South Asian Journal of Social Review
Vol. 2, No. 2, pp. 1-19
DOI: 10.57044/SAJSR.2302.2.2.2302

LabVIEW based ECG simulator and automatic detection system for cardiac disorders

Faryal Hamza [1*]

[1] *Faculty of Business Administration, Iqra University, Karachi, Pakistan*

**Corresponding email: faryalhamza19@gmail.com*

Article History

Received: 29 July 2023
Revised: 25 September 2023
Accepted: 30 September 2023

JEL Classification
I00
I10
I19

ABSTRACT

In the present age, most cardiac arrhythmias are emerging due to irregular rhythmic conditions of the heart. Diagnosis of cardiac arrhythmias plays an essential role in the survival of the human race. If rhythms of nature are distorted for any reason, it leads to several variations or abnormalities known as heart arrhythmias. Irregular heartbeats lead to anomalous P, QRS, and T values, which the patient's ECG can follow. The growing well-being concerns, especially for cardiac arrhythmias, reflect the requirement of creating a cheap and convenient ECG detection system. The most common heart conditions are tachycardia, bradycardia, atrial fibrillation, myocardial infarction and many other cardiac disorders. These diseases are one of the most significant causes of death worldwide. There is much research for recognizable proof of cardiovascular diseases utilizing ECG diagnostic toolbox and different software. So, in this project, the idea is to design an Automatic Disease Detection System on LabVIEW to detect various cardiac abnormalities such as Atrial Flutter (AF), Supraventricular Tachycardia (SVT), Left Bundle Branch Block (LBBB), Ventricular Fibrillation (VF), Myocardial Infarction (MI), Hyperkalaemia and Digoxin by comparing it to the normal ECG signal. So for this, NI LABVIEW (2018) software has been used for designing. This Automated Disease Detection System, hopefully, gives the best accurate and fast results which are low cost, effective, efficient, easy handled and high accuracy rate detection system which can be used in hospitals for medical professionals.

Keywords: *ECG, Irregularities, Cardiac arrhythmia, Automatic detection, LabVIEW software*

Citation of this article:

Hamza, F. (2023). LabVIEW based ECG simulator and automatic detection system for cardiac disorders. *South Asian Journal of Social Review*, *2*(2), 1-19. https://doi.org/10.57044/SAJSR.2302.2.2.2302

LabVIEW based ECG simulator and automatic detection system for cardiac disorders

1. Introduction

1.1 Overview

The heart is one of the most important muscular organ, which supplies the oxygenated blood to all parts of the body. In current years ECG (Electrocardiography) is the best and most widely used diagnostic tool in cardiology which records the electrical activity of the heart is known as electrocardiogram. Especially, it is used for the diagnosis of various cardiac arrhythmias and serious myocardial disorders which produces the abnormalities and irregularities in the ECG waveform. Biomedical signal monitoring is a very important tool used to understand physiological functions and mechanisms of the body and to diagnose the problems, particularly, ECG signal which is very important and much valuable clinical regarding information (Srivastava, 2017).

In 1893, William Einthoven presents the term of electrocardiogram at the meeting of the Dutch medical society. In 1924, he got the Nobel Prize for his work purpose in building up the ECG (Sandhiya, n.d.). The ECG is the noninvasive technique to record the electrical signal of the heart. ECG tests, measures the typical heart rate, irregularity, appearance of any defect to heart, which causes arrhythmias and impacts of medications used to control the heart (Nandagopal, 2016)

1.1.1 Working of heart

So, ECG signal is generated by electrical conduction system of the heart. These electrical signals are generated during alternating contractions of upper and lower chambers of the heart and these human signals are exceptionally powerless and are in the extend of mv (millivolts). A typical ECG of normal heart beat consists of different peaks. The normal ECG frequency range is 0.05 to 250Hz and its dynamic extend is of 1 to 5mv. There are two phases of the cardiac cycle, the one is systole (the pumping or contractile phase) and the other is diastole (the resting phase) (Kumar, 2014).

The normal ECG signal waveform is characterized by five peaks namely the P wave, QRS complex and T wave demonstrate the rhythmic repolarization and depolarization of the heart muscles display in the ECG (Kumar, 2006). The human heart comprised of four chambers, two upper chambers are called atria and the two lower chambers are called ventricles (Nagendra, 2011).The electrical system of the heart is also known as the conduction system. The P wave represents the activation of the upper chambers of the heart while the QRS complex, T wave represents the excitation of the lower chambers of the heart. From the recording graph (electrocardiogram) of the ECG, we can say whether the condition of the cardiac activity is normal or abnormal (Malge, 2015). Figure 1 illustrates the ECG waveform.

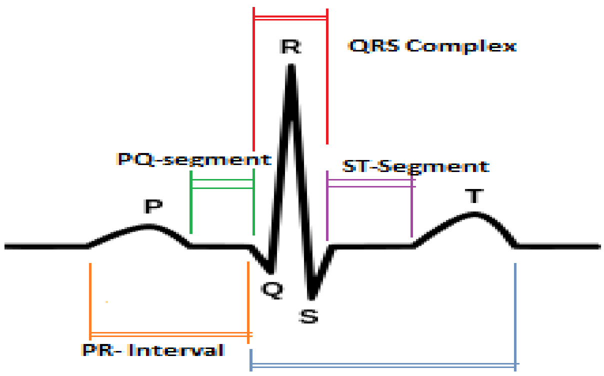

Figure 1: ECG Waveform.

1.1.2 Heart disorders

Whereas, the normal value of heart beat of an adult is ranges from 60 to 100 bpm (beats per minute). A slower heart rate than this normal value is known as the Bradycardia (below 60 bpm) , the higher heart rate is known as the Tachycardia(above 100 bpm), the condition where PR interval duration is greater than the normal(>0.2 sec) it is known as AV block, the absence of the P wave this condition is called Ventricular fibrillation, the condition in which interval of P and T waves are disappears this is known as Atrial fluttering, and the other condition is where QRS is less than 0.12 sec this is known as Atrial fibrillation (Bhyri, 2017).The viable depolarization of the ventricle mass cells requires that there be a specialized conduction pathway inside the ventricle. Ventricular conduction system is separated into right and cleared out Bundle branches after Bundle of His. Blocks can happen in this bundle branches and can results in Cleared out Left Bundle Branch Block (LBBB) (Geetha, n.d.). In this sort of tachycardia the patient will be having a heart rate more than 100 /min. Because of distortion in P segment, it will shows the absence of p waves or invisibility of p waves because of fast sequence of wave patterns in ECG waveform so that the person is suffering from Supraventricular Tachycardia (SVT) The foremost common causes of ST are in reaction to work out and in conditions in which catecholamine discharge is physiologically upgraded as in outrage, stress, flight, or dread (Al-Rawahi, 2007). Myocardial Infarction(MI), it is a silent disorder or condition that cause damage the heart muscles. If it is not treated early or timely it expands rapidly and continous damage to heart muscles. MI results in the ST and T wave abnormalities in the ECG waveform so that the person is suffering from MI (Kumar, 2017). Hyperkalaemia is caused by an abundance of potassium intake. Secondary Hyperkalaemia to diminished distal delivery of sodium and water happens with congestive heart failure, cirrhosis, intense kidney injury, and chronic kidney disease Patients with inveterate hyperkalaemia ought to be counseled to decrease dietary potassium (Viera, 2015). Other disease is digoxin, the digoxin is most widely used medication for the patients of heart disease, especially atrial fibrillation and no doubt digoxin is effective for the patients of left ventricular function and rate control in atrial fibrillation patients. But the scientific study about digoxin proved that digoxin may have negative effects on cardio pateints and leads to mortality (Vamos, 2015).These are the abnormal heart conditions which are commonly diagnosed by the ECG device in hospitals. Therefore, in this project, developed the ECG simulator and Automatic Disease Detection System which detects the abnormalities by automatic detection on LabVIEW softwar**1**e.

1.1.3 Early researches related to ECG analysis on LabVIEW

The heart sound signals by using wavelet transform technique in 1997. He designed the system for detecting cardiac arrhythmias by heart sound analysis through wavelet technique because wavelet change has been detailed to be reasonable to analyzed the no stationary signals and this system is designed on LabVIEW software. A virtual instrument for data acquisition and analysis of the phonocardiogram was developed in 1998. In phonocardiogram they analyzed the heart sound and murmur signal. This instrument can be utilized to show the PCG and to analyze the person heart sound and mumble for the location of heart valve disorders. It can also be utilized to analyze the carotid bruit for the determination of carotid supply route stenosis. Benitez et al. (2000) developed a Virtual instrumentation for clinical assessment of cardiovascular and autonomic function in the year 2000. In this system they studied the cardiac activities or circulation of the heart and physiological activity changes during an attack or failure of the heart. They designed this system on LabVIEW software due to large amount of data and calculation.

