Real Time Vehicle Monitoring and Tracking System based on Embedded Linux Board and Android Application

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***Abstract* - An advanced vehicle monitoring and tracking system based on Embedded Linux Board and android application is designed and implemented for monitoring the school vehicle from any location A to location B at real time. The proposed system would make good use of new technology that based on Embedded Linux board namely Raspberry Pi and Smartphone android application. The proposed system works on GPS/GPRS/GSM SIM900A Module which includes all the three things namely GPS GPRS GSM. The GPS current location of the vehicle; GPRS sends the tracking information to the server and the GSM is used for sending alert message to vehicle's owner mobile. The proposed system would place inside the vehicle whose position is to be determined on the web page and monitored at real time. In the proposed system, there is comparison between the current vehicle path and already specified path into the file system of raspberry pi. Here in the proposed system the already specified path inside the raspberry pi's file system taken from vehicle owner's android smartphone using android application. Means the selection of path from location A to B takes place from vehicle owner's android application which gives more safety and secures traveling to the traveler. Hence the driver drives the vehicle only on the vehicle owner's specified path. If the driver drives the vehicle on the wrong path then the alert message will be sent from the proposed system to the vehicle's owner mobile and also speakers alert driven using Raspberry pi's audio jack. If the vehicle's speed goes beyond the specified value of the speed, then also the warning message will be sent from system to the owner mobile. The proposed system also took care of the traveler's safety by using LPG Gas leakage sensor MQ6 and temperature sensor DS18B20.**

Keywords- Raspberry Pi, Sensors, Embedded system.

I. INTRODUCTION

In last decade, we observe the drivers fatigue driving and vehicle theft activity which causes social real time problem like accidents and many more hazards conditions. We daily see or read such type of activities which are raising the question of our safety and security in both public and private sectors. So there is need of real time monitoring and tracking the vehicle also storing and updating its database of certain situations. In the urban areas, human help is somewhat difficult in providing the database of tracked vehicle. In the proposed system, the system provides a fully automated tracking and monitoring of the vehicle which helpful for school bus, their owners, children's safety and also it provides the accurate arrival time of the vehicle at particular location or stop. And hence using accuracy in time, children can spend more time in studying, sleeping, or relaxing rather than wait for a delayed bus. Spending less time waiting for a bus improves comfortable and effective time management of the student as well [4]. In order to reduce man power and saving of money, here the system provides easy tracking solution using Embedded Linux Board. The proposed system get tracking information of the vehicle like vehicle number (Unique ID), location, speed, Date, Time and store into the database of Raspberry pi. The system also provides students safety mechanism with the help of temperature sensor and gas leakage sensor. Hence in the case of raising the temperature inside the vehicle due to some reason or leakage of the LPG gas inside the vehicle, the alert message get send to the driver as well as vehicle owner.

For tracking the vehicle using GPS and maintain its database, MySQL database system is use which advanced feature of Raspberry-Pi. In the database base monitoring and updating mechanism, the GSM/GPRS module is used which transmit the updated vehicle database to the server and user access the database using web page in Smartphone. That shows the real time vehicle location in the Smartphone [3]. Thus, users will be able to continuously monitor a moving vehicle on demand using the Smartphone and determine the estimated distance and time for the vehicle to arrive at a given destination.

II. EASE OF USE

System Objectives:

- Continuously monitoring and tracking the school vehicle at real time environment using web page in Smartphone and if the vehicle choose wrong path then

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system give the alert to the owner's Smartphone as well as on raspberry pi's audio system .

- The provision of more safety and secure travelling using travelling path selection facility based on android application of Smartphone. Also provide safety environment to the children using gas sensor and temperature sensor by messaging alert.
- Storing and updating the real time database of the vehicle like its Speed, Time, Location, and Date which is useful in case of vehicle theft detection.

