



IoT Based Health Monitoring System using Raspberry Pi

Megha Koshti¹, Prof. Dr. Sanjay Ganorkar²

M. E Student, Department of ENTC (VLSI & EMB), Genba Sopanrao Moze College of Engineering, Balewadi, Pune,
Savitribai Phule Pune University Pune India.¹

Department of ENTC, Sinhgad College of Engineering, Vadgaon, Savitribai Phule Pune University Pune India.²

ABSTRACT: Healthcare and wellness management is one of the most promising applications of information technology. A health care monitoring system is necessary to constantly monitor patient's physiological parameters. The tele-medical system focuses on the measurement and evaluation of vital parameters e.g. temperature, electrocardiogram (ECG), heart rate variability, fall detection etc. This project presents a monitoring system that has the capability to detect the specific abnormality of cardiac function. The system can analyse the signal, extract features from it, detect the normal or abnormal conditions like arrhythmia and with the help of Raspberry Pi, the result of the ECG signals is sent to the web server. The main advantage of this system is the result can be viewed at any time at any place. The proposed system uses MIT-BIH database of ECG signals, does processing on QRS part, with the help of MATLAB signal processing software. Appropriate algorithms are used for better accuracy. The result, normal ECG or abnormal ECG like Arrhythmia is then displayed on the web server with the help of Raspberry Pi. In this way, Internet of Things (IoT) concepts are used to support remote health monitoring services.

KEYWORDS: ECG, MATLAB, Raspberry PI, Python language, PHP

I.INTRODUCTION

Information and communications technologies are changing our lifestyle, our workplaces and our social interactions. Previously, the system is designed to read the body temperature and heartbeat of patient at run time. [1]The results or the collected information is sent to multiple users who share same area network. The analysis of ECG is widely used for diagnosing many cardiac diseases. Further, automated analysis of such recorded biomedical signals supports doctors in their daily work and allows the development of warning systems. Also due to IoT, continuous monitoring of biomedical signals will no longer be restricted to the home environment. With the help of internet, we can see data on the web at any time at any place. In the proposed system, Raspberry Pi serially reads the result and sends it to the web server. ECG signal database of MIT-BIH is used for the analysis. The main focus is on QRS wave of ECG signal for getting whether the ECG is normal or detects Arrhythmia. An arrhythmia is a problem with the rate or rhythm of the heartbeat. [2]

The objectives of this work include:

1. Utilise patient's ECG signal database and process QRS wave of it.
2. Creating reliable signal processing algorithm.
3. Extends communication coverage which allows patients health monitoring at any place at any time remotely.

ECG waveform:

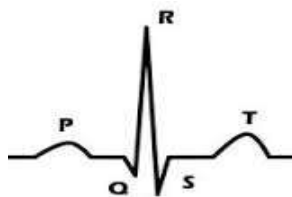


Fig. 1 A Typical ECG Waveform

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

This paper presents a method to analyse QRS part of ECG signal and extract the features to detect arrhythmia. In some methods, the 'P Q R S T' peaks are marked and stored over the entire signal and the time interval between two consecutive 'R' peaks and other peaks interval are measured to detect anomalies in behaviour of heart, if any. [3]Wavelet theory provides a unified framework for a number of techniques, which had been developed for various signal-processing applications.[4]Also for efficient automatic detection and classification of ECG heartbeat patterns robust feature extraction method is essential.[5]The information about the R Peak and QRS complex obtained is very useful for ECG Classification, Analysis, Diagnosis, Authentication and Identification performance.[6]The discrete wavelet transform (DWT) coefficients are utilized as features, which offer even a better recognition performance. [7]In ECG biometrics application, the focus is on the number of ECG data channels used, the operational setting, the method for generating desirable features, and the type of classifier adopted.[8]

II. SYSTEM DEVELOPMENT

The proposed system monitors ECG of patient, processes QRS part in computer system using DSP, consists of Raspberry Pi which collects processed data from computer system and sends it to web server, with the help of which we can monitor the health of patient remotely at any place at any time. Using MySQL and PHP, database is maintained and result is displayed on the web server.

