REAL-TIME WIRELESS ECG AND ITS SIGNAL DISPLAY ON LABVIEW

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Abstract-Ubiquitous vital signs sensing using wireless medical sensors are promising alternatives to conventional, in-hospital healthcare systems. The advent of modern age has shown a drastic shift in the way humans have worked leading into sedentary lifestyles. Change in dietary pattern where fresh food is replaced by processed and fast food along with the increase of stress has led to rise of cardio-vascular disease which is glaringly evident in developing countries. Especially, Asians are more prone to cardio-vascular diseases genetically. The ECG device is a diagnostic medical instrument which determines the electrical activity of the heart. The conventional ECG devices are powered by mains electricity, thus are not energy efficient. Transformers used make the device bulky and expensive. Optimum isolation amplifiers have to be incorporated in these devices for patient safety, adding to the cost and complex circuit. In this work, a wireless ECG sensor is proposed.

I. INTRODUCTION

The Electrocardiogram (ECG) is a measurement of the electrical activity of the heart over time, captured and externally recorded as measured by skin electrodes. ECG is a technique of recording bio-electric current generated by heart. The signals indicate the overall rhythm of the heart and weaknesses in different parts of the heart muscle. This technique is the best way to measure and diagnose abnormal rhythms of the heart, and is commonly used in hospitals all over the world[1]. It is also used in sports and military environments for advanced diagnostics of healthy individuals. In recent years, the research community has been active in pursuit of technologies for a “Wireless ECG” where patients are no longer required to be attached to a large stationary device while their ECG signals are monitored. A major motivator behind this trend is the reduced healthcare costs of remote monitoring, where patients can reside their homes rather than occupy a hospital bed. Many systems have been proposed to accomplish this feat, with varying goals and approaches. Wireless ECG monitoring can be done using 3, 4, 5 or 10 sensors, providing increasingly detailed information to cardiologists. The data is captured and monitored by wearable circuitry, and is then wirelessly transmitted to a nearby listening device. The nearby listener can be as simple as a basic logging or analysis device, or as complex as a large hospital information system that actively collects wireless data in real-time from multiple patients. Wireless ECG systems may be loosely grouped into two categories: those with wired sensors and those with wireless sensors [2]. The first group of systems uses physical wires to connect all sensors to a central PDA-sized device, which then transmits the data wirelessly to a monitoring station. These systems free the patient from being tethered to bulky equipment.

One of the main goals of this project is to provide maximum convenience to the user or patient during ECG measurements, especially for prolonged use. Wireless technology is able to generate interactive healthcare utilizing modern technology and telecommunication. In telemetry system is useful for absent of directly contact between the patient and doctor- physician. The wireless device employ for the efficient remote monitoring system, using for real time, continuous and accurately information of patient heart condition. In this project, design of wireless ECG sensor is performed and displayed its output on computer screen wirelessly.

II. LITERATURE REVIEW

1. International Journal of Computer and Electrical Engineering, Vol. 4, No. 3, June 2012 Study and Analysis of ECG Signal Using MATLAB (matrix laboratory) & LABVIEW as Effective Tools. This paper deals with the study and analysis of ECG signal processing by means of MATLAB tool effectively. Study of ECG signal includes generation & simulation of ECG signal, acquisition of real time ECG data, ECG signal filtering & processing, feature extraction, comparison between different ECG signal analysis algorithms & techniques (i.e. Wavelet transform or so), detection of any abnormalities in ECG, calculating beat rate and so on using the most familiar and multipurpose MATLAB software along with LABVIEW (Laboratory Virtual Instrument Engineering Workbench). The proper utilization of MATLAB functions (both built-in and user defined), toolbox and Simulation link can lead us to work with ECG signals for processing and analysis both in real time and by simulation with great accuracy and convenience.

