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Patient Health Management System using e-Health Monitoring Architecture

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Abstract—**This paper presents the design and implementation of patient health monitoring architecture using GSM. This is based up on the communication devices like mobile phones and wireless sensor networks for the real time analysis of the patient health condition. The main focus in this paper is on developing a model that can facilitate the doctors through tele-monitoring. This architecture or device will be useful for individuals who will be at home or at hospital. The device developed will be useful for Medical Applications.**

Keywords— **Health monitoring; Wireless sensor networks (WSN); Mobile phones; GSM.**

I. INTRODUCTION

An Embedded system is a single purpose system which is dedicated to unique system. It is not like the general purpose computer system where as a general purpose computer system can perform multitasking functions. It is hard to define embedded system because there are many types of embedded systems. In embedded systems, there are different applications in different functional areas like automobiles, medical, cameras, house hold applications, mechanical applications and toys making especially in WSN systems. These programmable applications are provided with programming interfaces for many applications [1-2].

In our day to day life, we are always busy with some responsibilities. So at this point of time it's tough to watch a person who is unhealthy. In order to overcome this problem, we have introduced a health care monitoring platform using sensor networks. These sensor networks are playing a vital role in the present world. The updates of the patient health can be seen in three ways viz. one is on LCD screen, the second is by an alert message and the last is stored in cloud. Even there is a buzzer that is attached to the module in order to indicate to the nearby people. To know the health parameters we used some sensor instruments. They are temperature sensor, MEMS sensor and heart beat sensor. By using all these parameters we can watch the condition of a patient digitally in LCD [3-4].

Sensor network is of large number of sensor nodes. The position of sensor node may not be pre-determined. The sensor network protocols, algorithms and operations show self-regulating capabilities. The co-operative efforts of sensor node are the unique feature of sensor networks. The sensor nodes have the processing abilities to perform the simple computations and transmit the data which is required.

All these features ensure a wide range of applications. The application areas of sensor are health, military, industrial, robotics, aerospace, manufacturing, space, research centers and security systems. For example, the health condition of multiple patients is physically tough to inspect at a time. If it is monitored remotely by the doctor, then he will come to know about the present condition of the patients. One of the most important constraints of the sensor nodes is low power consumption. The main elements in this work are sensor elements. To discuss about this, we need to know about sensor elements and its types as well as their significance. The significance of the sensor elements are already discussed in our previous sections [5-8].

II. DESIGN

A. *Design of the block diagram*

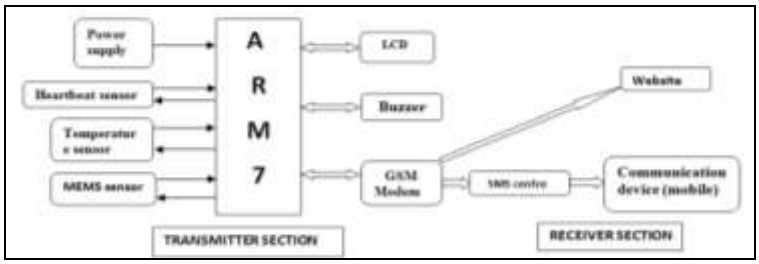

Fig. 1. Block diagram

Figure 1 shows the block diagram of our system. In this work, we consider ARM7 as heart of the system. The power supply is the first element that is important in this work. Initially, the power supply is 250V of AC. The adopter step downs the 250V to 12V power supply. This 12V AC power cannot be used by the circuit because alternating current is always fluctuating. To avoid this problem, we should use DC power supply. The rectifier is used to convert the AC to pulsating DC. The pulsating DC supply is also not constant. So to get the pure form of DC, we pass this to the regulator circuit. The regulator circuit will gives pure form of DC supply to the entire circuit. This results in a DC that has constant power supply.

In this work, three sensors are used namely, temperature sensor, heartbeat sensor and MEMS sensor. Temperature sensor will measure the temperature and this measured output will be given to the processor to display it on the LCD screen. Heartbeat sensor reads the heart-beat of the patient and if the limit changes then the alert will be given to the processor. MEMS sensor is an extension of this module which reads the tilt in the body movement of the patient. That means if there is a sudden fall in the patient the MEMS sensor will send the output to the processor. In this module a GSM modem is also inserted to send the alerts through a wireless network. GSM stands for Global Systems for Mobile communications. GSM modems are widely used tool to communicate or to transfer the data through a wireless network.

