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"Toughclinic" – Modern Medical Informatics Under Extremer Conditions

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Abstract

The care of seriously injured persons or victims of catastrophes in the medical way like in environmental conflict areas or in the administrative way like in a refugee camp often has to be guaranteed under bad conditions. Paper based documentations are easy to implement and to use, but they underlie known disadvantages. With the system "TOUGHCINIC" as an electronic file for exceptional circumstances emergency patients, victims or refugees can be set up very fast. Any facts can be documented in special adapted input and edit mask; digital photos can also be added. The software components are able to be adapted locally.

A wireless cross linking of many individual and extremely robust notebooks without central infrastructure is possible. A breakdown of a laptop or a component does not affect the others. The used applications in reach are automatically adapted with the others and therefore they get always an actual database. After the returning of an employee the data synchronization will be done automatically.

The three principles are the simple handling and the possibility of total configuration by non technical personnel in the case of need, the extremely fast operational readiness as well as the toughness under extreme environmental conditions.

Keywords:

medical records systems, computerized; developing countries; war; disaster help; aid, first

Introduction

The care of seriously injured persons or victims of catastrophes often has to be guaranteed under bad conditions. A save, simple and fast support of the real care is not only medically, e.g. in environmental crisis area, but also administratively necessary for a big amount of affected people in refugee camps.

Paper based documentations can be easily adopted and used, but they underlie significant and also known disadvantages. The material is not resistant, copies are not automatically updated if the original or one of the copies are changed, automatically analysis for example for stock administration (re-order, consumption analysis) or warning notices (immunisation status, dual-physicals) are not implemented and it is in principal only a limited structured documentation possible.

Because of many reasons computer based documentations were in this kind of operation not advisable. The standard hardware is under difficult extremely environmental conditions not reliable. Computer solutions often demand expert-knowledge and cabling on-site additional logistical problems e.g. in camps. Qualified personnel, who has to leave the base for a short time for working, e.g. to accomplish immunisations at nearby locations, could so far badly profit of networked knowledge. Furthermore available software solutions are too complex for the fast and uncomplicated access by international personnel, the features and installations of regular hospital information systems are often unsuitable.

The identification and registration of patients, victims or refugees are often only based on central kept paper lists or on handed out identifier for particular persons (e.g. wristlets). The control and administration of such lists or identifiers is connected with difficulties and time delay especially for searching, because of the typical handling to have either an actual list on a central location or part-actual lists on different locations.

With the planed system TOUGHCLINIC patients, victims and refugees can be registered fast. It supports a medical and/or administrative all-embracing care. The development of this system has started and is described in the following.

HL 7 as a communication standard [1] and communication server as technological middleware platforms are today in many hospitals central components of the hospital computing and from this surrounding hardly to think away [2]. In many hospitals single departments communicate electronically with purchased software products already so called hospital information systems. This is what Waegemann calls as "automized medical record (system)" [3].

If hospital information systems shall conform to the displayed definitions and requirements, it seems apparent that neither hospital information systems nor electronic patient records can be bought as a finished product. Rather the declaration of Van der Velde is true, which calls hospital information systems as a "conceptual bound", in which single appliances develop and can be integrated as an acting whole system [4]. The system TOUGHCLINIC offers such a bound.

Materials and methods

Necessary equipment

About 50 percent of all damages of notebooks go back to transport accidents like falling down or effects of pushing. Screens, cases and hard disc drives are the most affected. Especially the expected environmental conditions like aridity or clamminess, also extreme temperatures and in dealing with technical applications in limited situations let notebooks not appear as adequate equipment in areas of catastrophes or crisis.

Special notebooks e.g. Toughbooks of Panasonic have a special mechanical protection. The cases of these notebooks are manufactured of a magnesium alloy. Warp resistant magnesium alloys at all screens avoid warps or breaks. The hard drives are saved against vibrations. Because of their flexible bearing, connecting plugs resist extreme pressure. Furthermore keyboard and touchpad are sealed against entering fluid. Dust and dirt can not enter. The use of latest touch screen technologies allows although in direct sunlight a high-contrast screen. The specialised notebooks are up to the MIL standard MIL-STD 810F for shock-proof and up to norm IP54 for water and dust protection.

Also the photo industry made progress and offers digital cameras like Olympus µ720SW or Pentax Optio Wpi, which are useful for the project TOUGHCLINIC because of their attributes like waterproofness and resistance for sand and dust by special seals as well as their small dimensions with simultaneous simple usability.

