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Wireless Patient Healthcare Monitoring System For Cardiac Patient
(Wireless Heart Attack Predetecion System)

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Abstract— *in today's world of automation, application of engineering and technology has proved its significance in the field of biomedical. The wireless healthcare monitoring system (WHCMS) for cardiac patient is also a new step in the automation of supervision for doctors. Particularly we focused on designing WHCMS for people who stay alone at home or suffering from heart disease. After heart attack, it's critical to save much of the dyeing heart muscle because they are starving due to lack of oxygen supply and preventing permanent heart damage. The proposed system continuously monitors the vital parameter, heartbeat and ECG and then with help of intelligent data analysis scheme using lpc2148; it is possible to predetect heart attack and inform the doctor and concerned person by implanting chip on to the body. The chip perform a function of continuous sensing and comparing of sense data with standard threshold .If any abnormalities are present there then SMS will be sent with help oh GSM modem to the relative and doctors with measured values. So that patient can get medical attention within the first few critical hours.*

Keywords—*WHCMS; ECG; Heartbeat; GSM modem;Arm7 lpc2148*

1. Introduction

In 20^{th} century according to HOLTER system data processing and analysis were performed offline, making such system impractical and non-real time for continuous monitoring also the system with many sensors having many wires between sensors and the monitoring system, this wire limit the patient activity & level of comfort so wireless data connection was necessary. Wireless healthcare system is possible due to recent advances in wireless network technology & information processing .so there is approach towards telemedicine which includes the utilization of telecommunication technology for medical diagnosis ,patient care & treatment[1].The aim of telemedicine is to provide the continuous healthcare to patient at remote place due to changes in lifestyle the lots of people are suffering from heart attack so it is quite difficult to save the life of patients suffering from heart disease due to lack of provision of medical facility at critical time so the proposed system provide the continuous monitoring of vital signal like heart beat & ECG This Sense signal are compare with the help of data processing system. As we got any abnormalities then the SMS will be send to concern doctor and patient so that the patient can get the emergency medical facility [3].

The system can be operated in two modes 1) In real time mode 2) Store and forward mode...Basically the remote monitoring of physiological parameter can be categorized by many aspect like data processing device ,signal sensing device, data communication & processing algorithms [4]proposed system discuss the aspect with recent studies in the field of bio signal sensors, processing unit ,medical service center & data communication network. The bio signal sensor acquired the patient vital signal and transmits it to the signal processing unit. The several studies are done on tiny design [5] of this sensor along maintaining the patient mobility [6] with low power consumption [7] to reduce battery size.

At the next stage output of this sensors are connected to processing device for data acquisition ,signal conditioning & formatting of data .this processing unit can be PC,mobile phone or embedded system (microcontroller ,DSP Processor or FPGA)[12].Many algorithms have been developed on diagnosis & early detection of cardiovascular disease[14]. Along with vital signal, study of human pulse is also another area of interest in the field of telemedicine because it gives information about patient health.

Many researches have proposed remote monitoring system which measures vital signal like heart beat along detection of ECG. In the next level advances in wireless and network technology make it possible to provide telemedicine system. Telemedicine system can divide in to two mode of operation 1)real time mode 2)store and forward mode in both mode vital signal are transmitted through cellular n/w, PTN or cable TV n\w but wire connection gives problem of degree of freedom for patient so we prefer wireless communication media in proposed system initially the WAP base [22] devices are used for communication but they does not provide improvement in patient mobility, again there was use of ECG data acquisition circuit ,A/D converter & storage unit with indoor wireless transmitter but that also having limitation after that there is use of Bluetooth technology along with GSM/GPRS technology but that is also having patient mobility limitation after that there is use of mobile phone for ECG transmission but in that also the loss of efficiency because normal ECG also transferred so next system developed with PDA [26]& WLAN which only transmit the signal after analyzing data on mobile phone if any abnormalities occurs but due to use of mobile phone as processing unit there is limitation on data processing.

In this paper, we propose a wireless telemedicine system which integrated sensor unit, processing unit and communication unit in on chip bounded to patient body called mobile care unit this will improve patient mobility & make lower the cost of using GPRS N/w, because only abnormal reading are transmitted so the proposed system operated in two mode store and forward &real time mode .in store and forward mode the care unit record & transmit patients vital signal to the server trough internet. When an abnormal heart beat is detected, the care unit transmits it to server via GPRS N/W in real time. The remaining paper is organized as follows (1) system architecture (2) continues some discussion and conclusion.

2. SYSTEM DESIGN

This section describes in detail the system design based on physiological sensor, signal processing, embedded system, and wireless communication and World Wide Web technologies. Figure 1 illustrates the architecture of the proposed system. Section 2.1 presents an overview of the system architecture.

Section 2.2 describes the system components and the detail of the system operation.

2.1 System Architecture: The aim of this study is to design and implement a telemedicine system with intelligent data analysis based on physiological sensors, embedded system, wireless communication, andWorldWideWeb for vital signs monitoring, patient diagnosis, and home care. Architecture of the proposed system is shown in Figure1. It mainly comprises the following parts.

