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Simulation of Heart Rate Variability Detectors using MATLAB

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***Abstract*—This paper presents an ECG signal processing model to investigate multiple heart problems such as apnea, tachyarrhythmia, etc and heart rate variability (HRV). The HRV Processor was designed at Simulink. HRV is used as a quantitative indicator of the Autonomic Nervous System (ANS) and cardiovascular system. The ECG test system empowers us to study standard and irregular ECG waveforms without even using ECG instruments. To calculate the HR carrying HRV information, the QRS complex, which is the main component of the ECG signal, is used in this paper**

***Index Terms*— Heart Rate Variability, MATLAB, Signal Detection.**

I. Introduction

Each beat in the normal heart starts with Stimulus way up in the right atrium of the neuromuscular junction, causing the cardiac muscle to depolarize at this point [1]. This stimulation is random and automatic, has a speed of 100 to 120 beats per minute, and is the primary cardiac pacemaker cause (bpm) [2].

The pulse propagates to depolarize the atrium from the SA node (The Two Upper Cavities). Located in the right atrium, the electrical pulse then enters the atrioventricular (AV) node [3]. Usually, because a non-conducting fibrous band divides the myocardium's bulk from the ventricles, a momentum will only reach the ventricles through the atrioventricular junction [4].

It is now slowing down because of the majority of the muscle, whenever the AV junction is triggered. It thus acts as a defense mechanism while simultaneously avoiding the transfer to the ventricles of rapid atrial impulses [5]. If AV junction is unable to thrive impulses, it would be the new automated heart rhythm creator (with a heart rate of 40-60 bpm). A SA- NA division would hamper nuclear pacemaker before its pulses hits the atrioventricular junction [6].

It joins his box after the urge has gone through the AV node. This performing network extends through the septum and separates via the portions of the bundle branches [7]. It promotes the ventricles' depolarization like the momentum flow through their area and through the anterior and posterior fascicles. When the AV node fails, there is a ventricles pacemaker2 (with a beat frequency of 15 to 40 bpm) which takes over as the major heart monitor [8].

A transient phase happens during the ventricles' depolarization when no further ionic current will go into the myocardial disorder. This is referred to the refrigerant loop that least persists 200 ms [9]. Then the ventricular myocardium is recharged (depolarized) to the pending electrical strength of the heart will repeat the round.

A temporary phase follows the ventricles' depolarization, where no extra ionic current will pass across the connective tissue. This is referred to as the refractory duration, which continues for a minimum of 200ms [10]. The ventricular myocardium is then recharged (depolarized) to it's the pending electrical strength of its, Now the heart is still and steady primed to launch a new period.

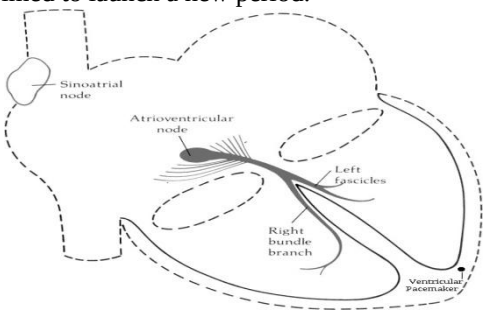

Figure 1: Source nodes of Electrical Stimulation

II. Proposed Methodology

The execution work is performed on the MATLAB r2011a. The reenactment of the base administrative work and the proposed work is finished by structuring the GUI. The GUI part of the MATLAB simply let us to make the screens by hauling the controls on the workspace. The structures which we make in the MATLAB are known as figures. MATLAB applications square measure independent MATLAB programs with interface front completes that mechanize a task or tally.

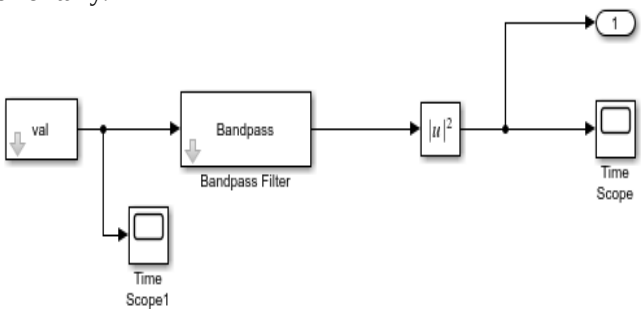

Figure 2: Proposed System Architecture

III. Simulation Results

PHYSIONET was taken from the data used for processing. In specific, sleep apnea cases and tachyarrhythmia of the CU

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Ventricular are being investigated.

