Ambulance Tracking and Patient Health Monitoring Using GPS and GSM

Divya D. Nanwani [1], Puja R. Kshirsagar[2], Bhavana P. Kawalkar[3], Pritish Deshmukh[4]
[1, 2, 3]UG, [4]Assistant Professor, Electronics and Telecommunication Engineering Department, DES'sCOET, Maharashtra, India.

Abstract – This project performs three main functions. First one is Patient health monitoring; second one is tracking the Ambulance which is carrying the Patient and third one is to send above two details to the Hospital or Doctor using a GSM technology. With the help of this project we can find out the location of ambulance and at the same time we can monitor various health parameter of a patient. These parameters are temperature, humidity and heart beat rate. A text SMS containing location and values of all the sensors is sent to a Doctor's mobile. Or we can send this text SMS to any authorized person in hospital. Then that person can intimate Doctor about ambulance location and health. By using these parameters, doctor can do the necessary preparation for treatment of patient. It uses Visual basic software at PC in monitoring system to display location of ambulance by using Google earth map and displaying SMS. After receiving SMS hospital can prepare their staff for proper treatment of coming patient.

Index Terms – Microcontroller, Temperature Sensor, Heartbeat Sensor, GPS Modem, GSM Modem etc.

1. INTRODUCTION

In this urban life transportation is very common. A lot of miss-happenings occur on the road every day. Therefore the need of security and monitoring is developed. To resolve such problems, a system is developed using GPS and GSM technologies and an application is introduced in this research work.

1.1: Various problems that we face:

1. In critical condition (when vehicle is stolen), one is confused what to do
2. If one has something expensive and he wants to check it regularly
3. To find the shortest path available

All these problems are overcome by this system immediate medical attention to critically ill patients and accident victims requires a system to transmit vehicle location information. A centralize monitoring system required in hospital which have information of accident victim vehicle and ambulance location. The doctor needs to understand the physical and physiological condition of the patient so that the right decision regarding administration of drugs and transport destination can be appropriately taken. Hence there is a need for communication between the staff of the ambulance and the monitoring station. The requirement can be achieved by using system in ambulance which uniquely transmits location information and status of patient through parameters i.e. heart beat rate and temperature etc. The system needs to include biomedical sensors to transmit status of patient. All systems are connected to each other through wireless communication which transmits information and data. Use of GPS and GSM for higher communication links will make system more effective and fast response even with this. There is also need of traffic control during transportation of emergency patient so valuable time of response can be saved. System will be interfaced with wireless RF Module to transmit low signals. Including all these requirements system will found to be very useful for emergency treatment of patient during transportation. Proposed project achieves all requirements by including four units called as Ambulance unit, Monitoring Unit, Vehicle Unit, and signal unit. Ambulance becomes intelligent due to interfacing biomedical sensors. This system also has Global Positioning System (GPS) which will receive the coordinates from the satellites among other critical information. Tracking system is very important in modern world. This can be useful in soldier monitoring, tracking of the theft vehicle and various other applications. The system is microcontroller based that consists of a global positioning system (GPS) and global system for mobile communication (GSM). This project uses only one GPS device and a two way communication process is achieved using a GSM modem. GSM modem, provided with a SIM card uses the same communication process as we are using in regular phone. T he system is not limited to find the location of the target but also calculates the distance travelled b/w two stations. This system is user friendly, easily installable, easily accessible and can be used for various other purposes. After installation system will locate target by the use of a Web application (HTML based application) in Google map. The system allows to track the target anytime and anywhere in any weather conditions.

1.2: Proposed System

Fig 1.1 shows a system designed in which four units are working simultaneously with GPS and GSM Modem to achieve all requirements. Ambulance becomes intelligent due to interfacing biomedical sensors.

