Smart Life Saver Ambulance System (SLSAS) furnished with IoT technology to accelerate the process of early patient treatment in hospital.

Roopa Jaya Singh J ¹, Jeba Kumar R.J.S ²

¹ Assistant Professor, School of Electronics and Communication Engineering, Department of Electrical Technology, Karunya Institute of Technology and Sciences, Coimbatore - 641114, Tamil Nadu – India, roopa@karunya.edu

² UG Student, School of Electronics and Communication Engineering, Department of Electrical Technology, Karunya Institute of Technology and Sciences, Coimbatore - 641114, Tamil Nadu – India, jebakumarjrs@gmail.com

Abstract. Ambulance, a prime life saver vehicle plays a vital role in saving the patients precious life. It is in need of prominent time constraint to direct the needful patients in the appropriate time and destination. This novel project highlights the solution which determines the occurrence of accidents in the road with the help of vibration sensing implanted over the vehicle with Micro Controller Unit (MCU) and intimating the occurrence of accidental location to the nearby ambulance service to the hospital service using Global System for Mobile communication (GSM) and Global Positioning System (GPS) enabled module. Life saver ambulance is also furnished with portable Electrocardiogram - ECG and Body Temperature estimation along with the aid kit, for the ease of patient monitoring. There are basically two modules in this Smart Ambulance System, i.e. Vehicle Module (VM) and Receiver Module (RM). VM is placed in the victim’s automobile with GPS and GSM enabled devices i.e. a mobile phone to transmit Short Message Service (SMS) of the accident location to hospital for smart ambulance service. RM is in the hospital ambulance service enabled with GSM receiver. Vibration Sensing technology is utilized in VM for accident detection, Microcontroller-RENESAS-R8C13 is utilized as a smart processing unit, Recommended Standard(RS) - 232 Interface for PC interfacing with GSM receiver module, Personal Computer (PC) in the admin hospital as a database for ambulance service and Portable ECG and Body Temperature estimation module furnished in the Smart Life Saver Ambulance System with IoT Technology. The
needed harvested details are pushed to the IOT to the doctor’s admin page to the appropriate hospital and thus the maximum time is saved in saving the patient’s life even before the ambulance reaches the hospital. This novel Smart Life Saver Ambulance System (SLSAS) will save the patient’s life by making a conclusion for the way of treatment needed for the patient during the patients boarding towards the hospital. Hence much time will be saved in taking the needed test and even before patients reach the hospital. The advent of IOT technology is utilised to send the harvested documents to the doctor’s admin page immediately and this overcomes the time constraints and distance constraints of saving the patient’s life. The entire monitored health detail is updated regularly in doctor’s admin page, to have the track on the patient’s severity condition. This novel research project will be a boon to medical patient assistance domain to save precious patient’s life.

**Keywords.** Global Positioning System, Global System for Mobile communication, Graphical User Interface, Electrocardiogram, Internet of Things.

1.1 Introduction

The evolution of ambulance dates back to 14th century where carts were used to take the needed patients to the hospital manually. As, centuries rolled on four-wheeler life saver vehicle came into an existence in the form of “Ambulance” to save patients precious life which god and nature has bestowed to all man-kind. Road accidents occur due to sudden misshapen or not following the road signs i.e. not serious about driving rules properly. Accident death rates are declining nowadays with the advent of ambulance system prevailing in modern society. Some of the death rate are due to delayed service of ambulance and delayed intimation to the hospital for the needed help [1]. This time lag between the occurrence of accident and intimation to the nearby hospital has to be reduced to save more precious life of victims. In this novel solution to combat accidents and to save patients life by harvesting necessary details about the victim during the onward safe journey to the hospital in ambulance.

Multiple existing concepts and some booming technologies are blended in this research work, to frame the safe and secure system for patient’s ambulance service [2,3]. Global System for Mobile communication (GSM), uses Time Division Multiplexing Access (TDMA) for sending short information’s i.e. Short Message Service (SMS) in mobile telephony network. GSM is the most widely used wireless telephony technology in the present world for enabling mobile communication. Global Positioning System (GPS) uses satellite for
tracking the mobile enabled with GPS module. Orbiting satellites are used to sends the latitude and altitude of the tracking targeted GPS enabled device using the process of Trilateration. At least three satellites are used to track the target device and the distance is calculated using trilateration, an advanced triangulation method. The harvested information from the patient is intimated to the doctor through the admin web page using IOT technology. This novel research paper highlights the needed advancement and solution, to save patients life by adding intelligence to the existing ambulance system i.e. occurrence of accident is tracked using GPS and it is intimated to the nearby ambulance service to the hospital.

