International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 5, Issue 11, pp 10-14, November-2021

https://doi.org/10.47001/IRJIET/2021.511003

Real Time Data Acquisition Using Portable ECG Equipment

[1]Shashank Rawat, [2]Sumi Sekhar, [3]Alwin Varghese

[1,2,3]Student, Christ (Deemed to be University) College of Engineering, Karnataka, India

***Abstract* – The ECG is an important and essential instrument to detect heart abnormalities. The conventional ECG uses a 12 lead system and is quite bulky in nature. Unlike the conventional one, an attempt to make a cost effective and portable ECG was made. The system has been implemented in hardware and tested. This work presents a first approach to the design, development, and implementation of a 3 lead portable ECG for the real time measurement of heart beats. The device follows a design scheme, which consists of an electrocardiogram (ECG) signal acquisition module, a processing module and a wireless communications module. From real time ECG signals, the processing module algorithms perform a spectral estimation of the HRV. The experimental results demonstrate the viability of the portable ECG machine and the proposed processing algorithms.**

Keywords: ECG/EKG, HRV, BPM, MATLAB, FFT, IFFT, HPF, LPF.

I. INTRODUCTION

Cardiovascular diseases are one of the main causes of population death around the world. It is estimated by WHO that around 17.3 million people die worldwide as a result of cardiovascular diseases. Electrocardiography (ECG) plays a central role in the diagnosis of cardiovascular diseases by reading the electrical activity of the heart. ECG is an easy non-invasive strategy to analyze different heart illnesses. ECG is a graphical record of the electrical potential created in relation with heart activity. Atrial and ventricular depolarization and repolarization are represented on ECG as a series of waves i.e. the P wave which is followed by the QRS complex and then the T wave. P wave depends on Atrial Depolarization, QRS complex on ventricular depolarization and T wave depends on ventricular repolarization. The ECG of an adult portrays the electrical action of the heart. The ECG is an important and essential instrument in the medical field to detect heart irregularities.

The present work shows an approach to do analysis in real time using a portable and low-cost ECG which uses a 3-lead system unlike the conventional one in the hospitals which uses a 12-lead system.

Even though the spread off hospitals across the country is wide and technology has evolved a lot, there are still a lot of rural areas in India where medical instruments like ECG machines are not available readily. Since the ECG machine used in hospitals are quite bulky in nature and are expensive it is not possible to afford them and carry them to remote places in case of emergencies. For such scenarios, an attempt was made to carry out HRV analysis using a portable ECG machine which is not bulky in nature, is cheap and still effective. (The ECG used in hospitals use a 12-lead system whereas the portable ECG machine mentioned uses a 3-lead system.)

In case of emergencies, it is not always possible to go to a good hospital which has all medical instruments available or call a doctor with all his devices. In such scenarios, a bulky ECG machine is not easy to carry if the situation arises in rural areas. In order to save a life faster and in an easier yet cost effective way a portable ECG machine is required.

The proposed system is designed to address the issue of Availability of ECG machines in rural areas.in order to do so a portable ECG machine which is cheap and still effective was made. An attempt to do real time analysis to get accurate results was made. The objectives are as follows:

1) Design and implementation of a portable ECG machine

2) Data acquisition using the portable ECG machine

3) Calculation of BPM (beats per minute)

4) Real time analysis using Matlab Simulink

1.1 Materials and methodologies

Figure shows the block diagram for the proposed work. The Arduino forms the core for the entire setup where it receives inputs from the ECG biometric sensors. The sensors in turn trigger the AD8232 ECG sensor module. The Arduino communicates with the Processing software through the serial port. The serial port transfers the signals to the MATLAB software.

