide FORTHNET with further expertise, especially in the area of home and business oriented automation technologies and advanced personalized well-being. The above will result in offering a richer and more advanced end user experience. Through the SEMEOTICONS exploitation framework, potential target groups in different sectors will be identified, analysed and prioritised according to commercial attractiveness of the Project's results. The commercial exploitation activities will be focused on adopting the Project results among selected customers, in order to optimise time-to-market.

COSMED – exploitation strategy:

COSMED is highly interested in the SEMEOTICONS Project in order to enlarge its range of products and expand the penetration into the international metabolic markets. With the acquisition of LMI Inc. (2011), COSMED now provides the best and most comprehensive cardiopulmonary and metabolic solutions for the medical, research, sport science and performance, and wellness markets, along with a worldwide structure for responding to the needs of their clients. With the addition of the BOD POD and PEA POD, COSMED further enhances its already extensive product offering, which includes application-specific solutions for the measurement of exercise capacity (VO2max) and indirect calorimetry, with Gold Standard products such as the K4 b^2, the Fitmate, and the Quark product line.
Additionally, the know-how acquired during the execution of the Project will increase the specific knowledge of COSMED and improve its competence and support towards customers.

DRACO – exploitation strategy:

Draco believes that SEMEOTICONS Project will result a great improvements to its commercial IP portfolio (high-speed I/O interfaces, camera interfaces, network interfaces, etc). Those results will be incorporated in the strategic roadmap of DRACO, and will contribute in reducing time to market to future products developments. In addition, the know-how gained on the particular topics covered in that Project will be used as input for new competitive advantages for new Draco platform developments.
Additionally, DRACO will identify and explore the concepts and technology of the whole project within their commercial network to maximise the impact of the project output and identify near future exploitation

opportunities. It may include collaborations with industry, particularly SME's, for technology transfer, licensing or direct agreements.

B3.3. Dissemination of Project results

An important aspect of the Project concerns the activities for promoting key dissemination actions targeted at wider communities, both scientific, industrial and the general public. The planning of high-level dissemination activities is considered fundamental for enhancing the visibility of the Project and for establishing long-lasting connections and cooperation among the Consortium. Another fundamental aspect will be the promotion of the Project's achievements to industrial communities, through the set up of an Industrial Advisory Board (IAB). Typical dissemination actions will also be organized, such as participation in conferences and workshops, publications in journals, etc.

The general activity of spreading scientific excellence will deeply involve all Partners, with different ones taking the lead depending on the specific topics concerned. The results of intra-project activities will be made available to the scientific and industrial communities as well as to a wider public audience. The dissemination activities will coordinate the different tasks planned for spreading excellence, which are:

- Project Website: the dissemination team and the Project Coordinator will structure and develop the Project website to provide an endpoint of public accessibility about Project's general information, ongoing activities and updates
- Scientific publications: the strong clinical and ICT interest within the SEMEOTICONS Project will enable the production of scientific works to be issued as part of the Project dissemination activities
- Press releases: appropriate press releases will be issued to publish updates and advertise on important events about the Project
- Training and workshops: the concepts and outcomes of the SEMEOTICONS Project will be advertised at workshops whose themes will be relevant with the ones here developed. The Partner's participation to this kind of events will allow for the targeting of a large audience.
- Participation/Disseminations in standardisation activities, journals & conferences: the knowledge obtained during the research will be published and applied to standardization committees, conferences and on publications on scientific journals
- Organization of thematic special sessions at the leading international conference (e.g. SMC, ICIP, MICCAI) to disseminate the results of the Project but also to stimulate cross-fertilization of ideas with other groups working in the related areas.
- Contribution to standards
    - ETSI TC Machine-to-Machine (M2M) and OneM2M TP: INTECS is involved in the Technical Committee of ETSI M2M and also in the Technical Plenary of OneM2M. During the Project lifetime the SEMEOTICONS ICT activities will be used as contribution to the standardization activities related to the e-Health use cases in the ETSI M2M and OneM2M.
- Coordination with other EC initiatives: The Project will be open to coordinated actions with other EC Projects with relevant objectives. The following coordination actions are foreseen during the Project:
    1. Advance notice of scientific or general audience event planning, possibly leading to co-location of events organized by other EC Projects;
    2. Cross-linking and advertising of each other's Projects, web-sites, publicity material;
    3. Exchange newsletters, prepare joint editorials with other Projects;
    4. Share and adopt Best Practices;
    5. Give access to confidential Project information (deliverables, reports, etc.) to other Projects, provided that a confidentiality agreement is duly signed.
- Support of a specific dissemination channel to industry through the creation of an industrial advisory board (IAB). Several companies have already expressed their interest in the Project's activities and scope. The IAB will be regularly informed about the ongoing actions. Their expertise will be used to:
    - identify relevant industrial open problems,
    - tune the research activities to address industrial needs,
    - evaluate the research outcomes.

