IJMRSET

e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 7, Issue 13, April 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.521

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| | Monthly Peer Reviewed & Refereed Journal |

|| Volume 7, Issue 13, April 2024 ||

International Conference on Intelligent Computing & Information Technology (ICIT-24)

Organized by

Erode Sengunthar Engineering College, Erode, Tamilnadu, India

Real-Time ECG Monitoring and QRS Complex Detection in Wearable Wrist Band

Thendral. M[1], Archana S[2], Deepa R[3], Lakshmi Praba D[4]

Assistant Professor, Dept. of B.M.E., Kongunadu College of Engineering and Technology, Trichy, Tamil Nadu, India[1]

Student, Dept. of B.M.E., Kongunadu College of Engineering and Technology, Tamil Nadu, India[2,3,4]

ABSTRACT: The heart is the most vital organ in the body because it keeps the blood flowing to all parts of the body. The electrocardiogram (ECG) system is used to track the electrical activity of the heart and provides valuable clinical information concerning heart-related problems. A rhythmic disease called cardiac arrhythmia is brought on by improper electrical impulse function in the heart. Majority of arrhythmias can be detected in QRS complex waveform itself. The proposed method is to design a real-time ECG monitoring system in the form of a wrist band device. The ECG signal is detected using the AD8232 ECG sensor and displayed. The detected signal is transmitted through arduino Uno. Here the R-wave peak can be counted and displayed in the LCD display. The Pan-Tompkins algorithm is used to process the detected signal using MATLAB software to extract the QRS complex. The procedure includes pre-processing of ECG signals and identification of QRS complexes using the Pan- Tompkins algorithm. Preprocessing includes noise removal and signal smoothing. At the decision-making stage, the thresholds will be used to filter out the noise peaks. The QRS complex is detected and analyzed using MATLAB for the detection of arrhythmias. The real time health condition is displayed in the wristband device.

KEYWORDS: Electrocardiogram, QRS complex detection, Pan-Tompkins algorithm, R-wave peak count, Wearable system

I. INTRODUCTION

The heart is the most vital organ in the body because it keeps the blood flowing to all areas of the body. The electrocardiogram signal, which captures the electrical activity of the heart, provides crucial clinical information about heart-related malfunctions. Arrhythmia is a heart rhythm abnormality that prevents the heart from pumping blood effectively. The electrical activity during a cardiac cycle is represented by the electrocardiogram, or ECG. To detect any deviations from normal cardiac activity and heart-related issues, it is a crucial diagnostic tool. The primary spike visible on a typical ECG is the QRS complex. It is the most noticeable and easily observable portion of the ECG.

The depolarization of ventricles is represented by the QRS complex. It displays the onset of ventricular contraction and systole. When it comes to clinical diagnosis, the QRS complex is very important. Globally, cardiovascular diseases, encompassing heart-related conditions, are the primary cause of mortality. The bulk of cardiovascular disease is non communicable, influenced by lifestyle choices and other variables, and increases in frequency as people age. A significant cause of death, heart disease accounted for 30% of all deaths worldwide on average in 2008. While the patient is away from the physician, this device can continuously record the electrical activity of the heart for up to 24 hours. The portable ECG system was designed to take in a signal from the recording device, process it in its initial stages, and identify cardiac arrhythmias that could be fatal, inform the patient of the findings, and send information to the application server.

The most important component of the ECG analysis algorithm is the high QRS detection rate method because, in a remote electrocardiogram monitoring application, QRS detection is the first step toward identifying the heartbeat for the subsequent rhythm classification. The primary goal of this work is to use the Pan-Tompkins algorithm to identify potential arrhythmia biomarkers. A person's real-time ECG signal can be obtained. These signals undergo pre-processing, and the aforementioned algorithm is used to identify the QRS complexes of the ECG signal. It has two stages: in the first, the ECG signal can be amplified and artifacts removed; in the second, the signal is first denoised, and the Pan Tompkins algorithm is then used to detect the QRS complex

II. OBJECTIVE

The objective of this paper is to develop and apply the pan-Tompkins algorithm with specialized amplification systems used in biomedical signal processing for the design and implementation of the electrocardiogram and QRS complex detection. Because the ECG technologies are expensive, nobody can use them in an emergency at home. In order to offer the portable ECG monitoring system at a lower cost. In order to lighten the weight of the ECG apparatus and minimize the number of electrodes utilized.