© 2021-2017 IRJIET All Rights Reserved

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 5, Issue 11, pp 10-14, November-2021

https://doi.org/10.47001/IRJIET/2021.511003

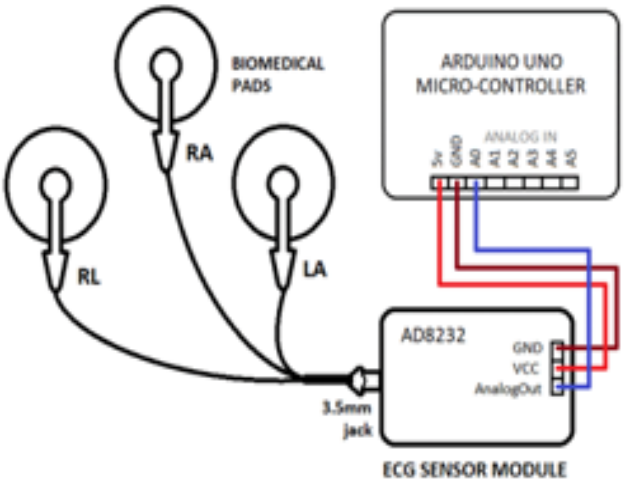

Figure 1: overview of portable ECG

1.2 Algorithm

First the data from ECG is acquired using AD8262 sensor for about 60 seconds which is then subsequently plotted on Arduino serial monitor. Followed by the usage of serial port of Arduino to transfer the signal to Matlab. Then Live script editor of Matlab is used to plot the signal. This ECG signal is then denoised using filters. The R peak is identified and Beats per minute is calculated.

II. DATA ACQUISITION

The first stage of the project was to acquire the ECG signals from the body. For this purpose, the ECG electrodes were attached to the body of the subject. The signals were transferred via the AD8232 heart sensor. The heart sensor sends the signal to the Arduino board. Now, the Arduino can show the signal using the Serial Plotter. But, it had a lot of low frequency noise. Therefore, the signals had to be processed before it could be put to any further use. The data can be used in 2 forms which is stored data and real time data.

Stored Data Analysis

In this method the data could only be de-noised if it was pre-stored. Real time analysis was not possible in this method. This method was done in 4 steps which involved removing the low frequency components from the mixture which required the signal to be converted into the frequency domain by using Fast Fourier Transformation. Then the low frequency components where removed from the mix. After this the signal was the converted into the time domain using inverse fast Fourier transformation. Using the windowed filter, the local maxima were found and the small values were removed storing only significant data. The filter size was then adjusted and the steps were repeated.

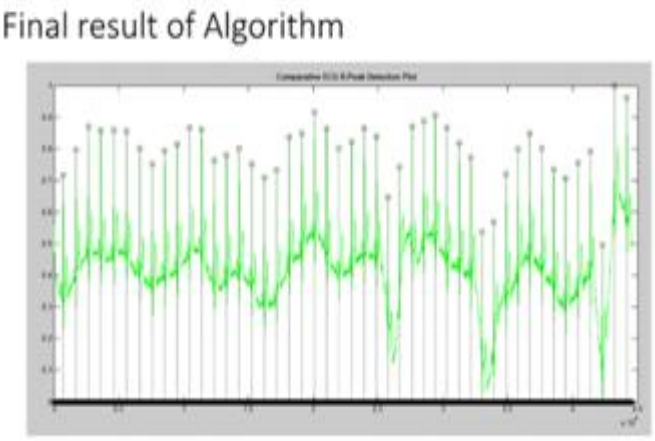

Figure 2: The final result of stored data analysis

After receiving the Final graph as in Figure, Calculation of heart rate is done to determine the BPM (beats per minute) of a body. The equation for the same is given below:

Heart Beat Rate= 60*sampling rate/(R-R interval)

2.1 Real Time Analysis

Since the stored data analysis method mentioned above was more tedious and required a lot of manual labor, the real time analysis method was introduced and tested. It is a more efficient method, requires less manual work and is much more user friendly in terms of usage. This method incorporates the use of MATLAB and Simulink and it can be used for both stored and real time data. Therefore, this was the preferred method. For this method, Simulink Support Package for Arduino was downloaded and installed along with MATLAB.

A code was written to import the raw ECG signal from the Arduino board to the MATLAB software via the serial port. Then Simulink was used to refine the ECG signal and deliver accurate results. The following flow diagram as shown in Fig was built by us using the function blocks existing in the Simulink Support Package.

