Web Based Analysis of Physiological Variability in Cardiac Event

Sneha Bharat Bansod and Jyothi Satish Warrier

Student in Department of Bio-Medical Engineering, Mahatma Gandhi Mission's College of engineering and Technology, Navi Mumbai, Maharashtra, India.
Assistant Professor in Department of Bio-Medical Engineering, MGMCET, Mumbai University, India.

bansods055@gmail.com, jyotisat@gmail.com

Abstract

This paper introduces a software application designed for analysis of physiological variability in cardiac event. The application, named ePulse Variability Analyzer (ePVA), was aimed to develop a user-friendly, modular and scalable web-based system and processing part develop by BARC using LabWindow CVI. ePVA based on the principle of impedance plethysmography for the assessment of central and peripheral blood circulation. ePVA is now in an early development stage, and it is focused on being used by researchers or clinical professionals non-skilled in informatics for upload and download cardiac signals into a custom database and would perform complete heart rate variability (HRV) analysis of each anonymous CC-interval time series.

Keywords: *Heart rate variability, Impedance plethysmography, LabWindow CVI, Variability analysis*

1. Introduction

The changes occur in physiological parameters of the body even when a person in state of rest, is called as physiological variability. Physiological parameters are very important to better described functioning of the living body. Physiological variability in cardiac event is nothing but heart rate variability and has been a very active research field for last twenty years. The interest in this field is based on the fact that relationship between HRV and pathologies like myocardial infarction, circulatory problems, hypertension and ischemia has been well established by experimental evidence. Design web portal for ePulse Variability Analyser used to early detection of coronary heart disease using LabWindows CVI software and generating heart rate variability report. The web portal dashboard secured by the password under admin authorization. Artifacts peaks in raw signal investigated by algorithm which is manually corrected for improving the results. Resultant peaks comparing with the 8 dominant morphological patterns of the peripheral pulses depending upon their status of health. Fourier transform based method has been developed and incorporated with the instrument to obtain Morphology Index (MI) of the peripheral pulse[1]. The index varies from 0 to 1, the former indicating the poorest and later the complete health. These observation by variability spectrum of heart rate and peripheral blood flow. The average index is observed to be around 0.3 in patients with myocardial infraction. Early stage of coronary artery disease

brings down the index to around 0.4. Thus, it is possible to detect coronary artery disease in early stages. The Poincare plot was displayed. Graphical User Interface (GUI) was prepared which shows the raw signal, pre-processing step and Poincare plot.

2. Materials and method

2.1. Implementation phase

Open source development tool NetBeans IDE is used to create the hypertext markup language (HTML) and hypertext pre-processor (PHP) code. The database is implementing using MySQL. In the beginning of the implementation phase a development environment is set up. Apache web server and structure query language (MySQL) database is installed and configure to the environment. The visible parts of the software were coded at first. And the next step is to create the modules which needed for the database access and implement the database integration to the software.

2.2. Login page

Enter the "http://epv-repo.website.tk" at address bar. Only Admin has power to create new user or delete user. Third person will access current workstation and continue to work within a certain time under login if directly close the window, so used logout button for closing window.

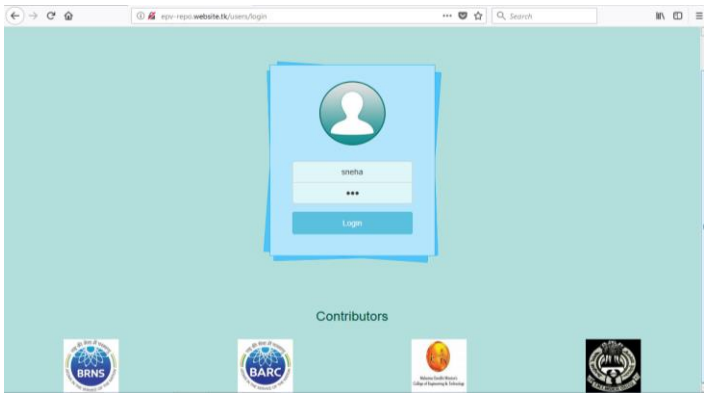

Figure 1. Screen shot of login page.

To access the further information, user have to login using username and password at the login page has been developed in PHP using cascading style sheets (CSS). Thus, our database information is password protected and can only be accessed by authorized users after authentication of username and password.