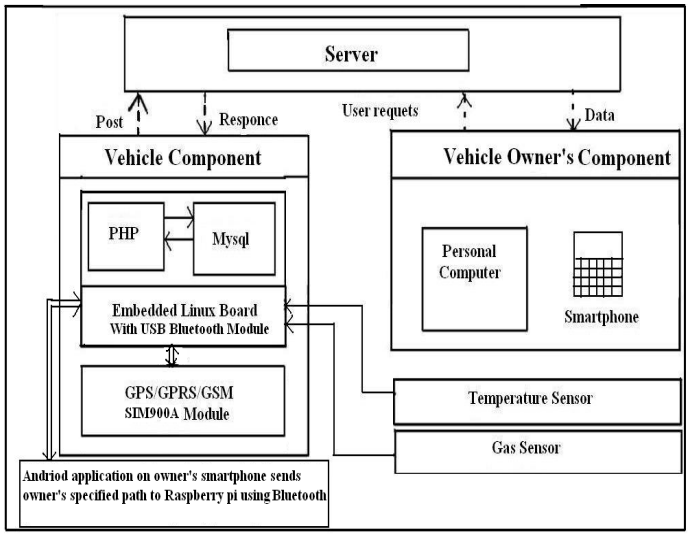

Fig. 1. System Block Diagram

The proposed system would get controlled with the help of Raspberry pi which placed inside the vehicle. The GPS/GPRS/GSM SIM900A module get communicate with raspberry pi using USB interface. The longitudes and latitudes of the current path received from GPS get compared with the stored longitudes and latitudes in the particular file format inside the database of raspberry pi. If that longitudes and latitudes not match with the stored one then wrong path detection alert massage will get sent to vehicle's owner mobile. Also the longitudes and latitudes of the current path received from GPS will get sent to the server with the help of GPRS which helps to track the vehicle's current location on the web page using Smartphone. Here for tracking the vehicle, the proposed system provides login facility on web page for vehicle's owner, students and their parents. Also proposed system provides student's safety with the help of DS18B20 temperature sensor and gas leakage sensor MQ6. These sensors get interface with raspberry pi. If the temperature inside the vehicle crosses the specific value or LPG gas get leakage inside the vehicle then the alert message will sent to the vehicle's owner. Likewise safety mechanism provided by system.

A. System Specification

1) Embedded Linux Board:

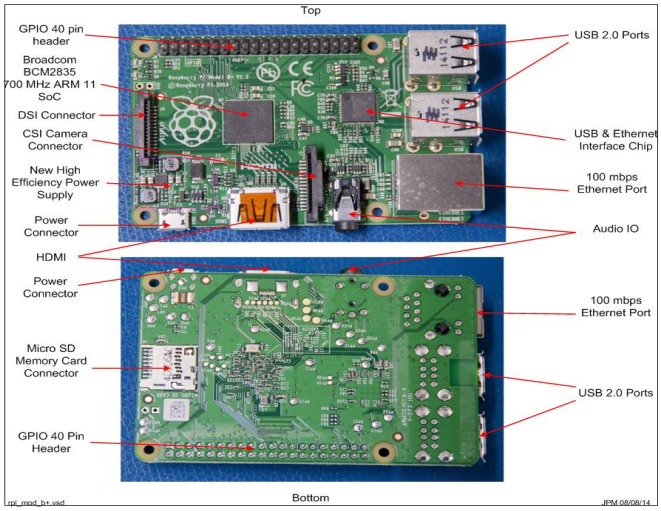

Fig. 2. The Raspberry Pi B+ Board

Features of Raspberry pi board:

- 5V@1A maximum power from an adaptor.
- 700 MHz ARM1176JZF-S core (ARM11 family, ARMv6 instruction set).
- 1GHz operating speed.
- 4 USB ports for accessing external memory.
- 40 GPIO pins.
- Ethernet port for internet connectivity.
- VGA connector and HDMI connector.
- 3.5mm stereo jack for audio out to amplifier.
- MicroSD card interface slot to carry the OS.
- 512MB of SDRAM.

