

Bio Medical Sensor Network for Patient Monitoring

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Abstract

Recent technological advances in wireless communications and wireless sensor networks have enabled the design of low-cost, intelligent, tiny, and lightweight medical sensor nodes that can be strategically placed on human body to create a Bio Medical Sensor Network (BSN) to monitor various physiological vital signs of patient for a long period of time and providing real-time feedback to the user and medical staff. Human health monitoring is emerging as a prominent application of the embedded sensor networks. In this paper, Design and Implementation of Wireless Bio Medical Sensor Network (WBSN) for patient monitoring is presented. The proposed WBSN uses miniature sensors to detect the health parameters. The attached sensors on patient's body form a wireless bio medical sensor network and they are able to sense the various health parameters of patient such as heart rate, temperature and sweat rate. These health parameters are then communicated to physician's server. The physician holds various threshold values of the health parameters for each and every patient. This system can detect the abnormal conditions, issue an alarm to the patient and send a SMS to the physician.

Keywords– Wireless Bio Medical Sensor Network (WBSN), Patient Monitoring System, Health Parameters, GSM, Physician.

I. INTRODUCTION

WIRELESS SENSOR NETWORK (WSN) is one of the upcoming trends in modern technology which is playing an important role in every field of science. With the growing needs in communications and recent advancement in very-low-power wireless technologies, there has been interest in the development and application of wireless sensor networks. A wireless sensor network (WSN) in its simplest form can be defined as a network of (possibly low-size and low-complex) devices denoted as nodes that can sense the environment and communicate the information gathered from the monitored field through wireless links. Currently, wireless sensor networks are beginning to be grow at an accelerated pace This new technology is exciting with unlimited potential for numerous application areas including environmental, medical, military, transportation, entertainment, and smart spaces With WSNs one can monitor and control factories, offices, homes, vehicles, cities, the ambiance, and the environment. WSN can also be deployed in remote even difficult-to-reach locations can be useful environmental-monitoring systems.

The emerging field of low-power wireless technologies provides a considerable interest in the development and application of wireless networks around humans. WSN provide capabilities that are valuable for continuous monitoring of health condition of a patient. A wireless bio medical sensor

network or wireless body area network (WBAN) consists of 3 to 5 invasive or noninvasive sensor nodes acquiring physiological signals from the body and transmitting it to the network co-coordinator through wireless channel. In the area of healthcare, according to the World Health Organization's statistics, millions of people suffer from obesity or chronic diseases every day, while the aging population is becoming a significant problem. Both the current situation and future trend call for new technologies such as WBSNs to facilitate first-hand health monitoring and medical care (point of care). From the consumer electronics perspective, short-range wireless technologies for human-computer interaction (HCI) and entertainment are booming.

WBSNs extends conventional bedside monitoring to ambulatory monitoring, providing a point of care to patients, the elderly, and infants in both hospital-based and home-based scenarios. Monitoring, autonomous diagnostic, alarm, and emergency services, as well as management of electronic patient record databases can all be integrated into one system to better serve people. The technological advancements in wireless communications have delivered an "anywhere and anytime connectivity". It involves the transmission of information over a distance without the help of physical connections. These developments in wireless networking and computing will facilitate remote patient monitoring system to collect

healthcare information from various wireless biomedical devices used by patients in their homes. Remote monitoring systems typically collect patient readings and then transmit it to a remote server for storage and later examination by the healthcare professionals. The technological breakthroughs in the miniaturization of processors, networking technologies, memory, displays and sensors have made possible for the mobile devices to become more powerful. Most popular portable and mobile devices nowadays such as Netbooks, Smartphone, personal digital assistants (PDAs), portable media players, global positioning systems (GPS) and mobile internet devices.

The remaining paper is organized as follows. System architecture is discussed in section II. This section depicts the hardware architecture and the software architecture. Section III discusses the wireless connectivity. Section IV gives the scheme of working. Experimental results are presented in Section V. Finally section VI gives the conclusion.