In this context they present how Zigbee meets the requirements for bandwidth, power, security and mobility. The data throughputs has been examined for various medical devices, the requirement of data frequency, security of patient data and the logistics of moving patients while connected to devices. This paper describes a new tested architecture that allows this data to be seamlessly integrated into a User Interface or Healthcare Information System (HIS).

3. Lamei C, Mohamed S, Shakshuk M, Badreldin I, ElBab I, “A ZigBee-based tele cardiology system for remote healthcare service delivery,” IEEE Trans. 978-1-4244-7000-6/11/$26.00 ©2011 [2] IEEE. This paper describes the design and implementation of a tele cardiology system using Zig Bee. The proposed system will provide doctors with the ability to monitor, and diagnose their patients remotely over the Internet. This system is capable of receiving a serial stream of data and extracting relevant packets from the measurements of the patient’s vital signs. The implemented software allows patients to easily connect with their doctors and to send their data via Internet. The ECG signal is monitored in a real-time mode with the ability of keeping records through SCP-ECG (Standard Communication Protocol) standard.

III. BLOCK DIAGRAM FOR WIRELESS ECG

The signals from the body is taken by the electrodes (Ag-AgCl electrodes), the signals are very weak hence it is given to the amplifier. The front-end for the signal acquisition system is an instrumentation amplifier. It has a very high common mode rejection ratio (CMRR) and high input impedance which is required for capturing EKG signals. Along with the signal noise also gets amplified, this noise is removed by band pass filter. Since the acquired signals are weak it is given to the buffer amplifier. The signals are digitized using Analog to Digital Converter (ADC).

The ADC used is I2C ADC. The main objective behind the invention of I2C bus is to establish a simple low pin count bus that can connect different ICs on a circuit board. The two I²C signals are serial data (SDA) and serial clock (SCL). Together, these signals make it possible to support serial transmission of 8-bit bytes of data-7-bit device addresses plus control bits-over the two-wire serial bus. The device that initiates a transaction on the I²C bus is termed the master. The master normally controls the clock signal. A device being addressed by the master is called a slave. Then Microcontroller will format the data for in the form suitable for transmission. A Micro controller consists of a powerful CPU tightly coupled with memory RAM, ROM or EPROM), various I  O features such as Serial ports, Parallel Ports, Timer/Counters, Interrupt Controller, Data Acquisition interfaces-Analog to Digital Converter (ADC), Digital to Analog Converter (DAC), everything integrated onto a single Silicon Chip. Then it is wirelessly transmitted to PC using RF module. The RF module used is Tarang F4. Tarang modules are designed with low to medium transmit power and for high reliability wireless networks. Tarang can be interfaced with a micro controller or a PC using serial port. The result is viewed in LABVIEW (Laboratory Virtual Instrument Engineering Workbench). LABVIEW is a graphical language method by which codes are generated and saved. There is no text based code, but a diagrammatic view of how the data flows through a program. LABVIEW contains a comprehensive set of
tools for acquiring analyzing, displaying, and storing data.

IV. ECG SIMULATOR

The aim of the ECG simulator is to produce the typical ECG waveforms of different leads and as many arrhythmias as possible. This ECG simulator is a LABVIEW 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 waveforms. First one is saving of time and another one is removing the difficulties of taking real ECG signals with invasive and non invasive methods. The ECG simulator enables us to analyze and study normal and abnormal ECG waveforms without actually using the ECG machine. One can simulate any given ECG waveform using the ECG simulator.

Significant features of ECG waveform

A typical scalar Electrocardiographic lead is shown in Fig. 1, 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. ECG signal is periodic with fundamental frequency determined by the heartbeat. It also satisfies the Dirichlet’s conditions. Hence Fourier series can be used for representing ECG signal. By observing Fig. 1 carefully, it may be notice that a single period of an ECG signal is a mixture of triangular and sinusoidal wave forms. Each significant feature of ECG signal can be represented by shifted and scaled versions one of these waveforms as shown below.