2) Sensor:

a) Temperature Sensor:

Specifications:

- Unique 1 wire interface requires only one port pin for communication.
- Each device has unique 64 bit serial code stored in an On Board ROM.
- Requires no External components.
- Can be powered from Data line; power supply rang is 3.0v to 5.5v.

- Measures temperature from -55 to +125 Degree C.
- User definable non volatile (NV) alarm settings.
- Thermometer resolution is user selectable.

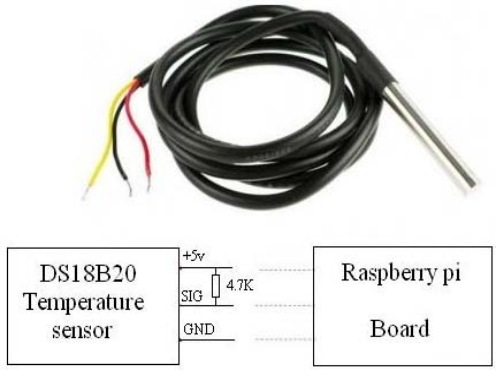

Fig. 3. The temperature sensor DS18B20

b) LPG Gas leakage sensor:

Specifications:

- High sensitive to LPG Gas, iso-butane, propane.
- Small sensitive to alcohol, smoke.
- Fast response.
- Stable and long life.
- Simple drive circuit.

Fig. 4. The LPG Gas leakage sensor MQ6

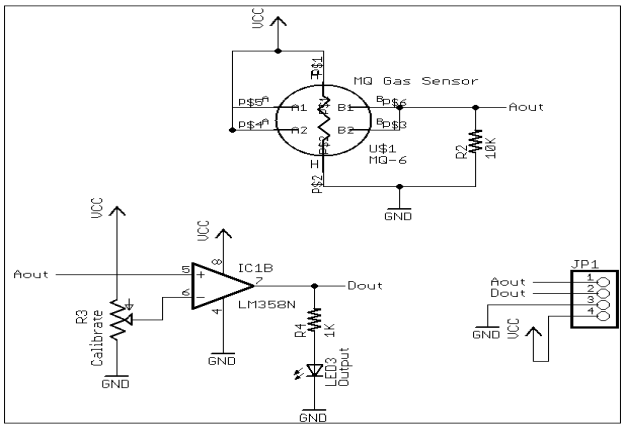

Fig. 5. Circuit diagram of Gas sensor MQ6

c) GPS/GPRS/GSM Module SIM900A:

MAIN FEATURES:

- Dual-Band GSM/GPRS 900/ 1800 MHz
- TTL data (RX, TX, GND).
- ESD Compliance.
- Power controlled using 29302WU IC.
- Enable with MIC and Speaker socket.
- SMA connector with GSM Antenna.
- Configurable baud rate.
- Inbuilt Powerful TCP/IP protocol stack for internet data transfer over GPRS.
- High quality PCB FR4 Grade with FPT Certified.

GPS Receiver PA6E-CAM Features:

- 33 tracking/ 99 acquisition-channel GPS receiver.
- Supports QZSS, SBAS (WAAS, EGNOS, MSAS, GAGAN*) ranging.
- Ultra-High Sensitivity: -165dBm.
- High Update Rate: up to 10Hz (SBAS can only be enabled when update rate is equal or less than to 5Hz.).
- 12 multi-tone active interference canceller (Some features need special firmware or command programmed by customer please refer to "PMTK Command List").
- High accuracy 1-PPS timing support for Timing Applications (±10ns RMS jitter).
- AGPS Support for Fast TTFF.

