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RESEARCH ARTICLE

Bio-Signal Monitoring System using Mobile Phone

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ABSTRACT

This paper proposes the Electrocardiogram (ECG) monitoring system using mobile phones. The proposed methodology facilitates the ECG signal of the patient to be monitored by the doctor via internet. Real-time remote monitoring intends to improve and facilitate the accessibility of vital signals of patients. The core board is centred on an Advanced RISC Machines (ARM) microprocessor and is used for continuous monitoring of bio-signals. Data is transmitted over the internet using Transmission Control Protocol/Internet Protocol (TCP/IP) or user datagram Protocol protocols. The real time ECG signal has been acquired through LabVIEW Data Acquisition (DAQ) and is communicated to the mobile phone.

Keywords: ECG signal, ARM processor, Web services, Real-time remote monitoring, LabVIEW DAQ.

1. INTRODUCTION

Real-time remote monitoring system improves and facilitates the data accessibility regarding vital signals of hospitalized patients, or patients who are monitored by professionals at home [1]. Nowadays, numerous portable and simple devices are used to diagnose the result of the heart status [2, 3]. [4] has developed an inexpensive and efficient medical care system. The factors such as ECG, body temperature and blood pressure are important references for to diagnose the patients' condition. Currently, most of the monitoring systems send patients' data to the hospital through Personal Computers (PC) located in the patients' home [4]. Personalized remote health monitoring system has become possible due to the larger developments in body sensor, wireless sensor and smart phone technology with low cost cloud computing [5]. The conventional physiological signal measuring units generally has limitations like high price, bulky dimensions and excessive connection cables. Hence it is aimed to propose a system overcoming these drawbacks. It uses internet technology to invisibly transmit and receive physical signals. Bluetooth covers only some distance (i.e. approximately 10 m) and Zigbee covers the distance of 100 m whereas internet transmits the ECG signal anywhere in the world through TCP/IP protocols. In receiver section, mobile phone is used instead of computer [6].

This paper employs a versatile hardware tool for the methodological monitoring of ECG signals. ECG generates the electrical signal of the heart activity. A typical tele-monitoring system includes medical signal or image acquisition, data storing, data analysis and data transmission subsystems. It can also be based on mobile phones. The patient information can be accessed by the doctor anywhere by using the mobile phone. Therefore, mobile phones are used instead of PC. When medical assistance seems crucial for the user, the system automatically alerts the medical service providers via short and Multimedia Message Service (MMS) based on the analysed results. The overall objective of this paper is to develop microcontroller that measure ECG of a subject, analysis the obtained result using LabVIEW software and

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transmit data using internet module. This paper also determines the feasibility and application of PC and internet technology to a wireless type physiological signal measuring system.

2. LITERATURE SURVEY

ECG tele monitoring system operating in store and forward mode is proposed [7], in which the holter records the ECG signal of the patient regularly. When an abnormal heartbeat is detected, the holter transmits it with the Global Positioning System (GPS) information to the server via MMS. In the server, a geographic information system is resided for locating the patient in an emergency case by using the GPS information. The cost of using the GPS network is lowered because only abnormal ECGs are transmitted. The mobile telemedicine system [8] describes about the patient (client) and the health-care professional. Its main purpose is to monitor the cardiac activity of patients and to perform signal acquisition process using ECG electrodes. ECG makes communication with the mobile phone via Bluetooth connection, in which the written data in blocks is sent to secure digital memory. Wireless sensor network [9] places a node in patients home through which it acquires the signal from ECG and transfers it to central nodes that is placed at hospital by means of an internet. This type of remote monitoring system reduces the cost and time when compared to PC. Remote monitoring system [10] uses a Zigbee network interface to collect the data and it sends to the server by means of wireless network thus making it available to professionals through web applications. A multi-hoping sensor network system has been implemented to monitor the physiological parameters from multiple patient bodies by means of medical communication standards. Unlike the other medical sensor network (like 2.4 GHz ISM band), two medical standards occupying the frequency bands that are mainly assigned to medical applications are used [11]. A heterogeneous sensor network system that has the capability to monitor physiological parameters from multiple patient bodies by means of different communication standards is proposed [12].