1.2 Aims and Objectives

The aim of this project is to detect faster and accurate cardiac disorders by automatic detection from ECG simulator on LabVIEW software. The objectives of this project are;

- Designed a normal ECG signal in software LabVIEW
- Waveform peak detection by peak detector /pulse detection

- Counter used for counting the no of peaks
- Display results
- Designed abnormal signal of ECG
- Pulse detector
- Identify the problems or disorders
- Automatic disease detection
- Indicate the results

So, going to simulate the virtual system which can be detected the range of cardiac diseases which can be automatically determined from ECG signal. This system, hopefully gives the best accurate and fast results which are low cost, effective, efficient, easy handled and high accuracy rate detection system which can be used in hospitals for medical professionals. Diagnosis of cardiac disorders at early stage plays an important role for the survival of humans. At present, In hospitals and laboratories there are different innovations for the detection of cardiac diseases utilizing equipment components which are time expending and not at reasonable rate and sometimes not showing the accurate results and because of this many people died from severe cardiac disorders. The developing wellbeing concerns, particularly the cardiac disorders need the developing of effective, inexpensive ECG system which gives quick and accurate results of the patients. So, wanted to design this simple virtual detection system for the accurate and fast results of the cardiac disorders and this method can save the human lives as much as possible because of accurate diagnosis. And because of developing this observing system can bring the possibility to record the heart conditions at an early stage, and this automatic detection system could detect the cardiac arrhythmias with high accuracy level

2. Literature Review

2.1 Review of Related Work

There are numerous procedures acquainted by the researchers to overcome the heart issues in day today-life. ECG is an important medical parameter used to diagnose the various diseases which are related to heart. Cardiovascular disorders are an ailment that includes the heart or veins. Most nations confront high and expanding rates of cardiovascular ailment. Every year, coronary disease murders very nearly 2.6 million individuals which constitute 54.1% of all CVD passing in India by 2020. Cardiovascular sicknesses are the world's biggest executioners, asserting 17.1 million lives every year (Kypridemos, 2016).Cardiac disease or arrhythmia is an abnormal rate of heartbeat. So, this section examines different strategies and techniques proposed earlier in literature for detecting the cardiac diseases on LabVIEW.

The Holter observing method which records ECG persistently in walking condition for a sizable time and framework transmit the recorded information to hospitals when the recorded period is finished. The waveform extraction is improved the situation characterization of the coronary illness like Ordinary, Bradycardia Arrhythmia, Tachycardia Arrhythmia and Ischemia characteristics. Then compressive strategy is improved the situation transmitting the signal from the health care services to clinic server. Many reduction techniques are used by the different researchers for the removal of noise. A way to deal with Heart Arrhythmia Investigation by utilizing Concealed Markov Models (Vimala, 2013).

2.2 Researches for ECG analysis on LabVIEW

This section deals with brief research reviews of various detection and classification of cardiac arrhythmias, cardiac transient rhythms for ECG using wavelet transforms, Filters, Artificial Neural Network (ANN) techniques by using NI LabVIEW software, which are found in the literature and outlines the proposed approach of the present thesis work. The researchers has designed the system for the identification of ECG signal analysis by signal extraction on LabVIEW but they are not focusing on the detection of the cardio vascular diseases (Belgacem, 2012).The another researcher analyzed the heart sounds on LabVIEW software (Ruban, 2012). The temporal analysis of the ECG waveform by using LabVIEW software in this research they study the different parameters such as P wave, QRS complex, RR intervals, PR durations and amplitudes of P wave, and ST wave (Mhatre, 2014). Some researchers used the filters technique for detecting the cardiac irregularities these filters are (IIR, butterworth and notch filters for power line removal) then they design the wavelet de trend VI for baseline wandering removal on the LabVIEW Software (Kaur, 2017).

The researcher Mohy-Ud-Din et al. (2014) proposed the technique to automatically detect the atrial fluttering in the ECG signal by using LabVIEW software. A model of automatic detection of the junctional rhythm (1st and 2nd degree Av block) from a simulated ECG signal by using LabVIEW. But they did not work on a range of cardiac disorders (Mohy-Ud-Din, 2014; Waseem, 2018). Abed et al. designed and implement of the ECG feature extraction by using LabVIEW. They extract the features of an ECG wave and then detect the condition of the wave according to data whether it is normal or abnormal and they also used the MIT-BIH database (Abed, 2015). The researcher designed a mixed signal system for wireless transmission of body temperature, heart beat and ECG. This system includes Human's electrocardiogram (ECG), body temperature and heart rate data are obtained from body of the understanding and sent to a PC/laptop utilizing IEEE 802.15.1 Bluetooth. The body parameters values are appeared on NI LabVIEW in digits and in waveforms (Dhakne, 2016).

The heart sound analysis instrument on LabVIEW. There are five subsystems in this instrument: heart sound accepting subsystem, wavelet de-noise subsystem, time domain analysis subsystem, recurrence space examination subsystem and heart sound flag generation subsystem. The instrument is created in PC, by utilizing hand crafted remote heart sounds receiving gadget and heart sounds flag accepting subsystem to induce heart sound signals, and then utilizing wavelet de-noising subsystem to expel the foundation clamor, at long last, the instrument uses time-domain examination subsystem and recurrence space examination sub-system to analyze the heart sounds signals. The working environment of this instrument demonstrates it can collect striking heart sound flag, decrease clamor successfully, computer the characteristic values rapidly and precisely, create and play heart sound accurately (Cheng, 2012). The ECG signal by UWT and features extraction by using LabVIEW. They firstly denoising the signal by using wavelet transform and then extract the signal by features extraction for better ECG peak detection (Choudhary, 2016).

The techniques for heart disorders by features extraction by using artificial neural networking (ANN). In this system or technique, they diagnose four diseases namely, Atrial fibrillation, Bundle branch block, Atrial fluttering and myocardial infarction. After finding the precise heart arrhythmia, the framework calculates the criticality of that disorder. But they did not work on the range of diseases and are not using LabVIEW software. The researcher designed ECG signal acquisition and processing system.In this system the ECG signal anti-aliasing filtering circuits were planned and made to get the analog ECG signal. By Utilizing the information procurement card USB-6008 created by NI Company for A/D transformation, computerized shape of ECG signal may be gotten, and it can be transmitted to a individual computer for advance preparing by LabVIEW2009 (assessment adaptation). For the reason of wavelet sifting/ filtering, the ECG signal was reproduced with the signal components in sub groups which reflect the characteristics of ECG and perfect impact of ECG was gotten (Gao, 2012). After completing the literature review there are many techniques used for the analysis and detection of cardiac diseases. Therefore, there is a need to design a virtual system that would check all the possible cases or disorders frequently and then give the best coefficients for the better results.

3. Research Methodology

3.1 Basic Idea of the Research

The basic idea of this project is to design an Automatic Disease Detection system on LabVIEW software. In this system design an arbitrary ECG waveform without taking signals from a human being and then design abnormal ECG waveforms for each disorder and comparing both waveforms on LabVIEW software and the system is detected the abnormal ECG signal. These abnormal signals are detected by designing different algorithms for different types of arrhythmias. First designed an normal ECG signal by signal generator then use pulse detection for the detection of ECG peaks and segments and counts the number of peaks by counter, then designed an abnormal ECG signal for detecting arrhythmias software detects the disease or abnormality in the waveform such as Ventricular fibrillation (VF), Myocardial Infarction (MI), Supraventricular Tachycardia, Hyperkalaemia, Atrial flutter, Digoxin and Left Bundle Branch Block (LBBB).

3.2 Overview of LabVIEW Software

This ECG detection system provides fast identification of the cardiac disorders. Now for the automatic detection of these cardiac diseases, using LABVIEW software and installed the NI LabVIEW 2018 (32bit) software on PC/Laptop. LabVIEW is a graphical programming language made particularly for the estimation and computerization of different systems and application. It is moreover called as LabVIEW program. Since their usefulness is software-defined by the client, virtual instruments are amazingly adaptable, Effective, powerful as well as cost-effective. Each program created in LabVIEW is referred to as Virtual Instrument (VI). It has two windows: a block diagram, a front panel. The front panel contains the controls and indicators. Controls are the inputs which are inputs they permit a user to supply data to the VI. Indicators are the outputs which are used to display the results on the back panel based on inputs given to VI. In this way a virtual instrument can either be run as a program or as a graphical user interface (GUI) and the front panel defines the inputs and outputs for the nodes given on block diagram. Figure 1 illustrates the basic block diagram of an ECG system.

3.3 Basic Block Diagram

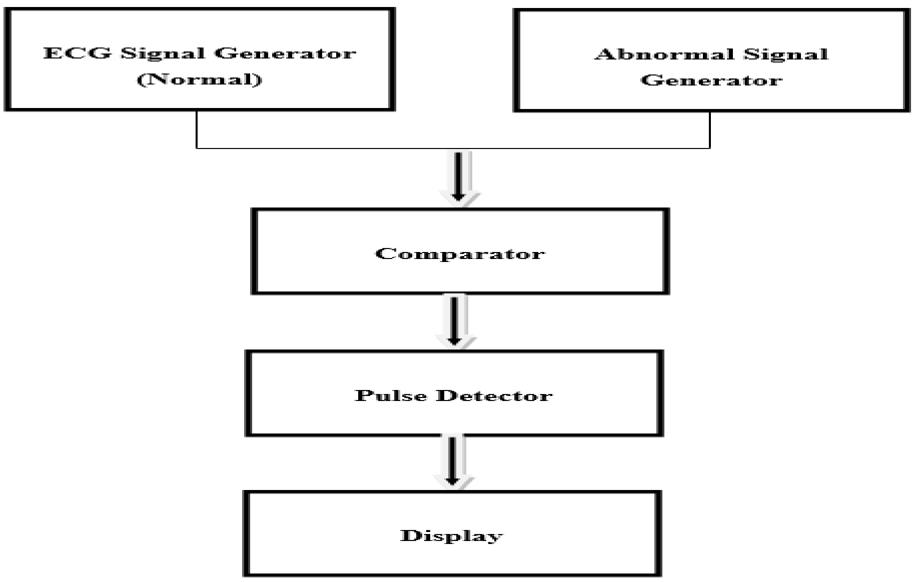

Figure 2: Basic block diagram of an ECG system

3.4 Algorithm Design for Atrial Flutter

First of all, a normal simulated ECG waveform was generated using the arbitrary signal generator in LabVIEW and an abnormal ECG wave was generated with two P-waves for the detection of atrial flutter. These signals were placed in a case structure to toggle between two waves. Then the signals were collected and fed to peak detectors. Three peak detectors were used with the threshold level set (0.07 for P wave, 1.6 for R and 0.3 for T wave) and width is 3 to detect the Atrial Flutter.