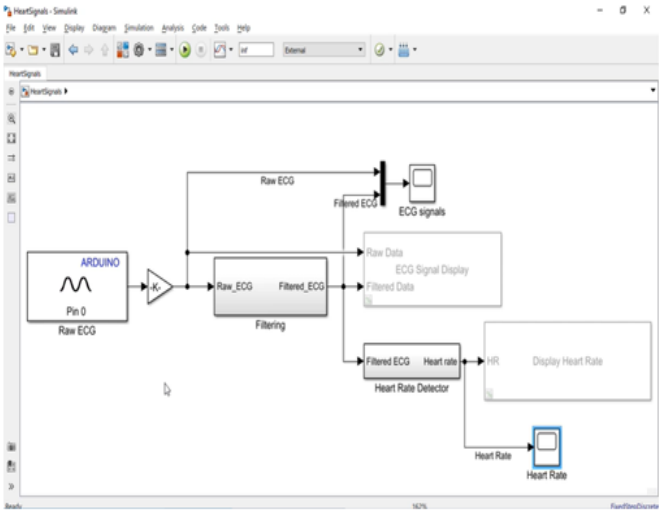

Figure 3: Flow diagram in Matlab Simulink

© 2021-2017 IRJIET All Rights Reserved

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 5, Issue 11, pp 10-14, November-2021

https://doi.org/10.47001/IRJIET/2021.511003

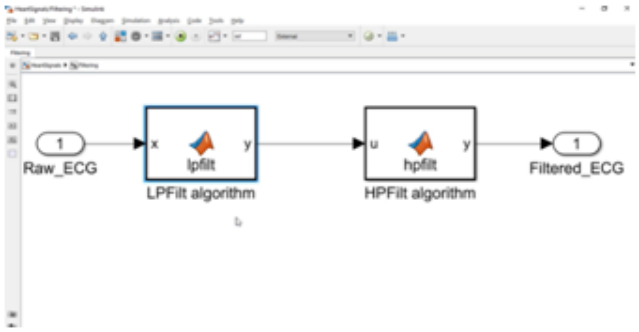

Figure 4: Filter Raw ECG using LPF, HPF

For filtering the raw signal, the signal was passed through a LPF (Low Pass Filter) and a HPF (High Pass Filter) Which is a predefined function in toolbox.

Fig. shows the graphs of a raw ECG signal (in yellow) and the graph below shows the ECG signal after filtering. Both the signals were acquired using Matlab Simulink. The figure on the right represents the heart rate of the person in digital form. The objective of data acquisition from a portable ECG machine was accomplished and accurate results were achieved.

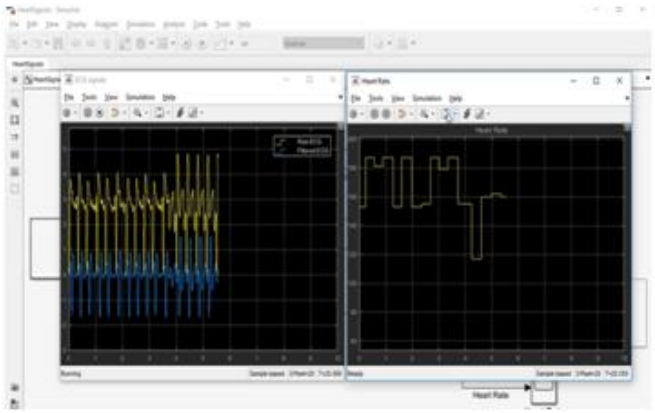

Figure 5: Real time data from portable ECG

III. RESULTS AND DISCUSSIONS

The literature review of the proposed objective was done as follows:

[1] A.Malik developed a model for processing ECG signal for analysis of various heart conditions like apnea, tachyarrhythmia etc. and heart rate variability (HRV). The HRV processor has been designed in Simulink. HRV is utilized as a quantitative indicator of the Autonomic Nervous System (ANS) and cardiovascular system. The ECG test system empowers us to study normal and abnormal ECG waveforms without really utilizing ECG machines. In this work the QRS complex which is the main component of ECG signal is used to calculate HR which carries information about HRV. Further the model designed in Simulink can be implemented on FPGA.