III. LITERATURE REVIEW

An Signal Quality Assessment and Lightweight QRS Detection for Wearable ECG Smart Vest System contains the IoT-based wearable 12- lead ECG Smart Vest system for early detection of cardiovascular diseases. A combination method of multiple signal quality indices and machine learning is proposed for classifying 10-s single-channel ECG segments as acceptable and unacceptable. Then a lightweight QRS detector is developed for accurate location of QRS complexes. This is become Low cost and Light weight.

The Wearable ECG for Real Time Complex P-QRS-T Detection and Classification of Various Arrhythmias system used to detect the R peaks of the ECG signal based on the Pan Tompkins Algorithm. To validate the effectiveness of the proposed algorithm, the MIT/BIH arrhythmia database is used as a source for the ECG signals and the reference for R peak annotations. It also detects the P and T waves from the signal. This system has to be improving its accuracy.

In the Wearable ECG Measurement System for Detection of Cardiac Arrhythmia system the single- lead wearable ECG monitoring system for acquiring the ECG signals along with the proposed simplified processor for arrhythmia detection. To ensure correct functional verification, the proposed system is implemented in hardware and tested using the MIT-BIH ECG arrhythmia database and the Creighton University Ventricular Tachyarrhythmia Database It is a compact, user-friendly and cost-effective device.

A Real-Time QRS detection System With PR/RT Interval and ST Segment Measurements for Wearable ECG Sensors Using Parallel Delta Modulators system they used parallel delta modulator architecture with local maximum point and local minimum point algorithms to detect QRS and PT waves. It can be used as the Long-term wearable ECG recording devices. The parallel delta modulators consume 720 nW at 1 kHz sampling rate with ±0.6 V power supply.

In Wearable ECG Electrodes for Detection of Heart Rate and Arrhythmia Classification system Real-time wearable ECG monitoring system with related cardiac arrhythmia classification of stepwise algorithms is implemented. Less in weight and has reduced power consumption. Designing is difficult. Continuous monitoring of Electro Cardio Gram (ECG) for long term in our living environment provides the necessary information for preventing the heart attack and other cardiac diseases.

IV. METHODOLOGY

In this ECG monitoring system developed using Arduino Uno presents a comprehensive solution for real-time cardiac health evaluation. By integrating electrodes for signal acquisition and Arduino Uno's processing capabilities, the system ensures accurate capture and analysis of ECG signals. The detection of R-waves, essential for heart rate determination, is facilitated through sophisticated algorithms implemented within the Arduino environment. This approach not only enables precise measurement but also enhances the system's adaptability to different physiological conditions. The graphical representation of the ECG waveform using the Arduino Serial Plotter provides a visual interpretation of cardiac activity, aiding clinicians and users alike in understanding the data. Additionally, the integration of an LCD display allows for convenient real-time monitoring of heart rate, promoting timely intervention in case of abnormalities. The system's versatility enables it to be utilized in various settings, ranging from clinical environments to personal health monitoring applications. Furthermore, the modular design of the system facilitates easy expansion and customization, allowing for the integration of additional features or enhancements as needed. Further the signal can be exported to the MATLAB software for the QRS complex detection. By using the Pan-Tompkins algorithm, the signal can be processed. Overall, the ECG monitoring system built with Arduino Uno offers a cost-effective, accessible, and reliable solution for continuous cardiac health assessment, with the potential to improve patient outcomes and enhance overall well-being.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| | Monthly Peer Reviewed & Refereed Journal |

|| Volume 7, Issue 13, April 2024 ||

International Conference on Intelligent Computing & Information Technology (ICIT-24)

Organized by

Erode Sengunthar Engineering College, Erode, Tamilnadu, India

V. Methodology

In this ECG monitoring system developed using Arduino Uno presents a comprehensive solution for real-time cardiac health evaluation. By integrating electrodes for signal acquisition and Arduino Uno's processing capabilities, the system ensures accurate capture and analysis of ECG signals. The detection of R-waves, essential for heart rate determination, is facilitated through sophisticated algorithms implemented within the Arduino environment. This approach not only enables precise measurement but also enhances the system's adaptability to different physiological conditions. The graphical representation of the ECG waveform using the Arduino Serial Plotter provides a visual interpretation of cardiac activity, aiding clinicians and users alike in understanding the data. Additionally, the integration of an LCD display allows for convenient real-time monitoring of heart rate, promoting timely intervention in case of abnormalities. The system's versatility enables it to be utilized in various settings, ranging from clinical environments to personal health monitoring applications. Furthermore, the modular design of the system facilitates easy expansion and customization, allowing for the integration of additional features or enhancements as needed. Further the signal can be exported to the MATLAB software for the QRS complex detection. By using the Pan-Tompkins algorithm, the signal can be processed. Overall, the ECG monitoring system built with Arduino Uno offers a cost-effective, accessible, and reliable solution for continuous cardiac health assessment, with the potential to improve patient outcomes and enhance overall well-being.

