

Data Mining in Medical Analysis and Performance Evaluation

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Abstract. The aim of work was the registration and processing of results of scientific work carried out in the framework of grant projects and the processing of single and multidimensional biosignal. In the field of measuring and control technology, biomedical focus, it is an application for processing ECG signals, and neurological applications in signal processing, we analyzed the signals and systems with lumped parameters.

Keywords: Data Mining, Bio Signals, Medical, Evaluation

1. Introduction

It is more than likely that MATLAB is now an integral part of researchers and educators, and penetrating into various fields of human activity and includes both technical and non-technical disciplines. In this article we want to present some previously unpublished applications created in this environment and demonstrate the breadth of its application.

The history of research work dates from 1991, since the inception of the Faculty. Currently the product is used in most school subjects, and therefore was in 1997 at the Department of Measurement and Control A new course Using MATLAB with Simulink in engineering studies. As the name implies Department, dealing mainly with the measurement and control, but some applications created in this environment are also focused on signal processing and applications in MATLAB seemingly unworkable. They work especially created for the semester and diploma theses.

2. Analysis of Signals and Systems

Analysis of signals and systems for the primary processing plant and visualization of results. In the exercises, the emphasis on the theoretical foundations of the subject and the practical demonstration and trained agents in Matlab.

An example is a sample program that complements the above script and used to analyze the user-defined and finite periodic signal, this signal may be a signal of continuous time or discrete-time signal. The signal may also be brought to a linear system of first or second order with constant lumped parameters specified transmission or differential, respectively. Differential equation and initial state of the system. The program is developed in MATLAB GUI. Its user interface is intuitive and simple, it is an effective teaching tool. Example: given a periodic signal $u(t)$, whose one period is specified as: [1]

$$u(t) = \left. \begin{array}{ll} 2 & \text{pro } x \in \langle 0,1 \rangle \\ 3 \cdot t + 1 & \text{pro } x \in \langle 1;2 \rangle \\ 3 \cdot \exp(-0.5 \cdot t) \cdot \cos(5 \cdot t) & \text{pro } x \in \langle 2,5 \rangle \end{array} \right\} \quad (1)$$

This signal is fed to the system of second order differential equation $3 \cdot y'' + 2 \cdot y' + 1 \cdot y = 5 \cdot u' + 4 \cdot u$ described and initial condition $y(0_-) = 6$, $y'(0_-) = 7$ The task is to analyze the signal $u(t)$ and specify an output signal $y(t)$ system.

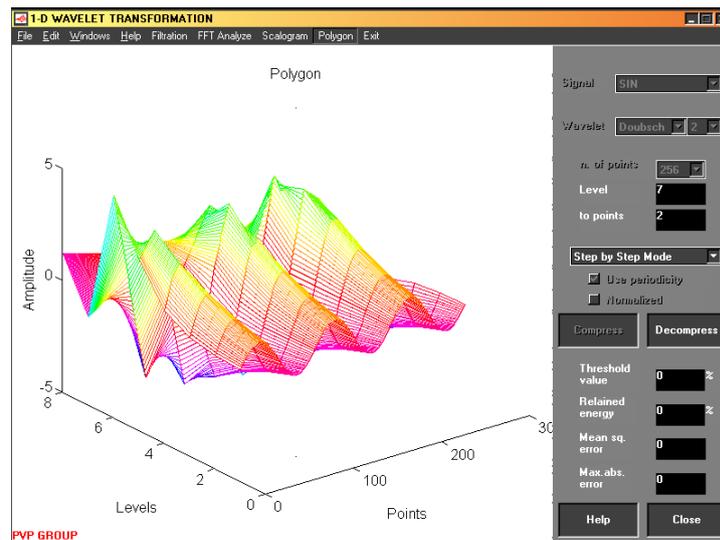


Fig. 1: Interactive Display System for Analysis and Data Analysis Results

3. Application for Investigation Neurovisual Expressions

The program serves as a substitute for medical devices for the investigation of the optic nerve. This device is used in the fields of neurology and ophthalmology. The advantage of the program is executable on any platform for which there is a MATLAB program. When using the program (the patient looks at the computer monitor) is to stimulate the optic nerve. The ophthalmic nerve is stimulated by a special shape - two rotating concentric circles with white and black sections. Concentric circles rotate defined speed and direction. You can also change the number of sections of both communities. [2]