- QRS, Q and S portions of ECG signal can be represented by Triangular waveforms.
- P, T and U portions can be represented by triangular waveforms.

Once we generate each of these portions, they can be added finally to get the ECG signal. So the generated output ECG signal by LABVIEW is shown in Fig. 2. The specifications are default for this signal which can be changed according to the user’s requirement while simulating the LABVIEW code.
ECG analog signal acquisition
The Analog signal portion has been simple, in order minimized space board. The raw signal- noisy ECG signal is acquire through disposable electrodes, attached to cables through a couple of standard clips. That signal applied to the Filter circuit and then to wireless module for transmission. Electrodes are used for sensing bio-electric potentials as caused by muscle and nerve cells. EKG(Electro Cardio Gram) electrodes(Ag-AgCl electrodes) are generally of the direct-contact type. They work as transducers converting ionic flow from the body through an electrolyte into electron current and consequentially an electric potential measurable by the front end of the EKG system. These transducers, known as bare-metal or recessed electrodes, generally consist of a metal such as silver or stainless steel, with a jelly electrolyte that contains chloride and other ions.

Wireless Transmission/Reception
Wireless module based on IEEE 802.15.4 used for transmission and receiving the signal. ECG front end circuit connected with wireless module as remote base station. Receiver module is interface with PC at Base station. Analog signal, ECG form measurement data from the sensor (electrodes) are transmitted wirelessly using low cost module (Zigbee-802.15.4 or Tarang F4) radio equipment. Tarang modules are designed with low to medium transmit power and for high reliability wireless networks. The modules require minimal power and provide reliable delivery of data between devices. The interfaces provided with the module help to directly fit into many industrial applications. The modules operate within the ISM 2.4-2.4835 GHz frequency band with IEEE 802.15.4 base band. Tarang wireless module working is like zigbee modules so these modules are direct replacement for zigbee modules,. They are available from 100meter range version to 50km range version. At the receiver side same type of radio module for receiving the wireless signal which was transmitted by the transmitter module at ECG taken from the body using transducer (electrodes). Then forwarded to com port of PC for further processing of ECG signal. Display of signals can be done on LABVIEW.

VI. HARDWARE REQUIREMENTS
1) Ag–Agcl electrodes
2) Instrumentation amplifiers AD620 or INA333
3) General purpose opamp LM324
4) Resistors and capacitors for filter design
5) ADC PCF8591
6) Embedded boards
7) RF modules
8) PC usb2serial cables

VII. SOFTWARE REQUIREMENTS
1) Keil for embedded C programming
2) Excel for intermediate results verification and plotting waveforms.
3) Lab view.

VIII. ADVANTAGES
1) Portable system patient is not tether to the huge machines With this system patient is given portability.
2) As system is portable it runs on battery so no problem of 50Hz noise and shock hazards.
3) Doctors can see data remotely and analyze the ECG signals of patients.
4) ECG signals can be stored in computer as files for further analysis.

IX. DISADVANTAGES
1) As system runs on battery you have recharge or change the batteries frequently.
2) Electronics has to be carried always along with patient.
3) Wireless can be jammed or can have interference from similar frequency sources.

X. APPLICATIONS
1) Long term monitoring of patients
2) Low power ECG monitoring.

XI. EXPECTED RESULT
A wireless ECG sensor which displays its out on computer using Lab view. A device which employs efficient remote monitoring for real time, continuous, and accurate information of heart condition.

XII. FUTURE SCOPE
Instead of body worn ECG electrodes we can use capacitive electrodes which can be fitted in clothing instead of sticking to body using gel. Wi-Fi can be used as it can be directly connected to phone and hence to internet directly with dedicated android app.
1) Ultra-low power system can be built with low power wireless protocol to save power and longer battery life.
2) Solar powered ECG electrodes can be used in future.
3) Very small electrodes with all electronics can be built in future no need to carry Mextra electronics.

REFERENCES

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