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Biometric Monitoring System for Multi Sensor Multi-modal Node Architecture

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***Abstract* – Biometric monitoring and healthcare using wireless sensor networks is an active area of applied research. The general network topology used for wireless body area networks is the star topology with the sensor nodes sending their data to a central processing node for data fusion. Reliability of these networks is very important since they deal with human life. Reported applications have had performance and reliability problems. In the paper, several reported applications of wireless body area networks are reviewed and the reliability of a sample WBAN is computed.**

I. INTRODUCTION

The "Biometric Monitoring System" program gives users the ability to easily create custom ECG and Blood Pressure. The program stores the waveform data in a Matlab array and plots the waveform. It then provides the user the ability to send the ECG waveform to an arbitrary waveform generator or to store the ECG waveform in a CSV file. The arbitrary waveform generator feature allows you to easily recreate a real world ECG signals for testing ECG measurement equipment.

The CSV file storage allows to store the custom ECG waveform created for later analysis and use. It also allows analyzing and manipulating the ECG waveform using Excel tools. The aim of the Biometric Monitoring System is to produce the typical ECG and heartbeat waveforms of different leads and as many arrhythmias as possible. The given Biometric Monitoring System is a matlab based simulator and is able to produce normal lead II ECG waveform.

The use of a simulator has many advantages in the simulation of ECG and Blood Pressure. First one is saving of time and another one is removing the difficulties of taking real signals with invasive and noninvasive methods. The Biometric Monitoring System enables to analyze and study normal and abnormal ECG and Blood Pressure without actually using the machine.

The program can remotely send and store the waveforms on the 33521A Function / Arbitrary Waveform Generator and the 33522A 2-Channel Function / Arbitrary Waveform Generator for testing ECG measurement equipment. Besides providing the ability to continuously output any stored ECG waveform, the 33521A and 33522A also have a feature known as waveform sequencing that allows creating long complex patterns of waveforms stored in memory. The sequencing feature is analogous to creating a playlist on the MP3 player. Multiple ECG waveforms are collected together in memory to create a long complex pattern of ECG waveforms for creating real world ECG patterns. The instrument must be connected to the computer running the program via a LAN cable or to the same Ethernet network that the computer is connect to. It is necessary to have the Matlab "Instrument" toolbox to run this program.

Wireless body area networks (WBANs) promise ambulatory health monitoring for extended periods of time and near real-time updates of patients' medical records through the Internet or intranet. Jovanovet al. (2006) presented a WBAN as shown in Fig. 2 utilizing a common off-the- shelf wireless sensor platform with a ZigBee-compliant radio interface and an ultra low-power microcontroller. The standard platform interfaces to custom sensor boards that are equipped with accelerometers formation, monitoring and a bioamplifier for

electrocardiogram or electromyogram monitoring. They used TinyOS operating system to develop the software modules for on-board processing, communication and network synchronizations.

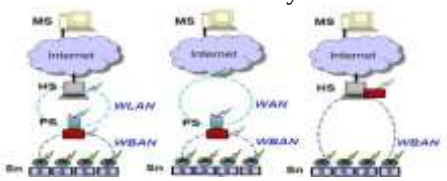

Fig. 1- The Wireless Body Area Network (WBAN) for ambulatory monitoring.

II. PERFORMANCE AND RELIABILITY OF WBAN

In recent years, interests in the application of Wireless Body Area Network (WBAN) have grown considerably. A WBAN can be used to develop a patient monitoring system which offers flexibility and mobility to patients. However, there are serious performance and reliability issues in WBANs that must be addressed. The network topology that is generally used in wireless sensor networks for such ambulatory studies is of the star configuration as shown in Fig.2. This is because nodes usually are sensor nodes and do not need to communicate with each other.

Therefore, the star topology is used and each sensor node communicates with the central node using a hub. This raises reliability questions as the hub or the central node may fail leading to total system failure. Even the communication links may perform poorly or fail. Since data fusion is used in almost all applications, even the failure of any of the sensors or the communication links would result in system failure. Ylisaukko-oja etal.(2004) presented the implementation and practical use of an unobtrusive five-point acceleration sensing wireless body area network(WBAN) with mobile device data logging capabilities.

They used TDMA based MAC protocol and RS232 for serial communications with external devices. They reported good communications performance in laboratory conditions but weaker field test performance. Their tests indicated significant losses in communication. Under laboratory conditions, they lost the remote slots from 0.31% to 3.09% in various parts of the test while in the field tests; they lost central data upto 3.84%and lost remote slots from13.66%to52.51%.This indicates a high degree of reliability problems especially in communications.