Mainly the GSM operates under three carrier frequencies: the 900MHz frequency band, which is used by the original GSM. The 1800MHz frequency band is used to support the bulge customers. The 1900MHz frequency band is used in U.S. The GSM module can be recognized by the subscriber Identity module which is nothing but the SIM card. The GSM modules are locked with a special carrier signal.

When the particular conditions of sensor elements exceed the limit then the readings will be displayed on the LCD screen. At the same time the buzzer will give the alert as beep sound. Simultaneously the same information will be sent to guardian or doctor mobile phone using GSM module. All these functionalities are operated by the micro controller ARM7.

To get a clear idea of this work, we must know about the ARM7 microcontroller. The main functional attributes and algorithms are processed by the microcontroller. The microcontroller has all the features that are found in microprocessor. The main advantage is that it has inbuilt RAM, ROM, serial communication ports, input and output ports, interrupts, clocks and timers. The main difference for a general purpose computer and microcontroller is the microcontroller is an entire computing system manufactured in a single chip whereas the general purpose computer need to have additional setup of input and output devices including memory elements. Microcontrollers are classified on the basis of the bits processed like 8bit microcontroller and 16bit microcontroller.

We have developed this work by keeping five constraints in mind. The first is proposed method which was developed for the patients who are at risk. So it is not possible for the guardian or to doctors to stay with them always. Even for the hospital caregivers also have several duties so they cannot have continuous monitoring for each and every patient. There are some benefits to the patients and even the work becomes easier for the hospitality members. The doctors will be having updated status of patient's health. The guardians can also get the updates of the patients.

The second is we can place these modules to the patients and the separate digital monitoring will be taken care of the hospitality person.

The third constraint is security of the patient will be increased more and if there is anything that goes wrong immediate response will be there.

The fourth one is if the sufferer is physically handicapped or unconscious then this is more useful criteria to take care. If the patient is unable to move anywhere then by the alerts the health status will be received by the caregivers.

The last one, it is not only used in hospitals but also at home the patient health will be monitored by the caregivers.

All these constraints are met by sending an alert to the caregivers from a GSM modem which is incorporated in the module. This is not only by the GSM the surrounding people can be seen by hearing the buzzer sound.

III. OPERATION

The project design operation is very simple to the normal person. Before providing the power supply we have to insert the identity module which is nothing but the SIM card in to the GSM modem. We should make sure that it was entered properly. Initially provide the power supply of 5V. This is converted to 3.3V DC power supply using rectifier, filters and regulator. Initially the programming code was dumped into the microcontroller. The operation of the microcontroller is based on the code that developed for the project to implement the required criteria.

When the module was initially starts with a buzzing sound. Initially the command was not given. We have to wait till the GSM module gets the signal. When the module gets the signal then a LED will glow in the GSM modem. Press the reset button then give the input number as your phone number to get the alerts of the patient health. The SIM card number of GSM modem should take and then in your mobile press * and mobile number as SMS to the GSM. Then the GSM will send the alerts to the given mobile number.

Coming to the operational part, fix the module near by the patient. Then put the heartbeat sensor to the patient's finger. Fix the temperature sensor to the patient's hand. At last put the MEMS sensor on patient body in order to detect if there is a tilt or fall. So if there is any one of the parameter exceeds then guardian or doctor will get an alert and buzzing sound from the module. At the same time this will be sent to the unique IP address of website. This will be seen by authorized person only. Whenever we start the module we have to reset it and give the required identity number.

IV. HARDWARE COMPONENTS

The health monitoring system has some hardware components. In this mainly GSM, temperature sensor (LM35), heartbeat sensor and MEMS sensor, LCD 16x2 screen, MAX-232, buzzer, power supply, ARM7LPC2148 microcontroller

and mobile phone. These are the main components of the system.

A. GSM:

The Global System for Mobile communications is a 2G for mobiles. The GSM is for the transfer and receiving the voice and data transmission. The first GSM technology was established in the year 1982 in Europe. This was developed by using digital network. It carries 64kbps to 120Mbps. It provides the data roaming service also. Digital mobile communication system was developed by European Telecommunication Standards Institute. The first wireless services were through GSM technology which is popularly called General Packet Radio Service (GPRS). The end users are the first to take the option of Short Message System (SMS).

