Temporal Analysis of ECG using LabVIEW

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Abstract- **The system "Temporal analysis of ECG signal using LabVIEW" is developed to assist patients and doctors in health care. An arrhythmia is an abnormal heart rhythm. It may be so brief that it doesn't change overall heart rate, but it can cause the heart rate to be too slow or too fast.When arrhythmias are severe or last long enough, the heart may not be able to pump enough blood to the body. This can cause patient to feel tired, lightheaded or may make him pass out. It can also cause death. Before treatment, it's important for the doctor to know where an arrhythmia starts in the heart and whether it's abnormal. An electrocardiogram (ECG) is often used to diagnose arrhythmias. "Temporal analysis of ECG using LabVIEW" is meant to acquire ECG signal from patient and analyze it to detect and classify its anomalies and abnormalities. This is achieved by extracting amplitudes and durations of parameters of ECG waveform such as P wave, QRS complex, RR interval and PR durations. These parameters are compared with the normal values to determine the type of abnormality. Database of the patient is maintained for further use by the doctor.**

I. INTRODUCTION

India is one of the many countries facing severe shortages of trained medical professionals. Considering the large number of critical patients and the need for accurate interpretation of their cardiac status and the limitations of humans to observe the fine details in ECG waveform, automated arrhythmia monitoring systems are being developed to assist cardiologists in detecting the signs of arrhythmia at early stages which can save patient's lives [3-4].

The objective of "Temporal Analysis of ECG signal using LabVIEW" aims at acquiring and analyzing temporal parameters of ECG signal such as P wave, QRS complex, RR interval, PR durations and amplitudes of P wave, ST wave, identification of cardiac arrhythmia using LabVIEW. The research work has helped us to explore various features of LabVIEW like signal processing and automated database generation.

II. THE ANALYSIS OF ELECTROCARDIOGRAM (ECG)

The normal ECG is composed of a P wave, a QRS complex and a T wave. The P wave and the QRS represent atrial and ventricular depolarization respectively. The T wave reflects the phase of rapid repolarization of the ventricles [1].

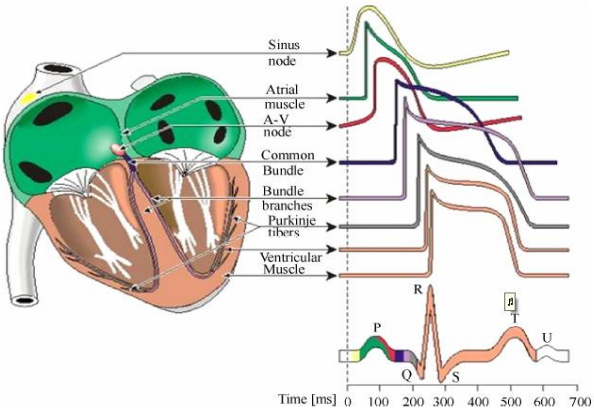


Fig.1. Typical representation of the ECG wave [16]

The P wave is the first wave of the electrocardiogram and represents the spread of electrical impulse through the atrial musculature that is activation or depolarization. The PR interval reflects the time taken by the impulse to travel the entire distance from the SA Node to the ventricular muscle fibers.It represents the spread of the electrical impulse through the ventricular muscle that is depolarization.The S-T segment follows the QRS complex.The T wave represents the period of recovery for the ventricles [2].

Table 1.ECG reference model for a normal man[8].

Parameter	Reference Value
Heart Rate	60-100 beats per minute (BPM)
P wave	Duration < 0.12 s; Amplitude < 0.25mV
P-R interval	Duration 0.12 - 0.20 s
QRS complex	Duration 0.04 –0.12s; Amplitude 0.5–1mV
Q-T interval	Duration 0.39-0.42 s

An arrhythmia is an abnormal rate and/or rhythm of the heartbeat. It arises when the electrical impulses to the

heart that coordinate heartbeats are not working properly, making the heart beat too fast/slow or inconsistently. [7-8].

Arrhythmias may occur because of the following reasons,

- Sinus node is not able to generate enough heartbeats.
- Abnormal rhythm of sinus node.
- Other area in the atria take over the function of the sinus node.

Abnormally fast heart rate is called as Tachycardia and abnormally slow heart rate is called as Bradycardia. Tachy and Brady are Greek words which means fast and slow respectively. In Bradycardia, the heart rate is too slow that is less than 60 beats per minute. Whereas in Tachycardia, the heart rate is too fast that is more than 100 beats per minute.When the electrical signal is slowed or disrupted as it moves through the heart, it is considered as a Heart block. Heart block is also a type of arrhythmia. A first degree AV node block occurs when conduction through the AV node is slowed. A first degree AV block is indicated on the ECG by a prolonged PR interval. First-degree heart block is not very severe [5].