PROPOSED SYSTEM BLOCK DIAGRAM

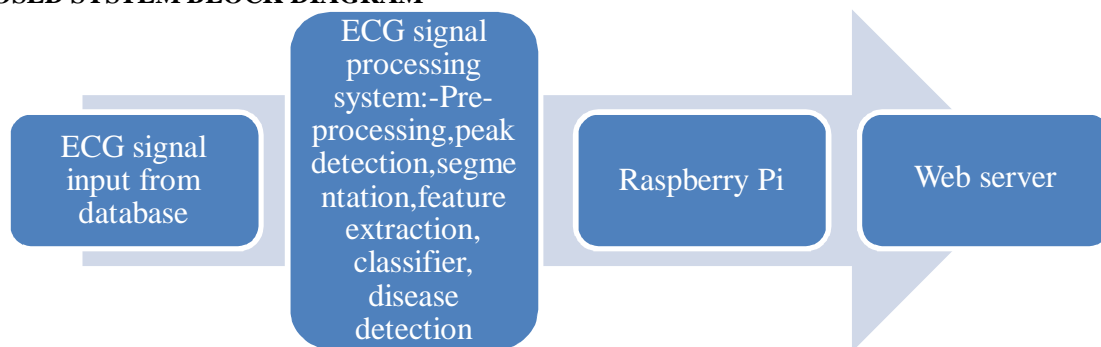


Fig. 2 Block Diagram of Proposed System

- a) We use **ECG signal database** and process it with the help of suitable algorithms of DSP using MATLAB software.
- b) **Signal processing steps are**
 - Load ECG - loads a sample ECG from database into MATLAB software.
 - Apply DCT - brings out a set of coefficients, does filtering too.
 - Apply IDCT - to get the original signal.
 - Detect Peak - detects R peak from ECG signal.
 - Segmentation -Convert complete ECG signal into appropriate no. of segments each containing PQRS wave.
 - Average - Calculate average of segmented samples for the next process.
 - Extract Features - With the help of symlet wavelet transform, decomposition of signal, perform various actions on this signal and calculate values like approximate coefficients, detailed coefficients and statistical features such as Ea, Ed1, Ed2, Ed3, Ed4, energy of signal, mean, kurtosis, skewness, median, mode, standard deviation etc.
 - Predict - Normal Minimum Distance is the classifier used, Normal ECG or Arrhythmia is the result displayed.
- c) **Raspberry Pi**
This powerful credit-card sized single board computer can be used for many applications.[9]

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

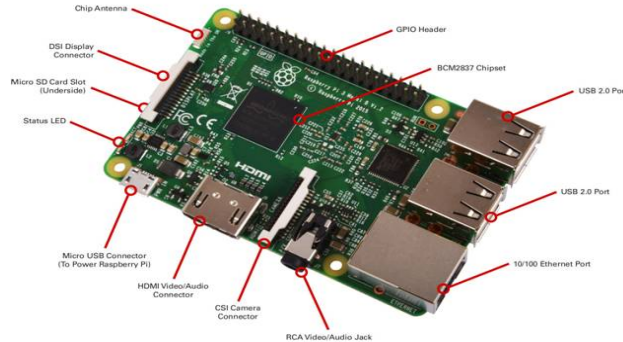


Fig. 3 Raspberry Pi board

- Key benefits of using this Raspberry Pi board is low cost, 10X faster processing speed compared to previous boards and additional connectivity.
- Boots from Micro SD card, running a version of the Linux operating.
- Its few specifications are Broadcom BCM2387 chipset, 1.2GHz Quad-Core ARM Cortex-A53, 802.11 b/g/n Wireless LAN and Bluetooth 4.1, 10/100 BaseT Ethernet socket. The device uses the ARM processor which does most of the hard work in order to run the Raspberry Pi. The SD card must contain the operating system, programs and the data needed to run the Raspberry Pi. The operating system tells the Raspberry Pi how to function, how to handle any input from the user and how to manage programs when they are running.
- It is used in various applications such as low cost laptops, robotics, home automation, gaming, health monitoring systems etc.
- It supports Python language.

d) Web Server

Using MySQL database management system and PHP (Hypertext Pre-processor), database i.e. samples and their respective results are maintained and result is displayed on the web server. Every time the result is read serially, it gets updated into MySQL. Fetching this data from database and displaying it on the web server is done with the help of PHP script. Updating PHP page using Apache server means web page is updated.