There are four types of GSM networks namely macro, micro, pico and femto cells. Micro and macro cells are provides for outdoor coverage. Pico and femto cells provides for indoor coverage. There are some features of GSM discussed here.

- It gives improved spectrum efficiency.
- It provides international roaming.
- The cost of the mobile is less.
- Speech quality is high.
- GSM supports new services

GSM has ample of functional units. GSM is combination subsystems. The GSM broadly divided as,

- Mobile Base Station (MS)
- Base Station Of Subsystem (BSS)
- Network Switching Subsystem (NSS)
- Operation Support Subsystem (OSS)
- GSM has additional components namely databases and messaging system.

The architecture of GSM is given below:

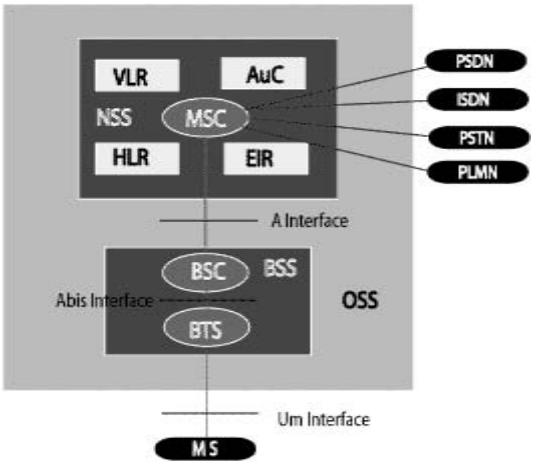

Fig. 2. GSM architecture

In the above figure 2 we can see some blocks. These blocks comprise of databases and messaging system functions. To know clearly about the architecture abbreviations are given.

- Home Location Register (HLR)
- Visitor Location Register (VLR)
- Equipment Identity Register (EIR)
- Authentication Center (Auc)
- SMS Serving Center (SMS SC)
- Gateway Mobile Station Center (GMSC)
- Chargeback Center (CBC)
- Transcoder And Adaptation Unit (TRAU)

B. MAX-232

Fig. 3. MAX-232 IC

The MAX-232 IC was developed in 1987 Maxim. The MAX-232 has a dual transmitter and receiver is used to convert the TX, RX, CTS, RTS signals. MAX-232 has two drivers that convert from RS-232 to TTL logic and TTL to RS-232 logic levels. The signals from RS-232 serial port signal converts to the Transistor Transistor Logic signals by MAX integrated circuit. This IC operates with single 5V supply. It also operates under low power consumptions. The MAX-232 is the dual driver/receiver.

C. BUZZER

The buzzers main application is to give an alert or ring physically. There are several kinds of buzzers. Depends on the application specific buzzer will be used. In previous days electric bells were used for the alerts but buzzer has come into existence the work become easier to the users. There are different buzzers are used like mechanical, electromechanical and piezoelectric buzzers. The modern applications of buzzers are alerts in electronic equipments, alarms, game shows and home appliance devices.

D. LCD

LCD is termed as Liquid Crystal Display. This is used to display the output on the screen. The LCD manufactured with a polarizing material and liquid crystal solution. The liquid crystal solution inserted between the two sheets of polarizing material. The light passes through the crystal to align when an electric current is passed through it. In LCD response time is very important. Response time is nothing but the amount of time taken by liquid crystal to go from active to inactive stage. The LCD used at both

transmitter and receiver side. At the transmitter the input is displayed through LCD and is sent to the receiver. The receiver also required LCD t read the output message.

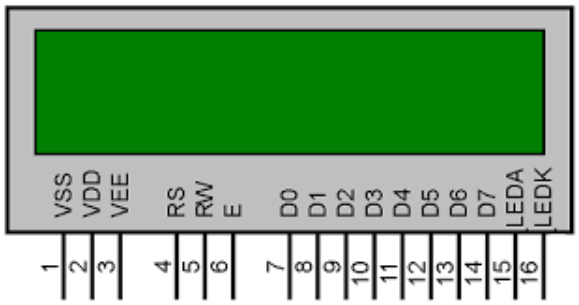

Fig. 4. 16x2 LCD pin diagram

LCD is available in many sizes and shapes. In our project we used 16x2 LCD screen interfacing with ARM7 microcontroller. The LCD is 16x2dot matrix. Then it will be having 32 characters. Totally 1280 pixel is there in 16x2 LCD screen. There are many applications with LCD screen.