Members of the IAB will be called upon to act as industrial advisors to support the Managing Board and advice whenever needed, especially in matters concerning possible industrial exploitation of network results. Consequently, there will be a direct industrial influence on the running of the Project.

CNR

CNR plans to focus its dissemination activity mainly on:

(i) Creation and maintenance of a public website. The website may include a news section containing the most recent advances, an updated Project roadmap, a detailed description of the WPs and technical activities, the scientific publications, the public deliverables, an updated list of dissemination events and achievements;

(ii) Promotion of a multidisciplinary academic network. The Project will have a fundamental role in establishing new exchanges, cross-contributions, and synergies with ongoing National and European research Projects; moreover it will lay the foundations for a multidisciplinary academic network, devoted to Digital Semeiotics, arising from the SEMEOTICONS Consortium;

(iii) Scientific production. CNR aims at showing the advances of the Project in relation with the theoretical and technological developments. The publication process will be facilitated by having an outstanding record of publications and impact on the academic and industrial scientific communities, and being currently involved in scientific events and groups. In particular, we will prefer high quality journals with short review periods, fast on-line publication and those indexed by widely accessed research databases (ISI Web of Knowledge, IEEE Explore). Relevant journals and magazines for publications are: ACM Transactions on Embedded Systems, Sensors, IEEE Transactions on Medical Imaging, IEEE Transactions on Biomedical Engineering, ACM Transactions on Sensor Networks, IEEE Transactions on Computers, IEEE Transactions on Industrial Informatics, IEEE Transactions on Intelligent Transportation Systems, IEEE Transactions on Pattern Analysis and Machine Intelligence, IEEE Transactions on Vehicular Communications, Image and Vision Computing, International Journal of Distributed Sensor Networks, Pattern Recognition and Image Analysis, Pattern Recognition Letters, J Consult Clin Psychol., MC Medical Research Methodology, Hypertension, European Heart Journal, American Heart Journal, Trends Cardiovasculary Medicine, Diabetes, Circulation, Journal of Preventive Cardiology, Obesity. It is foreseen to initiate special issues in IEEE, ACM, Springer, etc. journals, within the Project lifetime, as a means to achieve faster publication times of scientific results related to the SEMEOTICONS topics;

(iv) Participation at conferences. Conferences of interest for a rapid dissemination of the results are well-known venues in the community of researchers and practitioners of e-health systems and related technologies, including the ACM Conference on Embedded Networked Sensor Systems (SenSys), Euromicro Conference on Real-Time Systems (ECRTS), European Conference in Computer Vision (ECCV), European Conference on Machine Learning (ECML), European Conference on Wireless Sensor Networks (EWSN), IEEE Conference on Computer Communications (ICC), IEEE Conference on Intelligent Transportation Systems (ITSC), IEEE Consumer Communications and Networking Conference (CCNC), IEEE Pervasive Computing and Communication (PerCom), IEEE Real-Time Systems Symposium (RTSS), International Conference on Computer Vision Theory and Applications (VISAPP), International Conference on Machine Learning (ICML), International Conference on Machine Learning and Applications (ICMLA), Mass Data Analysis of Images and Signals (MDA), ESC Congress, American Heart Association Congress;

(v) Participation in public events in order to disseminate the scientific results to the general public and stimulate the awareness of cardio-metabolic prevention and healthy lifestyle;

(vi) Organization of an international workshop during the final Project phase.