FLOW GRAPH OF PROPOSED SYSTEM

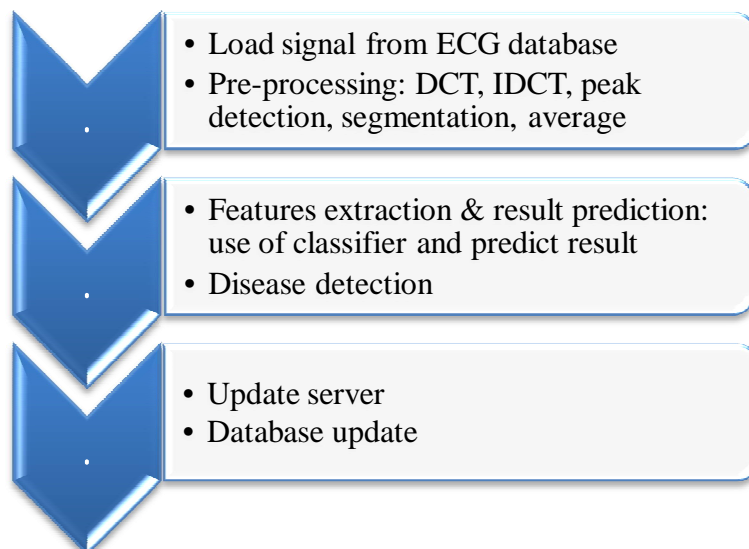


Fig. 4 Flow Graph of proposed system



ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

III. SOFTWARE DEVELOPMENT

MATLAB R2012a(version 7.14)

A proprietary programming language developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, Fortran and Python. This software is used for signal analysis in digital signal processing, in image processing, statistical analysis, aerospace etc. Using Matlab, signal processing i.e. DCT and IDCT application, peak detection, segmentation, average, feature extraction, classification and result prediction is done.

Raspbian OS

Raspbian is a free operating system based on Debian optimized for the Raspberry Pi hardware. OS family is Unix like. An operating system is the set of basic programs and utilities that make your Raspberry Pi run. To download OS in Raspberry Pi, insert SD card into Raspberry Pi board. Then power up Raspberry Pi board using Micro USB socket and connect Ethernet wire to Raspberry Pi board.

Python

Python is a powerful modern computer programming language. Raspberry Pi supports this language. [10] It is a major tool used by many web developers. Python allows you to use variables without declaring them (i.e. it determines types implicitly) and it relies on indentation as a control structure. You are not forced to define classes in Python (unlike Java) but you are free to do so when convenient. Instructions like 'sudo su' provide administrative access, 'Nano' is the editor which is a software environment where users are being able to write code, debug and compile their programs.

MySQL

It is the most popular Open Source Relational SQL database management system. MySQL is a small, compact database server ideal for small and not so small applications. In addition to supporting standard SQL, it compiles on a number of platforms and has multithreading abilities on UNIX servers, which make for great performance. In this work, we are displaying patient's heart condition on web server, and database is created using MySQL. The ECG signal feature values get inserted into the table using MySQL.

PHP

The PHP Hypertext Pre-processor (PHP) is a programming language that allows web developers to create dynamic content that interacts with databases. PHP is basically used for developing web based software applications. PHP is a recursive acronym for "PHP: Hypertext Pre-processor". PHP is a server side scripting language that is embedded in HTML. It is used to manage dynamic content, databases, session tracking, even build entire e-commerce sites. PHP syntax is C-Like. Fetching of value from database is done by using this script.

