ABSTRACT: This paper presents the biological data acquisition and transmission for the remote monitoring of some severe diseases and disorders e.g. Diabetes and Cardiac activity. These types of patients have to need close and continual monitoring in order to prevent further damage. Patient monitoring and the acquired data are transmitted through wireless medium by using BLUETOOTH technology. Bio-signal can be acquired and high frequency noise cancellation also be processed with the help of MATLAB Digital Filter Design Tool (FDA Tool). Data or signal is transmitted to the patients’ mobile continually using BLUETOOTH. Security is the main problem in wireless transmission but it can be solved by using frequency hopping technique which is broadly used in BLUETOOTH technology and moreover, to increase the security level, we can use link level security where the security procedure initiates before the channel established.

Keywords: Data Acquisition, Wireless Transmission, Bluetooth, Wireless Monitoring, FDA Tool

1. Introduction

Patient monitoring in a clinic or hospital is an essential part for a doctor. Generally, patient and doctor communicate face to face. In this way, a doctor can not give enough time for a patient. But at present, medical science and patient monitoring system have become more advance and easier in favor of modern science. To overcome this monitoring problem, telecommunication technology is used for not only monitoring but also remote diagnosis.

The use of telecommunication for remote diagnosis is growing rapidly. This monitoring and remote diagnosis system can be accomplished by using wireless transmission such as GPRS, GSM, Wi-Fi, Wi-max, Bluetooth technology, cellular phone, Wireless Local Area Network (WLAN) etc. But the Bluetooth technology is more reliable wireless transmission technology for short range communication. It has low cost and also transferred capability both data and voice. Bluetooth has
wide acceptance among manufacture because its chipset can be readily integrated with the existing medical equipment.

To establish this wireless network, the data collection system of the hospital is technically upgraded. When the network will be established, it would be helpful to reduce the doctor’s work load. Here, doctor can easily communicate and diagnosis the disease using his mobile or PC.

The patient monitoring system is being developed day by day. Many scientists and researchers are working hard and soul to upgrade the system and to consume the doctor’s and patient’s valuable time. Telemedicine and telecare are used in medical science for long time. But patient monitoring as well as diagnosis and treatment of the diseases using the wireless technology is new.

Several groups [1] have developed applications to monitor the ECG in mobile devices, where the samples have been obtained from standard data bases or they have development the ECG module [2]. Other works [3-5] have proposed techniques for signal processing via software to reduce noise or classify heart pathologies. In this paper, we describe not only EGC data but also several biological data acquisition system and its implementation with wireless transmission capabilities.

2. Proposed Model for Patient Monitoring System

Patient monitoring is one of the major duties of a doctor. In hospital or a clinic, a doctor can observe only a patient at a time. Doctor meets the patient and observes the biological data of the patient. It is very hard work for a doctor. On the other hand, a hospital or clinic needs more doctor for growing a better patient monitoring system. In this way, we proposed a model for better patient monitoring. This proposed model is able to establish a better monitoring system because one doctor can monitor seven patient’s biological data at a time without face to face communication in successfully. It would be also useful and effective for medical treatment.

The proposed model has two part, transmission side and receiving side. In transmission side, biological data acquire from the human body or patient and this data transmit through the BLUETOOTH. In receiving side, doctor receives the data from his mobile or pc but these devices must have BLUETOOTH technology. The figure 1 and 2 shows the parts of the proposed model.
Data acquisition is done by using personal computers with PCI, PXI/Compact PCI, PCMCIA, USB, IEEE1394, ISA, or parallel or serial ports. DAQ hardware is coupled via parallel or serial port with PC [6]. The computer is used for data acquisition system because it has maximum speeds and able to continuously acquire the data [7]. Today’s technology boasts Pentium, Dual Core, Core 2 Due and PowerPC class processors coupled with the higher performance PCI bus architecture as well as the traditional ISA bus and USB. The biological signal or data is collected from the human body. For collecting data, we use leads. In medical instrument, lead is one kind of transducer which converts the
energy from one form to another form. It senses physical phenomena and provide electrical signals that the DAQ system can measure. For example, thermocouples, RTDs and thermistors convert temperature into an analog signal that an ADC can measure. Other examples include strain gauges, flow transducers, and pressure transducers, which measure force, rate of flow, and pressure, respectively. In each case, the electrical signals produced are proportional to the physical parameters they are monitoring.

Bluetooth [8] is a low cost, low power, radio frequency technology for short-range communications. It has 2.4 GHz ISM bands, Frequency hopping, Gaussian shaped BFSK modulation, 723Kbps data rate. It has operated range 10 to 100m. It can be used to replace the cables connecting portable or fixed electronic devices, build ad-hoc networks or provide data or voice access points [9]. Bluetooth is extremely secure because Bluetooth devices combine the use of a Pass Key and a specific address to identify other Bluetooth devices [10]. Encryption can also be used to supplement the level of Bluetooth security. Several design features of Bluetooth devices like their intentional short range, frequency hopping and small data packets [11]. These features make the Bluetooth extremely resistant to RF interference.