Subtracting the number of QRST waves from total peaks gives us the number of P-waves in a sample. These numbers of P-waves are then compared to the number of R peaks. When the counted P waves are greater than the R peaks, atrial flutter is present or detected. A Boolean indicator is placed at the end of the circuit for which a Boolean switch is also attached at the case structure which contains the two conditions true and false. The block diagram of atrial flutter as shown in figure 3.

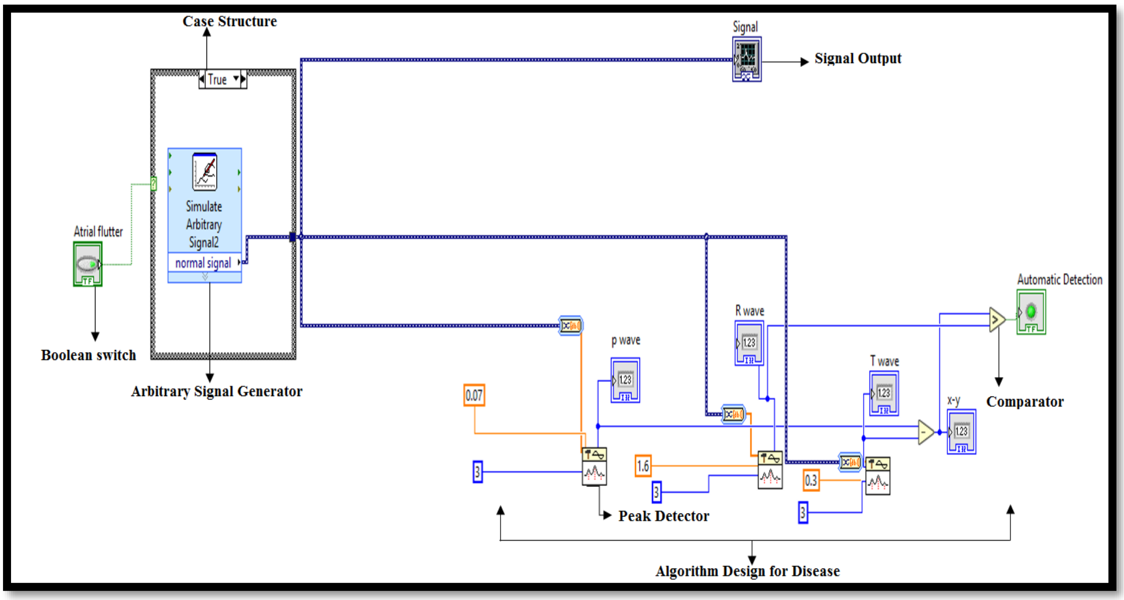

Figure 3: Block diagram for the detection of atrial flutter

3.5 Algorithm Design for Supraventricular Tachycardia (SVT)

For Supraventricular Tachycardia a normal simulated ECG waveform was generated using the arbitrary signal generator in LabVIEW and an abnormal ECG wave was generated with no P-wave. For detection of the supraventricular tachycardia three peak detectors are required for detection of the desired wave. First select the P wave detector then set the amplitudes of P wave (0.07) with a width of 3. The comparator is also used to compare the normal and abnormal peaks. The peak detector on P wave counts 3 waves (P, QRS and T) in normal condition and the condition is true and detect 2 P waves in abnormal condition when compares the abnormal signal with normal the condition is false and the absence of P wave is detected. As shown in figure 4 below:

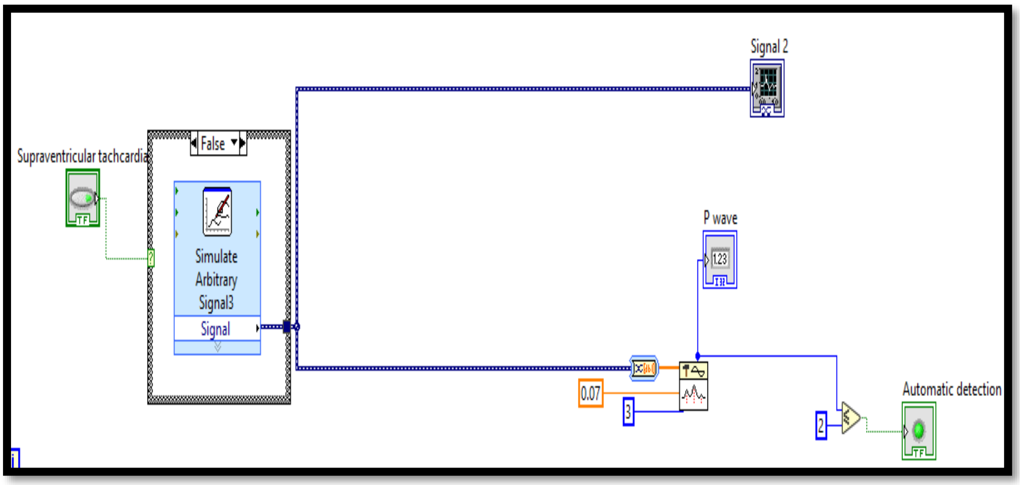

Figure 4: Block diagram for the detection of Supraventricular Tachycardia (SVT)

3.6 Algorithm Design for Left Bundle Branch Block (LBBB)

For the detection of left bundle branch block (LBBB), a normal simulated ECG waveform was generated using the arbitrary signal generator in LabVIEW and an abnormal ECG wave was generated with an inverted R wave in LBBB. Now place both signals with true/false conditions (true for normal ECG waveform and False for abnormal ECG waveform) and connect with a boolean switch. Place a peak detector of R wave with amplitude of (-1.6) and converted into valley. After that, place a comparator for comparing the signal with 0 and at the output of comparator place an indicator. The peak detector detects the inverted R waveform so the abnormal condition is detected, it means Left Bundle Branch Block is present. As shown in figure 5.

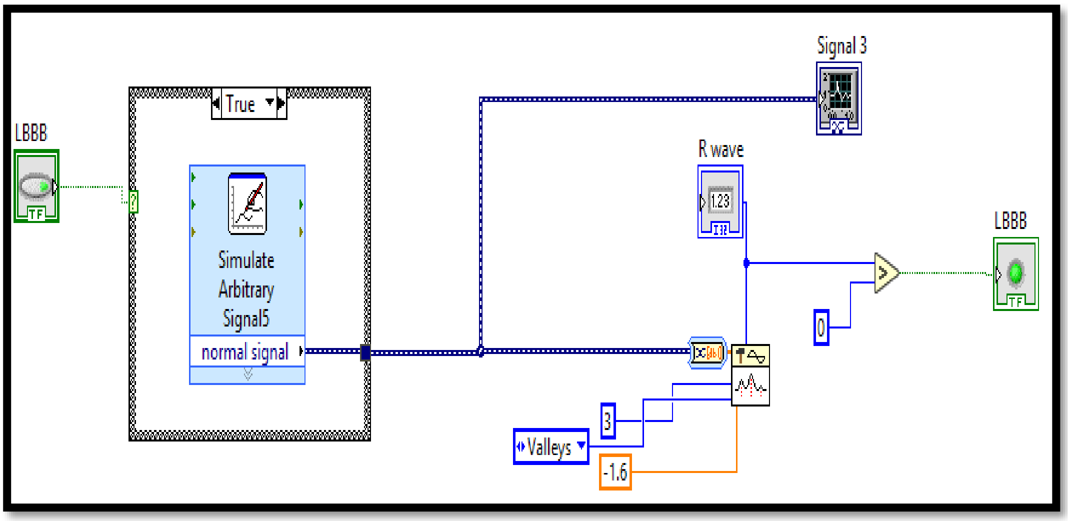

Figure 5: Block Diagram for the detection of Left Bundle Branch Block (LBBB)

3.7 Algorithm Design for Ventricular Fibrillation

For Ventricular Fibrillation a normal simulated ECG waveform was generated using the arbitrary signal generator in LabVIEW and an abnormal ECG wave was generated by irregular or not clear QRS complex and no T wave. For detection of the Ventricular Fibrillation one peak detector is required for detection of the desired wave. First select the T wave detector then set the amplitude of T wave (0.3) with a width of 3. The comparator is also used to compare the normal and abnormal peaks. The peak detector counts 2 T waves in normal condition and the condition is true and detect 1 T wave in abnormal condition when compares the abnormal signal with normal the condition is false and the absence of the T wave is detected. As shown in figure 6.

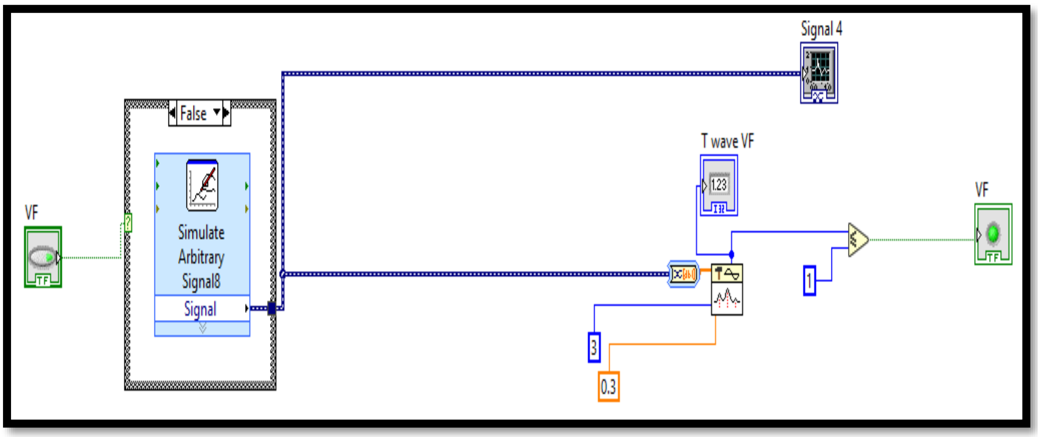

Figure 6: Block diagram for the detection of ventricular fibrillation

3.8 Algorithm Design for Myocardial Infarction

For Myocardial Infarction a normal simulated ECG waveform was generated using the arbitrary signal generator in LabVIEW and an abnormal ECG wave was generated with elevated ST segment in waveform. For detection of the Myocardial Infarction one peak detector is required for detection of the desired wave. First select the T wave detector then set the amplitude of T wave (0.3) with a width of 3. The comparator is also used to compare the normal and abnormal peaks. The peak detector counts 2 T waves in normal condition and the condition is true and detect 1 T wave or detects ST elevation in abnormal condition when compares the abnormal signal with normal the condition is false and ST elevation or unclear ST wave is detected. As shown in figure 7.

