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AMBULATORY PATIENT EAVES-DROPPING SYSTEM

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ABSTRACT

Patients who are alone at home should be monitored by the caretakers or by the nurses. There is no automatic patient monitoring and alerting system implemented so far. In this project the patient is affixed with the MEMS sensor, temperature sensor and heart beat sensor. The microcontroller consists of both normal and abnormal values of pulse and temperature. In case it detects the abnormal changes the buzzer alarms for 5 minutes. If the patient is not able to switch off the alarm, it is considered as emergency and automatically the GPS interfaced with the microcontroller is triggered and the GPS coordinates of the patient's location is sent to the server. The server will compute the shortest path of the ambulance to reach the patient and also an alert SMS is sent to the relatives.

Index Terms: *Microcontroller, Sensors, GSM, and GPS etc.*

1. INTRODUCTION

Automatic emergency detection system is used to recognize the location of the casualty and to reach the location easily. Every second is valuable for the ambulance vehicle. There is danger in losing life due to the delay in informing the ambulance to the patient's location in the golden hours. So time plays an important role in this task. The ambulance will automatically reach the patient's location and the nearest hospital at the exact time to save the human life. This paper is fully automated and thus it locates the emergency spot exactly.

The increase in elderly people over the recent years is the major challenge faced by the developed countries in the world. According to the statistics, over the next 20 years the population of age 65 and above in the developed countries would become 20% of the total population. Therefore there is a vital need to provide quality and low cost healthcare service to the countries with increased elderly population. Hence the ubiquitous monitoring of patients using the bodily attached sensors will increase the early detection of casualty conditions and decrease the rate of fatality.

1.1SYSTEM ARCHITECTURE

The automatic monitoring system is made up of three units.1) Home unit 2) Ambulance unit 3) Server unit.

In the Home unit, the sensors such as heartbeat sensor, temperature sensor, MEMS sensor and vibration sensor are interfaced with the microcontroller AT89C51 and then attached to the patient's body. In the server unit, the server consists of the details of the authorized and registered patients and the details about the ambulances in the whole city.

In the ambulance unit, the server will send the address of the patient to the registered ambulance phone number and the ambulance reaches the location of the patient.

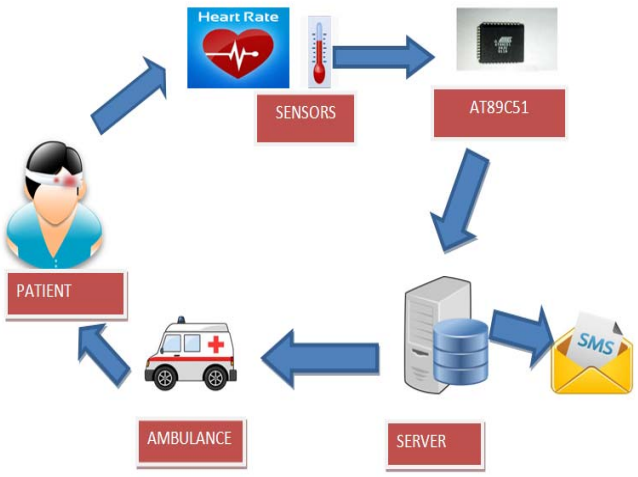

Figure 1: Architecture

1.2 SYSTEM COMPONENTS

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Heartbeat sensor: Heartbeat sensor affords a modest way to study the function of the heart which can be measured based on the principle of psycho-physiological signal used as a stimulus for the virtual- reality system.

Temperature sensor: LM35 is a precision IC temperature sensor with its output proportional to the temperature (in ºC). This sensor is completely vacuum-packed and therefore it is not exposed to oxidation and other processes. Using LM35, temperature can be measured more precisely than with a thermistor. The working temperature range is from -55°C to 150°C.

MEMS SENSOR: MEMS is a micro-electromechanical system including accelerometers, gyroscopes, digital compasses, inertial modules, pressure sensors, humidity sensors and microphones. It converts mechanical energy into electrical energy .MEMS consists of coin-cell battery which makes it live long for up to 75 years and it weighs less than 8 grams.