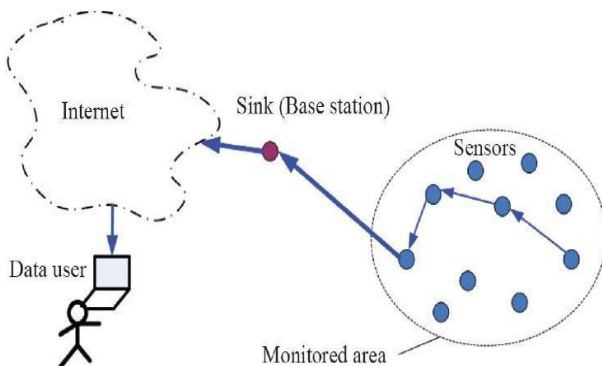


Fig 1. Bio Medical Sensor Network

II. SYSTEM ARCHITECTURE

In design and implementation of a WBSN based patient monitoring is to monitor the patients' health parameter status pervasively, WBSN is implemented at the patient side and the patient database is created at medical server side by maintaining a unique patient ID on both sides. It is possible to monitor hundreds' or thousands of patients at the same time by physician having this WBSN based Patient Monitoring system by registering and generating a unique patient ID for each patient. This wireless health monitoring device not only receives physiological signals, but also transfers the physiological data through the wireless network to the back-end health management server, so that complete and continuous personal physiological records can be kept. The communication between the patient server and medical server is accomplished by GSM wireless communication technology.

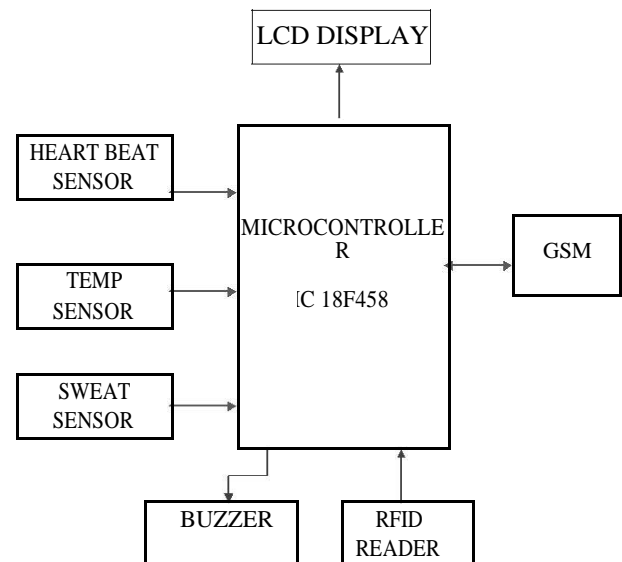


Fig 2. Proposed system architecture

The architecture of the proposed system is shown in Figure 2. The WBSN includes three sensors which are responsible for collecting the physiological signals from patient. It automatically monitors and if there is any problem relating to abnormality in heartbeat or so, it certainly buzzes an alarm which indicates that there is an urgency to monitor and treat that patient according to the situation. In this design, a micro controller is used to control the patient's conditions automatically, depending upon the various biomedical parameters such as body temperature, heart rate, and sweat rate. The microcontroller then sends an SMS to the healthcare provider or patient's family in emergency conditions through the GSM.

A. Heartbeat Sensor

Doctors measure our heart rate manually. By holding our hands they feel the pulse in the nerve and look at their watch to count our heart beats per minute. Even we also can feel the pulse on our finger when our heart pumps blood into our blood vessels. This pulse is felt due to the expansion and contraction of blood vessel when blood enters and leaves it. Our heart does this around 72 to 84 times a minute for a healthy person.

What we do to measure the heart rate is, first we will detect the heart beat/pulse and count the pulses for one minute to get the beats per minute. So in order to detect the pulse we will pass light (using an LED) from one side of the finger and measure the intensity of light received on the other side (using an LDR). Whenever the heart pumps blood more light is absorbed by increased blood cells and we will observe a decrease in the intensity of light received on the LDR. As a result the resistance value of the LDR increases. This variation in resistance is converted into voltage variation using a signal

conditioning circuit usually an OP-AMP. The signal is amplified enough to be detectable by the microcontroller inputs. The signal given to the microcontroller input will look somewhat like shown in the image above in a oscilloscope. The microcontroller can be programmed to receive an interrupt for every pulse detected and count the number of interrupts or pulses in a minute. The count value of pulses per minute will give you the Heart rate in bpm (Beats Per Minute).