Apache server

Apache is the most widely used web server software. Developed and maintained by Apache Software Foundation. It is an open source software available for free. So basically a web server is the software that receives your request to access a web page. It runs a few security checks on your HTTP request and takes you to the web page. Depending on the page you have requested, the page may ask the server to run a few extra modules while generating the document to serve you. It then serves you the data you requested. Updating PHP page using Apache server web page is updated.

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

IV. RESULTS

MATLAB signal processing steps output-

1. Graphical User Interface (GUI) in MATLAB is initially created. ECG signal sample from database is loaded into MATLAB software.

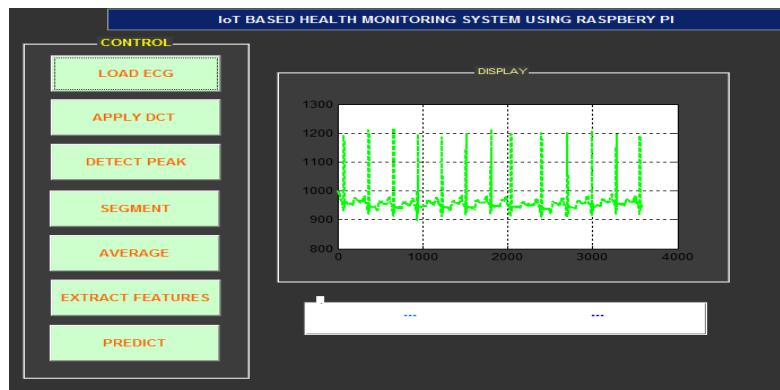


Fig. 5 ECG signal loaded from database

2. DCT is applied on the input signal which brings out a set of coefficients and does filtering too. IDCT is applied again to get the original signal.

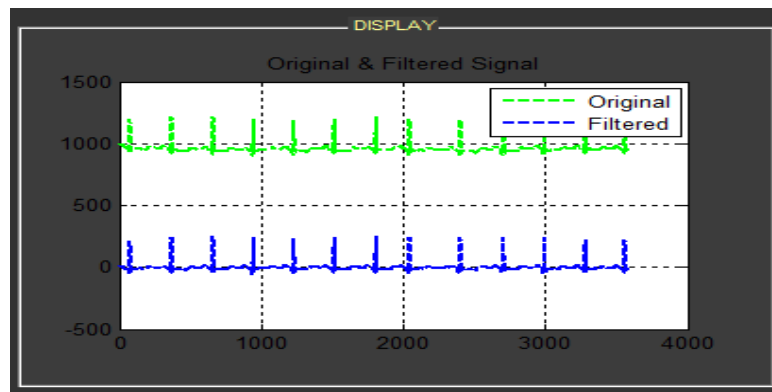


Fig. 6 Applied DCT and IDCT on signal

3. Specific details i.e. QRS part of above signal are selected to detect the R peaks. The detection of R peaks is the first step of feature extraction.

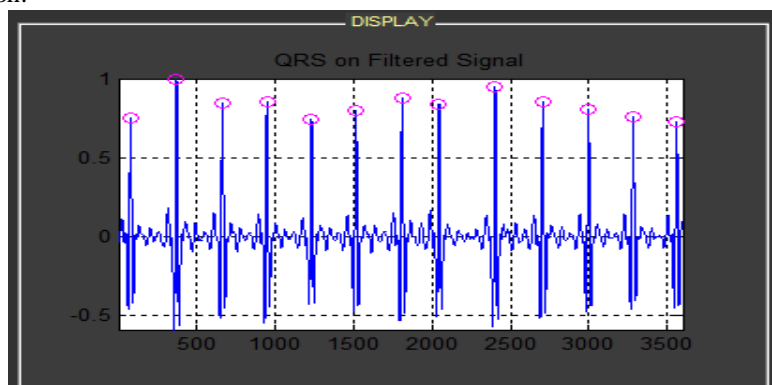


Fig. 7 Peak detection

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

4. Convert complete ECG signal into appropriate no. of segments each containing PQRS wave. Consider suitable sampling frequency and number of samples to perform segmentation.