This novel project aids in adding additional feature to the existing system by tracking facility of occurrence of accident and intimating to the nearby hospital for ambulance service, which is equipped with the portable devices ECG and Body Temperature estimation.

1.2 Research Motivation

The prime spark for this novel project was conceived from the facts and figures from the daily newspaper and media depicting the number of deaths, due to accidents in the highways which is shocking and alarming nowadays. Statistics shows that approximately 1 dies in every 30 hours in a fast lane road of dense populated road for example, Coimbatore City. The approximate overall death rate in Tamil Nadu is around 43 in 100 persons a day as cited in Deccan Chronicle Published on Jun 11, 2016 in Nations and Current Affairs Column. Pensioner of age 73 died due to delay in ambulance service in Collectorate of Kakinada district on 13th June 2016 as telecasted on media in ABN Telugu News channel. Ambulance 'delay' leads to patient death as cited in Times of India daily Newspaper in city column Bhubaneswar Sep 22, 2016.This delay of ambulance service is seen not only in India but also in developed western countries as cited in British Broadcasting Corporation (BBC) in Paramedic section “Paramedic Ambulance delays causing harm and death’s” was the alarmed news on 4 May 2013. The existing work of bridging the gap in ambulance delay is done with the help of Android, Bluetooth and ZigBee technologies but, the main disadvantage of this existing work is that the system is confined to limited area of the coverage range. [4,5].

All this flaming news triggered the need of ambulance system which rescues the patient in appropriate time thereby taking the needed reading of the patient if needed during their on-board travel towards the
hospital using portable ECG and Body Temperature estimation and pushing the harvested data to the doctor’s admin page in the hospital using IOT Technology. All these sensors and entire system is interlinked with the common access as Wireless Sensor Network [6].

The primary organisation of this research paper deals with the Smart Ambulance System with accident tracking facility using GSM and GPS technology. The secondary part of the paper deals with the added features inside the ambulance to take the needed reading if the patient is in need of those test and this saves the time for his treatment analysis even before the victim reaches the hospital i.e. Portable ECG and Body Temperature estimation. The tertiary part of the paper deals with the IOT concept i.e. pushing the data to the doctor’s admin page in the nearby hospital where the patient is boarding.

1.3 Proposed Smart Life Saver Ambulance System (SLSAS)

Proposed Smart Ambulance System aims at drastically reducing the deaths due to highway accidents, it ensures that the ambulance arrives in time by informing the nearby hospital automatically and hence smart ambulance which has the needed portable equipment’s furnished net connection to push the data to the doctor’s admin page with IOT connectivity.

There are basically two modules in this Smart Ambulance System, i.e. Vehicle module which is placed in the patient’s vehicle with GSM & GPS enabled devices and receiver module which is a mobile phone to receive Short Message Service of the accident location to the nearby hospital for ambulance service.

The needed modules are, Global Positioning System- GPS for accident location information, GSM Transmitter and Receiver, Vibration Sensing for accident detection, Microcontroller-RENESAS-R8C13 as a processing unit, RS-232 INTERFACE for PC interfacing with GSM receiver module, Personal Computer (PC) as a database for ambulance service, Portable ECG and Body Temperature estimation module. The overall system architecture for Smart Ambulance System is as portrayed in Fig. 1.1.
1.3.1 Accident Detection using Vibration Sensing System (VSS)

The occurrence of an accident is identified using a vibration sensing with the basis of conversion of mechanical vibrations to electrical pulses. When a mechanical vibration is given to the plate it is converted to an electrical signal and this signal gets amplified when it gets through the LM 741.1N4007 is used for limiting the current and the signal is passed through a comparator circuit where another LM 741 is used. This signal then goes to the BC 547 a transistor which used for switching purpose. Negative clipping takes place and this signal is passed through a LM 555 timer for delay purpose. Then this signal goes to a BC 547 a transistor to trigger the alarm and the microcontroller initiates its process for the predetermined action dumped in MCU for accident occurrence’s. The circuit diagram for vibration sensing is as portrayed in Fig. 1.2.
1.3.2 Fail-Safe Mechanism to avoid havoc in SLSAS

A RESET switch is integrated to stop the MCU from sending the signals for an ambulance service to arrive. This is used in the case that the injury to the driver is not serious due to the accident or to avoid false information due to system malfunction to avoid the havoc. Fig. 1.3, portrays the circuit connection for reset switch with the MCU unit to trigger OFF the entire system, if the driver is not affected by the unexpected accident.
1.3.3 Flow Chart for GPS initialisation in SLSAS.

GPS Module is positioned in the vehicle to share the location information in precise manner in terms of latitude and longitude readings from the satellite [7,8]. Four satellites communicating with the GPS module are needed to mention the tracked location precisely in 3-D geographical area. The functional flow chart for GPS initialisation as portrayed in Fig. 1.4.