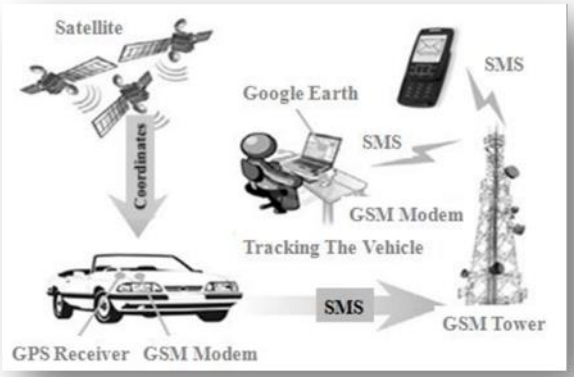

Figure 1.1 Proposed Systems Display of Result

2. OVERVIEW

2.1 Block Diagram of System

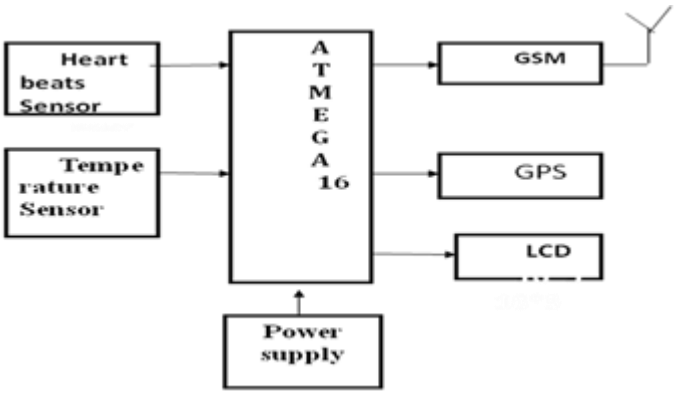

Fig. 2.1: Transmitter Sections of Ambulance Tracking and Patient Health Monitoring System

The above figures 2.1 contain the block diagram of transmitter section of Ambulance tracking and patient health monitoring system. This system performs three main functions. First one is Patient health monitoring; second one is tracking the Ambulance which is carrying the Patient and third one is to send above two details to the Hospital or Doctor using a GSM technology. With the help of this project we can find out the location of ambulance and at the same time we can monitor various health parameter of a patient. These parameters are temperature, humidity and heart beat rate. A text SMS containing location and values of all the sensors is sent to a Doctor's mobile.

2.1.1 Heartbeat Sensor

Heart beats are important for the health of patient. Heartbeat sensor works on a principle that blood in human body pumps with every heartbeat. We have used a Red LED and LDR. Patient needs to place his/her finger between these two components. Red light will be reflected from patient's finger to LDR. And blood will pump with every heartbeat. This will cause fluctuations in the light intensity. Heart beat sensor used in this project works on the above principle. It gives out high pulses with every heartbeat. It works on pure 5 volt DC. It works on the principle of light modulation by blood flow through finger t each pulse.

Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heartbeat. This digital output can be connected to microcontroller directly to measure the Beats per Minute (BPM) rate.

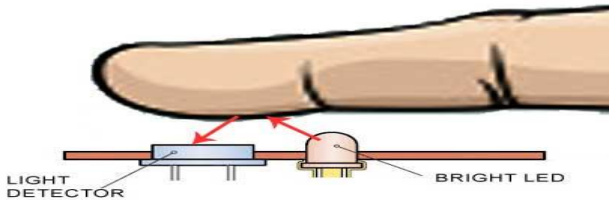

Fig. 2.2: Light Detector

The above figure 2.2 shows the light detector, Heart beat is sensed by using a high intensity type LED and Light Detector. The finger is placed between the LED and Light Detector. As Sensor a photo diode or a photo transistor can be used. The skin may be illuminated with visible (red) using transmitted or reflected light for detection. The very small changes in reflectivity or in transmittance caused by the varying blood content of human tissue are almost invisible. Various noise sources may produce disturbance signals with amplitudes equal or even higher than the amplitude of the pulse signal. Valid pulse measurement therefore requires extensive preprocessing of raw the signal. The new signal processing approach presented here combines analog and digital signal processing in a way that both parts can be kept simple but in combination are very effective in suppressing disturbance signals.

