IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A REVIEW PAPER ON REAL TIME ECG SIGNAL ANALYSIS AND PROCESSING USING ARM A-72

Ritik Tyagi, Shivansh Agrawal, Swatantra Pratap Singh, Uddeshya Kasaudhan

Student, Student, Student, Student

Dr. Ashish Gupta, Dr. Devvrat Tyagi

Assistant Professor, Assistant Professor

Electronics And Communication
ABES Engineering College, Ghaziabad, India

Abstract: This review paper deals with the study and analysis of ECG signal processing by means of various tools ,techniques and algorithms . Study of ECG signal includes generation & simulation of ECG signal, acquisition of real time ECG data, ECG signal filtering & processing, feature extraction, comparison between different ECG signal analysis algorithms & techniques (i.e. discrete Wavelet transform or so), detection of any abnormalities in ECG and so on.Finally ,in the concluding part about its technological implementation using various small,inexpensive ,easy to use devices such as arduino ,raspberry pi along with the implementation using edge technologies such as IOT and cloud .

Index Terms **– Arduino, Arrythmias, ECG, IOT, LabView, MATLAB, Raspberry Pi**

I. INTRODUCTION

An ECG is generated by a nerve impulse stimulus to the heart. The current is diffused around the surface of the body. The current at the body surface will build on the voltage drop, which is a couple of μV to mV with an impulse variation. Usually, this is a very small amplitude of impulse, which requires a couple of thousand times of amplification.
Arrhythmias are caused by abnormalities in the conduction system of the heart. So, one of the most effective tools for arrhythmia diagnosis is the detection of ECG signals.

II. Literature Survey

2.1 Labview Based ECG Patient Monitoring System for cardiovascular Patients Using SMTP Technology.

This work depicts a ECG patient monitoring system using Simple Mail Transfer Protocol for any cardiovascular patient based on LABVIEW. The designed the device has been divided into 3 halfs, the primary part is that the ECG electronic equipment circuit, engineered using an instrumentation amplifier (AD620) followed by an indication learning circuit with the operation amplifier (lm741). Secondly, the DAQ card is employed to convert the analog signal into digital type for the more process. Furthermore, the information has been processed in LabVIEW wherever the digital filter techniques are enforced to take away the noise from the noninheritable signal. once processing, the algorithmic rule was developed to calculate the heart rate and to analyze the heart condition condition. Finally, SMTP technology has been additional in our work to create the device a more communicative and a lot of more cost effective answer in telemedicine technology that has been key-problem to appreciate the tele diagnosing and observance of EKG signals. The technology can also be simply enforced over already existing Internet.

2.2 ECG Signal Analysis and Arrhythmia Detection using Wavelet Transform

In this paper, ECG signal has been analyzed to detect the QRS complex and R-wave and Arrhythmia has been detected on the basis of heart rate. The detection is done using methods of wavelet transform and PCA. In DWT, the first stage of denoising is done through process of thresholding. Further, detection of QRS complex is the signifi-cant part of ECG signal analysis. It is correctly detected using reconstruction of detail and approximation coefficients and then R-wave is detected. .

FinallyArrhythmia is detected on basis of heart rate and the disorders or abnormalities like ventricular bigeminy, multiform PVC,Bradycardia, Tachycardia and Atrial flutter are identified.

2.3 A Review Paper on Analysis of electrocardiograph (ECG) Signal for the detection of Arrhythmia Abnormalities

The aim of this paper presents analyses of cardiac disease in Electrocardiogram (ECG) Signals for Cardiac Arrhythmia using analysis of resulting ECG normal & abnormal waveforms. This paper presents a method to analyze electrocardiogram (ECG) signals, extract the features, for the classification of heartbeats according to different arrhythmia. Cardiac arrhythmia found are Tachycardia, Bradycardia, Supraventricular Tachycardia, Incomplete Bundle Branch Block, Bundle Branch Block, Ventricular Tachycardia, hence abnormalities of the heart may cause sudden cardiac arrest or damage of the heart. The early detection of arrhythmia is very important for cardiac patients. Electrocardiogram (ECG) feature extraction system has been developed and evaluated based on the multi-resolution wavelet transform.

2.4 Real time ECG on internet using Raspberry Pi

An ECG monitoring system as described in this paper is a device which acquitizes hearts electric signal using AD8232 ECG module. Serial ADC MCP3008 converts the analog signal digitally in order to make it fit for embedding to raspberry pi model 3 processor. Plot.ly is an online graphics tool which is used to plot the signal. Anyone with the user credentials of the programmer can view these signals. This system is designed keeping in mind the importance of ECG study for detecting and diagnosing the heart diseases and the overall well-being of patients. Any abnormality detected can alert the doctor via an alarm system on the basis of the real time data being monitored. Therefore, it can easily avoid any kind of risk and handle any critical condition. Reducing time laps between critical situation and alerting the doctor makes it an advantage to use this system.