GSM MODULE: GSM (Global System for Mobile) TTL-Modem is SIM900 Quad-band GSM device, works on frequencies 850 MHZ, 900 MHZ, 1800 MHZ and 1900 MHZ. It is very compact in size and easy to use as plug in GSM Modem. The Modem is designed with 3V3 and 5VDC TTL interfacing circuitry, which allows users to directly interface with 5V Microcontrollers.

GPS: Global Positioning System is used for both tracking and navigation. Tracking systems assist a base station to keep track of the GPS attached vehicle or person without the intervention of that particular person where, as navigation system helps the person to reach the destination. For both navigation system and tracking system, the architecture is comparatively similar. When an emergency situation occurred at patient's location then GPS system tracks the position of the patient and sends the information to the particular person through GSM by alerting the person through SMS or by a call.

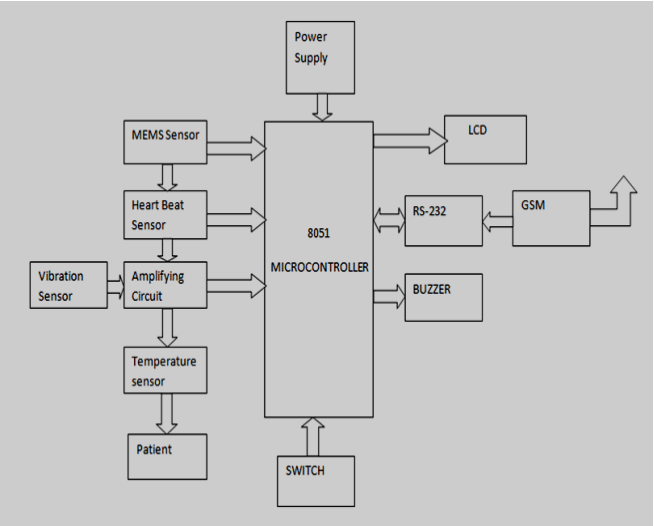

Figure 2: System Components

2. WORKING

In this section the detailed working of all the three units are described.

2.1 HOME UNIT

The AT89C51 microcontroller is a The AT89S51 is a low-power, high-performance CMOS 8-bit microcontroller with 4K bytes of in-system programmable Flash memory. The heartbeat sensor, temperature sensor, vibration sensor, MEMS sensor and GSM module are interfaced with the microcontroller and the fabricated module is attached to the patient's body. The sensors continuously sense the pulse rate, body temperature, electrocardiogram and posture of the patient and send the data to the microcontroller. The microcontroller consists of normal and abnormal value of an average human being for example, pulse rate while sleeping, during meditation, during exercise etc. If the microcontroller senses the value equal to or greater than the threshold value which is predetermined, the buzzer beeps for 5 minutes. If the patient does not off the buzzer it is considered as the emergency situation and the GPS location of the patient is sent to the server using GSM technology and also an alert SMS is sent to the relatives. If the patient is not very serious and he/she is able to off the buzzer, there is no need for an ambulance so that only alert SMS is sent to the relatives.

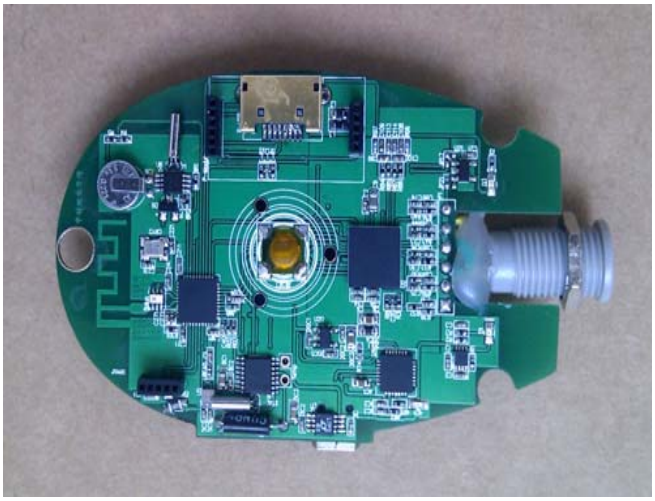

Figure 3: Fabrication of sensors

2.2 WORKING OF GSM AND GPS

GSM: The GSM module is used for the communication between the microcontroller and the mobile phones via UART. To converse over UART or USART, three basic signals are needed namely, RXD (receiver), TXD (transmitter), GND (common ground).