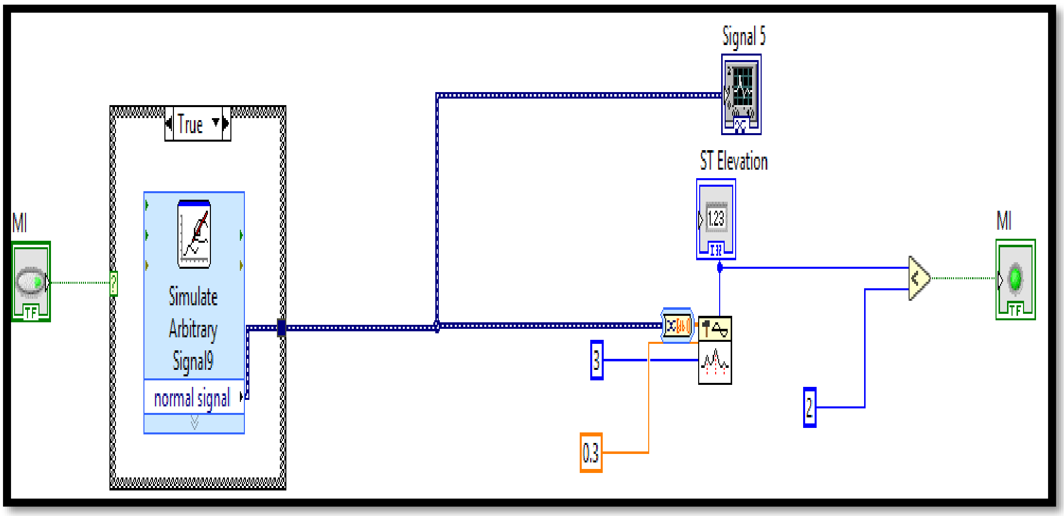

Figure 7: Block diagram for the detection of myocardial infarction

3.9 Algorithm Design for Hyperkalaemia

To design, Hyperkalemia detector by defining coordinates of the simulated arbitrary signal on LabVIEW and an abnormal ECG wave was generated by the absence of P wave and long pointed T wave. 3 peak detectors for the pointed ends of ECG and hyperkalaemia signals, case structure, comparator, collector signal, Boolean controller, LED indicator, graph indicator, After setting points on the graph of ECG and hyperkalaemia. Choose 3 peak detectors for 3 major ECG point. Give constant threshold value of (0.07 for P wave, 1.6 for R and 0.3 for T wave) and width 3 to detect the hyperkalemia. After comparison the absence of P wave and long T wave is present in the signal and the conditions is false it means the Hyperkalemia is detected or present. As shown in figure 8.

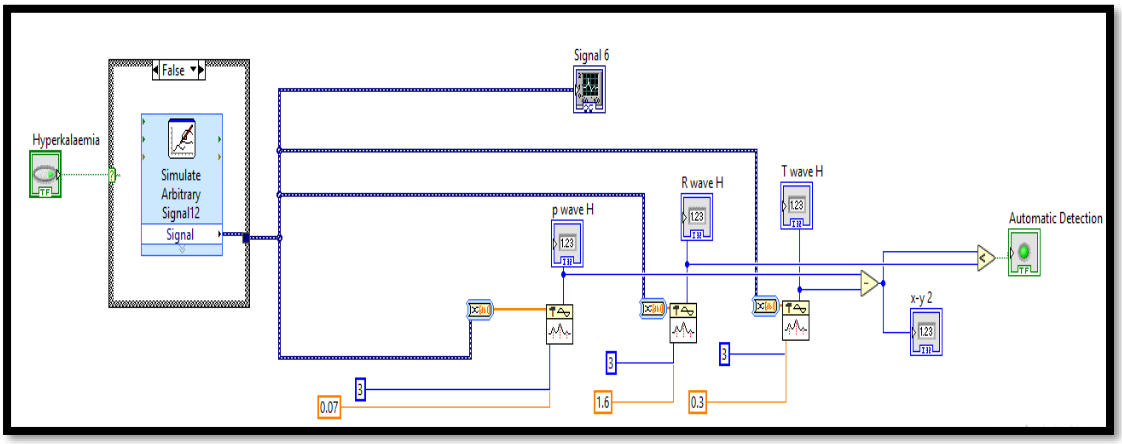

Figure 8: Block diagram for the detection of hyperkalemia

3.10 Algorithm Design for Digoxin

For the detection of Digoxin, a normal simulated ECG waveform was generated using arbitrary signal generator in LabVIEW and an abnormal ECG wave was generated with an inverted or biphasic T wave in Digoxin disorder. Now place both signals with true/false conditions (true for normal ECG waveform and False for abnormal ECG waveform) and connect with a boolean switch. Place a peak detector of T wave with amplitude of (-0.3) and converted into valley. After that place a comparator for comparing the signals and at the output of comparator place an indicator. The peak detector detects the inverted or biphasic T waveform so the abnormal condition is detected means Digoxin is present. As shown in figure 9.

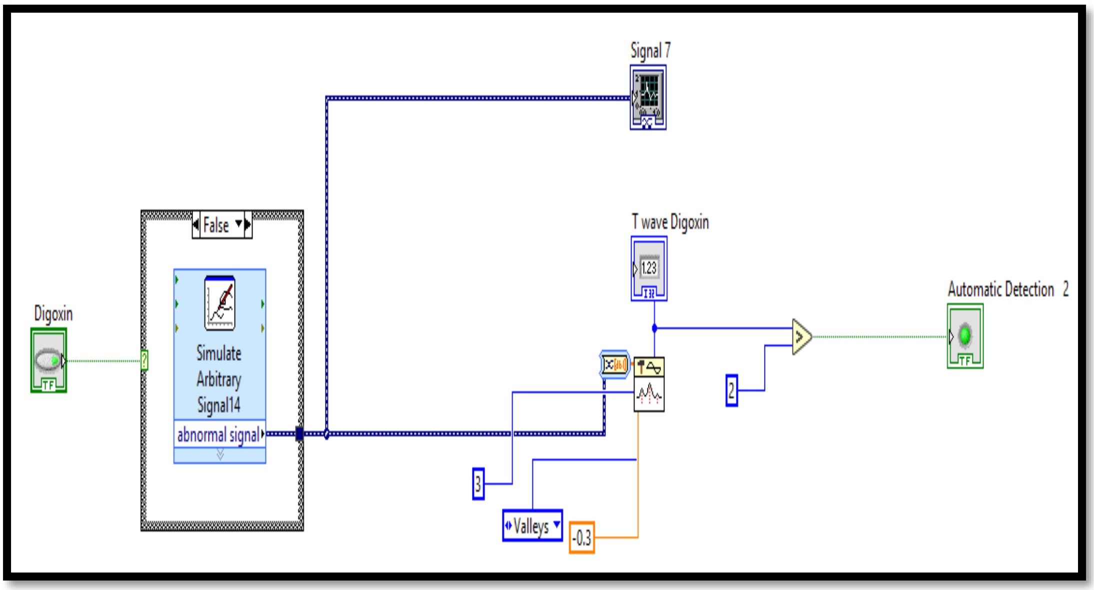

Figure 9: Block diagram for the detection of digoxin

4. Results & Findings

4.1 Atrial Flutter Detection

In false condition the LED remains off, which means the ECG waveform is normal, but when the condition is true which means the abnormal signal is detected the two P waves are present in the signal so the glowing LED indicating towards the Atrial flutter and it can be detected by the system easily. Figure 10 shows the false condition, and the LED is off indicating the ECG wave is normal.

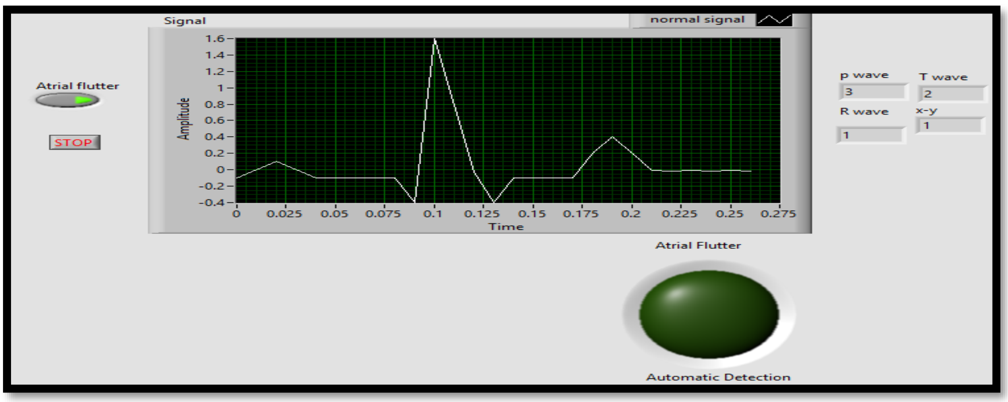

Figure 10: Shows the false condition, and the LED is off indicating the ECG wave is normal

4.1.1 True condition

This figure 11 illustrates that the abnormal condition of atrial flutter is detected because the two P waves are present in the signal. The LED is glowing because the condition is true means the below signal is a diseased signal.