2.5 Real Time Arrhythmia Monitoring and Classification Based on Edge Computing and DNN

In order to identify arrhythmia one should know how to put intelligence into human-centric IoT edges, a heart ailment that is typically associated with morbidity and mortality, in this research. To auto detect the type of arrhythmia in the edges, the authors present a classification technique based on the intrapatient convolutional neural network model and the interpatient attention residual network model. They slice and overlap the original ECG signal to homogenise the heartbeat sets of different types, and then the preprocessed data is used to train the two proposed network models; the results achieved an overall accuracy rate of 99.03 percent and an F1 value of 0.87, respectively, are then achieved as results. And the imbalance categories in the MIT-BIH arrhythmia database are used in the algorithm. This presented model can be employed as a real-time diagnostic tool in next-generation wireless communication networks for remote E-health systems.

2.6 Research on a Practical Electrocardiogram Segmentation Model

A practical ECG segmentation model is introduced in this paper, which is built on-time processing. With the model,the ECG signal is divided into several pieces. Each piece has an adjustable sampling time interval and can be processed in a time sequence. Also, the signal amplitude can be adjusted. This is very useful in practical application. According to the sampling theorem, by changing the Different sampling time intervals, simple data compression and signal extending in time coordinates are realized.Subsequent interpolation is to retain the original information and characters used for observation and analysis after extending.

2.7 Review paper on denoising of ECG signal

The proposed paper focuses on the study of different techniques of denoising and an identification of a person through an ECG signal. The denoising of signals becomes an important stage in any signal processing technique and has a lot of scope involved in computer aided diagnosis of the heart. Much research work focuses on denoising the signal for extracting important features like Extended Kalman Filter, Wavelet Transformation and Singular Value Decomposition (SVD). The denoising signal processing techniques evaluated using mean square error and signal to noise ratio. In addition, ECG signals are used for person authentication

2.8 Stages-Based ECG Signal Analysis From Traditional Signal Processing to Machine Learning Approaches: A Survey

This paper portraits an in-depth study on ECG Signal analysis. First of all a stage-based model is instigated for analyzing an ECG signal along with a survey based on an analysis of ECG related work. Both traditional time/frequency-domain and advanced machine learning techniques are detailed at each and every stage of analysis, beginning from acquisition of ECG Data to its classification for both simulation and monitoring system. They depict a brief review of pre-recorded clinical ECG data along with de noising and processing of signals, the acquisition of real-time ECG signals, feature engineering based detection of ECG diagonsed points and also the classification of signals with a comparative discussion among the reviewed material. Feature engineering for ECG-based body sensor networks in portable and wearable ECG devices for real-time cardiac status monitoring is also explained very well in this literature review.

2.9 Review of noise removal techniques in ECG signals

This study discusses the workflow, and style principles followed by these ways, and classify the progressive methods into completely different classes for mutual comparison, and development of recent methods to denoise ECG. The performance of those methods is analysed on some benchmark metrics, viz., root-mean-square error, percentage-root-mean-square difference, and ratio improvement, therefore scrutiny numerous ECG denoising techniques on MIT-BIH databases, PTB, QT, and different databases. it's discovered that Wavelet-VBE, EMD-MAF, GAN2, GSSSA, new MP-EKF, DSLR, and AKF are best suited for additive white

Gaussian noise removal. For muscle artefacts removal, GAN1, new MP-EKF, DSLR, and AKF perform relatively well. For base-line wander, and conductor motion artefacts removal, GAN1 is that the best denoising option. For power-line interference removal, DSLR and EWT perform well. Finally, FCN-based DAE, DWT (Sym6) soft, MABTW (soft), CPSD sparsity, and UWT are promising ECG denoising ways for composite noise removal.

2.10 A Review Paper on Denoising of ECG Signal for The application of Medical System

In this paper, the comparative study between all existing filters is discussed. As we know ECG signal processing has become an effective tool for research and medical practices. A typical computer based ECG analysis system includes a signal pre-processing, beats detection and feature extraction stages, followed by classification. Automatic identification of arrhythmias from the ECG is one important biomedical application of pattern recognition. As we also know in the current era heart diagnosis is done with the help of ECG. Here ECG signal is recording the form of electrical activities which is generated by the human heart. Now some time due to some electrical issue there may be chances of generation of some wrong information of ECG signal which is really too dangerous for the patient. So there is a need for some effective filtering applications which will filter the output of ECG signal and generate the real ECG signal which will help for human health diagnosigation.