The setup described here uses a red LED for transmitted light illumination and a Light detector. With only slight changes in the preamplifier circuit the same hardware and software could be used with other illumination and detection concepts. The detectors photo current (AC Part) is converted to voltage and amplified by an operational amplifier (LM358). Output is given to another non-inverting input of the same LM358; here the second amplification is done. The value is preset in the inverting input, the amplified value is compared with preset value if any abnormal condition occurs it will generate an interrupt to the controller ATMEGA 16

This circuit made from an infrared phototransistor and infrared LED. This transducer works with the principle of light reflection, in this case the light is infrared. The skin is used as

a reflective surface for infrared light. The density of blood in the skin will effect on the IR reflectivity. The pumping action of heart causes the blood density rises and falls. So that we can calculate the heart rate based on the rise and fall of intensity of infrared that reflected by skin. Following figure 2.3 shows the Heartbeat Sensor.

- **Features**
  - Microcontroller based SMD design
  - Heat beat indication by LED
  - Instant output digital signal for directly connecting to microcontroller
  - Compact Size
  - Working Voltage +5V DC

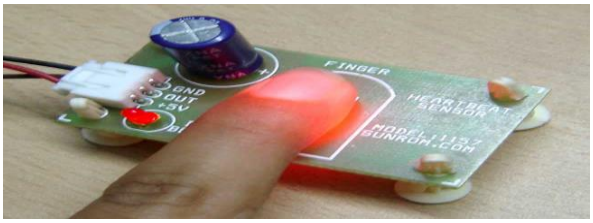

Fig. 2.3 Heartbeat Sensor

2.1.2 Temperature Sensor

The below figure 2.4 shows the Temperature Sensor. We have used temperature sensor to measure the body temperature of the patient. This is an analog type of temperature sensor. It gives variable output voltage as per the variations in the temperature received / sensed. This will help to monitor the variations in the temperature of patient.

Figure 2.4 shows the Pin Diagram of LM35 series which are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies.

As it draws only 60 μA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

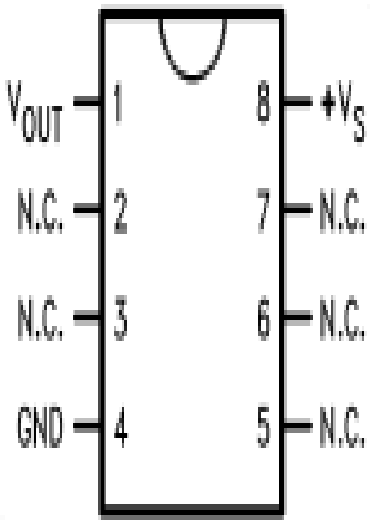

Fig. 2.4: Pin Diagram of LM35

2.2 Microcontroller

The below figure 2.5 shows the Pin Diagram of microcontroller, Microcontroller is main heart of the system as it communicates with all input and output devices and it controls whole operation of the system. We will use ATmega16 microcontroller. Following are the various functions of Microcontroller ATmega16 is an 8-bit high performance microcontroller of Atmel's Mega AVR family with low power consumption. Atmega16 is based on enhanced RISC (Reduced Instruction Set Computing, Know more about RISC and CISC Architecture) architecture with 131 powerful instructions. Most of the instructions execute in one machine cycle. Atmega16 can work on a maximum frequency of 16MHz.ATmega16 has 16 KB programmable flash memory, static RAM of 1 KB and EEPROM of 512 Bytes. The endurance cycle of flash memory and EEPROM is 10,000 and 100,000, respectively ATmega16 is a 40 pin microcontroller. There are 32 I/O (input/output) lines which are divided into four 8-bit ports designated as PORTA, PORTB, PORTC and PORTD.ATmega16 has various in-built peripherals like USART, ADC, Analog Comparator, SPI, JTAG etc. Each I/O pin has an alternative task related to in-built peripherals. The following table shows the pin description of ATmega16.