A. SYSTEM DESIGN

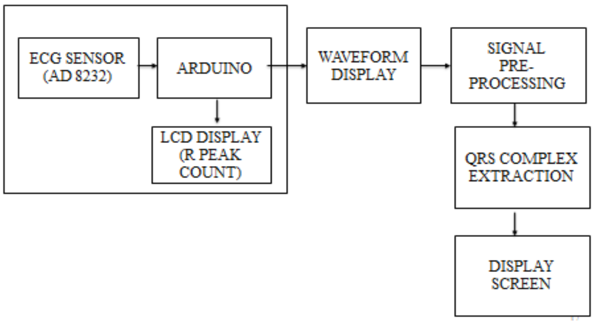


Figure 1: Block Diagram

B. IMPLEMENTATION

This project has divided into three parts such as designing, programming, and hardware implementation. The designing of ECG will focus on amplifiers for the small ECG signals. The ECG signal is detected using the AD8232 ECG sensor. The Pan-Tompkins approach can be used to process the detected signal using a MATLAB processor in order to extract the QRS complex. The procedure consists of two steps: the first stage pre-processes the ECG signals, and the second stage identifies the QRS complex using the Pan Tompkins algorithm

VI. Hardware And Software Implementation

A. INPUT SIGNAL

The input ECG signal can be taken from the person by using the AD8232 ECG sensor. The AD8232 ECG sensor can be removed the noise and filtered the unwanted signal. Then the signal can be send to the Arduino Uno for the displaying process.

B. R – WAVE PEAK DETECTION

The R-wave peak counting code for the Arduino Uno can be dumped in a specific range to display the R-Wave peak count. The ECG signal's r-wave peak typically falls between 65 and 85. This threshold range was also included in the R-wave peak count coding. The normal value is displayed on the LCD display when the R-wave peak count is within the threshold range; the abnormal value is displayed when the value is outside or below the threshold range.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| | Monthly Peer Reviewed & Refereed Journal |
|| Volume 7, Issue 13, April 2024 ||
International Conference on Intelligent Computing & Information Technology (ICIT-24)
Organized by
Erode Sengunthar Engineering College, Erode, Tamilnadu, India

C. ARDUINO IDE TO MATLAB

After the ECG wave can be exported to the MATLAB for the further process. The ECG wave from the Arduino IDE can be saved in excel format. Then this can be loaded as the input to the MATLAB software.

D. SIGNAL PROCESSING

For the QRS complex detection , here we use the Pan - Tompkins algorithm. This algorithm can be used to detect the QRS complex and also separate the QRS complex from the ECG signal. It contains the 2 stages of processing.

a) Pre-processing
b) Decision processing

a. Pre-processing

The raw ECG signal is ready for use as the detection process' input during pre-processing. Pre-processing includes expanding the width and QRS slope, smoothing the signal, and removing noise. A band-pass filter (Low Pass and High Pass Filters), derivatives, a squaring function, moving window integration, threshold, and decision are the components of the algorithm.

b. Decision processing

In this stage, the criteria are used to determine whether or not the MWI result is a QRS complex. Finding the local peaks of the integrated signal is necessary to identify a QRS complex. The point at which a signal changes direction is called a peak. In the decision-making stage, the thresholds are employed to only take into account the signal peaks and exclude the noise peaks.