Fig. 2: Neuro Application for Eye Image Evaluation

3.1. Program Settings

The user interface is neatly designed. From the main window you can set the direction and speed of rotation of rings. More accurate, fine-tuning of the program is done through additional dialogs. On the more details you can adjust the size of angles, distance from the patient monitor and the number of segments of circles. To calculate the correct size pattern is still necessary to specify the size of the monitor used (in the Options dialog), the size of the screen resolution you have, it checks itself.

To maintain fidelity (that is meant loyalty to the original medical device) can set the frame rate for playing shape (at least it is recommended that at least 25 frames per second). For the sake of reducing the memory demands of the program is limited to the total length of the animation and the maximum number of animation frames. These values can also be set in the Options dialog. [3]

3.2. Program Features

The whole concept of the program is based on the capabilities of MATLAB visualization. It is surprising what can be done in MATLAB. Beginning work, however, was still very difficult, but eventually managed to find the optimal solution. The whole problem lay in the fact that the resulting image as close as possible to the actual turning gearing. This was achieved using the movie feature, which alone is able to smoothly and especially with the constant speed of play each frame of the moving gears. MATLAB is more focused on calculations and not on visualization, so this feature is lagging somewhat, the actual play is not always smooth. Especially at the start of play is usually very quickly replayed the whole animation and then are given only to copy the playback speed (the animation is played over and over again). [2]

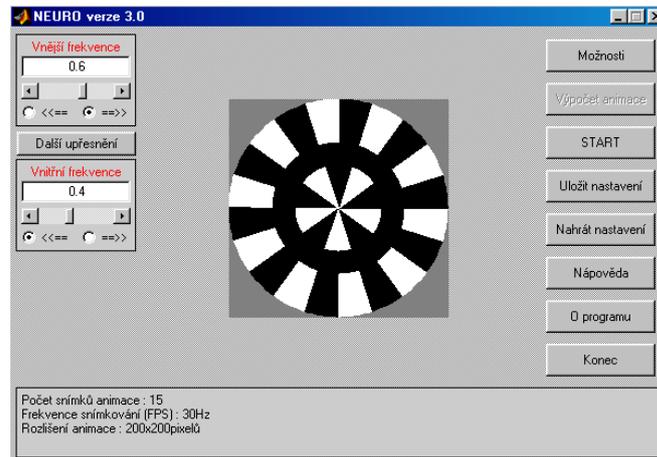


Fig. 3: Soft Application User Interface and Analysis Software

3.3. Calculation of Animation

Before you can run the animation (self-stimulation of the optic nerve), it must first be calculated. The calculation of the actual animation is the cornerstone of the program, even though the idea is ultimately not so complicated as it first seems. To calculate the animation The following parameters are important:

- The frequency and direction of each community.
- Number of segments of circles.
- Frequency of photography (the FPS) is the number of frames played per second.
- Maximum number of animation frames.
- maintaining accuracy parameters.

To make the animation to calculate these values:

- The actual rate of rotation circles.
- The total number of frames of animation.

The calculation of these values is made in these 3 steps:

1st Calculation of the differential rate. This is especially so, find out which frames are to each community to meet again in their original state so that it can from this position to repeat the entire animation. Thus it is not only less frequency, but less frequency, which are multiplied by the number of segments of circles. This is because, in order to reduce the number of animation frames. If the accident rate differential is zero (eg 1 Hz-5 segments with 0.5 Hz-10 sections), shall be taken as a differential rate, the frequency of one of the circles.

