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A SYSTEM DESIGN APPROACH TO EXTRACT AND ANALYSE ECG SIGNAL USING LABVIEW AND MATLAB

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ABSTRACT

Heart diseases are the leading cause of death globally. ECG is one of the oldest instrument- bound measurements in healthcare. Study of ECG signal includes generation & simulation of the signal, acquisition of real time data, signal filtering and processing, feature extraction, comparison between different ECG signal analysis algorithms and techniques , detection of any abnormalities and so on using the most familiar and multipurpose MATLAB software along with LABVIEW.

Keywords—*Electrocardiography,Ag-AgCl electrode, non-invasive,P-R interval,QRS interval,QT interval.*

I. INTRODUCTION

Electrocardiography is a technique of recording the electrical activity of the heart over a period of time using electrodes placed on the patient's body[2].This technique checks for changes or any abnormalities in the heart. This paper helps to detect various heart diseases by diagnosing the PR, QRS, ST and QT intervals. Using Ag-AgCl electrodes, the ECG signal is extracted by interfacing it to the PC with LabVIEW using NI DAQ 6009 card. Further the morphology of the ECG waveform is analysed in MatLab and various parameters **of the ECG signal is estimated.**

II. OVERVIEW OF ECG SIGNAL

An electrocardiogram is a simple, **non invasive** test that records the heart's electrical activity. T**his test can give the information about the heart condition.** With each heartbeat, an electrical signal spreads from the top of the heart to the bottom. As it travels, the signal cause the heart to contract and pump blood. The process repeats with each new heartbeat. The heart's electrical signals set the rhythm of the heartbeat [1]. The ECG records the electrical activity of the heart. The ECG signal is characterized by 5 peaks and valleys. These are labelled by the letters P, Q, R, S and T. The P wave represents the activation of the upper chambers of the heart and the atria, while the QRS complex and T wave represent the excitation of the ventricles or the lower chamber of the heart. **To analyse ECG signal QRS complex is the most important factor. Heart rate of the ECg segment can be detected precisely by estimating the QRS complex** [2].

III. ANALYSIS OF ECG SIGNAL

The components of the ECG can be correlated with the electrical activity of the heart atrial and ventricle muscle.The appearance of the ECG wave is divided into two phases:-

Systole: The ventricles are full of blood and begin to contract. The mitral and tricuspid valves close (between atria and ventricles). Blood **comes out** through the pulmonic and aortic valves [3].

Diastole: Blood flows into the atria and through the open mitral and tricuspid valves into the ventricles. The cardiac cycle involves a sequential contraction of the atria and the ventricles [3].

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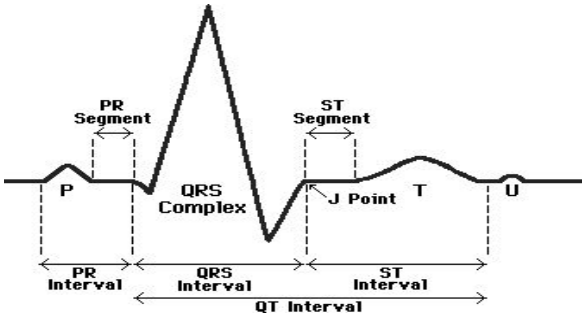

Fig 1: ECG Waveform

F**ollowing are the p**arameters of ECG waveform **that** are important in diagnosis of various heart diseases are as follows:

Interval	Duration(secs)
P-R	0.12-0.2
QRS	0.04-0.12
QT	Less than 0.42

Fig 2: Standard Interval range[4]

IV. PROPOSED METHODOLOGY

The block diagram of the proposed system is shown in figure 4. For the extraction of the ECG signal Ag-AgCl electrodes are used. The most obvious way to record the ECG is between the Right Arm (RA) and the Left Arm (LA) although another two combinations using the Left Leg (LL) are also used clinically (RA−LL and LA−LL). Another electrode is also used to connect the patient to the common ground of the instrumentation. Usually, right leg is considered as groung so ground electrode is placed here.

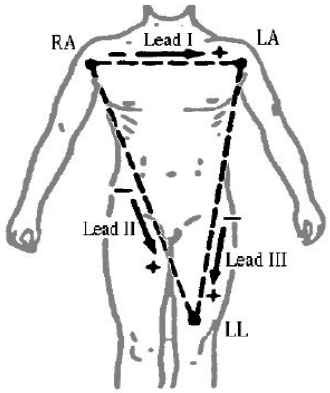

Fig 3: Typical Electrode Placement

After the signal is extracted from a particular subject using Ag-AgCl electrode, the signal is interfaced to the PC with LabView using DAQ card where it is further processed. Later the analysis is done using MatLab by comparing the various signals obtained with a standard signal. The resultant signal is displayed on the front panel of Labview.

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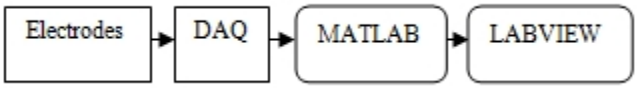

Fig 4: Block Diagram of the ECG extraction system

In LabVIEW, block diagram and front panel window appears. Programming code is prepared in the block diagram window and result is displayed in the front panel. The LabVIEW block diagram is shown in figure 5 and front panel is shown in Figure 6.