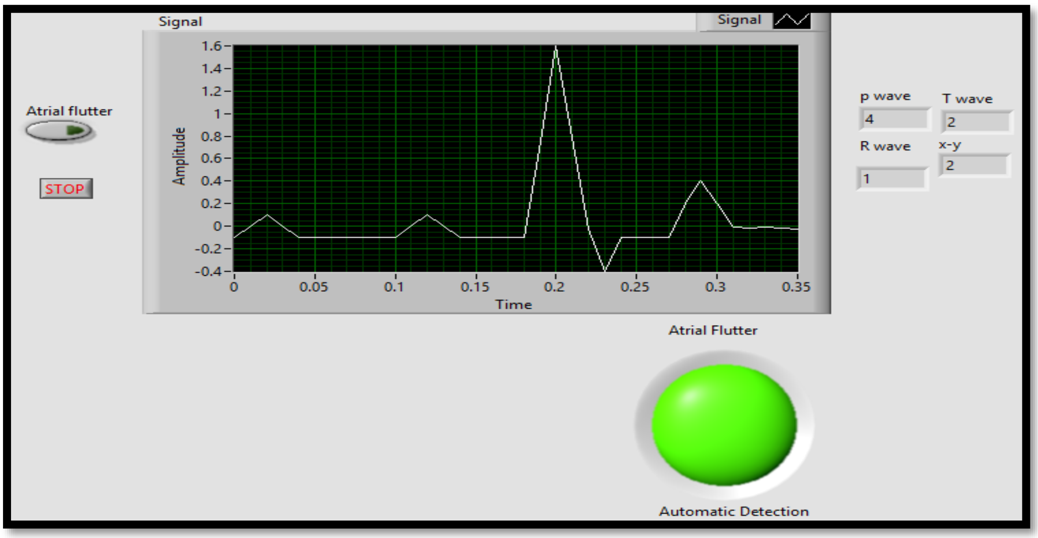

Figure 11: Shows the true condition, and the LED glows indicating towards atrial flutter

4.2 Supraventricular Tachycardia Detection

When the condition is false the LED is not glowing which means the signal is not diseased or normal ECG signal. But when the condition is true Supraventricular Tachycardia or abnormal signal is being detected which is a diseased signal in which there is an absence of P waves because of fast sequences in waveform. In Supraventricular Tachycardia (SVT) the heart beats at least or above 100 beats per minute and can be as high as 300 beats per minute. Figure 12 shows the false condition, and the LED is off indicating the ECG wave is normal.

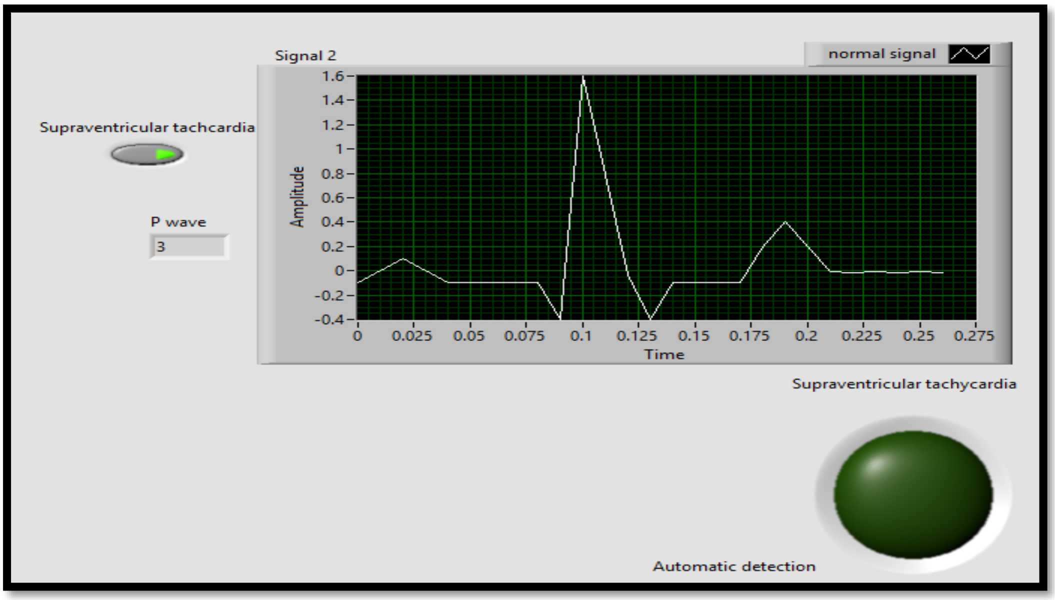

Figure 12: Shows the false condition, and the LED is off indicating the ECG wave is normal

4.2.1 True condition

This figure illustrates that the abnormal condition of Supraventricular Tachycardia is detected because the P waves are absent in the signal. The boolean logic LED is glowing because the condition is true means the above signal is abnormally detected or it is a diseased signal. Figure 13 shows the true condition, and the LED glows indicating towards supraventricular tachycardia.

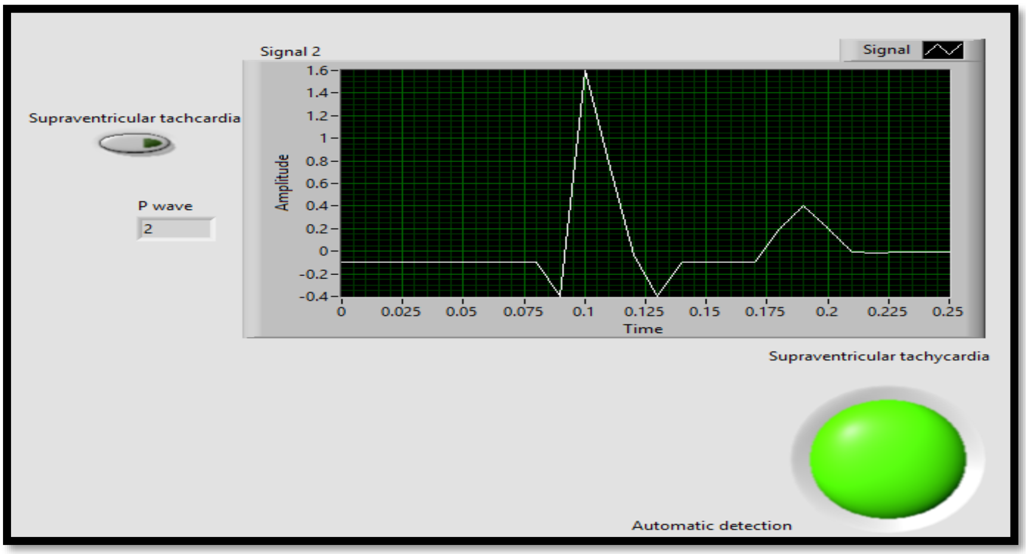

Figure 13: Shows the true condition, and the LED glows indicating towards supraventricular tachycardia

4.3 Left Bundle Branch Block (LBBB) Detection

In normal condition the peak detector counts R wave and the LED doesn't glow which proves that there is no LBBB and the signal is totally normal, but in abnormal condition peak detector counts 1 R wave or the inverted R wave is present and the LED glows which shows LBBB is detected or present. Figure 14 indicates the false condition, and the LED is off indicating the ECG wave is normal.

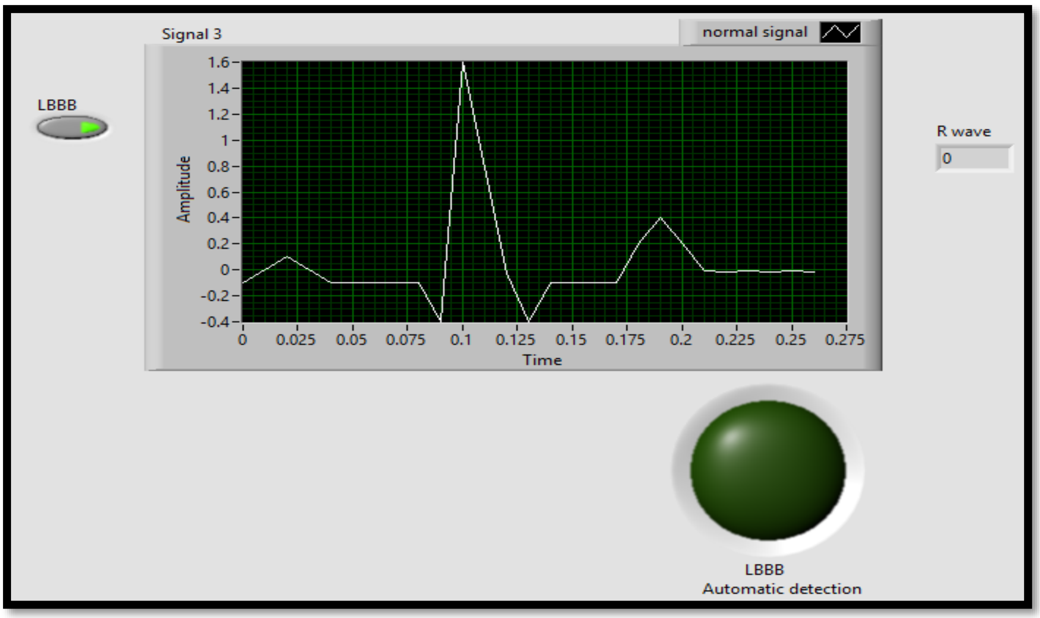

Figure 14: Shows the false condition, and the LED is off indicating the ECG wave is normal

4.3.1 True condition

The above figure illustrates that the abnormal condition of Left Bundle Branch Block (LBBB) is detected because the inverted R wave is present in the signal. The amplitude set for the abnormal signal is -1.6 so the peak detector detects the inverted peak. The boolean logic LED is glowing because the condition is true means the above signal is abnormally detected or it is a diseased signal. Figure 15 illustrates the true condition, and the LED glows indicating towards Left Bundle Branch Block (LBBB).