Computer language and architecture

In principal an enlargement of the project is possible, so that the fixed centre in the (first world) home countries always stays well informed about the actual data. This can be useful for automatically ordering or for global forwarded medical consultant requests. In this case, it would be an online available data base. This is not planed in this project, but could be already considered in planning stage. To not eliminate later synergies, a computer language like Java should be used [5]. Java works with the concept Write Once, Run Anywhere. This means that a program programmed in Java has to be compiled theoretically just one time and it runs on all other systems, which has a Java Runtime Environment. This JRE exists for all-around used operating systems like Microsoft Windows, Linus, Solaris, Mac OS X, AIS and many more. In addition there are the JRE not only for server- and desktop operating systems but rather for many other embedded systems like mobile phones, PDAs and also smartcards and other technical platforms, like car and TV. The independence of platforms ends for those systems for which a so called Java Virtual Machine does not exist.

There are many frameworks in uses to achieve an isolation of the systems components and to advance the use of "best-practice" [6].

Java encloses also industry standards for data persistence and network communication. The architecture of TOUGHCLINIC bases on a three-tier-model with the typical tiers: data management, business logic and presentation [7]. Each upper tier can access directly to the underlying tier.

A data base system which uses only a few resources is required for saving the appliance data. This DBS has to be easy to install and to administrate and it also has to support transactions at the same time [8]. HSQLDB and Java DB are two effective and perfected Java data bank systems, which achieve these requirements [9]. Furthermore both systems support the Embedded-Modus in which the DBS is incorporated into the Java appliance so that an exact installation and administration of the data bank system is not necessary anymore. To be transparently for the user it persist only one appliance which has to be started.

One of the central functions of the application is to exchange local data with every reachable co-equipment (unit, implement, and device) and to synchronize one another. One possible method of resolution would be the application of *SyncML* (Synchronization Markup Language), which was defined by the *Open Mobile Alliance* (OMA) to serve exactly this purpose. SyncML-messages are XML-documents, which are exchanged via SyncML-protocol in-between the mobile applications. In doing so there is a difference between the representation protocol and the synchronize protocol. The SyncML representation-protocol defines the message-structure and also the different types of messages e.g. Add, Alert, Atomic, Copy, Delete, Exec, Get, Map, Replace, Search, Sequence and Sync. Furthermore it defines methods for the consistent appellation and identification of dataset, which are synchronized.

The synchronization-protocol focuses on the administration of the particular synchronization-connection. It defines the information flow between the SyncML-client and -server during the synchronization-process as well as the different types of synchronization, like disposable- or non-disposable-synchronization. During the implementation of the SyncML respectively one application takes the role of the Client and another one the role of the Server. The roles are negotiating again for every Synchronization-process. If there is requirement e.g. for a backup, it is possible to synchronize every applications with a central SyncML-Server.

The Java Foundation Classes is a comprehensive collection of GUI-components and Services, which makes the development of demanding graphic user interface possible. More complex components, which are exceeding the

functionalism of the standard components, can be developed via the Java 2D interface. Also three-dimensional issues can be solved with the Java 3D functional-library.

MANET-Radio communication network

So far in a traditional radio-network (Wireless LAN, WLAN) [6, 7, 8] it was only possible to connect one notebook with exactly one central router or exactly one additional notebook. This makes the whole communication very depending on the central architecture and a breakdown of the router would shut down the whole network immediately. Also the bandwidth is limited. More connected notebooks would reduce the flow-rate of data.

Special wireless networks, so called mobile ad-hoc networks (MANET) consider the individual, attending notebooks as a joint, which serve as a repeater to stay in touch with one or more other joints. The result is a network, which can overcome long distances, especially in uneven or challenging terrain. Furthermore MANETs are very reliable, because every node is connected with many other joints. If a joint breaks down out of the network e.g. because of a hardware failure or another reason, the surrounding joints search for an alternative route. Thanks to this still young technology a project like TOUGHCLINIC is practicable.

