

Web Site on Heart Rate Variability: HRV-Site

M Álvarez-González, XA Vila, MJ Lado, AJ Méndez, L Rodríguez-Liñares

School of Computer Science. University of Vigo, Ourense, Spain

Abstract

Heart rate variability (HRV) is an easily measurable physiological indicator with relevant clinical applicability. One important problem for HRV researchers is the lack of common data collections that could be used for testing their own algorithms. Moreover, free software tools for analyzing ECG records are scarce or they do not exist. Inspired by the Physionet Website (<http://www.physionet.org>), we have developed a Web portal, HRV-Site, located at <http://www.hrv-site.net>, and devoted to the HRV. Our intention is to maintain a collection of heart rate records that could be analyzed on-line using our R-HRV software package, or downloaded for off-line analysis. HRV-Site is also aimed at maintaining updated documentation of both methodology and clinical applications of HRV, offering the researchers the possibility of building a growing HRV community, by forming discussion groups and adding either news or announcements.

1. Introduction

Internet was created with the goal of connecting researchers around the world. Today it has many other functions, but continues offering essential tools for the research community: on-line journals, support for organization tasks, experiments and meetings, . . . everything is running now over Internet. Even on-line medical consultation is now possible [1].

Heart rate variability [2, 3] is a research field where physicians, mathematicians, computer science engineers and other experts collaborate. However, Internet offers limited and rather disperse support to this community. Searching in Google “heart rate variability” yields results containing scientific papers, advertisements of devices and even software and some videos, but nothing about a *specialized* website. It is our opinion that this is a drawback and that the research community needs a meeting place, a reference website in this field.

This website must offer, among others, similar functionality to the Physionet web site¹. This is a site about

computer-based analysis of physiological signals, which offer tutorials, software and records, all of them very valuable for researchers. One paper describing this website [4] has more than 700 references, and every year more than 500 scientific papers that use data or software published in this site are written. Our goal is to develop and maintain a similar site for the heart rate variability field.

Although Physionet website was our *inspiration*, we pretend to include new functionalities. At the present moment we are in the web 2.0 age, and our site will have also some functions of social network, offering the researchers the possibility of adopting an active role.

2. The HRV-site

Figure 1 shows the welcome page of the HRV site. On the left there is the main menu. *Start* corresponds to this welcome page, *About* gives information concerning the development of this website and the research group support-

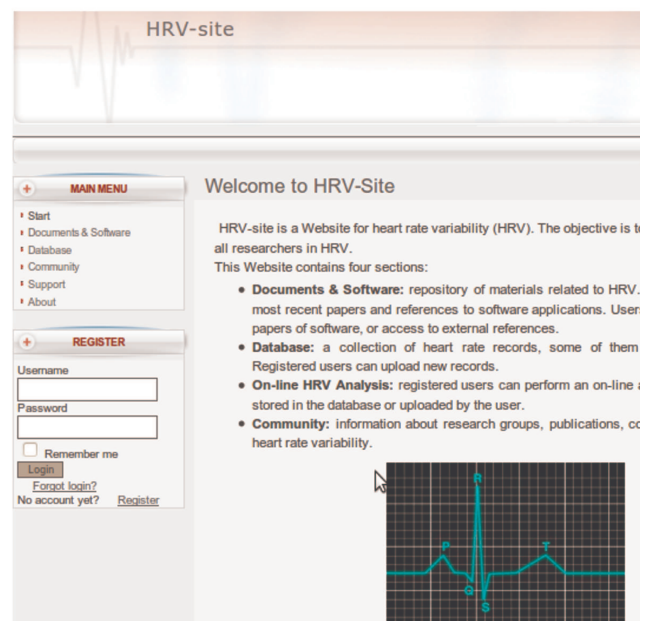


Figure 1. Welcome page of HRV-site

¹<http://www.physionet.org>

ing them, the MILE group². *Support* links to a Web form for sending comments, bugs, etc. Other items will be explained in next subsections.

On the left, it can also be found the *register* area. This is a public website and there are many actions available for anonymous users, such as browsing the heart rate database and the documentation area, or consult the list of registered researchers. Other functionalities require identification like performing an on-line heart rate variability analysis or uploading news and papers.

In the next subsections we would describe the four main menu options.