**Fig. 1.4.** GPS initialisation flowchart.

1.3.4 Intimation to nearby Hospital about Accident Location

Two mobile phones are used here as Transmitter and Receiver. The mobile in the Vehicle module acts as the Transmitter to transmit the Latitude and Longitude information to the receiver. The Receiver is again a mobile which is interfaced using MAX-232 to a PC. The PC is used for integrating the Auto-Dialler to call the ambulance service nearer to the accident location. This is accomplished using programs developed using VB 6.0. Pre-loaded Latitude and Longitude positions along the highways will be referred by the PC to compare with the information sent by the Transmitter from the accident location. By comparison the nearest Hospital or Ambulance service is dialled automatically using the mobile in the receiver module. The accident location is informed to the Hospital or Ambulance service by voice. The whole process goes on without any Human intervention. AT commands are used in both vehicle transmitter
module and receiver ambulance intimation module [9]. AT commands needed to establish intimation are as shown in Table 1.1. AT commands are used to initialise the communication in terms of short location information to the nearby hospital for ambulance service.

**Table 1.1. AT Commands in both transmitter and receiver module.**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Module</th>
<th>Command Syntax</th>
<th>Command Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transmitter Module</td>
<td>AT</td>
<td>To set the phone in command mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT+MGS=&quot;9894301617&quot;</td>
<td>To set the phone number to which the message should be sent.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ATDT&quot;9894301617&quot;</td>
<td>To set the mobile number to which the output is shown.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT+CMGR</td>
<td>To set the mobile in receive “Read” mode</td>
</tr>
<tr>
<td>2</td>
<td>Receiver Module</td>
<td>AT+CMGD=1</td>
<td>To delete the message that is in the inbox</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT+CPMS=1</td>
<td>Selects the memory storage space to be used for writing, reading</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT+CMGF</td>
<td>Indicates the message format used for send, read, write and list commands.</td>
</tr>
</tbody>
</table>

AT – Attention (Modem Control Commands)

### 1.3.5 Subsystem Connection with the MCU RENESAS-R8C13

GSM network is used with the help of a mobile to send the information about the accident location. GPS antenna and GPS receiver used for getting the latitude, longitude and altitude information of the vehicle which has installed this prototype. An alarm is used to identify the vehicle by the ambulance service easily in the highways and to inform the passer by vehicles and nearby men. The MCU controls all these, it is a highly advanced Micro-controller that is being used today. This MCU has two serial ports which not many Micro-controllers have today, which is the reason to choose this MCU. The basic block diagram of the smart ambulance system for the vehicle module implantation is as portrayed in Fig. 1.5.
Fig. 1.5. Basic Block Diagram of the Smart Ambulance System for the vehicle module.

Nearby ambulance service in hospital has the GSM receiver module connected to the hospital database as portrayed in the Fig. 1.6.

Fig. 1.6. Basic Block Diagram of the Smart Ambulance System for the Receiver module for Ambulance service in the hospital.

The entire system connection with the MCU - RENESAS-R8C13 to all the sub-devices like Vibration Sensing, GPS Module, GSM Module (Mobile Interface) and needed power supply is as depicted in Fig. 1.7.
With the help of this Smart Ambulance arrival to the victim’s location, the patient’s life can be saved as early as possible. IOT furnished ambulance service bridges the time gap between the ambulance arrival to save the victims life [10 - 12].

1.4 Results and Discussion on portable ECG and Temperature Sensor support in the Smart Life Saver Ambulance System(SLSAS) furnished with IoT Technology

The results followed are classified into two main categories i.e. Firstly, Occurrence of accident information detected using vibration sensor and location is shared using GPS enabled module in the passenger’s vehicle privately. Secondly, Smart Ambulance arrives and the victims personal and basic health details needed to test for his treatment is informed to the appropriate hospital using IOT furnished technology enabled in the smart ambulance. The readily available patients basic and health details are reflected to the assigned doctor even before the patient arrive the hospital for his/her treatment.
1.4.1 Accident information about location intimated to the nearby hospital with GPS enabled module.

The occurrence of accident is detected using vibration sensor positioned in the victim’s vehicle. GPS Graphical User Interface (GUI) system layout is as portrayed in Fig. 1.8. The location information about the accident is as depicted in Fig. 1.9.