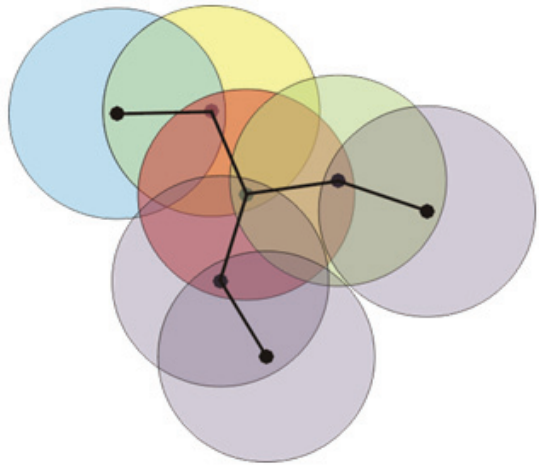

Figure 1- Schematic representation of a MANET-Wireless-Network

To make dynamic routing possible, every application has to send its routing information to every other application, with which one in makes a connection. To do this can be used e.g. the in the meantime fully developed Optimized Link State Routing Protocol (OLSR). At this distributed flexible process of routing, every Router knows the complete net-topology, so that they are able to configure from case to case the shortest way to the destination. Also the data-flow is not lowered because of more applications. It stays constant or even increases.

Structure of the electronic file and the form based additional documentation

Through the provision of a root-appliance and a (constructive) Plug-In-Architecture it is possible that new modules, e.g. (file-rider) in a patient record or also in an administration file, can be added and worked on fast and easy. A special component demonstrates a mechanism for the cognition and administration of Plug-Ins. Every installation of the TOUGHCLINIC can be arranged with a one sentence to Plug-Ins and consequently be arranged by IT-laymen. Because of the experiences of the submitter’s institution it’s easy to give a reasonable and still basic-documentation for a medicine and an administrative file.

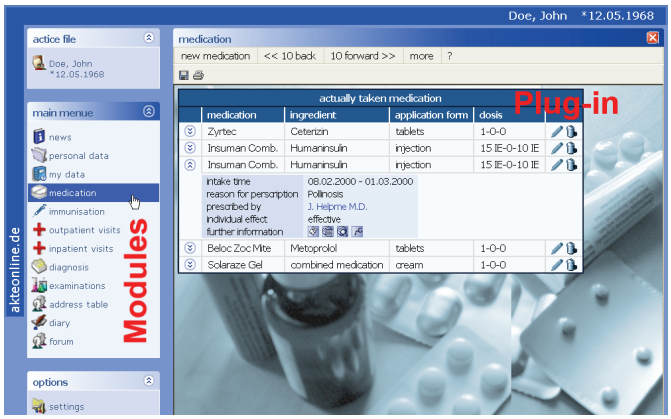

Figure 2- Presentation of modules and Plug-Ins with an example-screenshot of a consistent implementation of software in the system; akteonline.de“

The displayed file structure can include forms as basic modules. This very basic type of mask should be established and worked on by laymen on-site using a form-editor. A special component displays a mechanism for the cognition and administration of forms. Using the forms, the aim is achieved to cover as many as possible intended use, especially to cover the non-planable.

The operation of the system TOUGHCLINIC has to be possible in the English language and with international personnel. The difficulty of the language is not only limited on input and output. It is also included in the understanding and logic of the attendant persons. Some experiences show that for example support staff from different cultures approach problems in a different way than people from our culture. They could use the intended documentation and system functions for our culture, translated from 1:1 in their language, not in the expected way. Because of that preferably a lot of input and output possibilities should be structured in a selection or depend on

pictures. Graphic illustrations of body parts, which can be marked and annotated, could be a good example. These are available for every body part and can be put into the created forms.

Results

Using the system TOUGHCLINIC as here described, any circumstances can be securely documented in special adjusted input and output masks and digital pictures can be added. The software components are due to their modular construction also adjustable for the specific intended use on-site.

Through modern and only now available information technology a wireless networking of many individual, extremely tough and inconspicuous notebook computers without any infrastructure is possible. Breakdown of a notebook or a component does not have any influence on the others. It can be replaced directly by another one (without bothering about manually restoring or copying of data).

The used applications in reach are synchronized automatically with the others and so they receive always an actual dataset. This is also helpful, if notebooks will be launched outside the base. After the returning of the employee the data synchronization will be done automatically. In contrast to the existing W-LAN solutions there is no central hardware-effort necessary. Decoding is so efficient by now to avoid an interception of the content.

Because of the additional decoding of the individual datasets, a losing of one of the high-mobile workstation is limited to a financial loss.

The language barriers between employees from different countries are eliminated through the use of translation-patterns of the data masks, dynamic graphics, e.g. remarkable part of the human body rather than free-text-fields for localization-description.

The three principles of the system TOUGHCLINIC during the support of the medical and administrative care of patients, refugees and victims of catastrophes are very easy handling and the possibility of configuration by non-technical personnel in the case of need, the extremely fast operational readiness as well as the reliable service under extreme environmental conditions.

At the actual early status of development co-operations-partners for processing and use are sought-after, as well as sponsors.

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