- Features:
  - High-performance, Low-power AVR8-bit Microcontroller

- Advanced RISC Architecture

  131 Powerful Instructions – Most Single-clock Cycle Execution

  32 x 8 General Purpose Working Registers

  On-chip 2-cycle Multiplier
- Two 8-bit Timer/Counters with Separate Presales and Compare Modes
- One 16-bit Timer/Counter with Separate Presales, Compare,

  Four PWM Channels

  8-channel, 10-bit ADC

  Byte-oriented Two-wire Serial Interface
- Special Microcontroller Features

  Power-on Reset and Programmable Brown-out Detection

  External and Internal Interrupt Sources
- I/O and Packages

  32 Programmable I/O Lines
- Operating Voltages4.5 - 5.5V for ATmega16

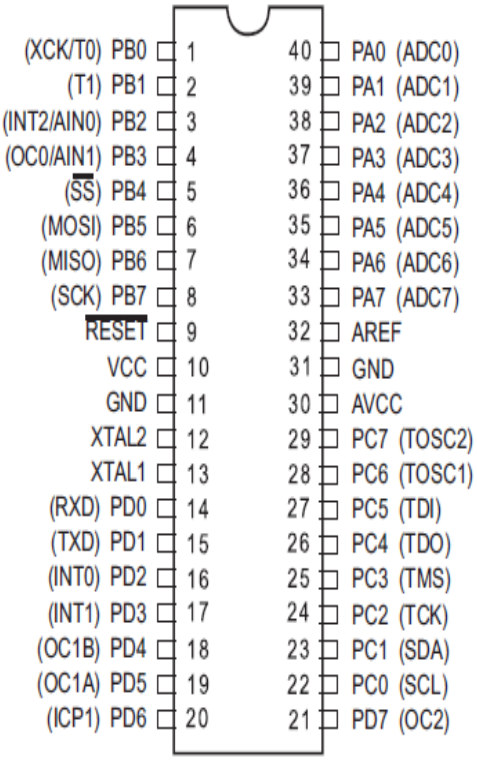

Fig. 2.5: Pin Diagram of ATMEGA 16

2.3 Global System for Mobile Communication

Global System for Mobile Communication (GSM) which is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephone technologies(TDMA,GSM and CDMA). GSM digitizes a compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900MHz or 1800MHz frequency band.

GSM Module consists of a GSM modem assembled together with power supply circuit and communication interfaces for computer. The modem is the soul of such modules. They generate, transmit or decode data from a cellular network, for establishing communication between the cellular network and the user. This is an ultra-compact and reliable wireless module. The SIM900A is a complete dual band GSM solution is a module which can be embedded in the customer applications allowing you to benefit from small dimensions and effective solutions.

Fig. 2.6: GSM Modem

Fig. 2.7: Doctor's Monitoring Screen

The above figure 2.6 shows the GSM Modem, The main function of GSM modem is to send all parameters to user Doctor through a text SMS. For sending SMS, Microcontroller needs to give various AT commands to GSM modem using a serial communication port. The following figure 2.7 shows

the Doctor's monitoring screen in which the physiological parameters that can be measured can be seen on Doctor's monitor as well as the location of the ambulance can be tracked.

2.4 Global Positioning System

The Global Positioning System (GPS) is a satellite based navigation system made up of a network of 24satellites placed into orbit by the U.S. Department of Defense.GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day .There is no subscription fees or setup charges to use GPS. Distance=Velocity * Time here Velocity of the GPS signal is the speed of light, approximately 300,000Km/s.GPS transmissions occur on a frequency of 1575.42 and 1227.60 MHz, Both of these frequencies are within L Band

The Global Positioning Systems Transmit signals to equipment on the ground. GPS receiver passively receive satellite signals, they do not transmit. GPS receivers require an unobstructed view of the sky, so they are used only outdoors and they often do not perform well within forested areas or near tall buildings.GPS operations depend on a very accurate time reference, which is provided by atomic clocks on board. Each GPS satellite transmits data that indicates its location and the current time. All GPS satellite synchronize operations so that these repeating signals are transmitted at the same instant .The signals, moving at the speed of light , arrive at a GPS receiver at slightly different times because some satellites are further away than others .The distance to the GPS satellite can be determined by estimating the amount of time it takes for their signals to reach the receiver When the receiver estimates the distance to at least four GPS satellite, it can calculate its position in three dimensions.