In practical moment, we proposed a flow chart which presents our overall experiment. The proposed flow chart worked with two signals. These signals are acquire from the patient’s body with the help of leads. After acquire the signals are going through a sophisticated device where these signals integrate and compress. Then, this device makes a data file (as image) and store it in a mobile or pc. Here, the mobile or pc has a BLUETOOTH capability to transmit the data file in another mobile. In transmission process, master mobile (this paper describe master mobile as patient’s mobile) send a request for a connectivity to the slave or selected mobile, if the slave mobile accept it and send its acknowledgement to the master mobile and then establish a connection path. In receiving process, slave mobile (this paper describe slave mobile as doctor’s mobile) receives the data file and also store in the mobile’s memory for future observation. From our experiment, we can say that master or slave mobile can communicate seven slaves or masters mobile easily. The figure 3 shows the flow chart of the proposed model.
3. Simulations and Testing

Bio-signal Data Acquisition:
To collect the biological signal or data, we take two types of data acquisition system. Firstly, we use real PCI-1711/1731 data acquisition card and then we take data by using MATLAB Simulink Model and Microphone.

For collecting the real time data, we use four leads which places on the right arm(RA), left arm(LA), Right leg(RL), and left leg(LL). The lead captures the bio-signal from the human body. Then the signal sent to the circuit board and connected them into the four input channel from the sixteen input channel board as shown in the figure 4. The data acquisition card is setup into the mother board of the Computer. This card processes the signal which is obtained from human body. It is also done amplification, filtering, multiplexing etc. Finally, show the output by using the MATLAB software.
The word lead has two meanings in electrocardiography, it refers to either the wire that connects an electrode to the electrocardiograph, or (more commonly) to a combination of electrodes that form an imaginary line in the body along which the electrical signals are measured.

A Bio-signal is obtained by measuring electrical potential between various points of the body using a biomedical instrumentation amplifier. A lead records the electrical signals of the heart from a particular combination of recording electrodes which are placed at specific points on the patient's body. To setup the PCI1711/1731 card into the motherboard of Personal Computer is essential. We place it in the PCI slot. So, by using Personal Computer, we can process the data and represent the output at a time [12]. After processing the bio-signal, the output is shown on the monitor, as shown in the figure 5. We can show the display in two ways, first one is PCI 1711/1731 software and another one is MATLAB software.
**Voice Data Acquisition using MATLAB:**

In this part, we use MATLAB Simulink and Microphone for acquire the data. In our voice data acquisition project, we produce audio signal and transmit it. A Microphone is a device made to capture waves in air, water (hydrophone) or hard material and translate them into an electrical signal. The most common design uses a thin membrane which vibrates in response to sound pressure, this movement being subsequently translated into an electrical signal. Most microphones in use today for audio use electromagnetic generation (dynamic microphones), capacitance change (condenser microphones) or piezoelectric generation to produce the signal from mechanical vibration. The Microphone which acts as the From Wave Device, according to the MATLAB Simulink capture the audio signal and link to the Time Domain output and also link to the Wave File, as shown in the figure 6. When the Microphone is on, it is then ready to capture the voice from the air. The voice signal then processing and convert into electrical signal.

![Simulink Model of voice data acquisition](image)

**Figure 6: Simulink Model of voice data acquisition**

The electrical signal can be displayed using MATLAB Simulink. In our Model, we use Time Domain Vector Scope which displays the output and Wave File which store the audio.wav file. After finishing the process, we get the output in Time Domain, as shown in the figure 7.

![Simulation result of the Electrical signal of the voice](image)

**Figure 7: Simulation result of the Electrical signal of the voice**
We know that sometimes the bio-signal may be corrupted by unwanted signal when it takes from human body. It is harmful to determine accurate disease for a doctor. In our experiment, we use PCI 1711/1731 data acquisition card which card has already noise cancellation feature. But we want to see, this card able to reduce the noise or not. For this reason, we use FDA Tool of MATLAB for examine the noise cancellation procedure of the card. The figure 8 shows the simulink model of noise testing.

![Simulink Model of noise testing](image)

**Figure 8: Simulink Model of noise testing**

We get the original output signal from PCI card software and also MATLAB software. In MATLAB software, we find an image data (.fig) and MATLAB data file (.mat). To exam the noise or unwanted signal, we used MATLAB data file (.mat). Then, this data file passes through the filter. Here, we use (FDA Tool) - Low Pass filter. Low pass filter is used to pass only low frequency components and prevent unwanted high frequency components. After filtering, we get two outputs in Time Domain and also observe that these two outputs have no difference which gets directly to the output and that obtained via low-pass filter (FDA Tool). These two outputs are shown in the figure 9 and 10 respectively.