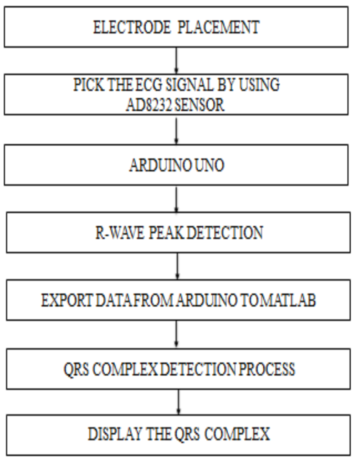


Figure 2: Flow Chart for the ECG monitoring system

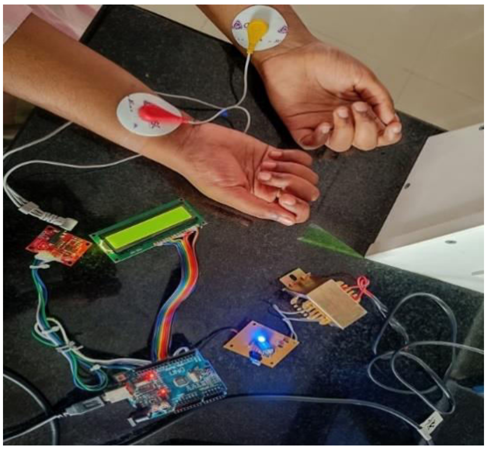


Figure 3: Hardware Connections

By using simple electronics components including the AD8232 ECG sensor, Arduino Uno, electrodes, Power supply unit and LCD display are used in the designing of the portable ECG monitoring system, which also includes R-wave peak counting and QRS complex detection. The QRS complex is detected and analyses using MATLAB for the detection of arrhythmias. The real-time health condition is displayed in the wristband device.

a.AD8232 sensor

The heart rate monitoring sensor like AD8232 includes the pins like SDN pin, LO+ pin, LO- pin, OUTPUT pin, 3.3V pin, and GND pin. So that we can connect this IC to development boards like Arduino by soldering pins. Additionally, this board includes pins like the right arm (RA), left arm (LA) & right leg (RL) pins to connect custom sensors.

b.Arduino Uno

The open-source electronics platform Arduino is built on user-friendly hardware and software. It is made comprised of a development environment, a microcontroller board, and community support. To write, compile, and upload code to the microcontroller board, Arduino offers a streamlined Integrated Development Environment (IDE). The Gnd and power supply pins of the Arduino are linked to the Gnd and power supply pin of the sensor. The Arduino digital pins are linked to the sensor lead pins.

c.Electrodes

To assess the condition of the heart, an ECG electrode is used to record the heartbeat pattern. On the skin, these electrodes are applied. They pick up the heart's electrical activity and show the waves on the monitor. It makes use of the disposable electrodes.

d.Power supply unit

A power source is referred to as a "power supply." A power supply unit is a system or equipment that provides electrical or other forms of energy to an output load or collection of loads. These components are present in this power supply unit: Regulator, rectifier, and transformer. The Arduino and ECG sensor require a 5V power supply only. An LCD display requires a 7V power supply.

e.LCD display

Similar applications that use LEDs also use liquid crystal cell displays (LCDs). These include segmental displays and dot matrix displays for the display of numeric and alphanumeric characters. Here, the LCD display can show the R-wave peak count value.

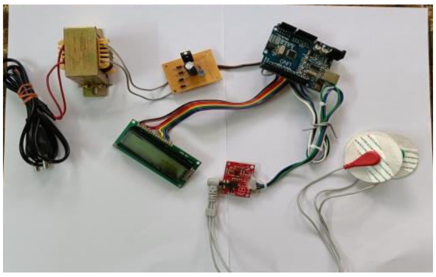


Figure 4: Hardware Connections

The signal's amplitude, width, and slope serve as a base for this method. Preprocessing and decision are the two distinct processes into which it is split. Preprocessing involves filtering out noise, enhancing the QRS width and slope, and preparing the signal for subsequent detection. Thresholds are applied to the signal later on in the judgment stage to exclude noise peaks and only take signal peaks into consideration. Preprocessing is the initial phase, in which the signal is run through a block of filters to lessen noise and T wave effect. Subsequently, the derivative is utilized to yield intricate slope data. Next, a point-by-point square of the signal is applied to increase the slope and decrease false positives.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| | Monthly Peer Reviewed & Refereed Journal |
|| Volume 7, Issue 13, April 2024 ||
International Conference on Intelligent Computing & Information Technology (ICIT-24)
Organized by
Erode Sengunthar Engineering College, Erode, Tamilnadu, India

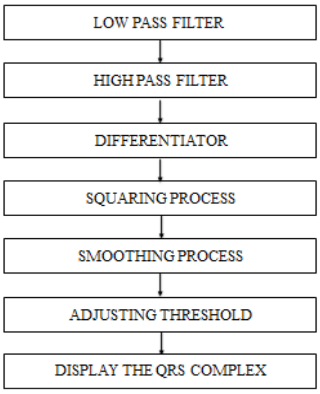


Figure 5: Flow Chart for the software process

Finally, a moving window integrator is used, along with the signal's width and slope information. Both the derivative signal and the moving window integration signal are subject to two sets of thresholds during the decision step. It is possible to increase the detection reliability by utilizing thresholds in both signals. Thresholds are floating above the noise, automatically responding to the conditions of changing signals. Since we define the fiducial mark in R peaks, we must first identify all local maxima peaks. Afterward, we apply thresholds, and we only take into account peaks that surpass the thresholds.