WSN and radio frequency identification technologies on health care system are proposed in [13]. The self-collected physiological signals are evaluated using improved particle swarm optimization, through which heart rate, blood pressure etc. are measured. This method offers better accuracy and efficiency. Cloud-based smart home environment is presented for home healthcare patients [14], which collects the signals through wearable sensors and provides the real time data information to the professionals. Processing of data is done by smart home gateway and is sent to private cloud infrastructure. Mobile phone based system for ELISA (MELISA) [15] provides an accurate measurement related to progesterone and the results are transferred using mobile phones. Enclosure and water bath heater are used to capture the image and incubate the samples at a suitable temperature respectively.

The obtained result matches the standard reader by 10%. Internet of things [16] based monitoring system monitors the physical signs of the patients and provides data about health care service. The transmission mode includes the real time continuous, special period continuous, event trigged, patients demand transmission and the selection of mode depending on the need and demand of the health care resources. The abnormal heart beat of the patient is transmitted by MMS on general packet radio service [17], in which the acquired data is stored in the hotler via internet. An accuracy of about 98.98% is obtained by this ECG tele monitoring system.

3. METHODOLOGY

Three electrodes lead system is used to acquire the ECG signal from the patient body. The leads are ring electrodes that can be worn around fingers just like a ring. It is suitable for all skin types and it acquires the bio-signal from the fingers**.** ECG monitoring is important for heart patient since it gives the complete waveform related to heart activity for diagnosis. Figure 1 represents the general block diagram of ECG signal. The heart patient might have valve problem, blood vessels block etc. and the only way to identify all the problems is to monitor the ECG parameter. Particularly for a heart patient, the data acquisition is carefully taken.

The three electrodes are fixed in the right ring finger, left ring finger & either in the left pointer finger or right pointer finger respectively. Here, two electrodes potentials

are considered for acquisition of signal where the other one is grounded. The electrodes potential is then given to the differential amplifier circuit. In the differential amplifier circuit, it measures the difference between the two input voltages and the corresponding output signal is then given to a filter circuit. The filter used in this system is of digital type. The filtration process removes all the ripples in the incoming signal to the filter circuit.

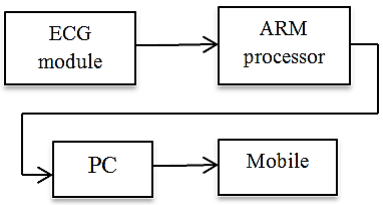

Figure 1.Block diagram representing the ECG signal acquisition on mobile

The ECG waveforms are of analog signals and these signals are transmitted over Bluetooth communication after encoding. At the receiver side, the signals are received and decoded, and finally it gives the output to PC through line printer terminal for monitoring. From this, ECG signal is monitored through PC. The microcontroller used in the system is ARM processor. PC is the host that is used to write the coding for acquiring and transferring the signal in the microcontroller, and also used to interface with the microcontroller and mobile. Through the computer, the ECG signal is transmitted to the mobile by means of TCP/IP protocol and also using web technology, data is transferred from system to mobile or system to system. TCP/IP defines how data is exchanged over the internet by providing end-to-end communications that specifies how it should be broken into packets, addressed, transmitted and received at the target. TCP determines applications to create communication channels across a network IP that defines the address and route for each packet to make sure that it reaches the right target address.

4. RESULTS AND DISCUSSION

Data acquisition is the real world sampling that generates data which can be manipulated by PC. Acquired data is determined and stored in the PC using LabVIEW, which offers a graphical programming environment suitable for data acquisition. By using LabVIEW, the ECG signal is acquired from the BIOKIT. Figure 2 represents the hardware setup of the working model. ECG records are obtained by sampling the bioelectric currents sensed by several electrodes, known as leads. So, three electrodes are connected to the patient to get the ECG signal using BIOKIT. ECG signal is acquired and monitored by PC using LabVIEW software. DAQ is interfaced with the BIOKIT and PC and is used to convert the analog signal into digital. Figure 3 shows the blocks of the ECG acquisition in the LabVIEW software.