![Fig. 1.8. GPS-GUI system layout](image)

![Fig. 1.9. GPS-GUI Accident Location Information](image)
1.4.2 ECG Monitoring system in Smart Ambulance Service equipped with IoT technology

Self-Power enabled voltage regulator is given to the ECG harvesting system. Pads are kept in the patient’s wrist and the heart rate is read and it is intimated as normal if the Beats Per Minute (bpm) is within 60-100 bpm. If the range is deviated either above or below this particular range it is found to be low heart rate or high heart rate respectively. ESP 8266 is connected to the core board PIC 16F877A, to create Wi-Fi connectivity to push the harvested patient’s data to the IoT using TCP connection and this in turn is reflected in the hospitals database collectively. DS18B20 (Digital Temperature Sensor) is attached to the core controller to harvest the patient’s body temperature and to push the data to the cloud. Fig. 1.10, depicts the entire hardware setup for Portable ECG harvest using PIC 16F877A, Pulse Pad and ESP 8266, to enable seamless IoT connectivity for pushing the data to the cloud [13-15].

Fig. 1.10. Potable ECG harvest to the patient in Mobile Smart Ambulance with added IoT Technology

The harvested ECG data which is taken in the ambulance is sent to the database through TCP Telnet protocol and any abnormalities seen in the harvested data is intimated and recorded simultaneously in the database as portrayed in Fig. 1.11.
ECG tracking and intimation to the hospital using ESP 8266 Wi-Fi Module

1.4.3 Hospital Database furnished with the patients basic details for the purpose of treatment

The prime gathered details i.e. patient’s health condition like Heart Beat rate, Temperature fluctuation and other Basic Patient Detail are pushed with the ability of IoT Technology using a Wi-Fi module (ESP8266) for IoT support to the doctor’s admin page of the appropriate hospital. This system will minimize the monitoring time and maximize the treatment efficiency by saving the patient’s life, even before the ambulance reaches the hospital. The communication link between the hospital and the smart ambulance is bi-directional, hence doctor can even aid the tele first-aid, medical facility through the attending nurse assigned inside the smart ambulance. This novel Smart Ambulance System will save the patient’s life by aiding a fast doctor’s decision for procedure of treatment needed for the patient during on-board journey of the smart ambulance towards the hospital. Hence, much time will be saved in taking the needed test even before patients reach the hospital. All the harvested data about the patient’s basic details and basic monitoring details are reflected to the hospital simultaneously as and when the device monitors the patient in the ambulance, even before the victim arrives the hospital for treatment. The
gap of time lapse in pre-treatment assessment is overcome by the IOT concept by putting each and every data into the cloud during the patient’s onboard journey to the hospital in the ambulance and retrieved by the appropriate doctor in hospital patient database for patient’s treatment reference. Fig. 1.12, shows the hospitals admin page for the secured database with password protection.

**Fig. 1.12.** Login Page of the hospital database

Based on the critical situation of the patient’s desperate need, the system automatically assigns to the specialist doctor for the noble reason of the early treatment. Fig 1.13, Portrays the doctor’s admin page, where doctor can choose his name tab to view the patients details and to be ready to start the treatment when the patient arrives immediately to the hospital.
Fig. 1.13. Doctors admin Page to view the patient’s details

1.4.4 Pushing Patients Monitored Data to IoT cloud and retrieved at hospital system database for Doctor’s Treatment Referral.

The pushed data to the cloud from the IOT enabled Smart Ambulance System is retrieved to the hospital patient database to be viewed by the appropriate doctor. The advantage of this is that, patients heart rhythmic rate is viewed with the help of time stamp. Fig. 1.14, depicts the specific assigned patient’s heart beat rate in the doctor’s admin page respectively.
Patients body temperature is noted in Degree Fahrenheit scale. The range of a normal body temperature is 97.7-99.5 °F and the body temperature above and below normal range is suspicious for patient’s illness and level of severity. Variation in the body temperature is noted in every specific time interval to view the rise and fall of temperature with the help of time stamp as depicted in Fig 1.15.
1.5 Conclusion

This Smart Life Saver Ambulance System (SLSAS) comprised of GPS and GSM facility to share the accident location to the nearby hospital for ambulance service. The occurrence of the accident is observed with the help of vibration sensing System which is implanted in public automobile vehicle and the location is intimated for ambulance service which is nearby. The smart ambulance consists of portable ECG and Heart Rate estimation system furnished with IOT technology to send the patients monitored basic health details to the cloud. The action of pushing the data is carried out during the onboard journey of the patient to the hospital and this saves the time to know the basic health details about the patient even before the victim arrives the hospital. This pushed data is retrieved to the hospital database for doctor’s referral to carry out needed arrangement to treat the patient immediately he/she reaches the hospital. Huge amount of time is saved to save the precious life of a patient with the help of this Smart Ambulance System, which is furnished with portable ECG and Body Temperature estimation with IOT technology for seamless connectivity between the patient and doctor, to boost the process of treatment preparation in hospital even before the patient arrives the hospital.
Reference