FORTH

The Computational Medicine Laboratory (CML) at FORTH has two main research directions. These are: (a) biomedical informatics in support of individualized medicine and, (b) ambient intelligence eHealth environments. CML focuses on computational aspects of biomedical informatics, e.g. ontology based integration and analysis of genetic and medical information for health applications, while also being active in the design and development of novel and prototypical DM/KDD methods, techniques, algorithms, tools and systems. In the field of ambient intelligence CML focuses on the development of new, innovative ambient intelligence service platforms for automatic, context sensitive offering and contracting of eHealth and mobile

Health (mHealth) services across heterogeneous networks as well as on supporting mobility among users by integrating them with seamlessly accessible ubiquitous intelligent surroundings that support self-configuring devices using semantic agents and tools for ambient awareness and decision support.
SEMEOTICONS outcomes give CML the ability to bridge the two activity directions mentioned above, while empowering it's excellence in scientific research. The tasks CML leads will furthermore support its on-going efforts in the specific area of facial expression analysis and health behaviour modelling. Developed methods have been applied so far in epileptic seizure detection and quantification.
FORTH's dissemination activities rely in publishing scientific results in peer reviewed journals, as well as conferences in the wider domain of biomedical engineering. Further dissemination will take place during business meetings, congresses and lectures held by CML's distinguished personnel.

LIU
The LIU dissemination of the Project results will be through the participation leading international biomedical optics conferences such as the SPIE (Society of Photo-Optical Instrumentation Engineers) Photonics West annual conference (San Francisco, USA) as well as publishing Project results as articles in scientific journals. We have a tradition of publishing in leading journals in the field of Optics (Journal of Biomedical Optics, Journal of Biophotonics, Optics Express), but also in more clinically oriented journals such as Microvascular Research and Diabetes.

UCLAN
UCLAN will contribute to the dissemination through publication of scientific papers, participation in conferences, workshop and seminars. UCLAN will also inform the general public about the Project through series of press releases, informing about the Project objectives, progress and outcomes. The results will be also disseminated in the UK through the existing contacts UCLAN researchers have with the clinical Partners working in the National Health Service (NHS). In particular, the proposed research is complementary with the existing UCLAN research on analysis of facial dysfunction and therefore it is expected that the research outcomes will be of interest to medical practitioners for early diagnosis, monitoring and treatment of neurological condition. In Europe UCLAN will disseminate the outcome of the Project through the existing Engineering and Computational Science for Oncology Network (ECSON), UCLAN is co-ordinating. The research undertaken on the Project for 3D surface description and sensing is highly relevant to the patient positioning and position monitoring during radiation therapy and therefore the outcomes of the Project will be highly relevant to the ECSON partners.

CRNH
CRNH will participate to dissemination by:

- Organising a workshop on the results of the validation phase and the clinical intervention.
- Presenting the results of the validation phase and the clinical intervention in international scientific meetings.
- Writing a publication on the results of the validation phase and the clinical intervention.

INTECS
INTECS has a particular interest towards the business sector of smart devices, for which it is already carrying out dissemination activities also for other international (FP7 BETaaS, FP7 ICSI, FP7 MOTO, …) and national research Projects. The participation in the SEMEOTICONS proposal will allow INTECS to create synergies between results obtained on different partnerships and disseminate the topics of the SEMEOTICONS Project with already established consortia.
INTECS portfolio of customers and its network of national and international contacts will allow the establishment of links over which to advertise the Project activities.
INTECS is also an active member of the ETSI TC on M2M and OneM2M partnership Project, whose activities may be highly relevant to the theme of eHealth.

DRACO
The dissemination of the Project results will be an important activity with the Consortium, which is imperative for a fruitful commercial and scientific exploitation. Draco attends every year at the Electronic Show in Munich. We expect to be able to have a demonstration at the exhibition, as well as some marketing

and promotional materials (brochure, flyers, posters, etc) to help us to promote our engineering services with a successful Project.