2.11 Denoising ECG Signal: A Review

In this paper, different kinds of noise present in the ECG signal are illustrated, and several techniques for their removal are discussed. Heart disease is one of the major problems that needs to be addressed using the latest methods of signal processing. Different measuring parameters are used to identify heart disease. Electrocardiogram (ECG) plays an important role in diagnosis of heart disease. Practically it is not possible to acquire an ECG signal without noise. For analysis and interpretation of ECG signals, it is very important to diagnose this signal.

2.12 ECG denoising and feature extraction techniques – a review

This paper presents the review of contemporary signal processing techniques such as discrete wavelet transform (DWT), Empirical mode decomposition (EMD), Variational mode decomposition (VMD) and Empirical wavelet transform (EWT) for ECG signal denoising and feature extraction. Various artefacts and measurement noise usually hinder providing accurate feature extraction such as power line interference, baseline wander, electromyographic noise (EMG) and electrode motion artefact. Therefore, for better analysis and interpretation ECG signals must be noise-free. Most recent and efficient techniques for ECG denoising and feature extraction techniques have been reviewed in this paper, as feature extraction and denoising of ECG are remarkably helpful in cardiology.

2.13 Performance Study of Different Denoising Methods for ECG Signals

In this paper, five common and important denoising methods are presented and applied on real ECG signals contaminated with different levels of noise. These algorithms are: discrete wavelet transform (*universal* and *local* thresholding), adaptive filters (LMS and RLS), and Savitzky-Golay filtering. Their denoising performances are implemented, compared and analyzed in a Matlab environment.

2.14 A Study of the Processes Involved in ECG Signal Analysis

This paper deals with some of the recent developments in the processes such as denoising, data compression, feature extraction and classification of the ECG signals. ECG Signal Analysis involves various processes and techniques which in recent years , have yielded better results in terms of accuracy in the diagnosis of heart diseases.

2.15 Computational techniques for ECG analysis and interpretation in light of their contribution to medical advances

This review describes the computational methods in use for ECG analysis, with a focus on machine learning and 3D computer simulations, as well as their accuracy, clinical implications and contributions to medical advances. The first section focuses on heartbeat classification and the techniques developed to extract and classify abnormal from regular beats. The second section focuses on patient diagnosis from whole recordings, applied to different diseases. The third section presents real-time diagnosis and applications to wearable devices. The fourth section highlights the recent field of personalized ECG computer simulations and their interpretation. Finally, the discussion section outlines the challenges of ECG analysis and provides a critical assessment of the methods presented. The computational methods reported in this review are a strong asset for medical discoveries and their translation to the clinical world may lead to promising advances.

2.16 Signal Processing Techniques for Removing Noise from ECG Signals

The chapter introduces the types of common noise sources in ECG signals and simple signal processing techniques for removing them, and also presents a section of Matlab code for the techniques described. The electrocardiogram (ECG) signals contain many types of noises- baseline wander, powerline interference, electromyographic (EMG) noise, electrode motion artifact noise. Baseline wander is a low-frequency noise of around 0.5 to 0.6 Hz. To remove it, a high-pass filter of cut-off frequency 0.5 to 0.6 Hz can be used. Powerline interference (50 or 60 Hz noise from mains supply) can be removed by using a notch filter of 50 or 60 Hz cut-off frequency. EMG noise is a high frequency noise of above 100 Hz and hence may be removed by a low-pass filter of an appropriate cut-off frequency. Electrode motion artifacts
can be suppressed by minimizing the movements made by the subject.

2.17 RASPBERRY PI BASED ECG DATA ACQUISITION SYSTEM

Aim of this paper is to develop low cost real time ECG data acquisition system. ECG signal analysis involves detection of P wave, ST segment, PR segment, T wave, QRS complex. So ECG sensors are placed on the body surface and sensor output is connected to AD8232 ECG acquisition module. Further ECG module is connected to ADC. Further it is connected to raspberry pi. A code is generated using Python-II language and ECG signal is displayed on screen.

2.18 Real time ECG on internet using Raspberry Pi

This paper aims at charting the ECG signal using the Raspberry Pi Arm processor. The ECG signals are recorded from the patient via the AD8232 ECG module and then this data is digitized using serial ADC MCP3008. The processor maps the signal on an online graphics tool plotl.ly using python programming.