There are at least 24 operational GPS satellites at all times plus a number of spares. The satellites ,operated by the U.S. Department of Defense , orbit with a period of 12 hours (two orbits per day) at a height of about 11500 miles travelling at near 2000mph. Ground stations are used to precisely track each satellite's orbit. The accuracy of a position determined with GPS depends on the type or receiver. Most handheld GPS units have about 10-20 meter accuracy. Other types of receivers use a method called Differential GPS (DGPS) to obtain much higher accuracy. DGPS requires an additional receiver fixed at a known location nearby. Observations made by the stationary receiver are used to correct positions recorded by the roving units, producing an accuracy great.

The below figure 2.8 shows the GPS Modem, The main function of GPS – Global Positioning System modem is to provide longitude and latitude of the ambulance. The GPS modem receives data from satellite. And then it gives this bunch of data to Microcontroller through serial communication. As ambulance moves along the way from patient's home to hospital, the co-ordinates of ambulance location will change and these variations are given to Microcontroller.

Fig. 2.8: GPS Modem

3. CIRCUIT DESCRIPTION

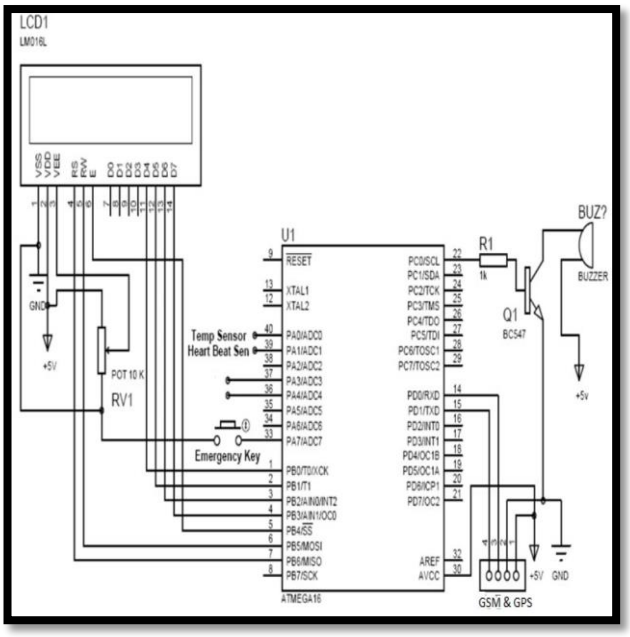

Figure 3.1 Circuit Diagram of Transmitter for Ambulance Tracking And Patient Health Monitoring System

The above figure 3.1 shows the circuit diagram of ambulance tracking and patient health monitoring system. This system is based upon GSM and GPS Technology in order to compensate for the existing health system, reduce the workload of the staff taking care of the patient, and improve the patient's mobility is specifically designed to provide better services and a better cure. The Hardware of the system consists of the two sections:

Transmitter and Receiver. The Description of both the section is as follows:

Description of Transmitter Section Transmitter section of the monitoring health care system consists of a GSM and GPS network. To keep the moment of the patient intact with the sensors on the body, the wireless sensors are required to be minimized and portable. These sensors are heart beat sensor, temperature are the basic requirements of a patient. Temperature sensor used here is LM35 which is a precision integrated device. LM35 is used to measure temperature of the patient's room. LM35 provides 3 pins as Vs, GND and VOUT. The VOUT pin connected to ADC0 pin of microcontroller. The second sensor heart bit sensor whose output connected to ADC1 Pin of microcontroller. The emergency key which is connected to PA7 pin.LCD which is connected to port B. Now the sensed or collected data from the sensors is to two be transmitted to the control unit for matching process.

