IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 6, Issue 1, June 2021
Impact Factor: 4.819

Microcontroller Based Wireless Patient Health Monitoring System

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Abstract: *This paper represents the design and simulation of a wireless patient health monitoring system. Generally, in the hospitals where patient's body temperature needs to be continuously monitored, which is usually done by a doctor or other paramedical staff by continuously observing the temperature, pulse rate, blood pressure and maintaining its record. This is a very monotonous routine and can really be nerve-racking, especially in overcrowded hospitals. The primary function of this system is to monitor the temperature, blood pressure and pulse rate of a patient's body, and transmit the information wirelessly to the doctor's office on the LCD display unit. In this advanced system, a transmitting unit constantly scan patient's body temperature, blood pressure and pulse rate through digital sensors, and shows them on the transmitter LCD. At the receiving end, a receiver is used to collect the data, decode it and feed them to another microcontroller which then displays it on the doctor's LCD screen. The receiver unit is kept in the doctor's office to constantly show the patient's body temperature, blood pressure and pulse rate wirelessly. An alarm is also activated at the receiver end where the doctor will be, and is activated when the patient's temperature, blood pressure and pulse rate goes below or above the normal human threshold value, which are 37°C, SBP- less than 120 mm Hg, DBP- less than 80mm Hg and 70 beats per minute. An SMS will be sent to the doctor, just in case he or she is outside the area and to present as a path for continuous update. The advanced system was simulated using Proteus software and programs written in Embedded C language. The result achieved shows a systematic method of relating information to the doctor on duty for urgent attention to patients.*

Keywords: Arduino Uno, Transmitter, Receiver, LCD, GSM technology, Health Pulse rate, WPHMS

I. INTRODUCTION

In current years, great innovations have brought advanced technologies in Medical sector. Most of the Health Centers and Hospitals are trying to make accessible and uphold the essential enduring treatments, with more alert and preventions [1]. Such an essential treatment requires a professional Patient Monitoring System. The Patient Monitoring System is a greatly developed technology for controlling and monitoring the situation of various Human-health parameters. Some of our Human-health parameters include temperature, heartbeat, blood pleasure, pulse rate, etc. requires constant monitoring process and update to doctors on duty.

The mobile computing set out a new class of mobile computing devices which are becoming worldwide in everyday life. Handheld mobile phones and several embedded systems make information and internet access easily available to everyone from anywhere at any time [2]. The main aim of mobile health care is to provide health care services to anyone anywhere at any time, overcoming the constraints of place, time and money.

The important present systems available allow constant monitoring of patient's vital signs, these systems require the sensors to be placed at bedside monitors or PCs, and limit the patient to his or her bed. This advanced system does not require patients to be limited to their beds but allows them to move around, although within a specified distance. This is because outside this range, the possibility of collecting data will be impractical.

A combination of wireless sensor networks, existing Radio Frequency Identification (RFID) and Vital Sign Monitoring technology to simultaneously monitor vital signs are used, while keeping track of the users' locations [3].

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The work of wireless technology makes it possible to install the system in our homes and link to various hospitals. Radio frequency waves can travel through walls and fabrics, sending the vital signs and locations' information to a central monitoring computer server via a miniature transmitter network at the patients' end. The advantages of wireless technology are: portability, convenience, ease of installation, and cost effective [4].

II. Related Work

Some of the related researched theses are:

A. Wireless sensor network for e-health system based on radio-active and radio-passive positioning

Anliker U., J. A. Ward et.al [5] has developed a wearable medical monitoring and alert system aimed at people who are at risk from heart and respiratory diseases. The system combines multi parameter measurement of vital signs, online analysis and emergency detection, activity analysis, and cellular link to a telemedicine centre in an unobtrusive wrist-worn device.

B. Model based on a fuzzy regular formal language to describe the current state of health of the wireless health monitoring system

Alexandros, Pantelopoulos et.al considered symptom ambiguity and causal relationships between various disorders and symptoms to derive a thorough estimation with a certain degree of confidence [6].

C. Design of a processor that samples signals from sensors on the patient health

Rasid M. F. A, and Woodward B. et.al [8] focused on the design of a processor which samples signals from sensors on the patient. It then transmits digital data over a Bluetooth link to a mobile telephone that uses the General Packet Radio Service.

D. A prototype system using open source technologies for centralized medical patient records

Shihab A. Hameed et al (2008) built a prototype system using open-source technologies for centralized medical patient records that can be viewed and updated by physicians using any web browser [9].

III. Methodology

The System Design of Wireless Patient Health Monitoring System (WPHMS) is designed in two sections namely; the transmitter section at the patient's room and the receiver section at the doctor's office. To realize these design research objectives, the block diagram of the wireless patient health monitoring system used is shown in fig.3.1.