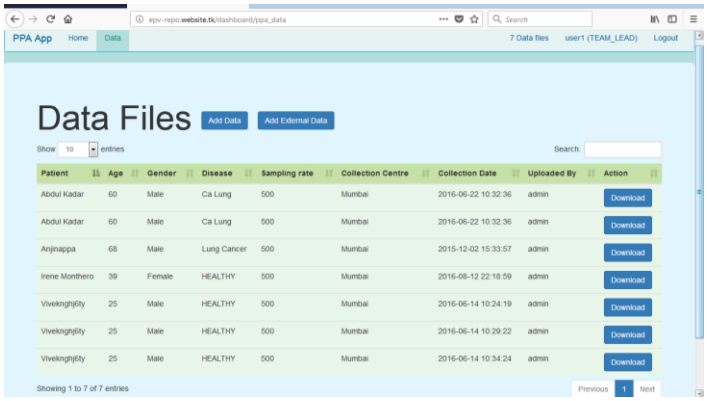

Figure 2. Screen shot of next page.

Once the information is verified by the system, a new page will be displayed to the user. Login page is important that according to the user's responsibilities and privileges. After login user get connected to dashboard, dashboard able to handle data, logout, and user profile management.

2.2.1. Add file to database: Once click on login after entering username and password prediction will be send to next authentication page. Verifying username and password whether it was before visited or new visitor if it successfully login then go for next process otherwise it will check whether login from user or admin. Once successfully login then the next page is open add file to database which is shown in the below screen short.

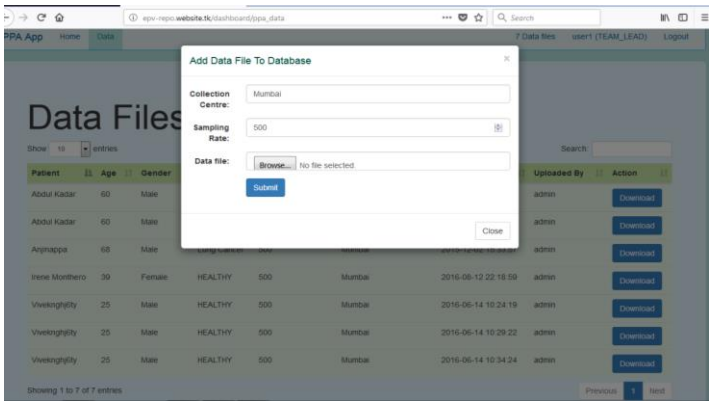

Figure 3. Screen shot of add file to database

2.2.2. Add external data file to database: Next page is open for the external data file add to database. In that patient personal information must be entered, for example, patient's name, age, gender, address, patient healthy or not if not then which type of disease patient has, address, collection date, referral doctor name, referral number, remark. Once the click on submit button all patient personal data is successfully store in database.

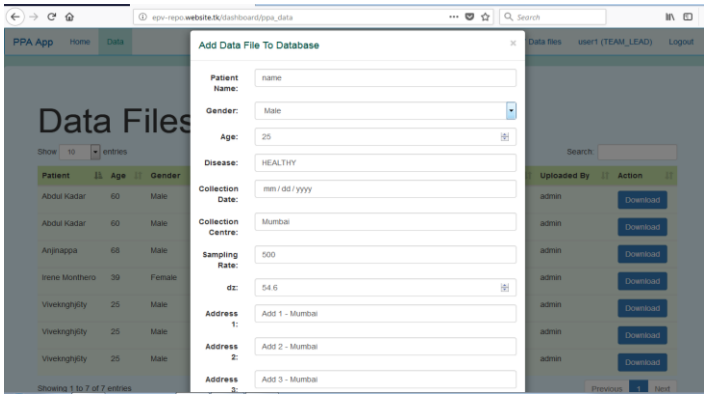

Figure 4. Screen shot of add external data file to database (A)

2.2.3. Select the data file: Data file downloaded from click on download. There are two options add data and add external data, also option to show how much entries. Logout option on top of the right side shown in the screen short.