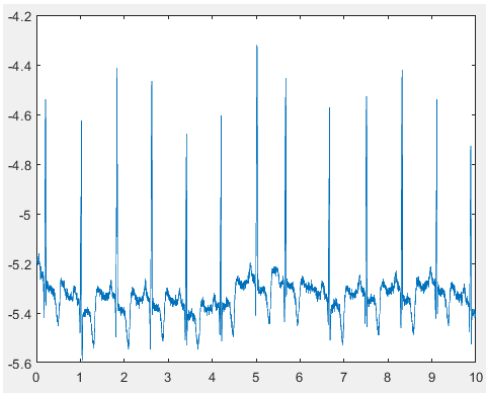

Figure 3:ECG waveform-1 as Input

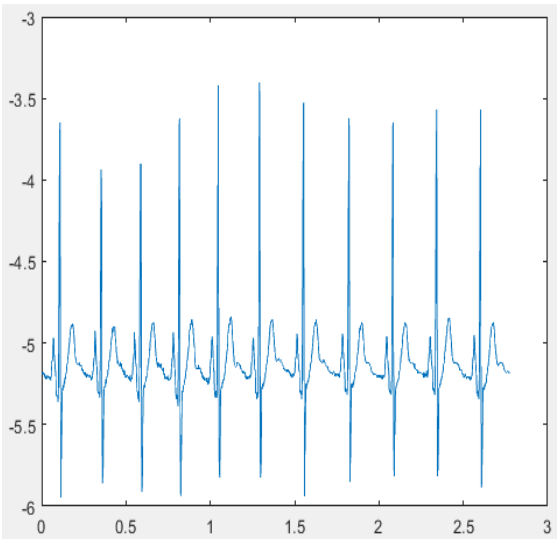

Figure 4:ECG waveform-2 as Input

The graph below demonstrates the filter block's performance that suppresses the ECG signal noise and produces this waveform output.