LCDs are used for many applications. The application areas may be different but the functioning is only to display.

- LCDs are used in aircrafts cockpit display, digital watches display, calculators display, mobile screens display, computer machines display, laboratories, security zones and televisions etc., application areas.

E. TEMPERATURE SENSOR

The main purpose of sensor is to detect events or changes in its surroundings and gives the output. The temperature sensor is used to detect the temperature or heat.

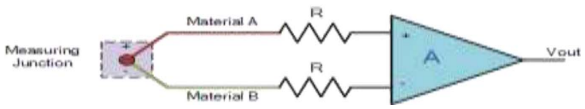

Fig. 5. temperature sensor circuit diagram

There are two types of sensors namely contact temperature sensors and non-contact temperature sensors. Contact Temperature sensors: These types of sensors are operated physically in contact with solids, liquids and gases.

Non-Contact temperature sensors: These types of sensors are operated without physical contact. These can be used to detect wide range of temperatures of liquids or gases. Temperature sensors are made up of Nickel, Constantan, Chromium, Copper, iron and Aluminum.

The temperature sensors are of three groups namely electronic, mechanical and resistive sensors. They are of several types of names like thermostats, bi-metallic thermostat

Fig. 6. Thermistor

and thermistor etc. Thermistor is having Negative Temperature Coefficient resistance (NTC). In this the resistance decreases with increases of temperature. There are wide ranges of applications of temperature sensors are there but the functionality is to detect the temperature.

F. HEARTBEAT SENSOR

The heartbeat sensor modules take the pulses and send to the microcontroller as external interrupt. These pulses are counted by microcontroller and this will be the status of the heartbeat.

Fig. 7. Heartbeat sensor

The heart beat sensor is connected to the finger or ear lobe in order to count the pulses. This sensor has infrared LED, Light sensitive detector and pleth (finger/ear lobe clip).

Electrocardiogram (ECG) reads the heart electrical activity like heartbeat rate, heartbeat rhythm, heart strength and timing. ECG works by detecting and amplifying the potential changes in the skin during each heartbeat.

G. MEMS SENSOR

Micro-Electro-Mechanical System is shortly termed as MEMS sensor. The physical dimensions of MEMS device will vary from well below one micron on lower end of the dimensional spectrum to several millimeters. In this project MEMS we use only two dimensions.

V. RESULTS AND DISCUSSION

The project is perfectly working with all the conditions. Power supply adopter was connected to the power. The power has

Fig. 8. Design Output

come to the device switch on the power supply button. When the power has come to the device we got a beep sound from the buzzer. Before switching ON this device I inserted a identity card into the GSM. At that time the identity card will not be having signal. Wait for a while for the signal. In GSM modem we can see one LED which blinks continuously. When the signal comes then it blinks slowly.

Then reset the device initially. Send a message to the GSM as * and mobile number in which we receive the alerts a patient health parameters. From here onwards the actual testing starts. We tested our device on various situations to see the alerts. When the temperature goes high then we will get the alert as "HIGH TEMPERATURE and the amount of temperature.

Fig. 9. Implementation output

When the heart rate exceeded it was shown as "HIGH HEARTBEAT" and the number of beats per minute. When there is a patient fall then the alert I received as "PATIENT FALL" and the tilt. With all these conditions the device is working perfectly. At the same time the messages are received to the website.

VI. Conclusion & Future Scope

We have processed with GSM module with the micro controller device. The research paper we have proposed an arrangement of novel administrations in light of observing frame work. This will require colossal research and testing before exaction, be that as another way for remote wellbeing observing frame works. The restorative information and history gained for the patients are close to home in nature. Subsequently this framework guarantees the security for the medical information on distributed storage. With further research in this perspective, our framework can change the way we take a gander at remote wellbeing observing administrations.

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