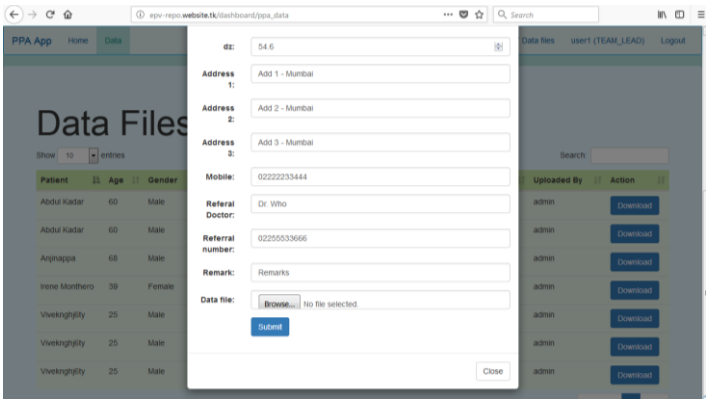

Figure 5. Screen shot of add external data file to database (B)

2.3. Process

This application can be downloaded from the web portal. Any data file downloaded from the database of the web portal can be process and analysis using above. A researcher gets advantage of data collected by other researchers, thus they need for data collection is avoided.

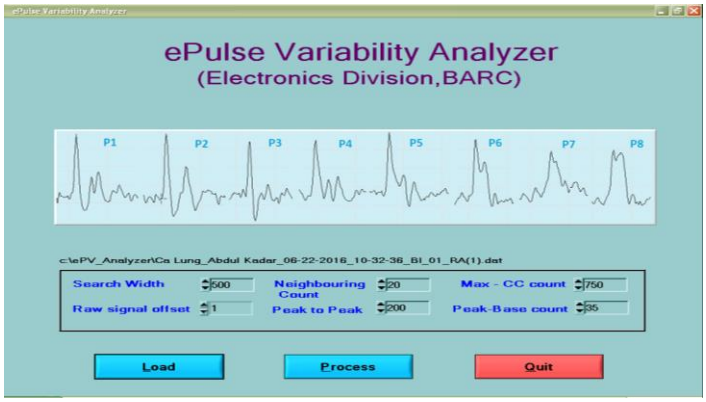

Figure 6. Screen shot for fornt panel of ePulse Variability Analyzer

Before doing any analysis to Load the previously acquired by clicking on “load button”. After reading the selected file, file name is displayed and the name of the file raw signals for which the data has been acquired. The processing software is developed on windows platform using LabWindows CVI for front end and data processing. Microsoft access is used for storing the data in the Database after the analysis of data and producing various reports.

Peaks are shown on graph move the RED cursor on the graph to select one of the peaks during selecting peak skipped starting portion of data which are settling time of patient. And click on ‘Locate peaks’ button, the peaks are identified data a red line marks each peak. These can be modified if peaks are not marked appropriately by peak finding algorithm.

2.3.1. Marking peaks for further calculation: Usually some artifacts are present in peaks defined. To remove the false peaks, use a simple search algorithm with facility to manually correct the peak positions so as to select only genuine peaks corresponding to maximum rate of change of impedance i.e. ‘C’ point. Initial position selected to start the search for peaks (highest amplitude) corresponding to next such peak. It is assumed that number of points of frame size, which is programmable and has a default value 40, the next genuine peak will not be found. So, this position will be used as the search starting point for the next peak. Minor adjustment of inserting/deleting/shifting peaks can be done using the buttons provided for this purpose on the peak selection panel.

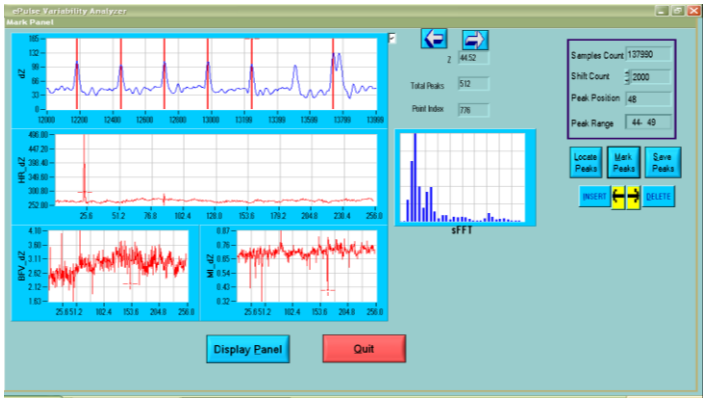

Figure 7. Screen shot for marking peak for furthur calculation

Above graph shown the HRV graph. If any uncorrected RR intervals then the raw signal graph readjusts by inserting peak or deleting peak which is artifacts by using insert and delete button which is on the processing panel. Make ensure that we are not deleting more than five peaks because value of HRV after deleting peaks should be around 750 in the position where the peak is deleted.