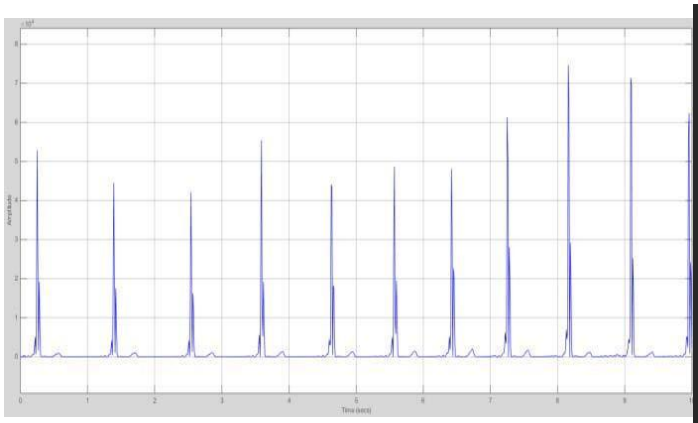

Figure 5: Filter Module's Output

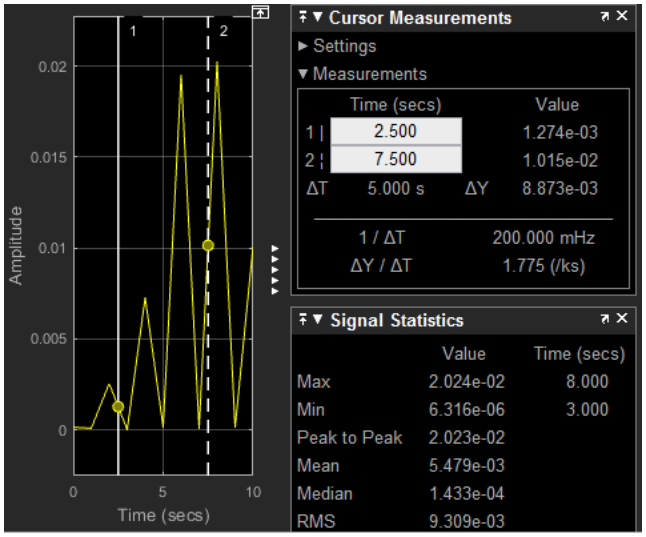

Figure 6: Heart Rate Time Measurement-1

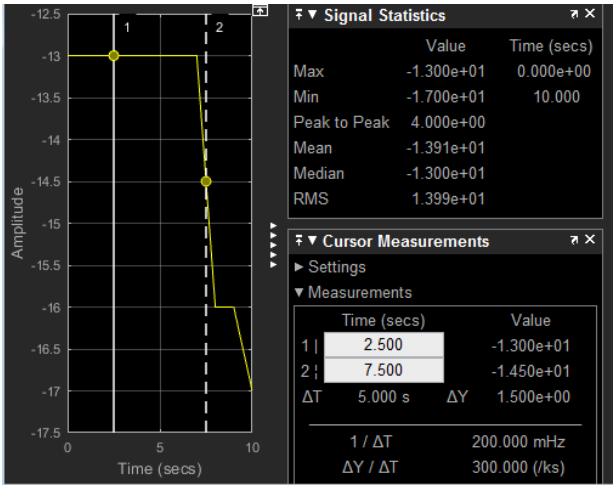

Figure 7: Heart Rate Time Measurement-2

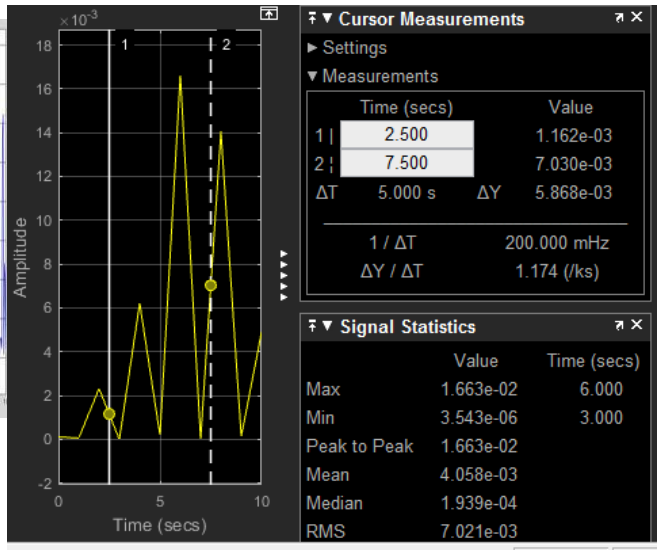

Figure 8: Heart Rate Time Measurement-3

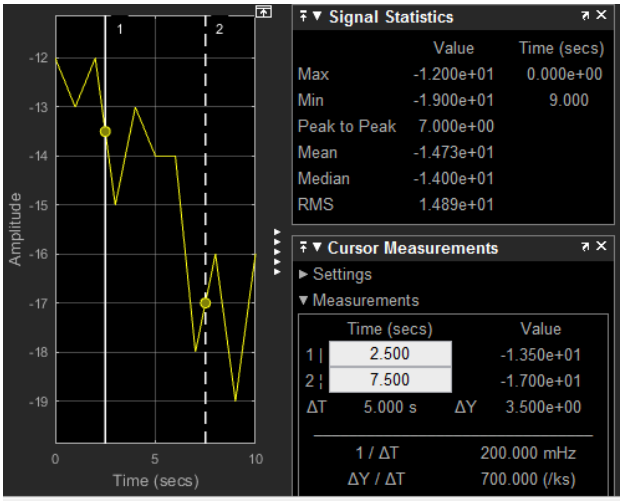

Figure 9: Heart Rate Time Measurement-4

The study's heart rhythm above is 11 beats per second or 66 beats per minute for a 1 minute sample.

IV. Conclusion

In MATLAB Simulink, the HRV Processor has been implemented and successfully studied. In the case of APNEA, heart rate variations have been seen and tachyarrhythmia's have been identified by the CU processor.

As the number of peaks occurred for 10 seconds, ventricular data indicates a greater heart rate than average for more than 15 seconds. The data acquired after processing is thus checked. In addition, with the aid of HDL coding of the processor built in Simulink, the processor can be implemented on FPGA for future work.

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