[2] Chandra Mukherjee, et al. "An analytical Evaluation of Heart Rate Variability and Its' Implication," In International conference for Strengthen Education in Engineering and Research (STEER-14), 2014 uses the stored data analysis method used above and HRV analysis is used for determination of the sex of the person, smoker/ nonsmoker and sleep patterns. The method uses Fourier transform and windows.

[3] J. L. A. de Carballo developed a tool for analysis of HRV called ECG Lab, which was developed in Matlab language in order to help research on HRV by making the analysis process faster and easier. The software obtains the HRV signal by using an automatic QRS detection algorithm. The user can inspect the ECG and correct mistakes in the detection process, and also identify ectopic beats. Importing RR intervals from previously typed ASCII files is also possible. Some of the most popular HRV analysis techniques were implemented: statistical and time series analysis, spectral analysis (using FFT, autoregressive and Lomb methods), Poincare plot analysis and sequential trend analysis.

[4] Chia-Ching Chou, developed a portable ECG processor designed for health monitoring applications is proposed. The ECG processor acquires three-channel ECG raw data through a front-end circuit, and measures the time between successive heart beats on lead II as RR intervals for heart rate variability (HRV) analysis. Functions such as R-peak detection, RR interval calculation, sliding memory window scheme, and time-frequency analysis of HRV have also been developed.

[5] Dipali Bansal described various QRS detection methods used to derive HRV. It also reviews various time and frequency domain HRV parameters. The significance and meaning of these different measures of HRV are a potential area of research.

[6] S. Y. Tseng presented an EKG system-on-chip (SOC) for portable health care and home monitoring applications. The EKG system acquires three channel EKG from front-end circuits and includes functions such as beat detection, interval calculation, and time-frequency analysis of heart rate variability (HRV) in real-time. An HRV analysis engine has also been developed using Lomb period gram for time-frequency power spectral density (PSD) analysis of heart rate. HRV analysis as well as raw data can be transmitted via Bluetooth to a cell phone or remote station through a UART interface.

[7] Y.H. Hsu proposed that the HRV analysis is divided into two parts, one is time-domain analysis in HCP and frequency-

© 2021-2017 IRJIET All Rights Reserved

ISSN (online): 2581-3048
Volume 5, Issue 11, pp 10-14, November-2021
https://doi.org/10.47001/IRJIET/2021.511003

domain analysis in PC. The experimental results analyze the life-behavior patterns of tested subjects that may affect HRV parameters (HF, LF and HF/LF) so that one may achieve the task of disease prevention and health management.

[8] P G Patel proposed the need to find an efficient method for ECG Signal Analysis which is simple and has goodaccuracyand less computation time. For analysis the ECG signals from MIT database are used. The initial task for efficient analysis is the removal of noise and detection of QRS peaks. It actually involves the extraction of the QRS component by rejecting the background noise.

Critical Review

The literature review suggests that considerable research has been conducted in portable ECG machine and HRV analysis using various methods and tools like ECG lab, Lomb method, frequency analysis, QRS detection methods, EKG system on chip (SOC). Arduino Uno, Matlab Simulink etc. has been incorporated to achieve various features according to the application. However, the systems can be made better and there is a huge scope for improvement. Considerable work has been done in the area of designing and implementation of a portable ECG, acquisition of data through ArduinoUno, calculation of BPM, real time analysis and extraction of features to name a few. An integration of the mentioned has not been reported to the best of the authors knowledge. The objective of the proposed project is to look into the above fields and come up with a solution and improve the existing outcomes.

Limitations and future studies

1. Even though our prototype involves a 3-lead portable ECG its result is not as efficient as the proper 12 lead ECG instrument used in hospitals.

2. The 3 lead ECG also requires a working laptop which has MATLAB Simulink for data acquisition.

Each and every system requires continuous upgradation which means additional features to be added. All projects are time bound and even though there might be several ideas that one might want to implement, one is unable to do so due to time restrictions. This is true for our case too, especially since this was a prototype and proof of concept. There are several avenues that one can look at to build upon the existing work.