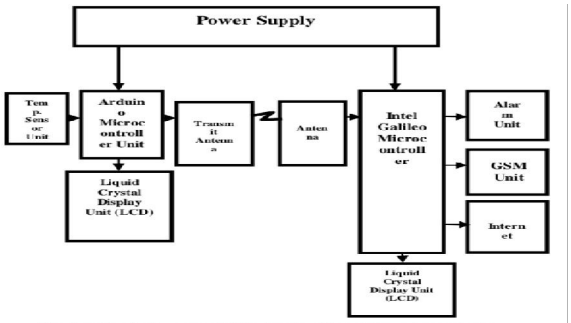

Fig.3.1: Block diagram of Wireless health intelligent monitoring system

3.1 Transmitter Section of the WPHMS

The proposed transmitter system at the health patient's location is designed following the diagram shown in fig.3.2 below. The transmitting section includes power supply, temperature sensor, pulse sensor, Arduino uno (microcontroller), LCD and RF antenna, that is the RF link transmitter.

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Power Supply is a system which supplies electrical energy to the entire WPHMS system. In the transmitter, the pulse sensor is created to give digital output of heart beat when a finger is placed on it. When the heart beat detector is working, the LED flashes also beat with each heartbeat. Then the obtain digital output is connected to Microcontroller directly to calculate the Beats per Minute (BPM) rate through program code. It also works on the principle of light modulation on blood flow through finger at each pulse. The temperature sensor is connected to the health patient whose temperature is to be calculated and its values are expressed in millivolts (mV), which is then sent to the Arduino uno Microcontroller. Which is received as an analog signal between 0-1024 and mapped to 5V through written program codes. The value is measured by the Arduino and converted to a digital value which is transmitted to the transmitter RF antenna and is shown on transmitter's Liquid Crystal Display (LCD). Then the parameters are transmitted by the RF link transmitter antenna to the receiver section in the doctor's office where output can be read by the health worker or doctor in charge.

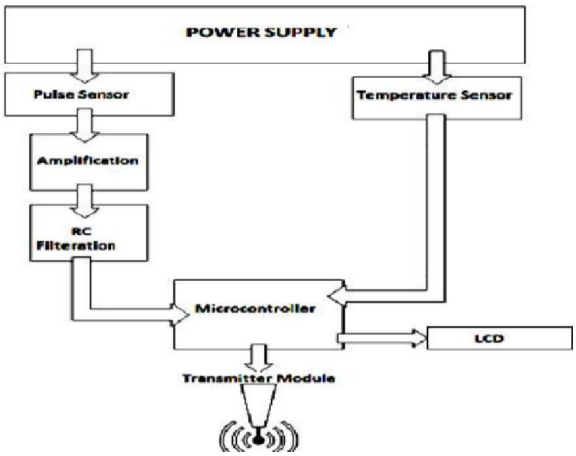

Figure 3.2: Block diagram of Transmitter Section [1]

3.2 Receiver Section of the WPHMS System

The signal from the transmitting section is obtained by the RF link receiver antenna. It works as a wireless data link, creating connection between the transmitting and receiving sections of the system. The received signal is transmitted to the Intel Galileo which prepares the data and sends it to the doctor's LCD for processed parameter display. Also, the prepared parameters are sent to the doctor's phone through GSM shield and to the internet cloud for storing and sharing. The GSM shield acts as a GSM modem that sends SMS to the doctor's phone once the value of the patient's health data goes above a certain threshold. The fig. 3.3 below shows the block diagram of the receiver section. The Internet cloud stores the patient's data in a database and can be evaluated online through internet enabled computer anywhere. The LCD placed in the doctor's office shows the result of the patient's parameters within a certain programmed period of time.

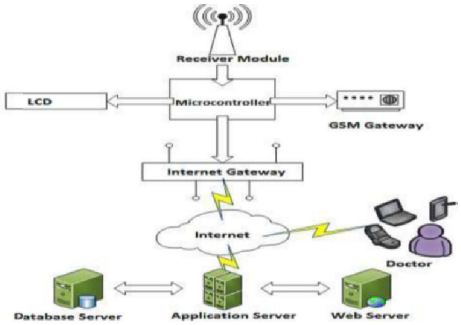

Figure 3.3: Block diagram of Receiver section [4]

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3.3 WPIHMS Operations and Circuit

WPHMS operates using +5v supply voltage from the external regulated battery source or direct plug to the USB port of the Laptop. The transmitter section and receiver section are initialized for operations through the embedded C language when properly set and powered ON. At the transmitter section, the Pulse sensor or blood pressure sensor is designed to be worn by the patient and temperature sensor placed anywhere on the patient's body which capture patient body temperature, blood pressure and pulse rate. They are sent to the Arduino Microcontroller which processes the data, shows the parameters on the patient's LCD and send the same parameters through RF antenna of the transmitter to the doctors' end wirelessly.

At the receiver section which is in doctor's office as well as mobile phone; the receiver RF antenna collects the transmitted signal with the same Radio frequency and sends to the Intel Galileo processor which processes the received data, activate alarm for 15 sec to attract doctor's attention. Then show the processed data on the LCD unit in the doctor 's office. Also, the SMS message of the parameters are sent using the GSM shield through SIM card to doctor's phone in case he or she is not in the hospital area for urgent attention to the patient.