For controlling action, AVR Microcontroller is used. It is an 8-bit microcontroller with inbuilt 128 bytes of internal random access memory, 4K read only memory, timers/counters, four general purpose input/output ports. Controller will match the limit predefined in the code of the microcontroller.GSM is required in Ambulance tracking systems because GPS system can normally only receive location information from satellites but cannot communicate back with them. Hence we need some other communication system like GSM to send this location information to central control room.

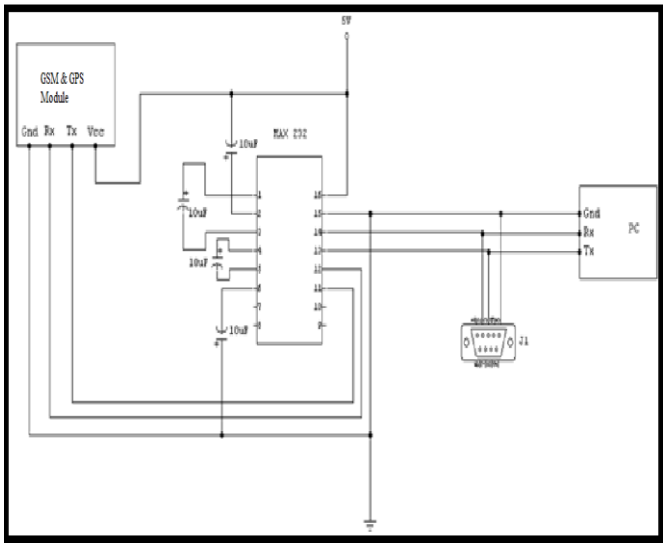

Fig. 3.2: Circuit Diagram of Receiver for Ambulance Tracking and Patient Health Monitoring System

The above figure 3.2 shows the circuit Diagram of receiver for ambulance tracking and patient health monitoring system. The information by the GSM module is received wirelessly by the other GSM module at the receiver section as shown. GSM module will transfer the data to the PC using MAX232. It is used for voltage conversion purpose.

3.1: FLOWCHART

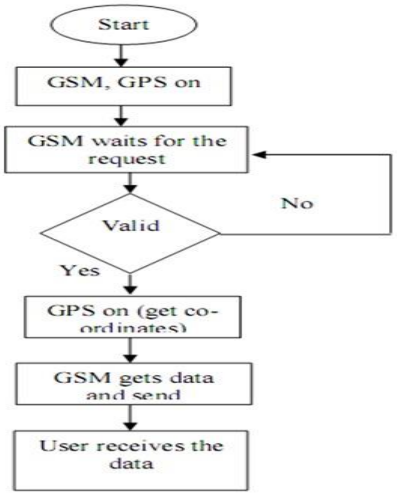

Fig. 3.3: Flowchart of Ambulance Tracking And Patient Health Monitoring System

4. ADVANTAGES

1. The main advantage of **"**Ambulance tracking with patient health monitoring system**"** is that with the help of GSM technology, the data of patient health can be sent to a longer distance through SMS. With the help of this, doctor could have all prior information ready in hand before the patient reaches to the hospital.
2. With the use of GPS technology, the exact co-ordinates of ambulance can be tracked. And then distance from the hospital can be found out. Thus we can get / manipulate approximate time for the ambulance to reach to hospital.
3. As this system is fully automated, it does not require any human interaction. This system receives the health parameter values, longitude and latitude and sends SMS automatically after a period interval of time.

5. DISADVANTAGES

1. We cannot implement the GPS & GSM in each and every ambulance, it leads to be costly.
2. We cannot do the many more arrangement for the patient who is in very serious condition.

6. APPLICATIONS

1. As the name suggests, this project finds its main application in hospital for the tracking of ambulance as well as to understand the health parameter values of patient.