Alternatively to save time, only the number of pulses for ten seconds are counted and then multiplied by 6 to get pulse count for 60 seconds/1 minute.

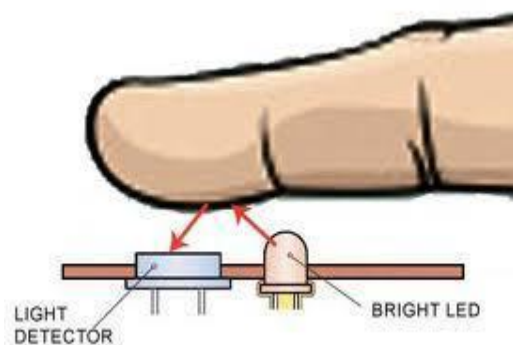


Fig 3. Heartbeat Sensor

B. Temperature sensor

The body temperature is measured by LM35, a precision integrated- circuit temperature Sensors, whose output voltage is linearly proportional to the Celsius temperature. It is an electronic device which provides a voltage analogue of the temperature of the surface on which it is mounted. The LM35 is a 3 pin IC, pin configuration of which is shown in figure 4

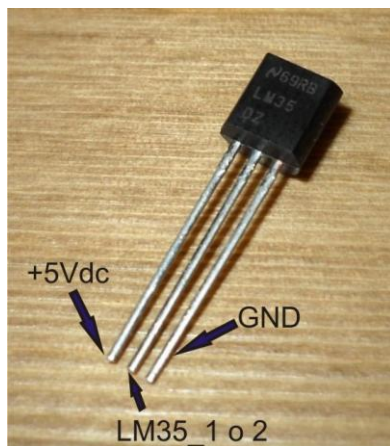


Fig 4. Temperature Sensor

The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified. Normally the body

temperature for a normal human being is about 35 degree Celsius.

C. Sweat Sensor

In this sweat measurement Conductor1 and Conductor 2 is placed in between skin. And a Low volt supply >>>>1----(here skin is conductor)---□>- get voltage—2. From the ckt diagram If we give supply to '1' get some current at end '2'. If skin is sweating conductance (getting current) will be high at end '2'. If there is no sweating conductance (getting current) will be low at end '2'. It is worn as wrist band in the hand to measure the sweat rate.

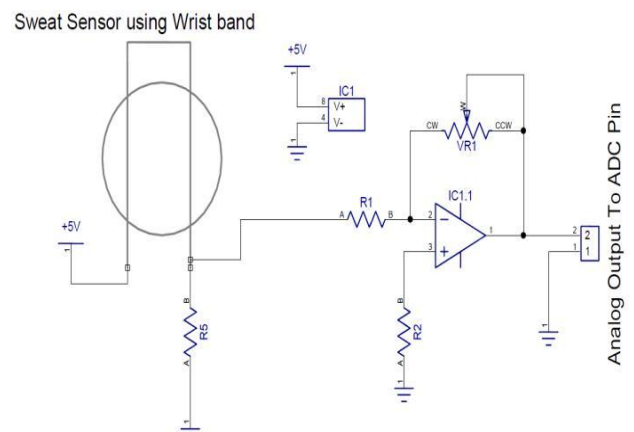


Fig 5. Sweat sensor Circuit

D. Microcontroller

The microcontroller used here is PIC 18F458. The program on the microcontroller, reads the value of body temperature, heart rate and sweat rate. Then the processed output in digital form is sent to the medical server through GSM/GPRS transmission and also display on LCD screen. The microcontroller programming is done using Embedded C, a middle level language for controller units. The PIC microcontroller is high performance RISC CPU and peripheral features. It has 5 ports for internal and external usage. It has three on chip Timers and in built 8 bit and 10 bit Analog to Digital Converter. It has serial as well as Parallel Communication facilities.