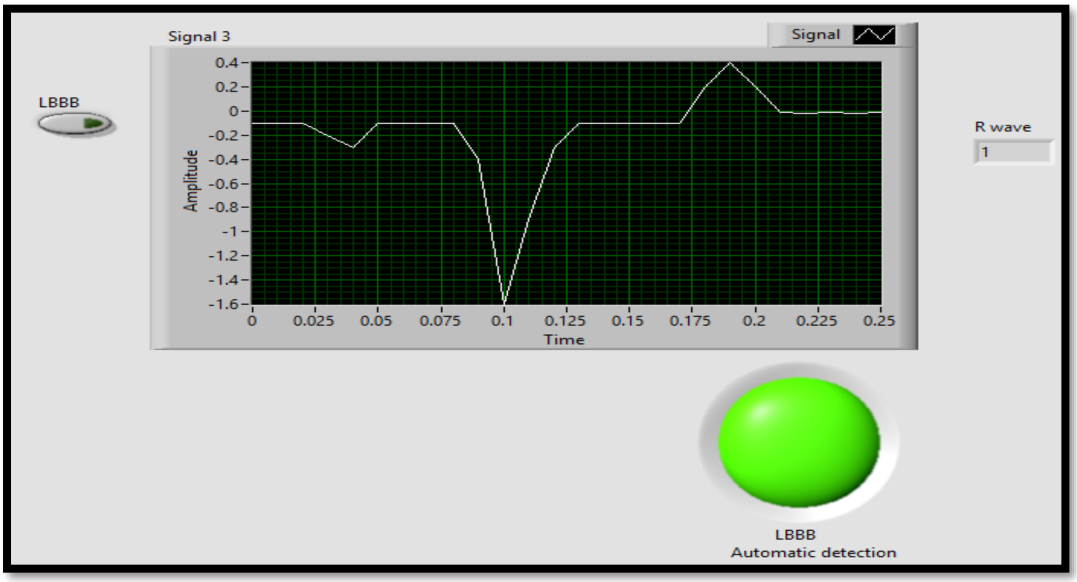

Figure 15: Shows the true condition, and the LED glows indicating towards Left Bundle Branch Block (LBBB)

4.4 Ventricular Fibrillation Detection

In normal condition the peak detector counts 2 T waves and the LED doesn't glow which proves that there is no VF and the signal is totally normal, but in abnormal condition peak detector counts 1 T wave or the absence of theT wave and irregular QRS complex and the LED glows which shows Ventricular Fibrillation (VF) is detected or present. Figure 16 shows the false condition, and the LED is off indicating the ECG wave is normal.

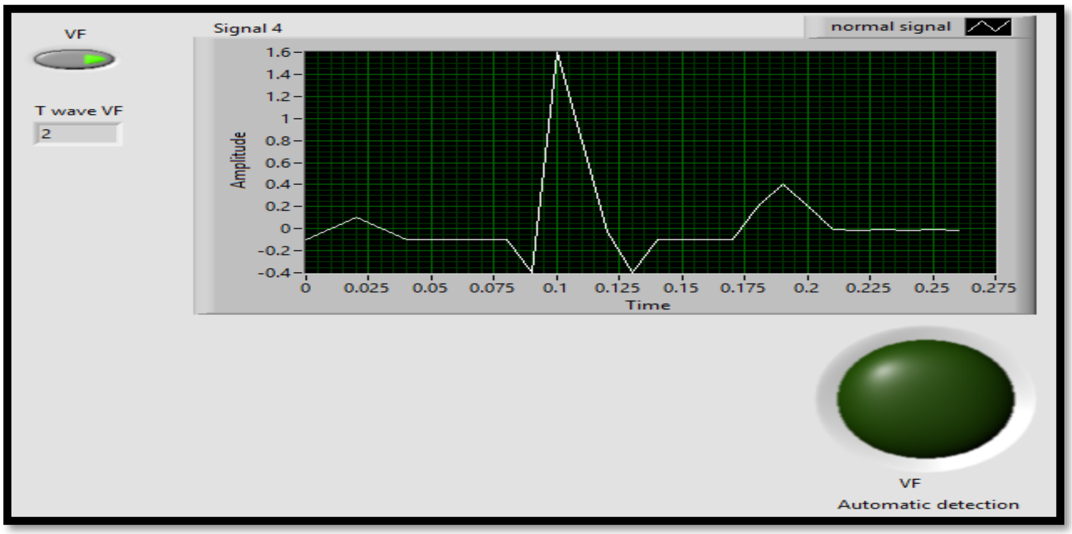

Figure 16: Shows the false condition, and the LED is off indicating the ECG wave is normal

4.4.1 True condition

The above figure illustrates that the abnormal condition of Ventricular Fibrillation (VF) is detected because the T wave is absent in the signal and irregular or disturbed QRS complex is present. The boolean logic LED is glowing because the condition is true means the above signal is abnormally detected or it is a diseased signal. Figure 17 shows the true condition, and the LED glows indicating towards Ventricular Fibrillation (VF).

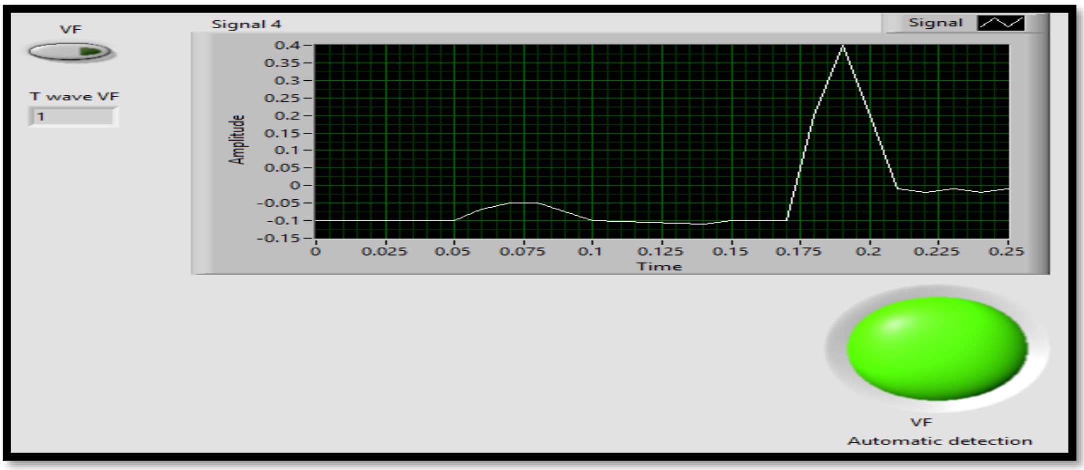

Figure 17: Shows the true condition, and the LED glows indicating towards Ventricular Fibrillation (VF)

4.5 Myocardial Infarction Detection

In normal condition the peak detector count waves and LED doesn't glow which proves that there is no MI and the signal is totally normal, but in abnormal condition peak detector counts 1 T wave and the elevation of ST segment or irregular ST segment and the LED glows which shows Myocardial Infarction (MI) is detected or present. Figure 18 shows the false condition, and the LED is off indicating the ECG wave is normal.

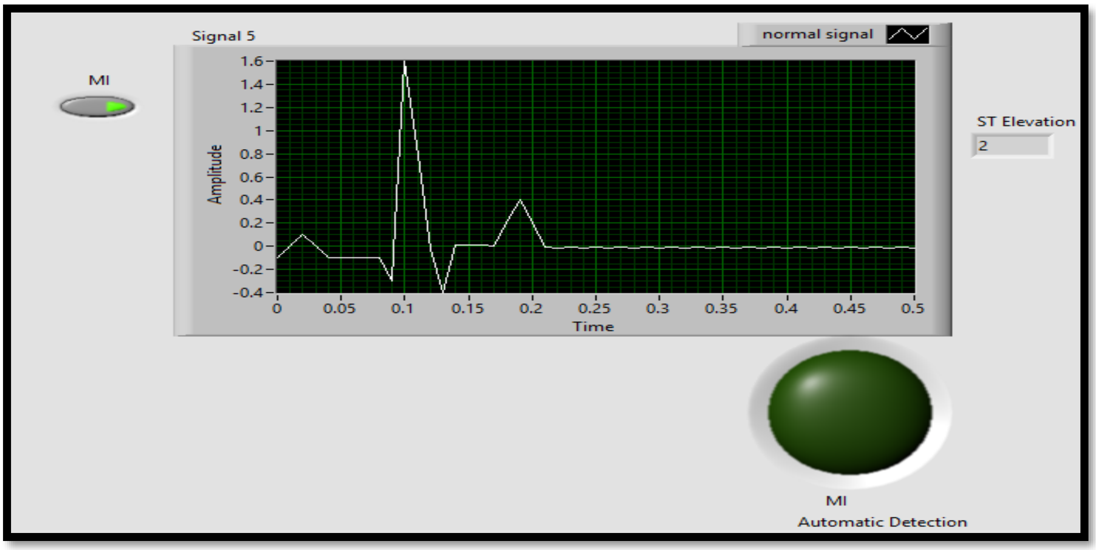

Figure 18: Shows the false condition, and the LED is off indicating the ECG wave is normal.

4.5.1 True condition

The above figure illustrates that the abnormal condition of Myocardial Infarction (MI) is detected because the ST wave is elevated in the signal and irregular or disturbed ST segment is present. The boolean logic LED is glowing because the condition is true means the above signal is abnormally detected or it is a diseased signal. Figure 19 indicated the true condition, and the LED glows indicating towards Myocardial Infarction (MI).