COSMED

COSMED dissemination strategy will be carried out through:

1. COSMED International Web site: www.cosmed.com
2. COSMED participation to the largest international healthcare exhibitions and medical congresses every year. The strategy foresees the dissemination through: International fairs (traid fairs such as Medica, Arab Health etc.), Congresses (the European Society for Clinical Nutrition and Metabolism (ESPEN), the American Society for Parenteral and Enteral Nutrition (ASPEN), the American Dietetic association (ADA), the European Congress on Obesity (ECO), Nutrition in Intensive Care, etc.), events, shows, dedicated seminars and several dealer meetings.
3. Press releases: appropriate COSMED press releases will be issued to publish updates and advertise on important events about the Project.

Scientific papers and validations: the strong interest within the SEMEOTICONS Project will enable the production of scientific works published by eminent international Universities and Research Institutes, altready in collaboration with COSMED (e.g. University of Rome "La Sapienza", Appalachian State University, University of Tennessee, Karolinska Institutet etc.).

B3.4. Management of Intellectual Property Rights

The Consortium Agreement, to be signed before the Contract comes into force, will set out the rules for all aspects of the Project operation that are not completely specified in the Contract. It will fill in the details of the responsibilities of the Project Coordinator, the operating procedures for the Management Boards, including decision-making and voting mechanisms; conflict resolution; IPR management, confidentiality and exploitation issues.

All the companies and universities have IPR management procedures and specialist professional advisors. However, the SEMEOTICONS Project has the additional feature of handling digital content from diverse sources, which imposes sensitivity in the handling procedures. IPR co-ordination is therefore an essential part of the work.

SEMEOTICONS will set up an IPR working group at Consortium level, to identify which inventions and content should be protected. This group will also be a forum to help the Partners negotiate transparent arrangements between inventors and would-be exploiters before going through formal and legal channels.

The Confidentiality and IPR rules will accord with the EC regulations and the following general principles:

- No Partner will divulge technical or scientific information belonging to other Partners if this information is not already in the public domain.
- Partners will maintain the confidentiality of all information contained in deliverables classified "confidential." Any Partner wanting to publish results will seek prior clearance from the others.
- The Consortium Agreement will specify which existing background IPR ("know-how"), which Partners will make freely available to Partners for access and/or for use and that which is subject to commercial restrictions or payment of license fees. The Consortium Agreement will draw attention to any areas or items of know-how that are specifically excluded from the Project.
- Researchers will have the right to publish research results in the scholarly press, subject to the terms of the Consortium Agreement and the terms of their employment with their University, Institute or Company.
- Should research results be patentable (or susceptible of registration under copyright or trademark law), the Partner who developed them will choose whether to deposit the patents or intellectual property. They must inform the other Partners of their decision.
- Patents or intellectual property filed by any of the Partners will mention the name of the inventors or the authors, who will be required to satisfy the formalities necessary for the filing, maintenance and prosecution of these patents.

Specific licensing terms and conditions for knowledge created will be negotiated case by case.

B4. ETHICAL ISSUES

SEMEOTICONS is a highly innovative Information and Communication Technologies (ICT) research Project; outcomes will represent a challenging step forward both in research and technology. We will set up methods to pre-process, process and integrate different physical signals, to optimize the quantity and quality of information extracted from the semeiotics and the biometrics of the face; the goal is to enable normal people to self assess their personal well-being status, particularly concerning their cardio-metabolic risk.
SEMEOTICONS respects the fundamental human right for private life, ensuring confidentiality of personal and especially health-related data. Security measures, data confidentiality and privacy are taken into consideration in system design and functional specifications, as well as in later development at the final stage. The medical researchers will be the only persons with an access to personal data of volunteers participating to pilot and validation studies. The technical Partners of the Project will not be in the position to link the provided data with a person's identity. Collected data at all stages, will be treated with respect to person anonymity, and will be discharged after system development and validation.
The clinical activities of this Project will be conducted according with the last revision of the Declaration of Helsinki, the National laws and the EU legislation. All the clinical activities are observational and do not require invasive diagnostic examinations with the exception of a venous blood sample for biochemical determinations. The study protocol and the informed consent form for the volunteers will be submitted to the individual local ethics committees in accordance with the laws of Italy and France concerning observational studies.
The protocol does not require modification of lifestyle and drug therapy taken by the volunteers, nor additional diagnostic investigations potentially harmful for the state of health of the persons. Specialized and skilled medical or nursing personnel will take the blood samples. The conduct of the study protocol is not associated with any additional risk for the volunteers, and at the same time, could make possible the interpretation and systematic recording of semeiotic signs so that they can be digitally elaborated and used for the implementation of the Wize Mirror.