GSM module is interfaced with microcontroller primarily to send SMS. Text messages can be sent over the GSM modem by interfacing only three signals of the GSM modem with microcontroller i.e., RxD, TxD and GND. The RTS (Ready to send) and CTS (Clear to send) signals of serial port interface of GSM Modem are linked with each other.

The receiver signal of serial port of the microcontroller (pin 10) is allied with transmit signal (TxD) of the serial interface of GSM Modem while the transmitter signal of microcontroller serial port (pin 11) is allied with receive signal (RxD) of serial interface of GSM Modem.

The SMS in text mode can enclose up to 140 characters at the most. It may vary depending upon the quantity of

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information collected from the GPS unit. The GSM module consists of a SIM (Subscriber Identity Module) card holder using which messages are sent to the server as well as to the relatives. The microcontroller and the GSM communicate through AT commands.

Figure 4: GSM module

GPS:

The Global Positioning System (GPS) is a grid of about 30 satellites circumnavigating the Earth at an altitude of 20,000 kilometer**.** Using a GPS device whether it can be a mobile phone or handheld GPS unit, anybody can take delivery of the radio signals that the satellite broadcast. Where on earth a person is, as a minimum of four GPS satellites are perceptible at any time. Each one transmits data about its position and current time at regular intervals. These signals travelling at the speed of light are intercepted by the GPS receiver, which estimates how far away the satellite is based on how long it took for the data to arrive. Once it has information on how far away at least three satellites are, the GPS receiver can determine the person's location. The more satellites there are above the horizon, the more accurately the GPS unit can determine the location of a person.

Figure 5: GPS receiver

The GPS sends the location of the patient in the form of GPS coordinates, such as latitude and longitude coordinates. The server receives these coordinates in the form of SMS using GSM technology, and then it converts these GPS coordinates as a human understandable address with the help of Google Earth.

There may be two possible situations regarding the location of the patient. The patient may be inside the home or may be outside the home. In the first case, when the patient is inside the home, the location is obviously constant so there is no need for triggering the GPS to find the location. While in the second case when the patient is outside the home, there is a vital need for the GPS to find the patient's location.

2.3 SERVER UNIT

When an abnormal value is detected, the microcontroller immediately sends the GPS location of the patient to the server. The server upholds a database of the ambulances accessible in the whole city. The server picks out the nearest ambulance to the patient's location using the database holding the details of free and busy ambulances at that point of time. Then the server scans the whereabouts of the free ambulances in the database. It computes the distance between the patient's location and each ambulance. Then it compares all the distances computed and selects the nearest ambulance. Thus for carrying out the above functions, the server must have the following databases:

- An Ambulance database - comprises list of free and busy ambulances at that point of time.
- A CITY database – The Server assigns a distinctive ID for each city and maintains a database which contains all the cities' IDs, GSM numbers and their GPS coordinates.
- A Hospital database - comprising their whereabouts (GPS coordinates) with their GSM numbers.

For the purpose of security reasons and to ensure that the ambulances are not misused, the relatives of the patients are asked to register the patient's full details and the mobile phone numbers to which the notification about the patient has to be sent. To make the process easier, we provide an application form to the users with the fields

Table -1: Name of the Table

User ID	Patient	Relative1	Relative2	Relative3	Near by police
Name					
DOB					
Age					
Phone number					
Address					

The application form has to be submitted along with the proof of address of the patient and the address proof of the relatives mentioned in the form. Also birth certificate of the patient should be submitted. Upon submitting the application form, a user id will be generated for that particular patient and also an emergency service number is to the patient. The notifications about the patient will be intimated through this number. These details are then updated in the server.

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To inform the server whether the patient is inside or outside the home, we include a field called 'status' in the server database. If the patient is inside the home, this status field is set to "in", on the other hand if the patient is outside, he/she should leave a message as 'out' to the emergency service number and automatically the status field will be updated as "out".

When the abnormal changes in the physiological parameters of the patient are detected by the microcontroller, it sends the user id and the GPS coordinates (location) of the patient to the emergency service number. The server can view the messages of this mobile using a software known as 'Cool muster Android Assistant'.

On getting the message, the server retrieves the database of that particular user id and first checks the 'status' field. If the field is set as "in", it gets the patient's address from the database. On the other hand if it is set as "out" then the GPS coordinates are processed and the corresponding location is determined from Google Map.