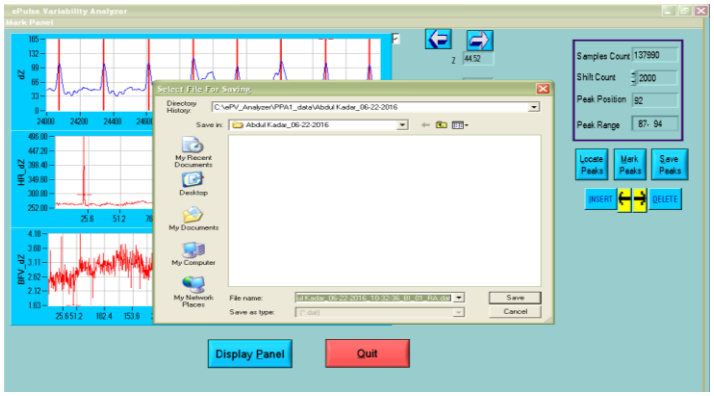

Figure 8. Screen shot for saving data

Once editing is finished on reference signal for locating the peak in remaining raw signal, and then can click on “Mark Peaks” button. Variation in BF, MI, and inter-relation gets plotted in the time domain. Observe blood flow (BF) and MI graphs, Make changes if necessary. Click on ‘Save Peaks’ to save the process data to dat file.

3. Results

After post processing of the data one can plot the variability in time domain as well as frequency domain shown in the display panel when click on the ‘Display Panel’ button in main panel. This panel is mainly used for analyzing the different physiological variability on the basis of different parameter such as average, total power, center frequency, amplitude.

Figure 8. Screen shot for showing heart rate variability

Here the selected data is displayed in the left-hand side graph along with FFT right hand side graph. This panel is used for feature extraction for each variability and generation of hard copy. The data display is for HRV, blood flow variability (BFV) and MI for each of the variability displayed it is required to identify peaks in different frequency ranges in the FFT display for each peak identified, attributes like peak amplitude, center frequency, amplitude of the peak are to be measured.

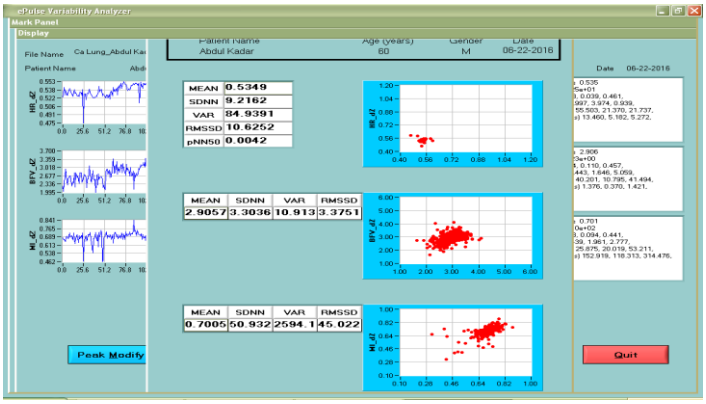

Figure 9. Screen shot for showing poincare plot

These values can be saved send to Microsoft access database by clicking 'Save to Excel' button, which will be used for generation of various queries and reports. While clicking on 'Poincare plot' button, Poincare plot display shown in above screen short. After completing the extraction of feature from the FFTs by clicking on the button labelled 'Print', one can get a print out of the screen.

4. Conclusion

This study develops a user-friendly modular and scalable web-based system where we can be uploading and downloading data. User privilege management through Admin login which is secured by the password. From this system easily access of data storage and filtering. Web page develop in PHP. Processing is done using LabWindow CVI which deriving different variabilities from the acquired data and acquired data display in time and frequency domain. Saving of calculated parameters in access database for further reporting and analysis. Report generation for all the variabilities. Data storage in the unique file name, automatic generation of file name with disease group, patient name and lead position. Easy and faster data entry and retrieval from access database. Easy adaptability by clinicians and medical practitioners.

5. Future scope

Further research and report analysis on the basis of the parameters can be done. On that basis new automations can be added like disease detection, pulse wave velocity etc. measure pulse velocity in the arterial system during blood circulation. This physiological phenomenon provides changes in blood pressure, flow, velocity and that can bring change in pulse wave. Cardiovascular disease is directly related to the condition of the small and large arteries. Arterial stiffness and augmentation of the major arteries is a powerful precursor to potential health problems including heart failure, renal complications, sclerosis and heart attack.

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