Informed Consent
The pilot and validation studies do not provide any kind of experimental medication or the performance of specific diagnostic tests with exception of ECG, peripheral arterial tonometry and blood sample. Before the beginning of any medical activity, an informed consent, preventively approved by local ethic committees, will be requested, including a detailed information form for both the volunteers and their family doctor. It will describe the aims of the research work, the methods that will be utilized, the potential discomforts and risks, as well as the research groups that will use the collected data. The informed consent will be dated and signed by the volunteer and by the doctor responsible for the task. The signed informed consent must be delivered to the patient and a copy kept by the researcher at the centre as part of the documentation of the study. It is the responsibility of the researcher to obtain written informed consent to use information related to the state of health of the person. If a person does not intend to continue the study, the researcher will require a written request of exit from the study that will be taken in the patient file. The data collected before the person's exit will be used for expected analysis, no other data on that person will be collected.

Security
The clinical protocol does not provide any kind of experimental medication or the performance of specific diagnostic tests with exception of ECG, peripheral arterial tonometry and blood sample. So, in this context, during the period of examination, a reporting of suspected adverse events will be required. Any adverse events will be managed according to usual medical practice.

Conflict of Interest:
No conflict of interest can be identified at this moment in the SEMEOTICONS Consortium. However, if unanticipated conflicts of interest arise, the SEMEOTICONS researchers will disclose them immediately to the Project Co-ordinator and the Project Management Board. The Consortium Partners will be legally committed, through the Consortium agreement not to withhold or manipulate data.

Ethical implications of research results
No ethical implication of the research results is identified due to the highly technological nature of the project. Ethical issues related to theoretical medical analysis and socio- economic, institutional and other studies, as well as clinical trials either have been described before or do not exist.

Ethical issues related to exploitation and end-user of wise mirror

The progress of new technologies for life-style monitoring has the potential to generate significant benefits for individuals and communities. As it may happens when ICT systems impact people daily life, ethical side effects may appear. In this respect, a peculiar characteristic of SEMEOTICONS must be pointed out: it is a non-obtrusive self-monitoring system under the total control of the individual end-user. Nevertheless, potential consequences for personal and data privacy, as well as related issues, will be carefully analysed, evaluated and adequately managed.
In particular, taking into account that:

> *the individual-user is the only owner of the data and is the only person enabled to decide about their usage,*

proper actions will be undertaken so as to make him/her aware of the potential ethics-related consequences of using the Wize mirror and make him/her able to confidently utilize the system for self-monitoring. These include:

- implementation of secure data acquisition and storage;
- implementation of data sharing strategies[11] according to good practice standards;
- design of installation and operation procedures customized for different working sites so as to face the different privacy and security problems that may arise.
- generation of extended documentation including detailed instructions and information about the Wize Mirror operation, measurements and policy issues. This will include specific informative forms for end-users and other operators such as fitness and health operators.

In addition to the aforementioned activity, SEMEOTICONS Consortium decides to establish an internal ethical committee (see SEMEOTICONS management details) that, during the entire project life span, will be in charge for advising about any aspect related to privacy, autonomy and data security, as well as any other potential ethical implication.