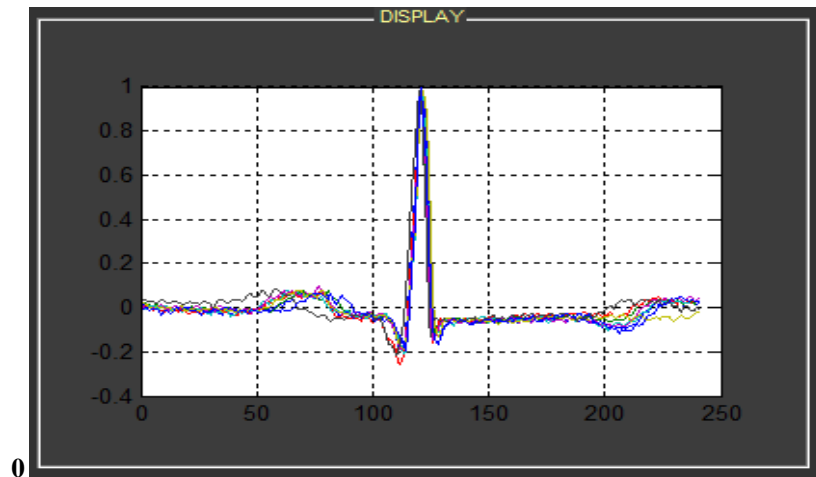


Fig. 8 Segmentation

5. Average of segmented outputs is calculated for further processes i.e. feature extraction.

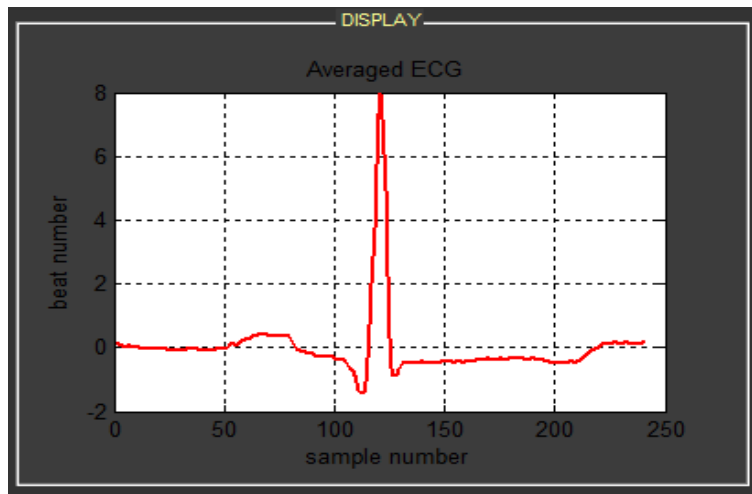


Fig.9 Average of segmented samples

6. With the help of symlet wavelet transform decomposition of signal is done and approximate and detailed coefficients and few statistical features like mean, median, mode, standard deviation, variance, packet energy, range, skewness and Kurtosis are extracted from above signal and those are matched with the trained data. The classifier used here is Normal Minimum Distance classifier. The predicted results are displayed in the form of normal ECG or arrhythmia.

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

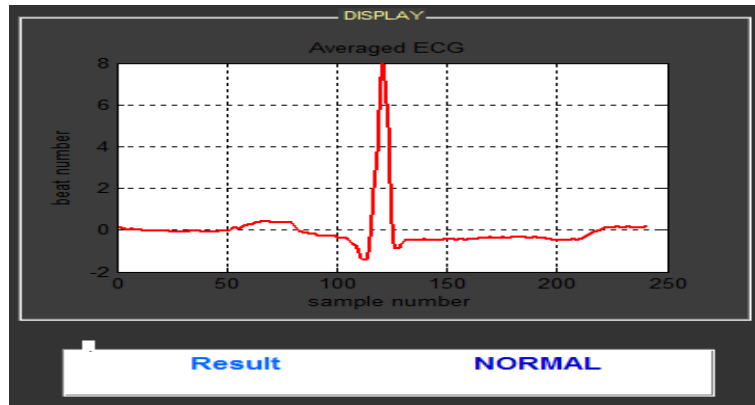


Fig. 10 Result- Normal ECG

7. Raspberry Pi reads the result serially with the help of RS232 and Python programming language. The ECG sample no. and its result both are stored into the database using MySQL database management system.