2nd Calculation of the final image. The calculated frequency difference is determined and the meeting time and FPS values are determined by the final frame. It is not always an integer. To this end, rounding frequencies so that the final film in number. This rounding frequencies and the final image is re-tested so that the irregularities came to maintaining the accuracy defined set of parameters (this value can be set in the Options dialog.). If the condition does not meet accuracy and for the final time, plus the original ending time (time of first meeting) and tested again. The attribution is repeated until the accuracy condition.

3rd The conversion rate is no trivial matter when the final number of shots, shooters, and the time of the first meeting of re-converted value of frequency, with whom then counted in animation. [3]

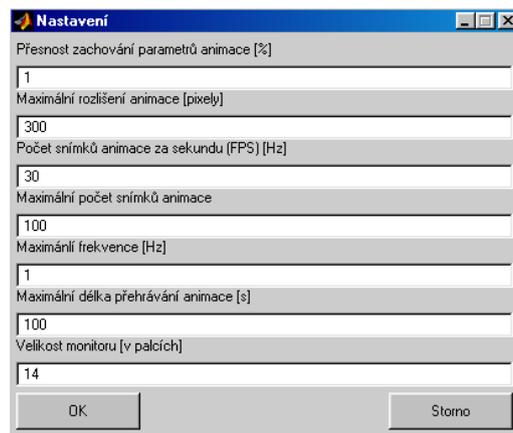


Fig. 4: Advanced Settings of Evaluation Eye Analysis

3.4. Creation of animation

Creating animations is the final stage of calculations in which the individual images calculated and displayed on the screen. When you see the image stored in the animation variable, and counts more. Animation is used for the reason that in normal viewing images is a flash of the image, which is to stimulate the optic nerve side effects.

4. Evaluation of ECG heart rate variability

Heart rate variability (HRV - heart rate variability), or if heart rate is one of the most basic and evaluated: the physiological data in medicine. It serves as an auxiliary diagnostic method in cardiology. It is a very good indicator of activity and performance of the heart. If the heart rate decreased below a certain level, we speak of bradycardia. Otherwise, the tachycardia. If there are irregularities in the functioning of the heart, then we are talking about arrhythmia. All of these changes and anomalies that we speak about the occurrence of a bug in the heart of the system. [4] [5]

Heart rate can evaluate the many biological variables that determine the functioning of the heart, directly or accompany. This is an electrical signal to the electrocardiograph - an electrocardiogram (ECG), the acoustic phonocardiographs - phhnocardiogram (FKG) and plethysmograph. Most often, however, evaluated the long-term (24 hour) or short (5 minute) ECG.

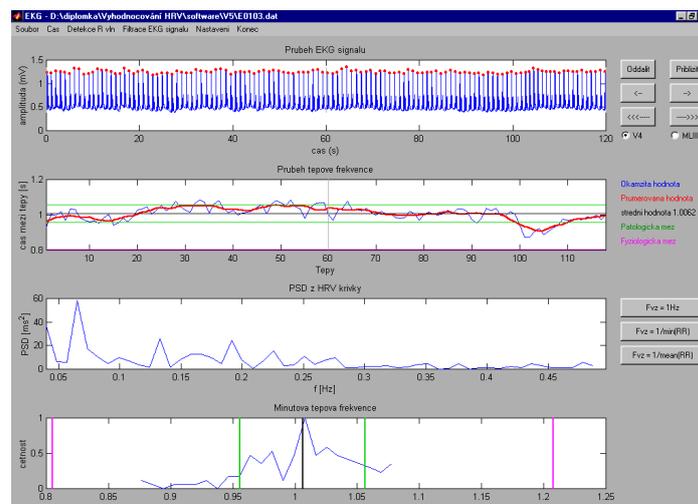


Fig. 5: Main Software Program Panel for HRV Analysing a Interpretation

In this paper we confine ourselves to determining the heart rate just short of the electrocardiogram waveform. The impetus for creating this work was the demand from doctors to monitor and evaluate changes in heart rate in infants and young children. It is known that in this group of patients, with a change of heart beat in time lead to sudden death, or loss of vital functions.