2.1. Documents and software

Documents & software links to a repository of books, papers, software and tutorials related with the HRV field. Presently, we have references to thirty books and papers, and four software tools. We expect collaboration for growing up this section.

Only registered users can contribute with new papers or software. They have a *submit file* button to perform this task (figure 2).

Figure 2. Form for uploading books or papers

2.2. Database

Our database is constituted by several heart rate records. Anonymous users can only see record names, but registered users can either download them or perform on-line analysis, as it will be described in the next subsection.

The heart rate records database can only be incremented by registered users. Figure 3 shows the web form for uploading new records. They must be ASCII files, containing

Figure 3. Form for uploading heart rate records

beat positions, measured in seconds, one beat in one line, without headings. The next listing is an example:

```
0.120
0.892
1.696
2.480
3.256
4.096
4.912
.....
```

Additional information can be given like age, sex, diagnosis, medication or date. This items will be very useful for searching the database, using this fields as keywords.

Presently, we have about 150 records in our database, obtained from two Physionet databases, The European ST-T database [5] and the Apnea database [6]. The heart rate signal was obtained from the ECG records using the *physiotoolkit* functions [4]. After that, an automatic and manual filtering was applied using our RHRV tool [7].

2.3. On-line HRV analysis

We have implemented a package for performing heart rate variability analysis with R, the most extended free software for statistical analysis [8]. The first version of this package, called RHRV [7], was published in 2008. Last version (available on-line at <http://cran.r-project.org/web/packages/RHRV/index.html>) allows researchers to perform time-domain heart rate variability analysis, to obtain non-linear parameters and the *time evolution* of the heart rate variability frequency components ULF, VLF, LF and HF [9].

We have integrated this package in our HRV-site, allowing on-line HRV analysis without installing any software in local computers. Researchers can use records from our database or upload their own records, select the type of

²<http://www.milegroup.net>

analysis (time, non-linear or frequency analysis) and obtain the results. For frequency analysis, researchers can also select some processing parameters such as band limits, window size and shift and number of samples for spectrogram calculation.

Figure 4 is a composition showing the results obtained for an arbitrary record of our database. We can see time-domain indexes, non-linear parameters and a screenshot corresponding to the frequency analysis (window length of 2 minutes, shift of 10 seconds).

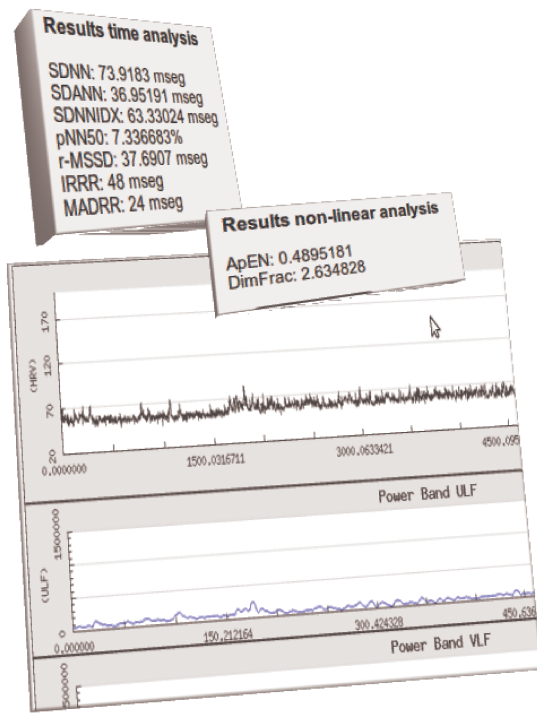


Figure 4. An example of heart rate variability on-line analysis

Results of frequency analysis can be exported. A compressed file, containing two CSV (*comma separated values*) files will be downloaded to the local computer. One of these files will contain the interpolated heart rate signal and the other the power corresponding to the four aforementioned spectral bands .

2.4. Community

Community section pretends to be the *agora*, the meeting point , for researchers in this field. Registered users can give information about new research groups or join to any one previously defined one. Non-registered users can

only consult the researchers and groups lists .

Other option is visualize a list of scientific conferences related with this topic, or to add information about a conference not listed in the website. Figure 5 shows the form used by registered users for including a new conference.