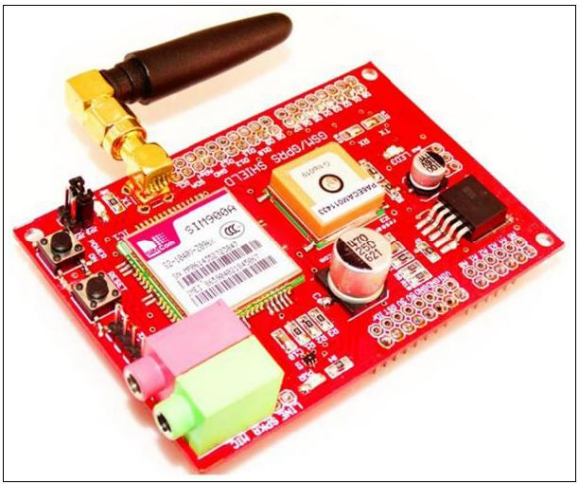

Fig. 6. The SIM900A GSM /GPRS with GPS receiver module.

B. System Design

1) Real time vehicle tracking on the web page using GPS/GPRS/GSM SIM900A module and Raspberry pi:

SIM900A Module which gets interfaces with the Raspberry pi gives the real time tracking information of the vehicle such as longitude, latitude, speed, time of the vehicle. That information taken from USB interface get stored into the database and further sends to the server. The system gives tracking provision on web page for registered user only as follows:

A) Super Login: In this provision, the vehicle's owner can track the vehicle in his Smartphone using Super Login on the web page. Hence only owner can access this login.

B) Primary Login: In this provision, the registered students can track the school vehicle in their Smartphone using Primary Login on web page. Hence only those students who get registered into the system can access this login.

C) Secondary Login: In this provision, the student's parents can track the school vehicle in their Smartphone using Secondary Login on the web page. Hence only registered student's parents can access this login.

2) Vehicle's right and wrong path tracking algorithm using Smartphone:

The proposed system provides more safety and secure solution using android application for wrong path alert. The vehicle owner's Smartphone having an android application that provides the information regarding selection of particular path from A to B through which the vehicle supposed to travel. And hence driver drives the vehicle on the path that decided by android application of owner's Smartphone only. At first vehicle's owner trace the decided path A to B on android application that gives longitude and latitude of that particular path. Then android application saves that longitudes and latitudes of traced path in a particular file format such that owner can send that file to the raspberry pi database using Bluetooth or USB port. And hence the proposed system can process further on that data.

Now whenever driver drives the vehicle on the owner's decided path i.e. A to B, GPS/GPRS/GSM SIM900A module inside that vehicle sends the longitudes and latitudes of current location to the raspberry pi through USB interface. Now using file system programming, the current longitudes and latitudes received from GPS of GPS/GPRS/GSM SIM900A module get compares with the longitudes and latitudes received from android application. Hence if this comparison gives less tolerance then we can say that driver drives the vehicle on the right path i.e. A to B else if there is large difference between longitudes and latitudes then system sends alert message on the vehicle owner's mobile that the vehicle is on the wrong path using GSM of GPS/GPRS/GSM SIM900A module.

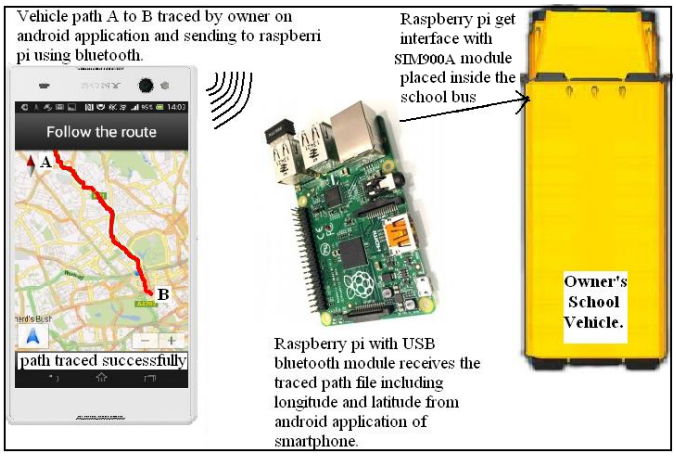

Fig. 7. The longitudes and latitudes which are stored in the file format inside raspberry pi have been taken from android application using Bluetooth.