![Output without Filter](image)

**Figure 9: Output without Filter**

![Output with Filter](image)

**Figure 10: Output with Filter**
After examination, we can say that this card able to reduce the noise when it acquire the biological data from the human body.

4. Results and Discussions

When the data or signal is acquired, it store in the computer memory. The stored signal is processing some times for matching the resolution of the image and better observation of the signal on mobile display. The signal keeps in the computer as an image for future need. For transmission, we used four Bluetooth mobiles- Nokia N70, Nokia6300, Nokia6630 and Motorola L6. The signal then transmits to the mobile using data cable or Bluetooth device as shown in the figure 11. The mobile also store the image data in its memory. When the patient is needed to transmit the image to the doctor, the mobile is always ready to do it.

![Figure 11: Mobile and PC connectivity using data cable](image1)

The patient mobile scans the other mobile which content Bluetooth as shown in the figure 12. The patient mobile may be got more then one’s.

![Figure 12: Scanning for other mobile](image2)

If the patient’s mobile found more than one mobile it select the doctor’s mobile. When the doctor’s mobile is selected, it found a request from patient’s mobile to active the connectivity. Then the doctor
accepts the request and the two mobiles ready to connect each other. After completing the connectivity the patient mobile send the message signal to doctor’s mobile as shown in the figure 13 (a and b respectively).

![Figure 13: (a) connecting and (b) Sending message](image1.png)

The message signal sent to the doctor’s mobile and ring a tone. The message can be opened and saved easily into the doctor’s mobile as shown in the figure 14 (a and b respectively).

![Figure 14: (a) The received message and (b) save and display](image2.png)

The doctor can see the message from his PC if necessary. For better observation, the doctor can use Zoom-in the image as shown in the figure 15.

![Figure 15](image3.png)
The doctor can also use a printer for print the image. Some times it gives better observation than image observation on the mobile screen.

Finally, we are able to do our experiment successfully. But we face a little problem to collect biological data and when we went through transmitting part. Our collected biological data content high frequency, so we need to filter and modify it for better observation. When the biological data transfer using Bluetooth, it makes problem in some specific sectors such as if the distance is longer. It also can not penetrate hard particle boundary. But in short range and open or thin wear or paper partition, Bluetooth transmission shows no abnormality. We are able to transmit the collected biological data within 10 meter apart.

5. Conclusion:
Throughout the paper a method has been shown to improve the connectivity doctor and patient. It can also improve the diagnosis and treatment activity faster. By this paper, it realized that all kinds of bio-signal (audio, video and image) can be transmitted easily using Bluetooth.

The successive points of the paper are,

1. It reduces the use of cables.

2. Patient and doctor communicate with Bluetooth mobile using Bluetooth facility. So, it reduces the cost of communication.

3. Data is stored in computer or mobile memory in a file format. So, the patient can get treatment for further time.
4. Pen and paper method can now be reduced in the hospital environment using this digital technology.

6. Suggestion

1. Bluetooth device can not establish network if it faces hard particle like bricks, heavy wood board or plastic board. But Bluetooth can penetrate wear or paper. So we design the clinic or ward by using clothed partition.

2. In design, one big room will be partitioned not more than eight and doctor’s place will be middle in the room.

3. We do not use Bluetooth network and Wireless Local Area Network (WLAN) at a time. Because they may create interference each other.

4. We do not use Bluetooth device for transmitting or receiving, if the patient use Electrocardiogram (ECG) pacemaker. It some times makes interference with pacemaker.

5. The guest will not be allowed with Bluetooth mobile, if he entered, must SWITCH OFF the Bluetooth. Some times, mobile data can be hacked by other mobile when Bluetooth switch is on. To prevent this illegal work, we can use some FIREWALL such as Sygate Personal Firewall, Armor2net Firewall, Comodo Firewall etc.

6. For better network, we can establish Virtual Private Network (VPN) with doctor and patients.

7. To increase Bluetooth coverage area, we can use Bluetooth updated version “BLUETOON”

7. Future Plan

In this paper, we have worked with remote patient monitoring which process is accomplished manually. Some times it takes more time to set up the connectivity between patient and doctor. Our present activity is not full wireless and patient is monitored within a clinic or hospital or a ward. Patient can not move freely.

But In our future plan, we want to design a fully wireless and sensor based monitoring system. In this monitoring system, patient will wear simply sensors. Suppose if he is a cardiac patient, will put on
some Leads on his chest. The leads will be connected with sensor and a portable data acquisition
device collects the signal. The patient’s mobile and portable device is connected with Bluetooth.
Finally, the patient mobile send the signal or Image to doctor by using Global System for Mobile
Communication (GSM) technology or upgraded Bluetooth technology. In this way the patient need
not to stay in hospital or home. He will be able to continue his regular activity.

Some times, it will be necessary to find the patient position and for this will try to use Global
Positioning System (GPS). In future we will plan a design with using sensor, GSM technology or
upgraded Bluetooth technology (Bluetooon). It will be helpful not only patient but also doctor.

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