Figure 5. Web form for including a new conference

We have included also a *News* section. Researchers can read the news in the website or subscribe to them using the RSS channel . Registered users can also upload new items, using the *Publish advert* option.

We have also integrated a *forum* tool. We believe this will be a useful tool for researchers, however at this moment it is under development.

3. Discussion and conclusions

This paper presents the first version of a Web portal, called *hrv-site*, that pretends to be a common place for researchers in the heart rate variability field.

A first implementation of this website was developed by a computer science student as a graduate paper (first author). Other authors collaborated developing the RHRV tool, defining and fulfilling the database and selecting and uploading papers. The website was developed with Joomla [10], the well-known open-source content management system. Some coding was done both in PHP and R languages where needed to integrate the RHRV tool .

The website is now running, but it has not been presented to the international research community. Only a few researchers are registered, and a limited volume of papers and heart rate records is included. Its future depends on the researchers community. A minimum number of active users is needed in order to offer an interesting service, to achieve a *communitary benefit*. Our intention is supporting administrative tasks, software updates, bugs corrections, etc., but collaboration for increasing the *documents & software* and *database* sections, for including interesting news, etc, is needed.

We intend to apply for funding to the local government for supporting and maintaining this website, if this *service* becomes interesting for the research community. Our intention is to improve the on-line analysis tool, with more

flexibility and better graphic representations . Another improvement will be a *browsing* option for the *documents & software* section ordering papers following some criteria like: methodology, clinical applications, software tools, etc. Finally, we are in negotiations for including in the database section new collections of heart rate records, corresponding to physiological records not published in the Web.

Acknowledgements

This work was supported by the Xunta de Galicia under the grant 08SIN002206PR.

We would like also to thank professor George Moody, from MIT, for giving us permission for including heart rate records extracted from ECG databases included in Physionet.

References

- [1] Soyer HP, Hofmann-Wellenhof R, Massone C, Gabler G, Dong H, Ozdemir F, Argenziano G. telederm.org: Freely available online consultations in dermatology. *PLoS Med* 2005;2(4):e87.
- [2] Malik M, Camm AJ. *Heart Rate Variability*. Wiley-Blackwell, 2005. ISBN 087993607X.
- [3] Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Heart rate variability: standards of measurement, physiological interpretation and clinical use. task force of the european society of cardiology and the north american society of pacing and electrophysiology. *Circulation* 1996; 93(5):1043–1065. ISSN 0009-7322.
- [4] Goldberger AL, Amaral LAN, Glass L, Hausdorff JM, Ivanov PC, Mark RG, Mietus JE, Moody GB, Peng CK, Stanley HE. PhysioBank, PhysioToolkit, and PhysioNet: Components of a new research resource for complex physiologic signals. *Circulation* 2000 (June 13);101(23):e215–e220.
- [5] Taddei A, Distanto G, Emdin M, Pisani P, Moody GB, Zeczenberg C, Marchesi C. The European ST-T database: standard for evaluating systems for the analysis of ST-T changes in ambulatory electrocardiography. *European Heart Journal* 1992;13(9):1164–1172.
- [6] Penzel T, Moody G, Mark R, Goldberger A, Peter J. The apnea-ecg database. 2000; 255 –258.
- [7] Rodríguez-Liñares L, Méndez AJ, Lado MJ, Olivieri DN, Vila XA, Gómez-Conde I. An open source tool for heart rate variability spectral analysis. *Computer Methods and Programs in Biomedicine* 2010;In Press, Corrected Proof, DOI:10.1016/j.cmpb.2010.05.012. ISSN 0169-2607.
- [8] Zuur AF, Ieno EN, Meesters E. *A Beginner's Guide to R*. Use R. Springer, 2009. ISBN: 978-0-387-93836-3.
- [9] Vila J, Palacios F, Presedo J, Fernandez-Delgado M, Felix P, Barro S. Time-frequency analysis of heart-rate variability. *Engineering in Medicine and Biology Magazine IEEE* sep. 1997;16(5):119 –126. ISSN 0739-5175.
- [10] Graf H. *Building Websites with Joomla!* Packt Publishing, 2006. ISBN 1904811949.

Address for correspondence:

Xosé A. Vila
Escola Superior de Enxeñería Informática. Universidade de Vigo.
32004 Ourense (SPAIN).
E-mail: anton@uvigo.es