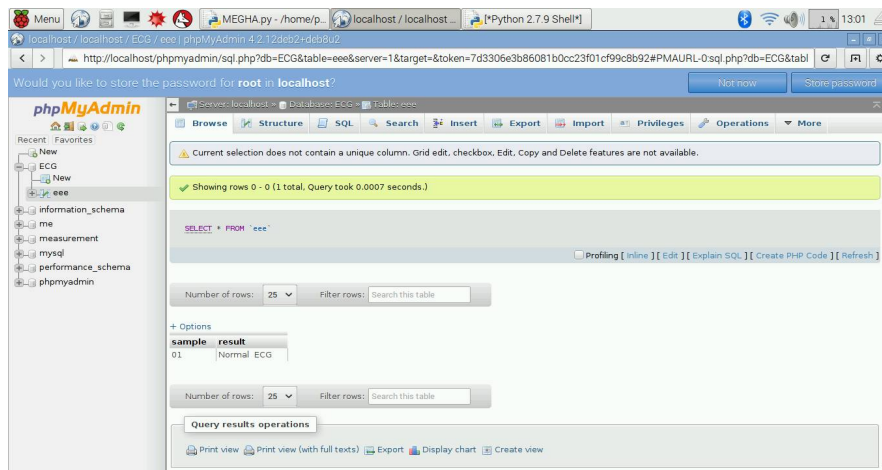


Fig. 11 Database entry

8. Fetching this data from database and displaying it on the web server is done with the help of PHP script.



Fig. 12 Result displayed on web server

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

9. In case of arrhythmia, processed signal looks like the below.

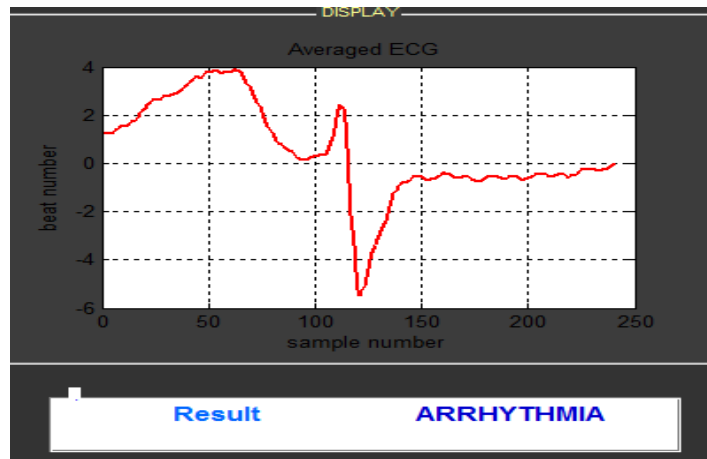


Fig. 13 Result- Arrhythmia

10. Every time when the data is read serially, it gets updated into MySQL.

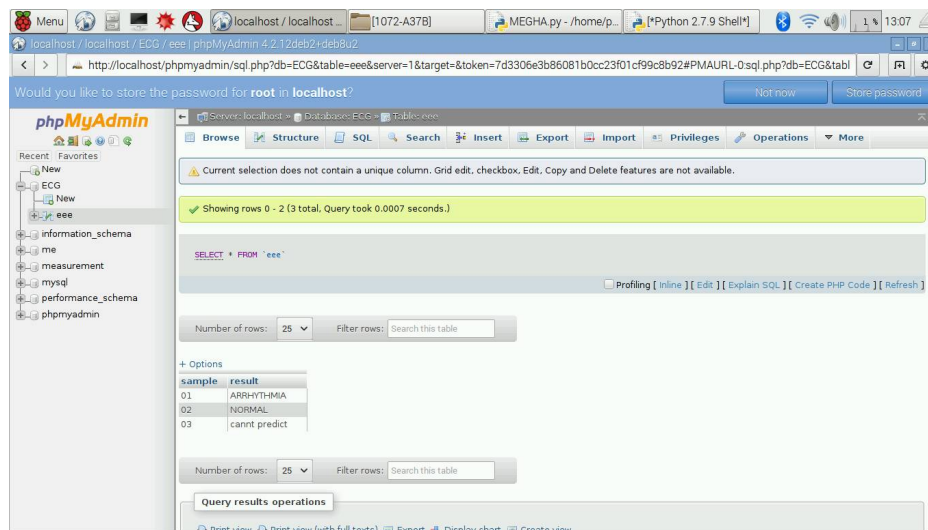


Fig. 14 Updating database

V. RESULTS AND DISCUSSION

Using Matlab, ECG signal processing is done. i.e. DCT and IDCT application, peak detection, segmentation, average, feature extraction, classification and result prediction. After analysing and processing 44 ECG signals from database, we have achieved around 95.4% success rate. Rest signals had lot of variations.

- Raspberry Pi reads the result serially with the help of RS232 and Python programming language. It also stores data in MySQL database system. Instructions like 'sudo su' provide administrative access, 'Nano' is the editor where users are able to write code, debug and compile the programs.
- The ECG sample no. and its result both are stored into the database using MySQL database management system.
- Every time when the data is read serially, it gets updated into MySQL.
- Fetching this data from database and displaying it on the web server is done with the help of PHP script. Updating PHP page using Apache server means web page is updated.



ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

V. CONCLUSION

The proposed system uses a database of ECG signals, does processing on QRS part with the help of MATLAB signal processing software. After analysing and processing ECG samples from MIT-BIH database, around 95.4% success rate is achieved. Rest samples have lot of variations. Appropriate algorithms are used for better accuracy. The result, normal or abnormal like Arrhythmia is then displayed on the web server with the help of Raspberry Pi. We can view this result at any place at any time. Also restructuring healthcare systems e.g. managing of wellness rather than illness, and focusing on prevention and early detection of disease is also achieved. A new heart condition discovery calculation in light of symletwavelet transform has been implemented effectively.