3. Transfer of data over a mobile handset.

4. Display of real time data (BPM level, Heart rate) on TFT screen.

The literature review suggests that considerable research has been conducted in portable ECG machine and HRV analysis using various methods and tools like ECG lab, Lomb method, frequency analysis, QRS detection methods, EKG system on chip (SOC). Arduino Uno, Matlab Simulink etc. has been incorporated to achieve various features according to the application. However, the systems can be made better and there is a huge scope for improvement. Considerable work has been done in the area of designing and implementation of a portable ECG, acquisition of data through ArduinoUno, calculation of BPM, real time analysis and extraction of features to name a few. An integration of the mentioned has not been reported to the best of the authors knowledge. The objective of the proposed project is to look into the above fields and come up with a solution and improve the existing outcomes.

IV. CONCLUSION

Most hospitals have ECG machines which use a 12-lead system which is bulky in nature and expensive. In order to make sure a cheaper and portable ECG is available the proposed method was integrated. This requires a multi-dimensional approach to effectively handle the situation. Different methods are therefore used to solve this challenge. The portable ECG made requires a 3-lead system, is cheap and is efficient. The real time acquisition and analysis using that data is done using less tedious methods.

REFERENCES

[1] A.Malik and R. K. Sharma," Detection of heart conditions using HRV processor in Matlab Simulink," 2017 International Conference on Trends in Electronics and Informatics (ICEI), Tirunelveli, 2017, pp. 861-864, doi: 10.1109/I- COEI.2017. 8300827.

[2] J. L. A. de Carvalho, A. F. da Rocha, F. A. de Oliveira Nascimento, J. S. Neto andL. F. Junqueira," Development of a Matlab software for analysis of heart rate variability," 6th International Conference on Signal Processing, 2002., Beijing, China, 2002, pp.14881491vol.2, doi:10.1109/ICOSP.2002.1180076

[3] Chandra Mukherjee, et al. "An analytical Evaluation of Heart Rate Variability and Its' Implication," In International conference for Strengthen Education in Engineering and Research (STEER-14), 2014.

[4] J. L. A. Carvalho," A Tool for Time-Frequency Analysis of Heart Rate Variability", IEEE EMBS, vol. 25, pp. 17-21, 2003.

[5] Dipali Bansal, Munna Khan, A. K. Salhan," AReview of Measurement and Analysis of Heart Rate Variability", IEEE ICCAE, pp. 243-246, 2009.

© 2021-2017 IRJIET All Rights Reserved

ISSN (online): 2581-3048
Volume 5, Issue 11, pp 10-14, November-2021
https://doi.org/10.47001/IRJIET/2021.511003

[6] S. Y. Tseng, and W.C. Fang, "An EKG system-on-chip for portable time-frequency HRV analysis," in IEEE International Conference on Consumer Electronics (ICCE), 2011, pp. 559-560.

[7] Y.H. Hsu, C.L. Lin, et al., "Health care platform based on acquisition of ECG for HRV analysis," In 10th IEEE International Conference on Industrial Informatics (INDIN),2012, pp. 464-469.

[8] P. G. Patel et al., "ECG Analysis and Detection of Arrhythmia Using MATLAB," Journal of Innovative Research and Development, Vol 11, no. 1, pp. 59-68, 2012

[9] Papathanassiou G, et al., "Effects of smoking on heart rate at rest and during exercise, and on heart rate recovery in young adults," Hellenic J Cardiol, Vol 54, no. 3, pp. 168-177, 2013.

[10] Reza Sameni, Mohammad B. Shamsollahi," A Nonlinear Bayesian Filtering Framework for ECG Denoising" IEEE Transactions on Biomedical Engineering, Volume: 54, Issue: 12, Dec. 2007.

[11] MATLAB, The Language of Technical Computing, The Math works.

[12] R.S.Khandpur, Handbook of Biomedical Instrumentation.

[13] Leslie Cromwell, Biomedical Instrumentation and Measurements, Prentice Hall of India.

Citation of this Article:

Shashank Rawat, Sumi Sekhar, Alwin Varghese, "Real Time Data Acquisition Using Portable ECG Equipment" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 11, pp 10-14, November 2021. Article DOI https://doi.org/10.47001/IRJIET/2021.511003

****

© 2021-2017 IRJIET All Rights Reserved