IV. Result and Discussion

Using PROTEUS software, the simulation of the WPHMS system design was done. The system was divided into two parts as earlier mentioned; both were integrated to obtain the design objectives and communication purposes. The transmitter and receiver sections result achieved at different conditions are explained below.

4.1 Transmitter Section (Patient Side)

1. Transmitter unit result at low conditions: The result achieved in simulating designed transmitter circuit at low temperature, blood pressure and pulse rate. At 33°C, the human body temperature is at low and is said to be critical, and at 60 bits per minute (BPM) the pulse rate is also at low. The values are achieved from the temperature sensor and pulse rate.
2. Transmitter unit result at normal conditions: The result achieved from the transmitter unit at normal temperature condition. This shows a temperature reading at 37°C, which is the normal human body temperature. This value is achieved from the temperature sensor which is placed at the transmitter unit that transmits the signal to the Arduino. The Arduino converts the signal and further transmit to the receiver through the RF antenna unit. The temperature value is shown on the LCD at the transmitter section.
3. Transmitter unit result at high conditions: The result achieved from the transmitter unit at high temperature, blood pressure and pulse rate. The values displayed on the transmitter unit LCD are 39°Cagainst BPM 120. The temperature value is high for human being because any value above 37°C is flagged as extreme and serves as a symptom of high fever. Also, the BPM value is recorded as120, which is also, a high pulse rate as any value above 100 is deduced as being extreme, irregular and critical. These values are shown on the transmitter LCD, and sent to the receiver LCD, which is placed in the doctor's office. The receiver unit results obtained at different conditions are shown below.

4.2 Receiver Section (Doctor Side)

1. Receiver unit result at low conditions: The result obtained from the simulating of the receiver circuit at low condition This shows a temperature reading at 33°C, which is a low human body temperature. The result is sent to the receiver unit from the transmitting section. As the receiving unit will be at the doctor's office, the display unit(LCD) at the doctor's office will display the temperature and pulse rate of the patient. An alarm is incorporated in the circuit to trigger at any temperature below 34°C, SBP lower than 90mmHg, DBP lower than 60mm Hg and also at a pulse rate of 60BPM and below. This alarm will continue for 15 minutes until it is reset by the doctor or health worker in charge. An SMS containing the details of the patient's temperature, blood pressure and pulse rate parameters will be sent to the doctor's phone for proper recording and acknowledgement, especially if the doctor is not physically present at that moment.

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2. Receiver unit result at normal conditions: The result obtained from the receiver unit at normal temperature condition This shows a temperature reading at 37°C, which is the normal human body temperature. This value was transmitted from the transmitter section through RF antenna to the receiver RF antenna. The antenna sends the signal to the Arduino Intel Galileo which operates and shows it on the doctor's LCD.
3. Receiver unit result at high conditions: The result obtained from the receiver unit at high temperature, blood pressure and pulse rate are the same as sent from the transmitter unit. The RF link transmitter receives the signal from the transmitter unit, sends to Arduino (where the processing is done) and the result is shown on the LCD in the doctor's office. An alarm is activated when signals of high temperature, blood pressure and pulse rate parameters are received. The alarm is programmed to continue for 15 minutes until the system is reset by the doctor or health worker.

4.3 SMS Technology

The GSM shield card is inserted on the Arduino board expansion slot provided and configured for SMS communication to Mobile phone through AT program codes. The network SIM card slot is found on the GSM shield board where any network SIM card can be slotted for use. Using the GPRS wireless network the Arduino GSM Shield connects the Arduino to the internet. We have to just plug this module onto the Arduino board, insert a SIM card from an operator offering GPRS coverage and follow a few simple instructions to start controlling your world through the internet. We can also make or receive voice calls, although would require an external speaker for that function.

V. CONCLUSION

Wireless Health monitoring system is a system which can wirelessly monitor vital signs such as the temperature, blood pressure and pulse rate of patients in real-time and inform medical team immediately in case of emergencies has been designed, simulated and implemented. The system monitors patient's health status, such as pulse rate, blood pressure and temperature; in case any of these parameters exceeds preset critical values, the RF antenna module send the parameters to pre-defined phone number in form of SMS using a GSM module and shows the information in the doctor's LCD for update.

The advanced system combines two frequently used technologies namely, Global System for Mobile (GSM) and Radio Frequency technology to reach the work objectives. All the information obtained from the human body via sensors is sent to the microcontroller system as digital values. The values gained from the pulse rate, blood pressure and temperature sensors are also displayed on the LCD in alphanumerical form at the transmitter and receiver sides. With the coming years, the wireless patient monitor is expected to upgrade the health care system across the world.

ACKNOWLEDGMENT

We would like to express our deepest appreciation to God for making this paper a reality. Also, to IJETT editors, for their humble commitment and prompt response in attending to Engineering Journal papers any time. Special thanks to our families and friends for all their moral support and encouragement throughout this paper work.

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