III. SYSTEM DESCRIPTION

The block diagram of the system is as follows:

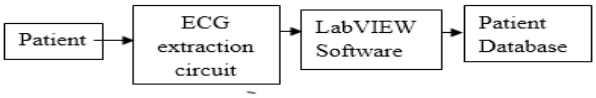


Fig 2. Block diagram of the system

Figure 3 shows the blocks in ECG extraction circuit. It consists of sensors electrodes, filters and amplifiers.

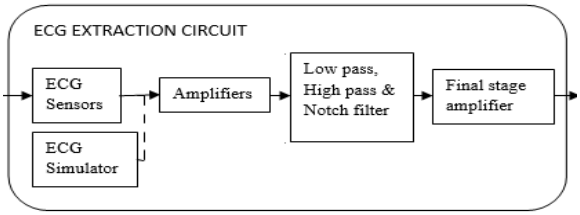


Fig 3. Blocks of ECG extraction circuit

LabVIEW is a graphical programming language that uses icons to create applications instead of lines of text [9]. ECG signal analysiscan be done as shown in figure 4.

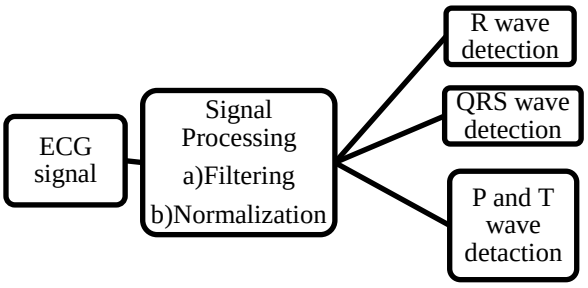


Fig 4. Flowchart of ECG analysis

Acquired ECG signal has been preprocessed by using the wavelet transform. The LabVIEW ASPT provides the WA Detrend VI which removes the low frequency trend of a signal. The Daubechies6 (db06) wavelet has been used since it is similar to the real ECG signal.

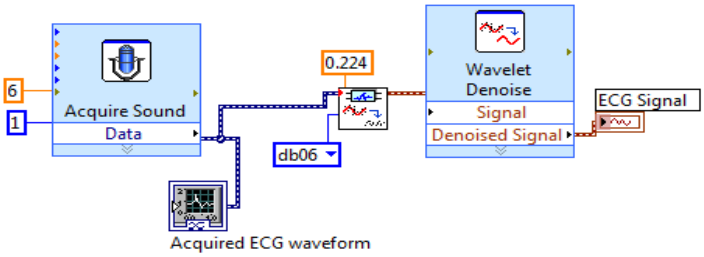


Fig 5.Code for Preprocessing of ECG Signal

The heart rate is calculated as follows,Heart rate =(1/RR interval in sec.)*60 .

The LabVIEW code for calculating heart rate is as shown in figure 6.

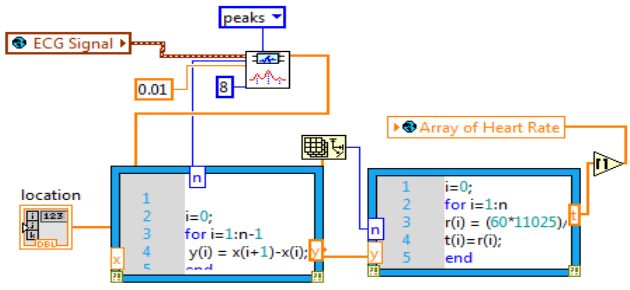


Fig 6. VI for Calculating Heart Rate

Analyais based on heart rate has been explained with the help of flowchart as follows.

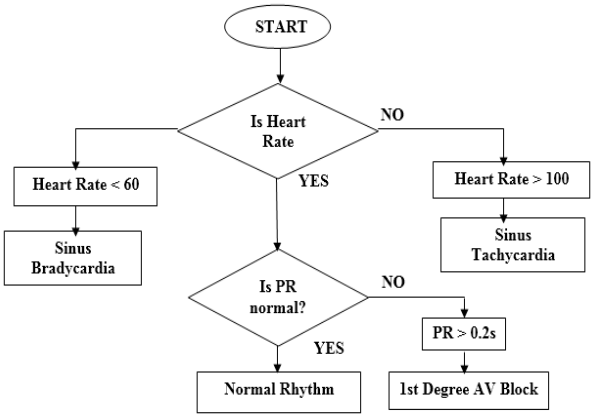


Fig 7. Analysis based on ECG

IV. RESULTS

The ECG signal has been acquired from a person using the designed circuit through Ag-AgCl electrodes and it has been displayed on DSO which has heart rate of 80 bpm and amplitude of 1.1V as shown in figure 8.