We utilize a moving window to find local maxima; a local maximum is when the window's maximum value is at its center position. We divide the signal into segments that contain at least one heartbeat and search for the highest and minimum peaks in each segment in order to properly identify the two initial R peaks.

The median of these maximum peaks is then determined, and a threshold is set at 35% of this median. We identify all peaks that do not surpass this threshold until the second R peak as noise, and we treat the initial peaks that do so as the two first R peaks. Next, we use the equations as the author has indicated.

XIII. RESULT

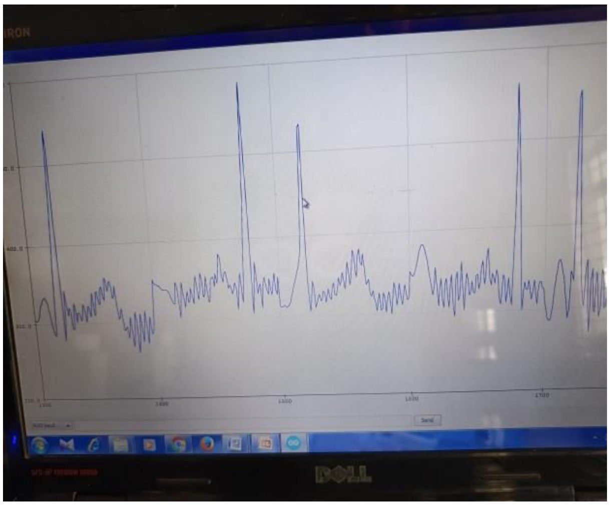
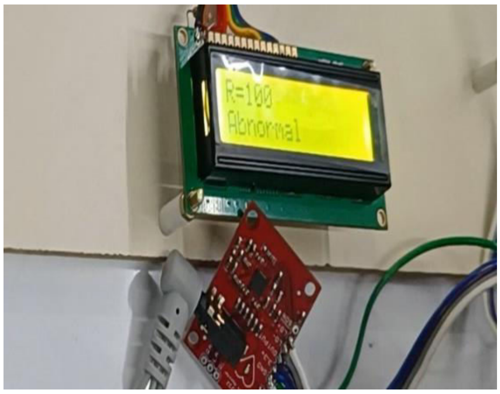


Figure 6: ECG Waveform Figure



7: R-Wave count display unit

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| | Monthly Peer Reviewed & Refereed Journal |

|| Volume 7, Issue 13, April 2024 ||

International Conference on Intelligent Computing & Information Technology (ICIT-24)