E. GSM/GPRS

GSM/GPRS modem used is SIM300, a global digital mobile communication system, whose coverage is the widest and reliability is very high. SMS (Short Message Service) is a kind of message service, by which the limited data or text message can be transmitted and GPRS provides Internet service by which faster data transmission can be done all over the globe. A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up

modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. GSM is the most popular standard for mobile phones in the world. Microcontroller transmits and receives the data through GSM/GPRS by connecting TxD pin of PIC microcontroller to RxD pin of GSM/GPRS modem and RxD pin of PIC microcontroller to TxD pin of GSM/GPRS modem. Like a GSM/GPRS mobile phone, a GSM/GPRS modem requires a SIM card from a wireless carrier in order to operate.

Additionally a LCD Display is provided for displaying the Physiological parameters of the patient locally for observation purpose and a buzzer is also provided to issue an alarm to the patient if any abnormal condition exists.

III. WIRELESS CONNECTIVITY

The WBSN based PMS system targets at ambulatory monitoring. So it is required to use wireless communication between the patient and the physician by which it does affect the daily routine of an individual. To perform the communication or data flow from the patient to medical server or physicians mobile and the feedback flow from physician to patient wirelessly SIM300 GSM/GPRS modem is used. Like GSM mobile phone it is necessary to insert a SIM card into this GSM/GPRS modem by activating internet facility without which data cannot be uploaded on the webpage and patient also will not be able to receive healthcare advice from physician. The kind of SMS service of GSM modem is used to send the message to physician and to patients' relative in case of threatening condition

IV. SCHEME OF WORKING

In this section the overall working of bio medical sensor network based patient monitoring system is described.

At The Patient Side

First the three physiological sensors which are used to measure heart beat, temperature and sweat rate of patient are placed on human body and then switch on the WBSN based patient monitoring system. The systems display the title as Patient Monitoring System using PIC controller. It then displays the values of measured health parameters such as body temperature, heartbeat rate and Sweat rate of patient. Connect the system to GSM to upload the current values of the health parameters to the physician. For each patient a unique ID is created and set of threshold values is given for each health parameter. The system compares the current health parameter value with the given threshold value.

i) If current values cross the threshold values then message is send to physician's number and

relatives' number and simultaneously it alerts the patient with the alarm signal.

ii) If health parameters are in expected health metrics then it displays as normal.

At The Medical Terminal

The physician opens the webpage of Patient Monitoring System. The page shows the various patient names with their unique ID number. It also shows the already recorded threshold values for each health parameter of the patient. The physician can also check the current health condition of patient by sending message as status of patient with the patients ID. If values of health parameters are not in expected range of health metrics then the physician can also initiate healthcare action. In the mean time the physician can also prescribe medicines depending on current health condition.

V. EXPERIMENTAL RESULTS AND DISCUSSION

By using the above physiological sensors the health parameters under measurement are heart beat, temperature and sweat rate of patient. The output of the sensors is amplified and sends to the microcontroller. The controller displays the parameters in digital value in LCD screen. The health condition of a patient is continuously monitored by the patient monitoring system and it keeps a track of all the changes observed. If the level of any one of the parameter is varied enormously, the buzzer will automatically ring and alert the patient and simultaneously sends message to the physician. This data, which is of the form as shown in the table 1 is continuously forwarded to the concerned physician.

Table 1: Testing Results

Patient ID	123456789
Heart Beat	72 bpm
Body Temperature	37 ° C
Sweat rate	Normal

Secondly, the patient terminal outputs are verified against the measurement of these same parameters using standard medical equipment's was found to be fairly faithful.

VI. CONCLUSION

In this paper design of bio medical sensor network for patient monitoring system is proposed. A Wireless BSN of physiological sensors integrated into a patient monitoring system holds the promise to

become a key element in remotely supervised, home-based patient rehabilitation. It has the potential to provide a better and less expensive alternative for rehabilitation healthcare and may provide benefit to patients, physicians, and society through continuous monitoring, early detection of abnormal conditions, supervised rehabilitation, and potential knowledge discovery through data mining of all gathered information. Continuous monitoring with early detection likely has the potential to provide patients with an increased level of confidence, which in turn may improve quality of life. An unobtrusive and continual communication between patients' terminal and medical server is achieved using GSM wireless communication technology.

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