Once the location is identified, the server will find the nearest ambulance from the patient's location using Dijkstras algorithm. Then the fields such as user id, name of the patient and address of the patient are sent to the ambulance's GSM number and to the registered relatives via SMS. Using these informations, the ambulance can reach the patient's location on time and can rescue the patient as early as possible.

In case, if the patient is inside the locked house, with the help of the police, the patient can be rescued safely.

DIJKSTRA ALGORITHM TO COMPUTE SHORTEST PATH:

As the cities in the particular area are fixed points and the distances between the cities are preset, the shortest path between the cities can be carefully chosen using DIJKSTRA algorithm. For instance when the ambulance travels from the patient's location to the hospital, the database in the server comprises the information about all the cities and the distance between the neighboring cities to which it is connected. The patient's location is taken as the source and the hospital is taken as the destination. The city next to the patient's location and the intermediate cities in the path to hospital must be marked out. So that patient's location is taken as source and the hospital is taken as destination and the DIJKSTRA algorithm is applied for these cities. There may be several routes between these cities and the algorithm discovers the shortest path. There may be one way roads alongside this path, consequently this must be a vector quantity. The server finds adjacent city from source and marks it as visited. Then that node is considered as source and the procedure is continued till the destination is reached. Primarily, the distance between the source and the destination is not known, so the distance is taken as infinite and subsequently on thorough computation, the shortest path between source and destination together with the distance will be known.

2.4 AMBULANCE UNIT

The server will correspondingly compute the nearest hospital and analyzes the shortest path joining the ambulance's current location, the patient's location and the nearest hospital. The shortest route will contain cities in the path. The server takes the GPS co-ordinates of all the intermediate cities in the shortest path from the CITIES database and together with GPS co-ordinates of the patient's location and the hospital; it conveys it to the ambulance unit in a standard format. The coordinates of the cities are alone sent to the ambulance. The format for sending the cities' coordinates is,

X1,Y1	X2,Y2	...	...	Xn-1,Yn-1	Xn,Yn

The last two coordinates (Xn-1, Yn-1) and (Xn, Yn) points to the location of the patient and the location of the hospital respectively.

This message format is also accompanied with other fields such as, name of the patient, address of the patient and also address of the registered relatives, phone number of the patient. This message is sent to the authorized GSM number of the ambulance.

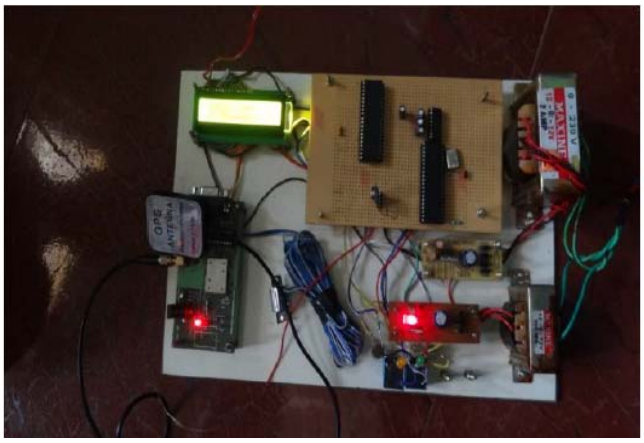

Figure 5: Ambulance unit with GPS

3. TEST RESULTS

The program for the microcontroller is written in the keil5 software and Proteus software is used for simulation. A programmer can Flash Magic is used to dump the coding in microcontroller. The programmer contains an IC base to which the micro controller should be connected and locked. Before this the program should be converted into .hex format using keil5. This figure shows the result of sensors in the home unit.