Organized by

Erode Sengunthar Engineering College, Erode, Tamilnadu, India

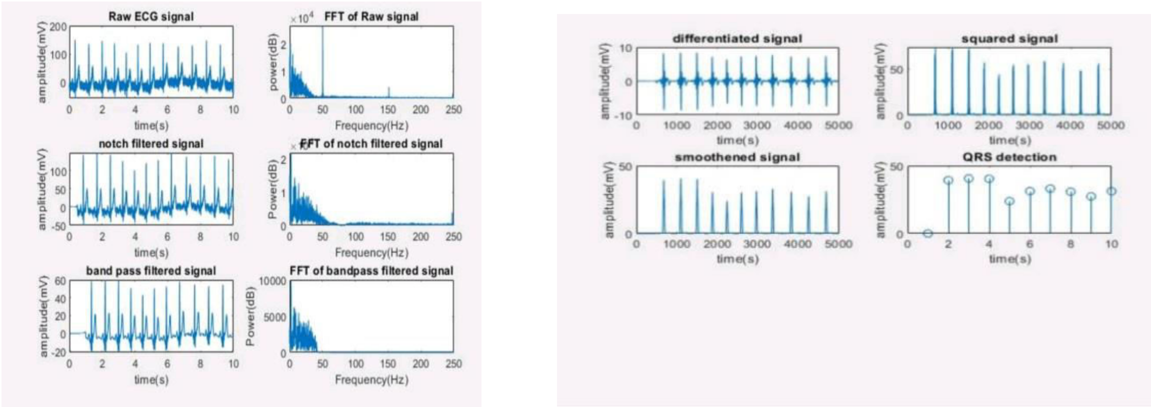


Figure 8: QRS Detection

XIV. CONCLUSION

In conclusion, the ECG monitoring system developed using Arduino Uno presents a promising solution for real-time cardiac health assessment. By seamlessly integrating hardware components such as electrodes and Arduino Uno microcontroller with software algorithms for signal processing, the system enables accurate capture, analysis, and visualization of ECG signals. The incorporation of features like R-wave detection and heart rate calculation enhances the system's diagnostic capabilities, while the graphical representation of the ECG waveform on the Arduino Serial Plotter provides intuitive insights into cardiac activity. Further, the QRS complex detection of in MATLAB software also successfully processed. By using the different filters and processing unit, the QRS complex detection is completed. With its cost-effectiveness, accessibility, and potential for customization, this ECG monitoring system holds great promise in improving patient outcomes, facilitating proactive cardiac care, and promoting overall well-being.

REFERENCES

1.Adil A, Abid H, Najib N, Jillani U, Saadeh W and Altaf, "Wearable ECG Measurement System for Detection of Cardiac Arrhythmia," 2019 UK/ China Emerging Technologies (UCET), Glasgow, UK, 2019, pp. 1-4, doi: 10.1109/UCET.2019.8881894.

2.Hui Liu, "Taxonomy and Real-Time Classification ofArtifacts During Biosignal Acquisition:A Starter Study and Dataset of ECG", March 2024IEEE Sensors Journal 24(6):9162-9171, DOI:10.1109/JSEN.2024.3356651

3.Jerold M ,Peeran A. and A. P., "Wearable ECG Electrodes for Detection of Heart Rate and Arrhythmia Classification," 2019 IEEE International Conference on Electrical, Computer and Communication Technologies (ICECCT), Coimbatore, India, 2019, pp. 1-6, doi: 10.1109/ICECCT.2019.8869143.

4.Jindal B, Saudagar, Ekta and Devi R, "Matlab Based GUI for ECG Arrhythmia Detection Using Pan-Tompkin Algorithm," 2018 Fifth International Conference on Parallel, Distributed and Grid Computing (PDGC), Solan, India, 2018, pp. 754-759, doi: 10.1109/PDGC.2018.8745865.

5.Liu C et al., "Signal Quality Assessment and Lightweight QRS Detection for Wearable ECG SmartVest System," in IEEE Internet of Things Journal, vol. 6, no. 2, pp. 1363-1374, April 2019, doi: 10.1109/JIOT.2018.2844090

6.Mishra B, Arora N and Vora Y, "Wearable ECG for Real Time Complex P-QRS-T Detection and Classification of Various Arrhythmias," 2019 11th International Conference on Communication Systems & Networks (COMSNETS), Bengaluru, India, 2019, pp. 870-875, doi: 10.1109/COMSNETS.2019.8711218.

7.Monika M and Sharma R K, "ECG Analysis and Automatic Detection of R-peak in MATLAB," 2018 International Conference on Recent Innovations in Electrical, Electronics & Communication Engineering (ICRIEECE), Bhubaneswar, India, 2018, pp. 2651-2654, doi: 10.1109/ICRIEECE44171.2018.9008447.

8.Palaniappan Y, Vishanth V A, Santhosh N, Karthika R and Ganesan M, "R - Peak Detection using Altered Pan-Tompkins Algorithm," 2020 International Conference on Communication and Signal Processing (ICCSP), Chennai, India, 2020, pp. 1501-1505, doi: 10.1109/ICCSP48568.2020.9182298.

9.Tang X, Hu Q, Tang W. A Real-Time QRS Detection System With PR/RT Interval and ST Segment Measurements for Wearable ECG Sensors Using Parallel Delta Modulators. IEEE Trans Biomed Circuits Syst. 2018 Aug;12(4):751-761. doi: 10.1109/TBCAS.2018.2823275.

10.Wu X, Z. Wang, Xu B and Ma X, "Optimized Pan-Tompkins Based Heartbeat Detection Algorithms," 2020 Chinese Control And Decision Conference (CCDC), Hefei, China, 2020, pp. 892-897, doi: 10.1109/CCDC49329.2020.9164736.

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com