REFERENCES

- [1]. Abhilasha Ingole, et al, "Implementation of Health-care Monitoring System using Raspberry Pi", in Communications and Signal Processing (ICCSP), 2015 IEEE International Conference on, vol., no., pp.1083-1086, 2-4 April 2015, doi: 10.1109/ICCSP.2015.7322668
- [2]. Anand Kumar Joshi¹, Arun Tomar², Mangesh Tomar³, "A Review Paper on Analysis of Electrocardiograph (ECG) Signal for the Detection of Arrhythmia Abnormalities", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (An ISO 3297: 2007 Certified Organization) Vol. 3, Issue 10, October 2014
- [3]. Mukhopadhyay, Sayantan, et al, "Wavelet based QRS complex detection of ECG signal." International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 2, Issue 3, May-Jun 2012, pp.2361-2365
- [4]. Cornelia, Gordan, and Reiz Romulus, "ECG signals processing using Wavelets." IEEE, proceedings of the fifth IASERD International conference May. 2005
- [5]. Khandait, P. D., N. G. Bawane, and S. S. Limaye, "Features Extraction of ECG Signal for detection of cardiac arrhythmias." International Journal of Computer Applications 2.1 (NCIPET 2012): 520-525
- [6]. Mehta, Priyanka, and Monika Kumari, "QRS complex detection of ECG signal using wavelet transform." International Journal of Applied Engineering Research ISSN 0973-4562 Vol 7.11 (2012): 1889-1893
- [7]. Fattah, Shaikh Anowarul, et al, "ECG signal based human identification method using features in temporal and wavelet domains." TENCON 2012-2012 IEEE Region 10 Conference. IEEE, 2012
- [8]. Odinaika, Ikenna, et al, "ECG biometric recognition: A comparative analysis." IEEE Transactions on Information Forensics and Security Vol 7.No. 6 (Dec 2012): 1812-1824
- [9]. OCR Raspberry Pi, (2013, January), "Getting Started Tutorials"
- [10]. Dr Andrew N. Harrington, (2013, August), "Hands-On Python A Tutorial Introduction for Beginners"