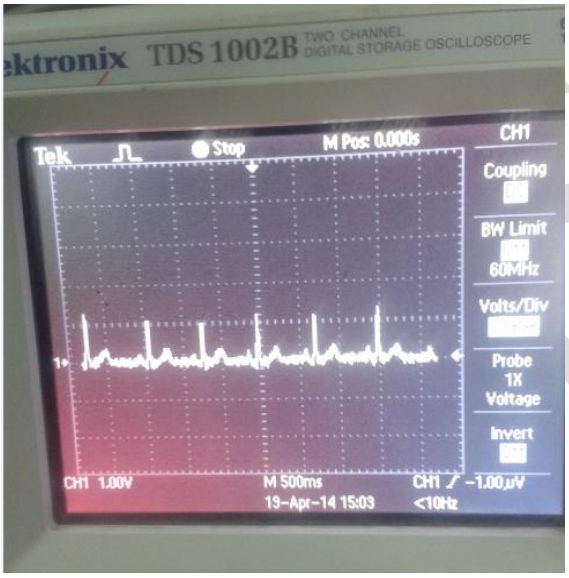
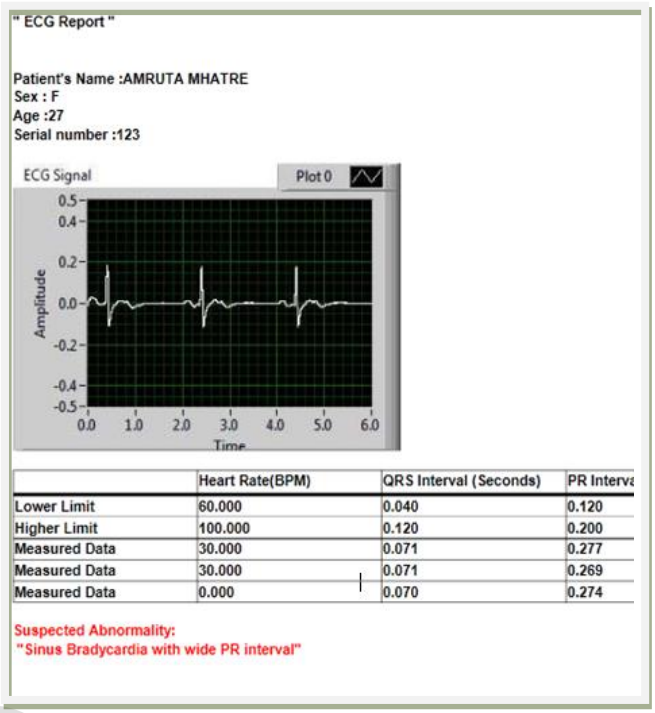


Fig 8.Acquired ECG signal on DSO

ECG signal analysis has been done with LabVIEW software with input collected from ECG simulator then filtered and amplified using designed circuit and the report also been generated as shown in figure 6.



	Heart Rate(BPM)	QRS Interval (Seconds)	PR Interva
Lower Limit	60.000	0.040	0.120
Higher Limit	100.000	0.120	0.200
Measured Data	30.000	0.071	0.277
Measured Data	30.000	0.071	0.269
Measured Data	0.000	0.070	0.274

Fig 6. Generated Report using LabVIEW

The measured and the observed readings are shown in the table 2.

Table 2 Measured and Observed values of ECG parameters

	PR interval (seconds)		QRS interval (seconds)	
	Measured Interval	Observed Interval	Measured Interval	Observed Interval
Normal Person	0.163sec	0.161sec	0.076 sec	0.0742 sec
HR=30 BPM	0.270sec	0.274sec	0.070sec	0.072sec
HR=60 BPM	0.163sec	0.165sec	0.058sec	0.056sec
HR= 120 BPM	0.1087sec	0.1089sec	0.042sec	0.04sec
1st Degree AV Block	0.32 sec	0.30 sec	0.047sec	0.048sec

V. CONCLUSION

"Temporal Analysis of ECG signal using LabVIEW" aims at acquiring and analyzing temporal parameters of ECG signal such as P wave , QRS complex, RR interval, PR durations and amplitudes of P wave, ST wave using LabVIEW.This work focuses on acquisition and analysis of ECG signal, identification of cardiac arrhythmia and database maintenanceusing LabVIEW. This system will help cardiologist and health care system in diagnosis of various types of Arrhythmia.

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