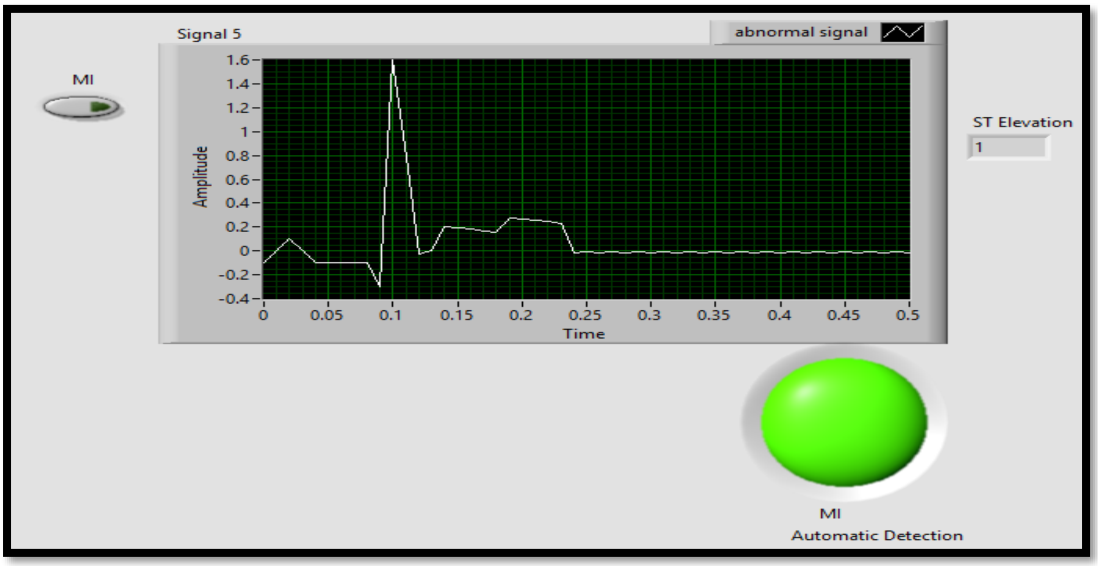

Figure 19: Shows the true condition, and the LED glows indicating towards Myocardial Infarction (MI)

4.6 Hyperkalaemia Detection

When the difference between the P wave and T wave is same as the R wave the signal is considered to be normal, and the condition is false the LED will not glow indicating the signal is normal. But when the difference between P and T wave is not equal to the R wave the signal is considered to be abnormal detecting Hyperkalemia which contains the long pointed T wave and absence of the P wave and it is indicated by a glowing LED as the condition is true. Figure 20 shows the false condition, and the LED is off indicating the ECG wave is normal.

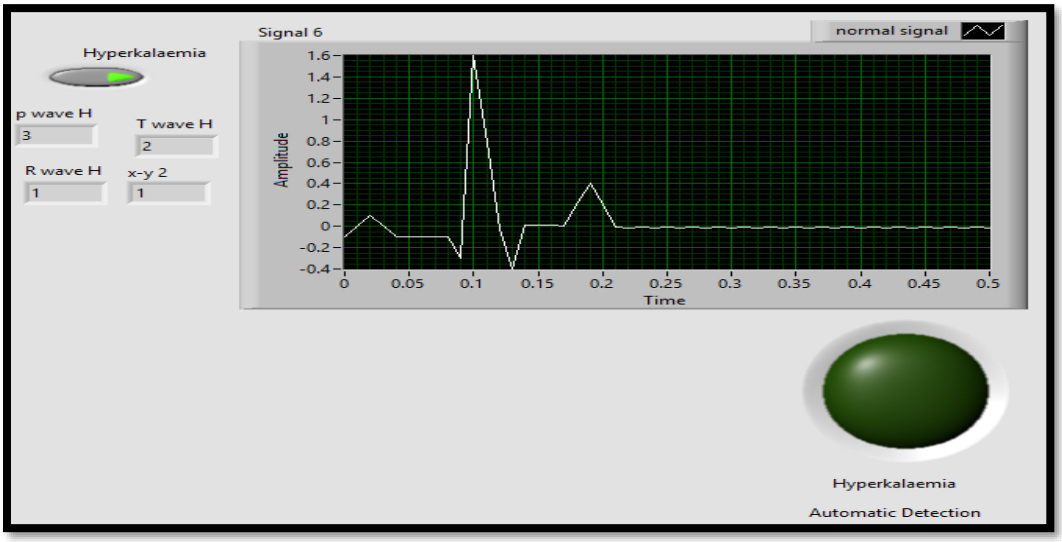

Figure 20: Shows the false condition, and the LED is off indicating the ECG wave is normal.

4.6.1 True condition

When the difference between P wave and T is not equal to the R wave the signal is considered to be abnormal means it has some kind of disease and it is indicated by a glowing LED as the condition is true. The above signal is abnormal detecting hyperkalemia as there is no P wave and has an elongated T wave. Figure 21 shows the true condition, and the LED glows indicating towards Hyperkalemia

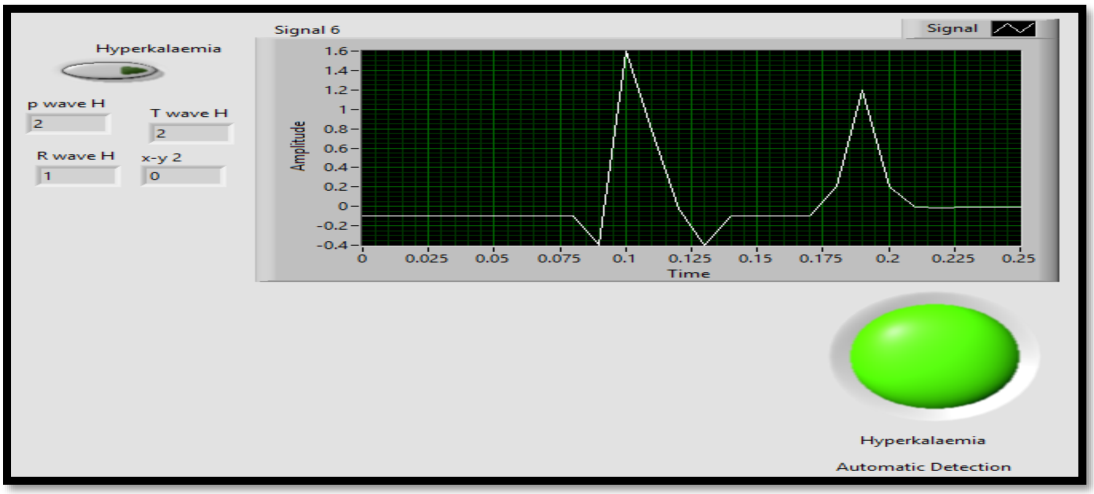

Figure 21: Shows the true condition, and the LED glows indicating towards Hyperkalemia

4.7 Digoxin Detection

In normal condition the peak detector count waves and LED doesn't glow which proves that there is no disease or digoxin and the signal is totally normal, but in abnormal condition peak detector counts 3 T waves or the biphasic T wave is present and the LED glows which shows Digoxin is detected or present. Figure 22 shows the false condition, and the LED is off indicating the ECG wave is normal.

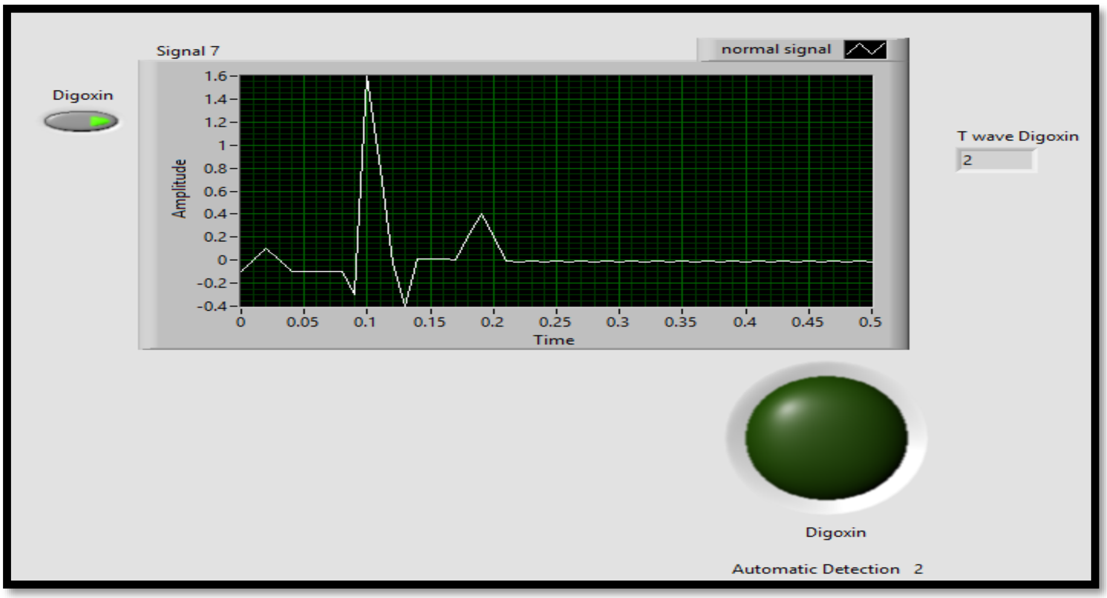

Figure 22: Shows the false condition, and the LED is off indicating the ECG wave is normal.

4.7.1 True condition

The figure 23 illustrates that the abnormal condition of Digoxin is detected because the biphasic T wave or concave shaped T wave is present in the signal. The amplitude set for the abnormal signal is -0.3 so the peak detector detects the inverted peak as well as normal T wave. The boolean logic LED is glowing because the condition is true means the above signal is abnormally detected or it is a diseased signal.