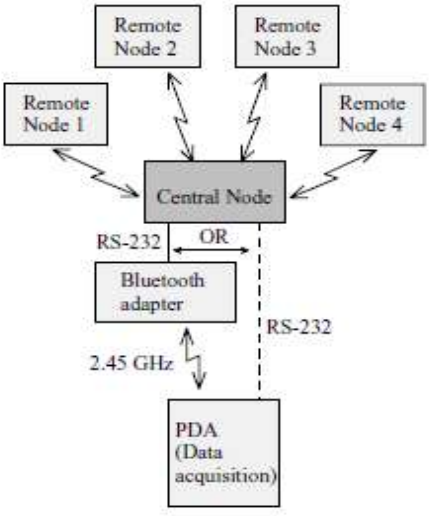

Fig2–The general network topology used in WBAN

III. SIGNIFICANT FEATURES OF ECG WAVEFORM

A typical scalar electrocardiographic lead is shown, where the significant features of the waveform are the P, Q,R,S,and T waves, the duration of each wave, and certain time intervals such as the P-R, S-T, and Q-T intervals.

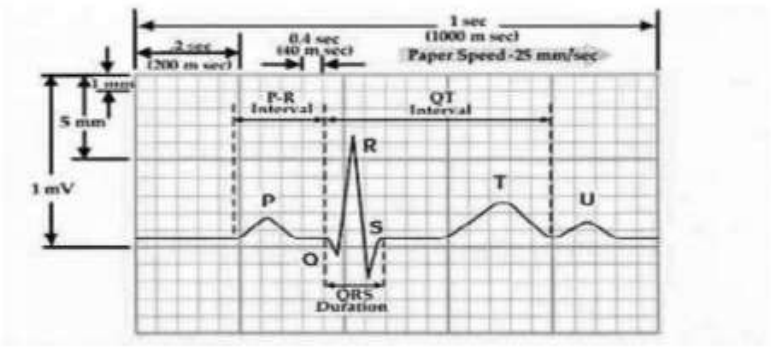

Fig 3 - Typical ECG signal

Below is a screen shot from an example run of the ECG Waveform Simulator program as well as a screen shot from an Oscilloscope that shows the resulting waveform being outputted from a 33522A. In the above screen shot the program was run using just the default ECG waveform settings. Next the ECG waveform was sent to a 33522A with IP address "148.5.250.140" and the ECG waveform was named "ecg2."

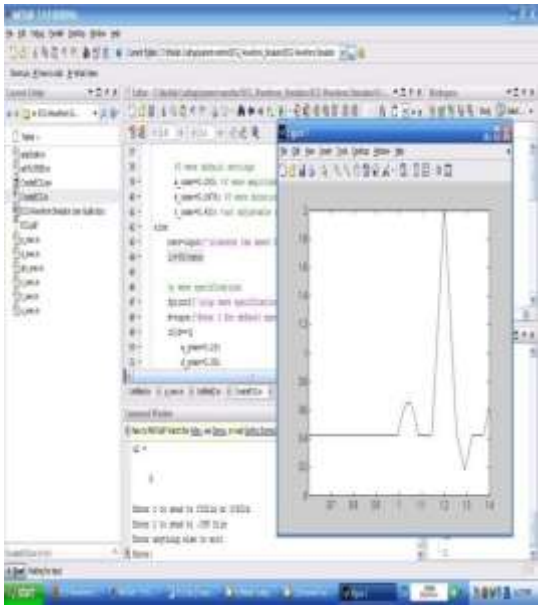

Fig 4 - ECG Simulation Result

Fig 5 - Sequence Output Waveforms

Above shows an oscilloscope screen shot of a sequence output from a 33522A of three ECG waveforms created using the program. Using the sequencing feature on the 33522A or 33521A allows you to create complex patterns of stored waveforms. For instance have played the first ECG waveform 150 times, the second 10 times, and the last one 300 times.

IV. Default Specification

Heart beat: 72

P wave Amplitude=0.25; Duration =0.09; Time interval=0.16;

Q wave Amplitude =0.025; Duration =0.066; Time interval =0.166;

QRS wave Amplitude =1.6; Duration =0.11;

S wave Amplitude =0.25; Duration =0.066; Time interval =0.09;

T wave Amplitude =0.35; Duration =0.142; Time interval =0.2;

U wave Amplitude =0.035; Duration =0.0476; Time interval =0.433;

They can be obtained from the code of the simulator from the file complete.m. The user can enter their desired values of specifications too. Other concepts of the code are simple and are self-explanatory. A typical output for the above specification is shown in the figure.

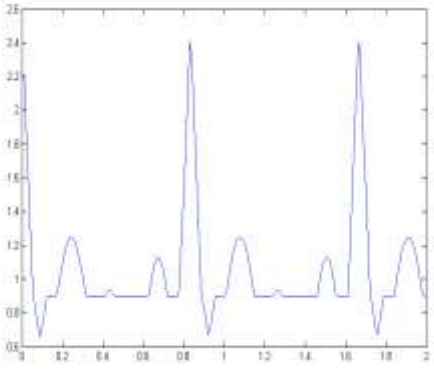

Fig.6 Output Waveforms

V. CONCLUSION

MATLAB is a powerful tool that provides enormous consequence on the processing of ECG signal. It is constructive and versatile that still individual can monitor his/her heart condition just utilizing the power of MATLAB without having an ECG machine and also self-diagnosis is possible. All these examples and techniques that are discussed here can be really useful for experimental and lab purpose.

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