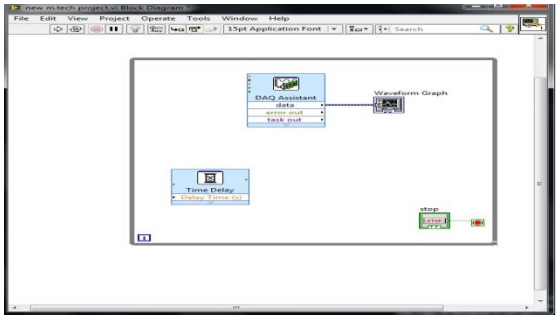

Fig 5: Back panel of Lab View

Fig 6: Front panel of Lab View

In the following table there is a list of heart diseases along with the abnormal findings. This table can be used to detect diseases very easily.

1. Atrial fibrillation	No P wave Irregularly irregular rhythm Tachycardia
2. Complete heart block	Increased R-R interval (Heart rate <50) No correlation of P wave with QRS complex PP interval < RR interval

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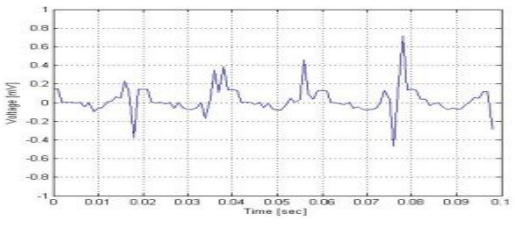
	Abnormal QRS complex
3. Myocardial Infarction	ST segment elevation > 1 small square in 3 consecutive precordial leads T wave inversion in precordial leads
4. First degree Heart block	PR interval more than 20 msec
5. Second degree Heart block	Gradual increase in PR interval followed by a drop beat.

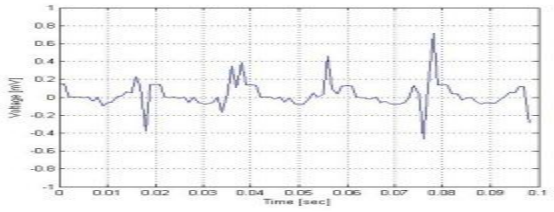
Table1: List of heart disorders along with their findings.

V. EXPERIMENTAL RESULTS

The ECG signal of 6 subjects are extracted in LabVIEW and the data is exported to Microsoft Excel from LabVIEW. This database is used as an input in MatLab and a program code is written to generate the desired output signal in MatLab.
The ECG waveforms of 6 subjects are as follows:



Subject1



Subject 2

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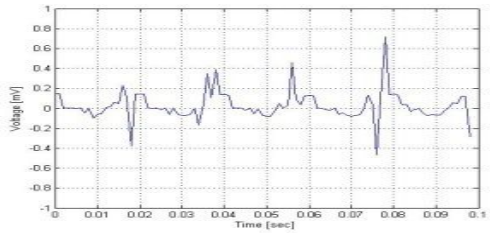
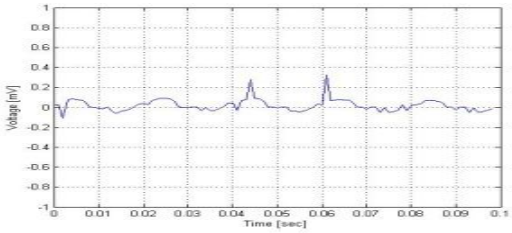
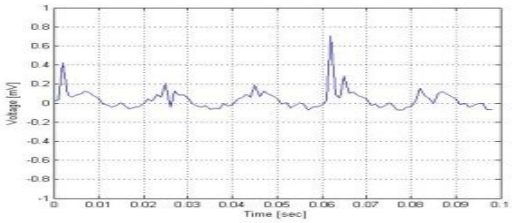


Subject 3



Subject 4



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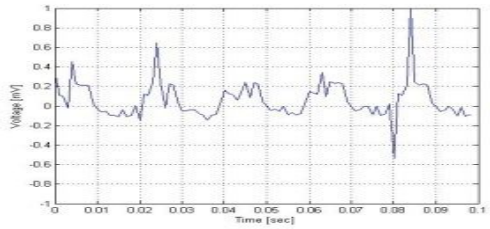

Subject 6

The various experimental parameters that are calculated from the waveforms of different subjects are tabulated in the following table:

Subject	Age	P-R interval(secs)	QRS interval(secs)	Q-T interval (secs)	Theoretical inference	Clinicians inference

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1. Female	24	0.15	0.12	0.3	Normal rhythm	Normal rhythm
2. Male	30	0.2	0.12	0.4	Normal rhythm	Normal rhythm
3. Male	20	0.12	0.06	0.4	Normal rhythm	Normal rhythm
4. Male	8	0.12	0.06	0.4	Normal rhythm	Faster rhythm
5. Female	46	More than 0.2	0.12	0.4	P-R interval not in range	Chance of 1st degree heart block
6. Male	40	0.15	0.13	0.43	Irregular rhythm	Tachycardia

Table 2: Experimental parameters of various subjects

Thus by calculating the P-R, QRS, Q-T intervals , the various heart conditions can be diagnosed. Also the readings and findings along with the respective graphs of various subjects have been sent to a pathologist and these conclusions have been made based on clinicians valuable comments and from theoretical research.

VI. CONCLUSION

ECG is one of the oldest and reliable instrument- bound measurements in medicine. It has faithfully followed the progression of instrumentation technology.It is a promising technology due to its simplicity, low cost and non-invasiveness. It provides an accurate method to detect the common heart diseases like 1st degree heart block, irregular rhythm, tachycardia. By analysing the morphology of the ECG signal, the P-R, QRS and QT intervals can be estimated and the various heart diseases relating to it can also be detected.

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