2. Many industries and companies have their own private ambulance. These ambulances proves helpful and life saver when any employee or worker met with an accident. Ambulance tracking with patient health monitoring system can also be in these industries to find out the position of ambulance carrying the injured employee to the hospital.
3. Ambulance tracking system can also be used in national parks or wildlife animal reserves where endangered species or rare species animals are preserved. If these animals have some disease or they have wounds due to some accident then these animals are carried from one place to another where they can get treatment for example to an animal hospital. In such situations, we can track the location of vehicle containing these rare species animals.
4. With little bit modification, this project can also be used for industrial purpose. This project can be used to track industrial vehicles carrying equipment or materials like fuel tanks, fuel containers or gas container. This system can be used in vehicle of scientific labs or industries carrying chemicals, radioactive materials and explosive materials. In these cases we can use this project to track vehicle location, however in such applications we need to modify the project.

7. CONCLUSION

As this project is based on micro-controller and GSM and GPS technology is used to transmit data via the text messages this field of medicine helps the doctors to keep a keen eye on the patients' health when patient is in Ambulance. Also the physiological parameters such as body temperature, heartbeat are monitored. The patient can be analyzed by doctors in any part of the hospital wherever they are. It reduces the doctor's work load and also gives accurate result.

The system can help to save a few critical minutes of response times by monitoring location of ambulance from Hospital. It uses Visual basic software at PC in monitoring system to display location of ambulance by using Google earth map and displaying SMS. After receiving SMS hospital can prepare their staff for proper treatment of coming patient.

REFERENCES

[1] Pankaj Verma 1, J.S Bhatia 2 Centre for Development of Advanced Computing, Mohali, Punjab, India pankajvermab35@yahoo.comjsbhatia.cdac@gmail.com"Design And Development Of GPS-GSM Based Tracking System With Google Map Based Monitoring".

[2] Tia Gao1, Dan Greenspan2, Matt Welsh3 1,2The Johns Hopkins University Applied Physics Laboratory 3Division of Engineering and Applied Sciences, Harvard University, MA, USA 1,211100 Johns Hopkins Rd, Laurel, MD 20723, USA 3233 Maxwell Dworkin, 33 Oxford St.m Cambridge **"**Improving Patient Monitoring And Tracking In Emergency Response".

[3] K .Navya et al.Int,Journal of Engineering Research and Applications Vol.3,Issue 5,Sep-Oct 2013,pp.483-486 "A Z Based Patient Health Monitoring System" K Navya-M-tech Dept of ECE, CMR College of Engineerinf and Technology,Hyderabad,AP-India

[4] Mohammad A. Al-Khedher,' Hybrid GPS-GSM Localization of Automobile Tracking System' International Journal of Computer Science & Information Technology (IJCSIT) Vol 3, No 6, Dec 2011.

[5] 1Baburao Kodavati, 2 V.K.Raju, 3S.Srinivasa Rao, 4A.V.Prabu, 5T.Appa Rao, 6 Dr.Y.V.Narayana , 'GSM and GPS based vehicle location and tracking system', International Journal of Engineering Research and Applications (IJERA) ISSN: 22489622 www.ijera.com Vol. 1, Issue 3, pp.616-625 Shriram K Vasudevan ,Sivaraman R ,Subashri V, 'Design and Development of an Embedded System for Monitoring the Health Status of a Patient', I.J. Intelligent Systems and Applications, 2013, 04, 64-71Published Online March 2013.

[6] K. Satyanarayana,1 A. D. Sarma,2 J. Sravan,1 M. Malini,1 and G. Venkateswarlu, 'GPS and GPRS based telemonitoring system for emergency patient transportation', Hindawi Publishing Corporation Journal of Medical Engineering Volume 2013, Article ID 363508, 9 pageshttp://dx.doi.org/10.1155/2013/363508.

[7] Ms. Sarika B. Kale, Prof. Gajanan P. Dhok, 'Embedded system for intelligent ambulance and traffic control management', International Journal of Computer and Electronics Research [Volume 2, Issue 2, April 2013].