The raspberry pi has a 3.5mm audio jack output facility. By using that audio jack facility, whenever driver drives the vehicle on the wrong path, then the "alert.mp3" file which already stored into the file system of raspberry pi will get call using "omxplayer alert.mp3" command and hence the wrong path detection alert message will be given using speakers. Hence the wrong path detection problem will get solve.

3) Vehicle tracking information database monitoring system using LAMP (Linux, Apache, MySQL, and PHP):

The vehicle tracking system works upon an algorithm in which, real time information of vehicle such as Longitudes, Latitudes, Speed, Date, and Time get store into the database of Raspberry pi using Linux, Apache, MySQL, and PHP i.e. LAMP system. The GPRS of SIM900A Module will sent this vehicle information to the server, and at server side, updating and storing of this vehicle information takes place dynamically which make easier for monitoring and tracking a vehicle at real time on web page using web browser on Smartphone which gives more accurate result of current location.

4) Students Safety mechanism using temperature Sensor and LPG gas detect sensor:

The proposed system takes care of the children's safety by using LPG Gas leakage sensor and temperature sensor. The temperature sensor DS18B20 which works on the 1 wire protocol gives a digital output hence can be get directly interface with the Raspberry Pi. The threshold value of the temperature set in the program. If that threshold temperature value gets cross by output value of the temperature sensor due to some reason then alert message will be sent to the vehicle owner's Smartphone. Also the LPG Gas leakage sensor get interface with Op-amp LM358N which gives a digital output. That output voltage can be controlled by using current limiting resistors which helps the Raspberry pi's GPIO from

damage. Likewise both sensors output driven through Raspberry pi would get compare with threshold values and if limit crosses then the alert message will be given to vehicle owners mobile using GSM of SIM900A module. In following results, the threshold value set at 30 Degree Celsius.

III. TESTING RESULTS

1) Testing of DS18B20 Temperature sensor using Raspberry pi*:*

The sensor testing and their results are taken as follows:

As temperature sensor DS18B20 works upon 1 wire protocol, the sensor gives digital output data whenever receives input voltage from raspberry pi and it get stored in file system of raspberry pi. Using file system programming, the sensor data get easily access and processed further for giving alert message. Here while performing sensors testing, major issues need to be considered namely:

- Raspberry pi's GPIO are compatible at 3.3V logic level so sensors output needs to be limited at this 3.3V logic level.
- Devices required in the proposed system needs to be selected as per Raspberry pi's GPIO and other interfaces logic level compatibility.
- The input voltage and input current driven through power supply to the Raspberry pi needs to be selected as per specified logic level.

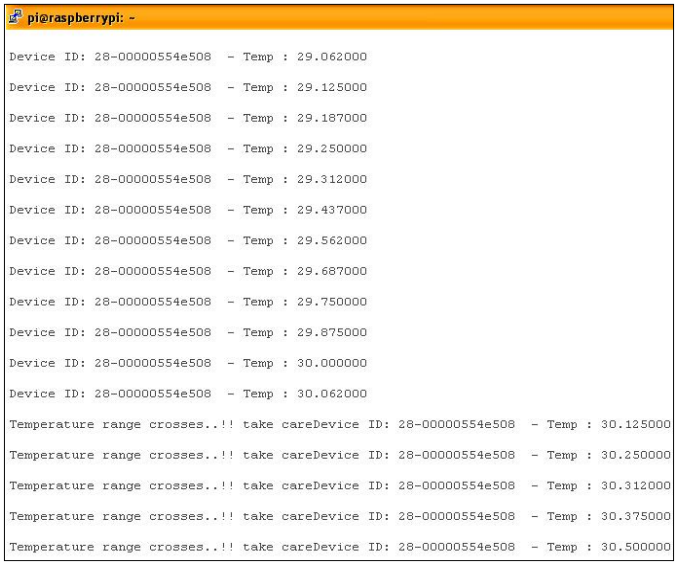

Fig. 8. Testing results of DS18B20 Temperature sensor

2) Testing of Gas Sensor MQ6 using Raspberry pi:

The Gas sensor MQ6 gives output as it receives 5V input. So whenever the sensor sense LPG gas it gives analog output which then given to LM358N Op-amp gives digital output. Then the digital output has driven through limiting resistor and further given to raspberry pi. The calibration of results of the output voltage has been taken using potentiometer. Hence by checking the raspberry pi's GPIO pin status, the sensor output data used for giving alert message of leakage gas to the vehicle owner Smartphone.

The sensor testing and their results are taken as follows:

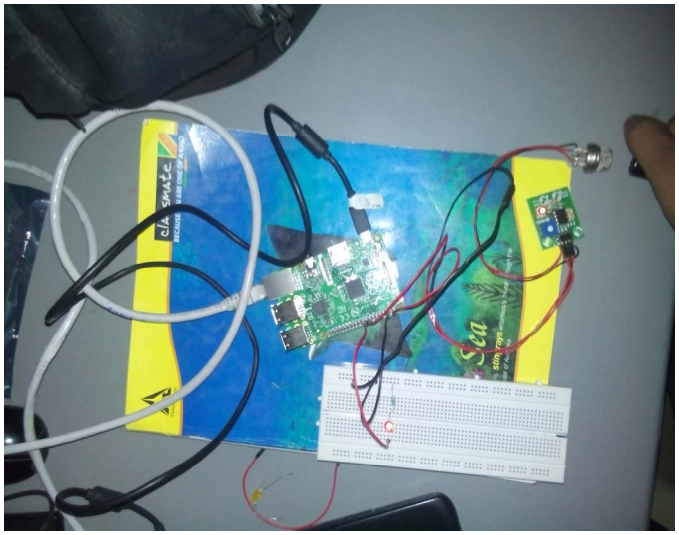

Fig. 9. Testing results of MQ6 gas sensor

3) Testing results of GPS module using Raspberry pi:

The GPS Module testing gives the following results of all output sequence GPS data.

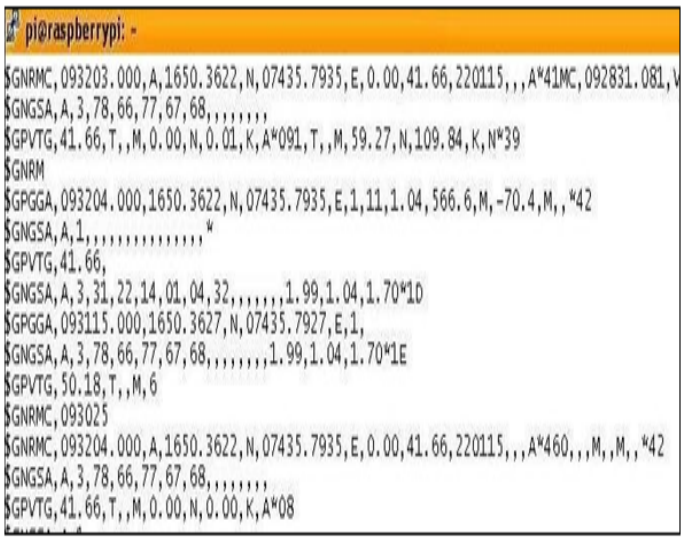

Fig. 10. Testing results of GPS Module using Raspberry pi.

But we need to separate the required GNRMC data format which is received from GPS and GLONASS satellite out of all

data formats. Because it gives us longitude, latitude, speeds, date and time which is useful in our application.