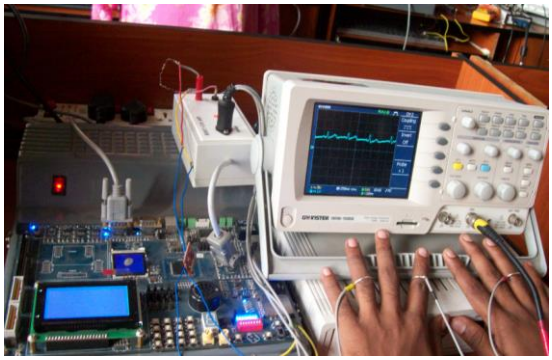

Figure 2.Hardware setup

Several cases use mobile devices to transfer data other than data analysis. Still, it can be further used to process complicated data with compact algorithms and programming by increasing the power of the mobile devices.

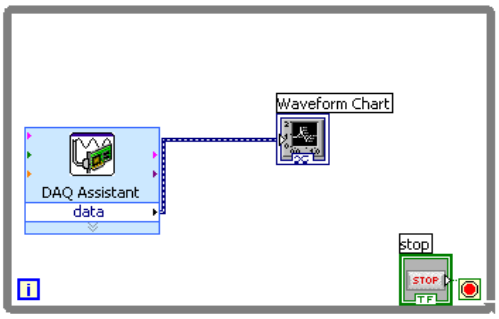

Figure 3.Block diagram of ECG acquisition

Then it is transferred to the particular client. The data server is given a port address and then the ECG signal is sent to the client through the TCP/IP protocols. Figure A1 shows the resulting ECG waveform plotted on the client's system. Based on the client address port, the data is sent from the server and monitored on the client's personal computer.

5. CONCLUSIONS

This paper provides new capability to remote healthcare and also offers real time monitoring of patients. It also finds use in cardiovascular applications due to the modular sensor design and its dependence on web service. Integrated intelligent data processing and alert agents provide optimized dynamic monitoring. Since wireless technologies enable faster client/server communications, such service would be beneficial for better healthcare.

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APPENDIX A

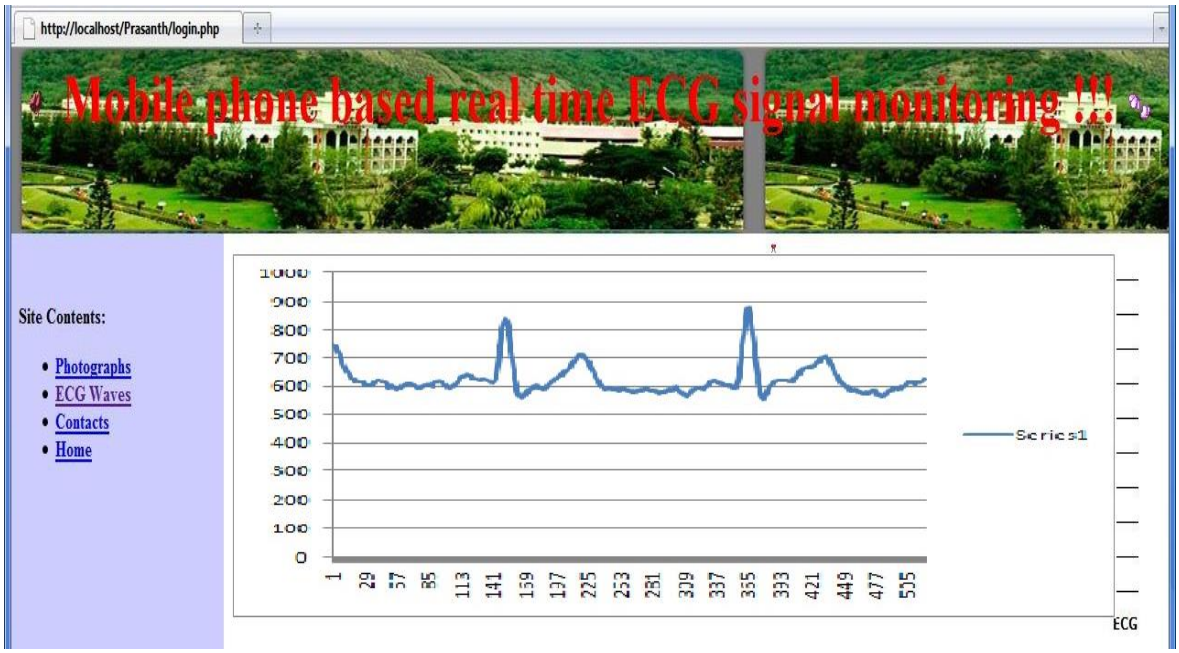

Figure A1.ECG waveform