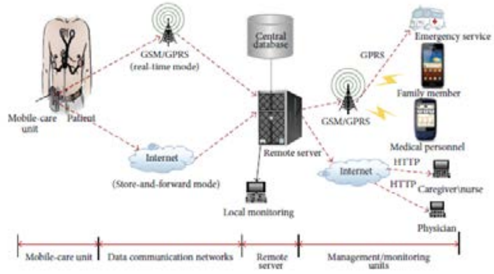

Figure 1: System architecture

(1) Mobile-care unit: it could be bound to patient's body and could acquire real-time or periodical vital signs information without affecting their normal activities. Then an intelligent data analysis scheme is applied to identify abnormal pulses and transmits these data to the remote server by wireless communication through either internet in store-and-forward mode for normal case or cellular networks in real-time mode for abnormal case. The transmission of patient data in real time mode can also be operated manually. Whenever the user feels uncomfortable, he can transfer his current vital signs to the management unit for advice or a checkup. By this way, the cost for using the GPRS network is lowered because only abnormal signals are transmitted. For possible long-term store and- forward mode, the raw data can be stored in the extended secure digital flash memory contained in the mobile-care unit.

(2) The remote server: it stores the received vital signs in a human physiology database and displays the physiology signals to the medical personnel through application program for diagnosis. Also, it enables remote access for caregivers and physicians to obtain vital signs through web-based interface over internet to monitor these data on their pervasive devices. After examining the vital signs data, the doctor can send a feedback MMS message to the user. The message may contain medical advice and/or a list of control commands to the mobile-care device for resending the abnormal case's vital signs data. Also remote server may alarm family member in abnormal case and call emergency service to transport patient to nearest medical center.

(3) Pervasive devices: pervasive devices include laptop, personal digital assistant (PDA), and mobile phone. Through these terminal devices family members or doctors can acquire abundant information about the healthcare recipients anywhere and at any time.

2.2 System Components: This section details the system components of the proposed emergency telemedicine system for patient monitoring and diagnosis.

2.2.1 Mobile-Care Unit: In the proposed system the mobile care unit was designed to be portable and lightweight which means it is easy to carry and easy to use making patients do nothing. The mobile-care unit consists mainly of three modules. These are mainly vital-sign signals acquisition module, data control and processing module (MCU), and data communication module. Thus it can collect critical bio signals, including three-lead ECG, HR which are vital signs. Also, it may evaluate patient status and trends in patient's medical condition and it may generate emergency alert if the patient's condition is critical. Moreover, it should support wireless communication and be compatible with global positioning information system to locate the patient position for emergency help. Figure 2 illustrates a block diagram of mobile-care unit. Also mobile care unit includes local data storage which is used for raw data recording together with signals processing results.

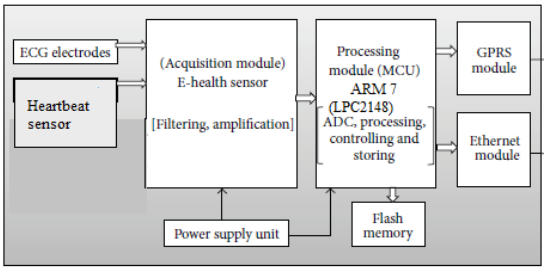

Figure 2: Mobile care unit

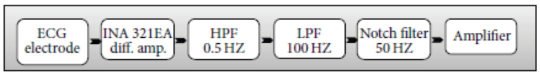

Figure 3: Block diagram of ECG acquisition hardware.

(1) Vital-Sign Signals Acquisition Module: Vital-sign signals acquisition module is responsible for collecting vital signs and then sends it to processing module for ADC, processing, and abnormal detection. E-health sensor shield V2.0 is selected to work as vital-sign signals acquisition module. This module can continuously acquire physiological signs like ECG, Heartbeat as shown in Figure 3. All of vital signs measurements will be noninvasive measurement. Noninvasive measurement of vital signs certainly has an advantage over its invasive counterpart due to the ease of use and lack of risks involved in such measurements. ECG Sensor. An ECG is a bioelectric signal which records the heart's electrical activity versus time. The electrocardiogram is obtained by measuring electrical potential between two points of the body using specific conditioning circuit. In the proposed mobile-care unit ECG signals from the electrodes are amplified with a gain of 300 and filtered with the cut-off frequencies of 0.5Hz in the high pass filter and 100Hz in the low pass filter. The ECG signals are typically 1mV peak-to-peak; an amplification of 300 is necessary to render this signal usable for heart rate detection and realizing a clean morphological reproduction. A differential amplifier with gain of 20 avoids the noises overriding the ECG signals; this is achieved by an instrumentation amplifier (INA321EA), CMRR of 100 dB, and at the end an operational amplifier (Analog AD8625) is used to amplify the signal with a gain of 15.The ECG signals are restricted in bandwidth of 0.5–100Hz using second order Butterworth high pass and low pass filters after the first stages of amplification. The power line interference in the ECG signal is filtered by a 50 Hz notch filter, which is user selectable to avoid loss of 50Hz component of the ECGsignals.Then the ECG signal is fed to the analog input of processing unit for digitizing and analysis. Figure 4 illustrates the block diagram of ECG signal acquisition hardware.