National and international regulations

The SEMEOTICONS participants are aware of the National laws and the EU legislation and are committed to perform system research and development in accordance to:

- Charter of Fundamental Rights of the European Union, signed in Nice on the 7th of December 2000 (2000/C 364/01).
- The Opinion n°13 of 30 July 1999 – Ethical issues of healthcare in the information society.
- The European Group on Ethics in science and new technologies (EGE) report - Citizens Rights and new technologies: a European challenge.
- The World Medical Association, Declaration of Helsinki, Ethical principals for medical research involving human subjects.
- The European Society Foundation Policy Briefing on Controlled Clinical Trials.
- The Ethical rules of the Seventh Framework Programme.
- The Directive 95/46/EC of the European Parliament and the Council of the 24th October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data The Directive 2001/20/EC of the European Parliament and the Council of the 4th April 2001 on the approximation of the laws and administrative provisions of the Member States relating to the implementation of good medical practice in the conduct of clinical trials on medicinal products for human use.

[11] In any case, data sharing must be decided and agreed by the user.

	YES	*NO*
Informed Consent		
Does the proposal involve children?		*X*
Does the proposal involve patients or persons not able to give consent?		*X*
Does the proposal involve adult healthy volunteers?	*X*	
Does the proposal involve Human Genetic Material?		*X*
Does the proposal involve Human biological samples?	*X*	
Does the proposal involve Human data collection?	*X*	
Research on Human embryo/foetus		
Does the proposal involve Human Embryos?		*X*
Does the proposal involve Human Foetal Tissue / Cells?		*X*
Does the proposal involve Human Embryonic Stem Cells?		*X*
Privacy		
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)	*X*	
Does the proposal involve tracking the location or observation of people?	*X*	
Research on Animals		
Does the proposal involve research on animals?		*X*
Are those animals transgenic small laboratory animals?		*X*
Are those animals transgenic farm animals?		*X*
Are those animals cloned farm animals?		*X*
Are those animals non-human primates?		*X*
Research Involving Developing Countries		
Use of local resources (genetic, animal, plant etc)		*X*

	YES	*NO*
Benefit to local community (capacity building i.e. access to healthcare, education etc)		*X*
Dual Use		
Research having direct military application		*X*
Research having the potential for terrorist abuse		*X*
ICT Implants		
Does the proposal involve clinical trials of ICT implants?		*X*
I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL		

B5. GENDER ASPECTS

SEMEOTICONS Consortium is characterized by (i) strong multidisciplinary, (ii) diffused presence throughout the Europe, (iii) very good proportion of female/male at the top of the proponent groups (CNR, NTNU, DRACO, INTECS, CRNH). This last point is just a consequence of the virtuous policy adopted by the most of the Partners in the Consortium, which already comply with the principles of gender equality in the recruitment of staff / personnel, contained in the European Charter for researchers and the Code of Conduct for their recruitment. Moreover, the multidisciplinary of the proposed research will promote a deep trans-national cooperation with the straightforward consequence to strengthen the European Research Area. The interaction and training of personnel involved in the Project and dissemination of the Project results will allow full exploitation of research technologies. This interaction will assist the policy objectives of the ERA, namely the reduction of research fragmentation, free movement of personnel between Member States, and fostering gender equality.

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B7. ADVISORS' LETTERS OF AGREEMENT

Please note that, in the preliminary submission, the Project acronym was SEMEOTICON'S. Since the submission site did not allow the use of apostrophe, the acronym has been changed in SEMEOTICONS. The Advisors' letters were antecedent to this change and report the initial acronym.

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Milan 10 January 2013

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Subject: Participation to SEMEOTICON'S Advisory Board

Dear Dr Colantonio,

I do accept becoming a member of the Advisory Board of the Project SEMEiotic Oriented Technology for Individual's CardiOmetabolic risk self-assessmeNt and Self-monitoring – SEMEOTICON'S.
I think worthwhile upholding you with such a project to help improving in any way the final result.

Yours sincerely,

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Yours sincerely,

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Yours sincerely,

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Subject: Participation to SEMEOTICON'S Advisory Board

Dear Sara,

I do accept becoming a member of the Advisory Board of the Project SEMEiotic Oriented Technology for Individual's CardiOmetabolic risk self-assessmeNt and Self-monitoring – SEMEOTICON'S.
I think worthwhile upholding you with such a project to help improving in any way the final result.

Yours sincerely,

Prof. Tamás Szirányi
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