2.19 Design of Real Time Cardiac Arrhythmia Detection Device

In this study, Raspberry Pi 3B+ based Electrocardiogram (ECG) device has been designed for real-time detection of cardiac arrhythmia. ECG signals that were taken by using AD8232 heart rate sensors have been displayed with developed software using Python in real-time. By using the R-peak detection algorithm, we determined beats per minute (bpm) and arrhythmia type that is related with bpm. These results have been screened into the user interface that has been created with Python. The arrhythmia detection success rate of this study is determined as 97.9%.

2.20 A Low-cost, Low-energy Wearable ECG System with Cloud-Based Arrhythmia Detection

Electrocardiogram should continuously be monitored for Cardiovascular Disease Patients. Unavailability and inadequacy of ECG Systems in hospitals and health care centers in low-resource countries worsens the patients' health condition. Lack of skilled staff at the hospital, limited number of ECG devices along with their high prices results in burdened CVD. In order to overcome these challenges we are here with a wireless ECG monitoring system that is low-cost and low-power device and is inbuilt with an auto arrhythmia detection. Facilitated monitoring along with the patient's comfort is kept intact by the flexible fabric-based design and the device's wearable nature. Two 450 mi-Ah Li-ion batteries are used for powering the device and an AD8232 chip being used for ECG Analog Front-End. Bluetooth can be used to transmit an acquired ECG Signal to a smart-device and can then be sent to a cloud server for further analysis. An accuracy of 94.03% in classifying abnormal cardiac rhythm on the MIT-BIH Arrhythmia Database is provided by the development of 1-D Convolutional Neural Network (CNN) based model.

REFERENCES

[1] Om Prakash Singh, Dawit Mekonnen, and M. B. Malarvili, Labview Based ECG Patient Monitoring System for Cardiovascular Patient Using SMTP Technology

[2] Inderbir Kaur, Rajni Rajni, Anupma Marwaha, ECG Signal Analysis and Arrhythmia Detection using Wavelet Transform

[3] Anand Kumar, Joshi Arun Tomar, Mangesh Tomar, A Review Paper on Analysis of electrocardiograph (ECG) Signal for the detection of Arrhythmia Abnormalities

[4] Pallavi Patil ,Kalyani Bhol, Real time ECG on internet using Raspberry Pi

[5] Mingxin Liu, Ningning Shao, Chaoxuan Zheng, and Ji Wang, Real Time Arrhythmia Monitoring and Classification Based on Edge Computing and DNN

[6] Jianjian Wang, Zheying Li, Research on a Practical Electrocardiogram Segmentation Model

[7] T. G. Keshavamurthy, M. N. Eshwarappa, Review paper on denoising of ECG signal

[8] MUHAMMAD WASIMUDDIN , KHALED ELLEITHY (Senior Member, IEEE),ABDEL-SHAKOUR ABUZNEID (Senior Member, IEEE), MIAD FAEZIPOUR (Senior Member, IEEE) AND OMAR ABUZAGHLEH (Member, IEEE)., Stages-Based ECG Signal Analysis From Traditional Signal Processing to Machine Learning Approaches: A Survey

[9] Shubhojeet Chatterjee, Rini Smita Thakur, Ram Narayan Yadav, Review of noise removal techniques in ECG signals

[10] Ragini Sharma, Rashmi Kashyap , A Review Paper on Denoising of ECG Signal for The application of Medical System

[11] Shanti Chandra , Ambalika Sharma , Girish Kumar Singh, Denoising ECG Signal: A Review

[12] Haroon Yousuf Mir, Omkar Singh, ECG denoising and feature extraction techniques – a review

[13] Mohammed Alhamdy ,H. BryanRiley, Ph.D, Performance Study of Different Denoising Methods for ECG Signals

[14] *A.Muthuchudar, Lt.Dr.S.Santhosh Baboo,* A Study of the Processes Involved in ECG Signal Analysis

[15] Aurore Lyon, Ana Mincholé, Juan Pablo Martínez, Pablo Laguna, Blanca Rodriguez , Computational techniques for ECG analysis and interpretation in light of their contribution to medical advances

[16] *Rahul Kher,* Signal Processing Techniques for Removing Noise from ECG Signals

[17] Ms.Gauravi.A.Yadav, Prof. Shailaja.S.Patil, RASPBERRY PI BASED ECG DATA ACQUISITION SYSTEM

[18] P. Patil, Kalyani Bhole, Real time ECG on internet using Raspberry Pi

[19] Yasemin Yol, Mehmet Akif Özdemir, A. Akan, Design of Real Time Cardiac Arrhythmia Detection Device

[20] N. Huda, Sadia Khan, R. Abid, S. B. Shuvo, M. M. Labib, T. Hasan, A Low-cost, Low-energy Wearable ECG System with Cloud-Based Arrhythmia Detection