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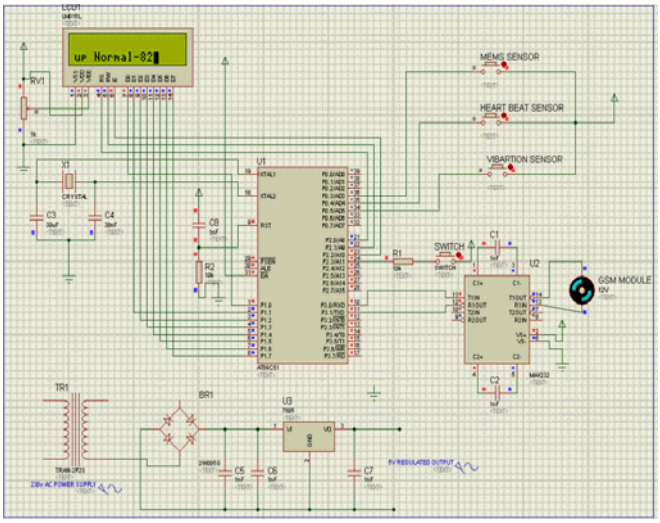

Figure 6: Result of sensor

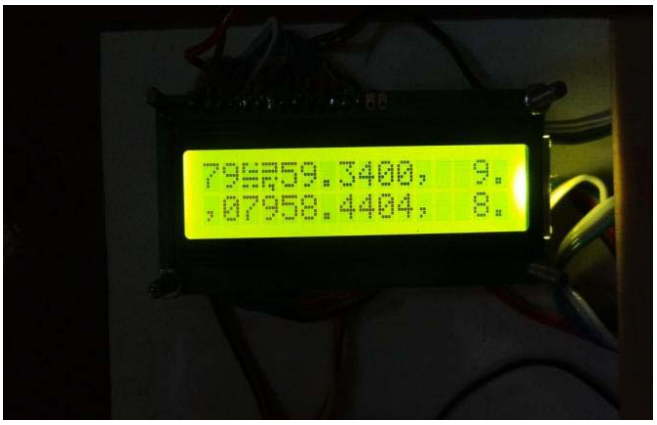

Figure 7: Result of GPS unit

RELATED WORK

Experimental Studies on Intelligent, Wearable and Automated Wireless Mobile Tele-Alert System for Continuous Cardiac Surveillance says that abnormal changes in the body of the patient can be detected by GSM and information is sent to the doctors provided that the patient should be in hospital. To overcome this, we propose this paper for in-patients who are alone at home where there the caretakers are not available.

A Mobile Health Application for the Elder-caregiver Monitoring Paradigm proposed an Android mobile application for the elder- caregiver paradigm, with a fully customized user interface to send SMS to their caregivers. Android is not affordable to all kinds of people, so in this paper we use GSM module for sending SMS to caregivers and nearby Ambulance Service center without using the android mobile which has a disadvantage of battery backup.

Design and Implementation of a Wireless Multi parameter Patient Monitoring System offered remotely operating physiological parameters monitoring device. It can only be implemented by using Wi-Fi internet connection. To overcome this, we develop GSM technique which monitors and sends SMS to caregivers without data connection.

Ubiquitous Health Monitoring Using Mobile Web Services articulates that People with chronic illnesses such as heart disease, which is the leading cause for morbidity and mortality, needs constant monitoring of their health conditions, using mobile application. Constant use of mobile phone for a long time affects the quality of the monitoring process. As a result in this paper, we introduce sensors for monitoring needy people which senses the body parameters constantly and takes the ambulance in an emergency situation.

A pervasive health monitoring service system based on ubiquitous network technology proposed a system where users can record vital signs including heart rate, blood pressure, and body temperature anytime either at home frequently. But this project can only sense the body parameters; neither alert SMS can be sent nor nearest ambulance can be found.

4. CONCLUSION

In this paper, a health monitoring system capable of detecting, monitoring and transmitting the Physiological parameters of the patient such as pulse rate, body temperature, and ECG is designed and implemented. The monitoring system is small, portable, low-cost and easy-to-use without the limit of time and places. This project is useful for elderly people where there is no caretakers and also for sick children whose parents are at busy work schedule.

5. FUTURE ENHANCEMENT

The overall concept used in this paper is for public health awareness and future addition and modification can easily be accomplished to it. Right from the beginning of the paper, provisions can be made to upgrade the product to meet future overall concept used in this enhancement. Enabling GPS helps in monitoring the patient even when the patient is in travel. This paper can also be used for detecting accidents and also ambulance can be sent to rescue the victim in less populated areas by attaching a vibration sensor and a buzzer to the vehicle. It can also be used for defence where the health conditions of the soldiers can be monitored continuously by the concerned commando in charge and can take immediate actions in case of an emergency. Instead of using GSM modem, android phones can also be used to send the alert SMS to relatives.

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