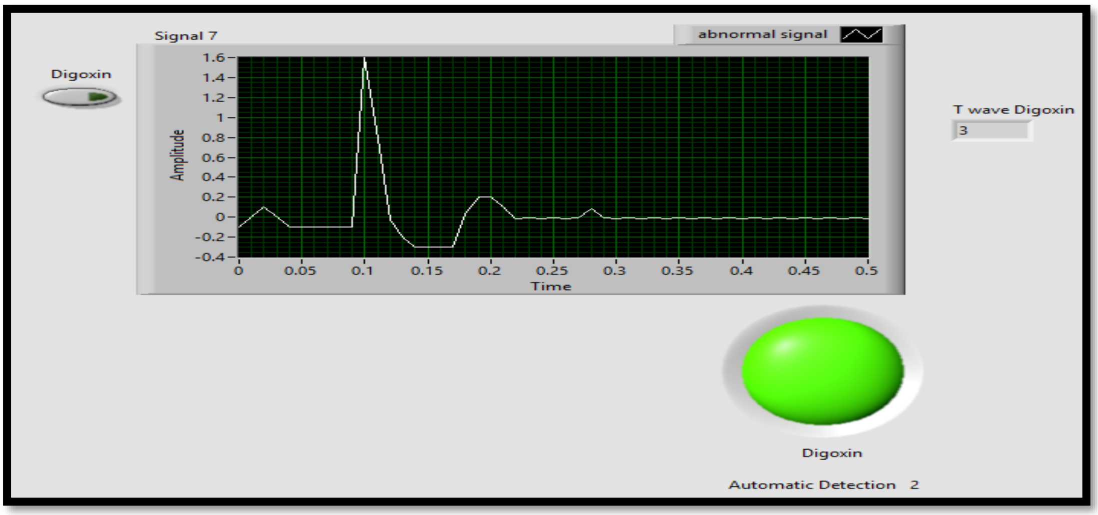

Figure 23: Shows the true condition, and the LED glows indicating towards Digoxin

4.8 Advantages

Diagnosis of cardiac disorders at early stage plays an important role for the survival of humans. In hospitals and laboratories there are different innovations for the detection of cardiac diseases which are time expending and not at reasonable rate and sometimes not showing the accurate results and because of this many people died from severe cardiac disorders. So, developed this simple arrhythmia detection system for the accurate and fast results of the cardiac disorders and this method can save the human lives as much as possible because of accurate diagnoses. And because of developing this observing system can bring the possibility to record the heart conditions at early stage. This system is cost effective, portable and easy to handle and large amount of data can be stored in computer for further studies.

5. Discussion, Conclusion, Recommendations Future Research

5.1 Conclusion

The Objective of this project is to develop ECG Automatic Disease Detection System on LabVIEW, which can identify or detecting different cardiac disorders, have been achieved. This system contains two parts the one is the simulation of ECG signal and the second part is the automatic detection of the cardiac arrhythmia by designing algorithms for different types of cardiovascular diseases. **I**n order to extract the important features of the ECG, the location of the P wave, QRS complex, and ST segment is fundamental. In this manner, abnormalities of these ECG parameters are related to cardiac arrhythmia. This simulated ECG and Automatic Detection system can provide physicians, doctors and nurses gives better information about the heart conditions of the patients and provides efficient environment and accurate detection of cardiac arrhythmia. It is cost effective, easy to handle or user friendly which are not time consuming and provide the faster results. This system is also can be very useful or effective for the early detection of cardiac ailments or arrhythmias and save the human lives. But in this system, it may additionally require filtering systems when pick up the ECG signals directly from the patient. This is because the original ECG signal contains more noise than the simulated signal. In the medial industry this work can be very useful for patients who are suffering from cardiovascular diseases.

5.2 Future Enhancement

Future enhancement can be done in this system by designing multiple algorithms for the detection of cardiac ailments. Other parameters such as temperature, PH, blood pressure can also be corporate. Instead of ECG, Other biosignals like the EMG, EOG and EEG signals and their diseases can be designed and analyzed by using this proposed method.

References

Abed, B. H., Ibrahim, R. K., & Almuifraje, M. H. (2015). Design and Implementation of ECG (Electrocardiograph) Feature Extraction using Biomedical Workbench and LabView. *International Journal of Computer Science and Mobile Computing*, *4*(5), 29–32.

Al-Rawahi, N., & Green, M. S. (2007). Diagnosis of supraventricular tachycardia. *The Journal of the Association of Physicians of India*, *55 Suppl*, 21–24.

Belgacem, N., Bereksi-Reguig, F., Nait-Ali, A., & Fournier, R. (2012). Person identification system based on electrocardiogram signal using LabVIEW. *International Journal on Computer Science and Engineering*, *4*(6).

Benitez, D. S., Fitchet, A., Gaydecki, P. A., Fitzpatrick, A. P., & Zaidi, A. (2000). Virtual instrumentation for clinical assessment of cardiovascular and autonomic function. *IEE Proceedings - Science Measurement and Technology*, *147*(6), 397–402. https://doi.org/10.1049/ip-smt:20000843

Dhakne, G. M., & Gaikwad, S. N. (2016). A Low Power, Mixed Signal System for Wireless Transmission of Body Temperature, Heart Beat and ECG. *International Journal of Innovative Research in Computer and Communication Engineering*, *4*(9).

Gao, Z., Wu, J., Zhou, J., Jiang, W., & Feng, L. (2012). Design of ECG signal acquisition and processing system. *2012 International Conference on Biomedical Engineering and Biotechnology*.

Geetha, A., Gopalakrishnan Nair, T. R., & Asharani, M. (n.d.). *Detection and identification of lbbb and rbbb rhythms in ECG waves using Gabor transform analysis*. Ijana.In. Retrieved September 27, 2023, from https://www.ijana.in/Special%20Issue/S48.pdf

Kaur, G., Singh, K., & Thakur, D. (2017). A LabVIEW approach for detection of cardiac arrhythmia. *Journal of Emerging Technologies and Innovative Research*, *4*(8), 1153–1165.

Kumar, A., Dewan, L., Singh, M., & Kurukshetra, H. (2006). Real time monitoring system for ECG signal using virtual instrumentation. *WSEAS Transactions on Biology and Biomedicine*, *3*(11), 638–643.

Kumar, M., Umesh, K., Pandiaraja, G., Thomas, S., & Venkatesh, M. (2014). *A Research Work on Identification of Cardiac Disorders using LabVIEW*.

Kumar, Mohit, Pachori, R., & Acharya, U. (2017). Automated diagnosis of myocardial infarction ECG signals using sample entropy in flexible analytic wavelet transform framework. *Entropy (Basel, Switzerland)*, *19*(9), 488. https://doi.org/10.3390/e19090488

Kypridemos, C., Allen, K., Hickey, G. L., Guzman-Castillo, M., Bandosz, P., Buchan, I., Capewell, S., & O'Flaherty, M. (2016). Cardiovascular screening to reduce the burden from cardiovascular disease: microsimulation study to quantify policy options. *BMJ (Clinical Research Ed.)*, i2793. https://doi.org/10.1136/bmj.i2793

Malge, K., Vanjerkhede, K., & Bhyri, C. (2015). ECG Signal Analysis. *International Journal of Computer Applications*.

Mhatre, A., & Pai, N. (2014). *Temporal Analysis of ECG using LabVIEW. III*.

Mohy-Ud-Din, Z. (2014). Diagnosis of Atrial Fluttering using LabVIEW. *Diagnosis of Atrial Fluttering Using LabVIEW. International Biomedical Engineering Conference*.

Nagendra, H., Mukherjee, S., & Kumar, V. (2011). Application of wavelet techniques in ECG signal processing: an overview. *Int J Eng Sci Technol*, *3*(10), 7432–7443.

Nair, T. R. G., Geetha, A. P., & Asharani, M. (2014). Adaptive wavelet based identification and extraction of PQRST combination in randomly stretching ECG sequence. In *arXiv [cs.CV]*. http://arxiv.org/abs/1408.0453

Nandagopal, D. V., Maheswari, D. V., & Kannan, C. (2016). Newly constructed real time ECG monitoring system using LabView. *Circuits and Systems*, *07*(13), 4227–4235. https://doi.org/10.4236/cs.2016.713347

Ruban, N., Arneja, G. P. S., Bansal, K., & Noel, M. M. (2012). Heart sound analysis using LabVIEW. *Journal of Theoretical & Applied Information Technology*, *46*(2).

Sandhiya, R., Thenmozhi, M., & Praveena, S. M. (n.d.). *Design and Development Virtual ECG Machine with Problem Identification Using Labview*.

Srivastava, V., Varshney, K., & Kumar, V. (2017). Labview based Electrocardiograph (ECG) Patient Monitoring System for Cardiovascular Patient using WSNs. *Communications on Applied Electronics*, *6*(8), 28–34. https://doi.org/10.5120/cae2017652541

Vamos, M., Erath, J. W., & Hohnloser, S. H. (2015). Digoxin-associated mortality: a systematic review and meta-analysis of the literature. *European Heart Journal*, *36*(28), 1831–1838. https://doi.org/10.1093/eurheartj/ehv143

Viera, A. J., & Wouk, N. (2015). Potassium disorders: Hypokalemia and hyperkalemia. *American Family Physician*, *92*(6), 487–495.

Vimala, K., & Kalaivani, D. V. (2013). Classification of cardiac vascular disease from ECG signals for enhancing modern health care scenario. *Health Informatics-An International Journal (HIIJ)*, *2*. https://doi.org/10.5121/hiij.2013.2405

Waseem, A. (2018). Identification of Junctional Rhythm Using LabVIEW. *Identification of Junctional Rhythm Using LabVIEW. ISIITA*.