(2) Data Control and Processing Module: Data control and processing module is the heart of the medical care unit. The main function of this module can be divided into two parts: in the first part the developed algorithm synchronizes, controls, and maintains the accurate operation and communication of all the other modules. In the second part the developed algorithm digitizes and processes the acquired vital-sign signals to determine if their respective values are above the preset limit or not. If any or all of these values are above their respective critical values then triggering alarm is made. After that all processed data is transmitted to communication layer. This module mainly consists of a microprocessor which is chosen to verify certain specifications. Microcontroller unit (MCU) with powerful processing and control capability is needed to adapt a large amount of data acquiring and processing. Moreover, this module also possesses a high degree of system integration as well as more extension interfaces. We select ARM7LPC2148 microprocessor as the MCU of medical care unit. The LPC2148 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine the microcontroller with embedded high-speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. Due to their tiny size and low power consumption, LPC2148 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol.

(3) Data Communication Module: Data communication module helps the medical staff to get patient's physiological data by connecting medical care unit to other networks such as cellular network

or internet. It is responsible for uploading the received vital signs data to the remote care server through cellular network to carry out the patient's health condition monitoring and diagnosis. This module operates in two modes: store-and-forward mode in which mobile care device records patient's vital signs continuously up to specified period and transmits it to the remote server and real-time mode which operates when an abnormal heartbeat is detected. Mobile-care unit transmits all vital signs to the remote server via GSM/GPRS network in real-time. In the proposed system, medical care unit can send data through internet network either by UDP or TCP protocols using ENC28J60 Ethernet module shown in Figure 10(a). For real-time Connection in emergency cases vital signs are transmitted through GSM/GPRS networks using sim900 GSM/GPRS module shown in Figure 10(b). The GSM/GPRS module used operates at Quad-Band 850/900/1800/1900 MHz and is controlled via AT commands.

2.2.2 Monitoring Units: Web tier in the remote server is designed to allow remote user to acquire abundant information about the healthcare recipients anywhere and at any time using pervasive devices such as laptop, PDA, and mobile phone. Finally we can say that the proposed system can operate in the following three situations.

(1) Time-based connection: all data needed by the remote caregivers or specialists should be uploaded. Data compression is essential to limit the upload time. In this situation the remote caregiver should determine time schedule for uploading all patient data to remote server. The time schedule is stored in the mobile-care unit so it will upload data according to this time schedule.

(2) Emergency connection: to lower the cost of using GSM/GPRS network we develop algorithm which detects abnormal heartbeats. So during sensor monitoring, if the mobile-care unit detects an abnormal condition it sends the collected data to the remote server in order to receive clinical assessment and treatment planning.

(3) (Event awareness) connection on demand: the mobile-care unit uploads the amount of data requested by the remote caregivers or specialists to monitor the health status of the patient

2.2.3 Remote Server Unit.

In the application of telemedicine, the medical information usually needs to be distributed among medical doctors and display, archival, and analysis devices. Therefore, the remote server unit is developed with the purpose of receiving, storing, and distributing the vital sign data from patients. The server is composed of presentation tier, web tier, and database tier. A multitier architecture allows for separation of concerns where any tier in the system can be expanded and updated with minimal or no effect on the client tiers.

3. CONCLUSION AND FUTURE SCOPE

This paper proposes the design and implementation of a wireless telemedicine system, in which all physiological vital signs are transmitted to remote medical server through both cellular networks in emergency case and internet in normal case for long-term monitoring. By this, the cost of using GSM/GPRS network is reduced as only abnormal cases will be transmitted through cellular network. Also the proposed system presents friendly web-based interface for medical staff to observe immediate vital signs for remote treatment. Comparing this system with other systems which are mentioned in the introduction [18–28], the proposed system integrates sensor unit, processing unit, and communication unit in one chip bound to patient's body called mobile care unit, so patient could do his/her daily activities during monitoring. In other words, this will improve the mobility of patient. Also the proposed system provides an ability to continuously monitor patient's vital health conditions instead of the discrete measurements.

In the future, a lot of work could be done in the three main aspects of telemedicine systems to enhance the healthcare services. The three main aspects are type of sensors, signal processing algorithms, and data communication technology. In the sensor layer wireless sensor network of wearable noninvasive sensor units can be designed. Fabrication of sensors can be improved to obtain small size and low power sensors to improve patient's mobility and prolong network lifetime. Also we can increase the number of transmitted vital signs to have a complete picture of patient's case. For more improvement in telemedicine systems, many medical algorithms can be developed to help in patient diagnosis and early detection of cardiovascular diseases and real-time analysis of vital signs can be performed in the place where the vital signs are acquired. The latest achievement on a smart phone market provided an opportunity to integrate smart phones in telemedicine systems. For example, android based mobile phones patient monitoring application could be developed which allows doctors to monitor the health and intelligent traffic control systems also has the potential to improve healthcare services, for example, when a moving ambulance vehicle is trying to reach a patient using the fastest route or when an ambulance vehicle carrying a patient is trying to get to the base hospital.

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