The goal of this work was the implementation of software for the analysis of heart rate variability of short-term results of heart tachogram in terms of spectral properties. This means from the electrocardiogram to determine the actual value of heart rate and calculate the curve of her power spectral density. For the purposes of calculation and graphical representation was used MATLAB version 5 March To evaluate the proposed procedures and methods were used in the test ECG waveform obtained from medical records database of clinical electrocardiography Physionet (<http://www.physionet.org/physiobank/database/>). There are many types of database of biological signals. The advantage of these results is that they are already evaluated exactly what the type of disorders and diseases.

For the analysis of instantaneous and average heart rate is very important to detect the tip of the QRS complex known as the R wave, and thus determine the temporal distance between two consecutive R waves. For these purposes have been developed and used partial method to detect QRS peaks. This is implemented by means of two detectors R wave.

The final output of the processing is the classification of the physiological and pathological changes in heart rhythm in patients measured.

5. Conclusion

The results of this work may be useful for identifying the causes of sudden death among infants and young children. They should serve clinicians as a tool to better understand the problem and also help correct diagnosis of cardiac patients, leading to improved patient health.

6. Acknowledgements

The work and the contribution were supported by the project Grant Agency of Czech Republic – GAČR 102/08/1429 “Safety and security of networked embedded system applications”. It was also supported by the Ministry of Education of the Czech Republic under Project 1M0567. Students Grant Agency SGS SV450021,” Biomedical Engineering Systems VII”

7. References

- [1] Labza, Z., Penhaker, M., Augustynek, M., Korpas, D. *Verification of Set Up Dual-Chamber Pacemaker Electrical Parameters*. In 2010 The 2nd International Conference on Telecom Technology and Applications, ICTTA 2010. March 19-21, 2010, Bali Island, Indonesia, Volume 2NJ. IEEE Conference Publishing Services 2010, p. 168–172. ISBN 978-0-7695-3982-9., DOI: 10.1109/ICCEA.2010.187
- [2] Idzkowski A., Walendziuk W. (2009) *Portable acquisition system for domiciliary uroflowmetry*, Journal of Vibroengineering, Volume 11, Issue 3, 2009, pp.592-596, ISSN 1392 – 8716
- [3] Cerny, M. *Movement Activity Monitoring of Elderly People – Application in Remote Home Care Systems* In Proceedings of 2010 Second International Conference on Computer Engineering and Applications ICCEA 2010, 19. – 21. March 2010, Bali Island, Indonesia, Volume 2NJ. IEEE Conference Publishing Services, 2010 p. ISBN 978-0-7695-3982-9
- [4] Krejcar, O., Cernohorsky, J., Fojcik, P., Janckulik, D., Martinovic, J., *Smartphone, PDA and mobile Embedded device clients of Biotelemetric System for monitoring of life functions*. In 5th International Conference on Innovations in Information Technology, Innovations 2008, December 16-18, 2008, Al Ain, United Arab Emirates. pp. 145-149. ISBN 978-1-4244-3396-4, DOI 10.1109/INNOVATIONS.2008.4781761
- [5] Krejcar, O., *Localization by Wireless Technologies for Managing of Large Scale Data Artifacts on Mobile Devices*. In The 1st International Conference on Computational Collective Intelligence - Semantic Web, Social Networks & Multiagent Systems, ICCCI 2009, October 05-07, 2009 Wroclaw, Poland. Lecture Notes in Artificial Intelligence, LNAI Vol. 5796. pp. 697-708. N.T. Nguyen, R. Kowalczyk, and S.-M. Chen (Eds.). Springer-Verlag, Berlin, Heidelberg. DOI 10.1007/978-3-642-04441-0