The GNRMC data format is shown below:

$GNRMC,093204.000,A,1650.3622,N,07435.7935,E,0.00,41.66,220115,,,A*460<CR>

The following table shows meaning of each data in the GNRMC data format received from GPS and GLONASS satellite.

Name	Example	Units	Description
Message ID	$GNRMC		RMC protocol header
UTC Time	064951.000		hhmmss.sss
Status	A		A->data valid or V->data not valid
Latitude	2307.1256		ddmm.mmmm
N/S Indicator	N		N->North or S->South
Longitude	12016.4438		dddmm.mmmm
E/W Indicator	E		E->East or W->West
Speed over Ground	0.03	knots	knots
Course over Ground	165.48	degrees	True
Date	260406		ddmmyy
Magnetic Variation	3.05, W	degrees	E->East or W->West (Needs Global Top Customization Service)
Mode	A		A->Autonomous mode D->Differential mode E->Estimated mode
Checksum	*2C		
<CR> <LF>			End of message termination

Fig. 11. Recommended Minimum Navigation Information data format

Hence the required GNRMC data format received from GPS and GLONASS satellite get separated as shown in the figure below.

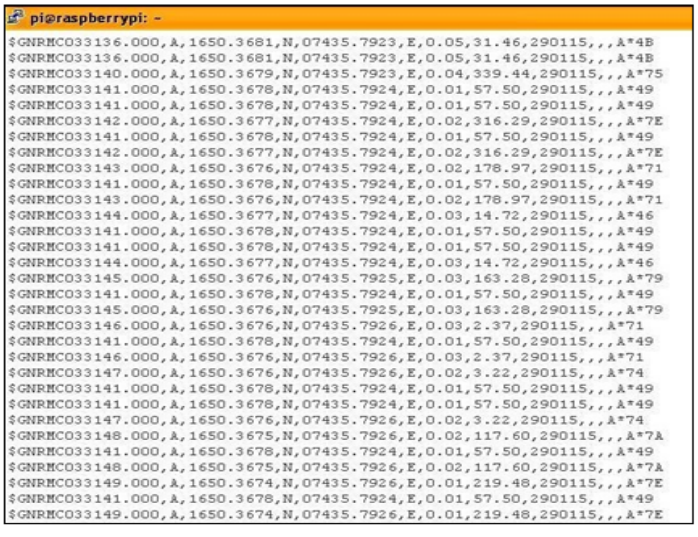

Fig. 12. Required GNRMC data format get separated using algorithm.

The result of separation of each GNRMC data which is actually required data for our application is shown in the fig below.

Fig. 13. Separation results of each GNRMC data.

Now in the further development, we take the tolerance between this separated current vehicle information like longitude, latitude, speed, date, time from GPS receiver and the information received from android application of owner's Smartphone so as to provide wrong path alert to the vehicle owner.

4) Tracking position on web page developed using HTML, PHP,CSS is shown in the figure below:

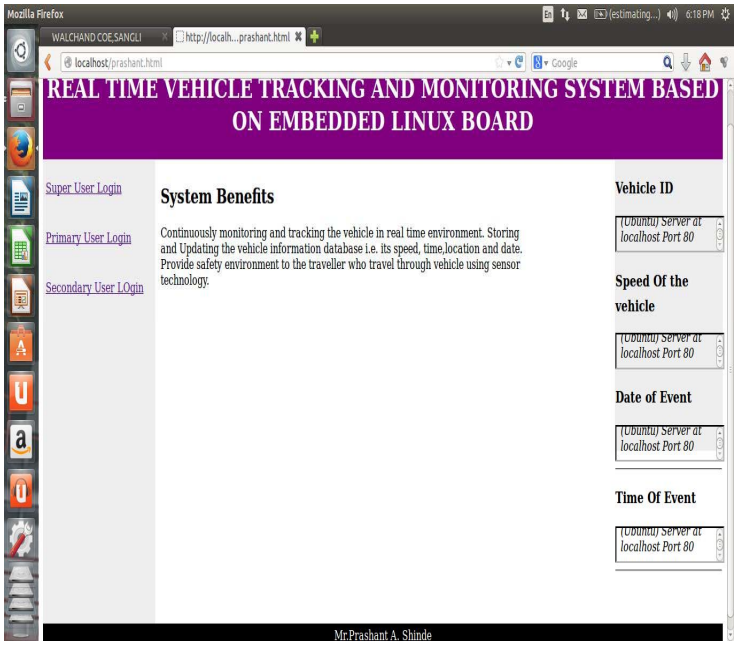

Fig. 14. Web page developed for vehicle database monitoring purpose.

IV. FLOWCHART OF THE PROPOSED SYSTEM:

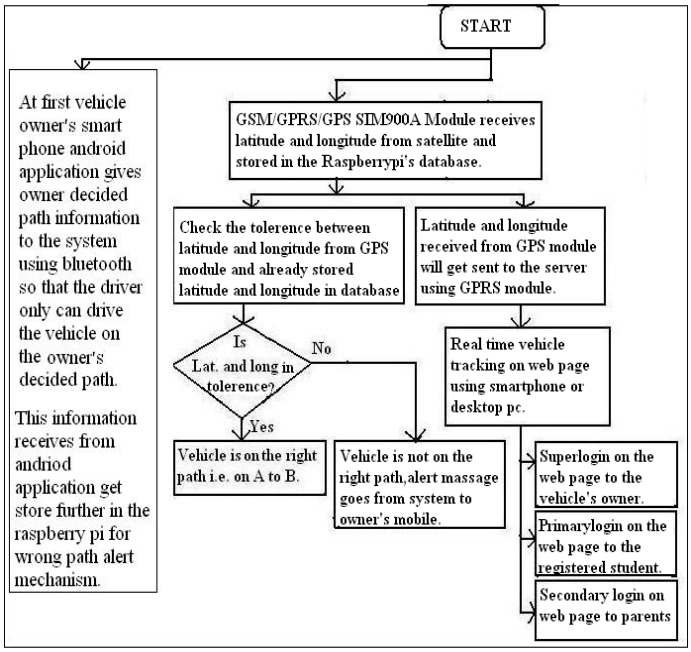

Fig. 15. Flowchart 1 of proposed system

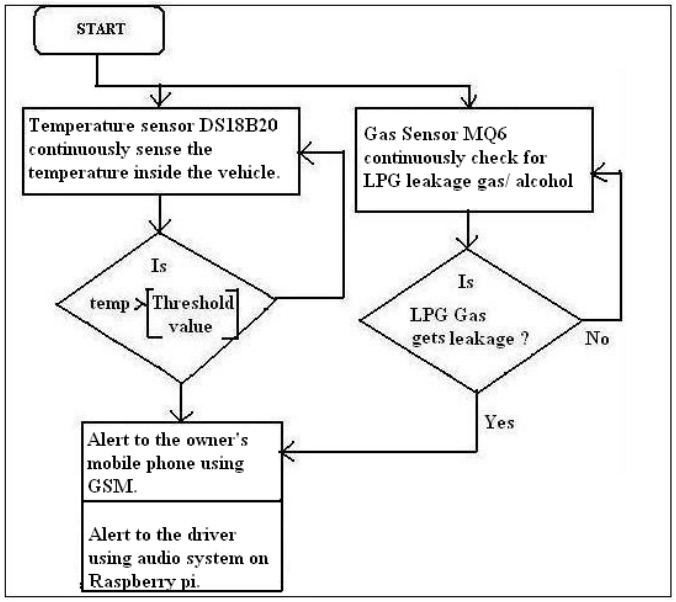

Fig. 16. Flowchart 2 of proposed system

V. CONCLUSION

The proposed system hence made good use of Smartphone technology by providing safety and secure traveling to the traveler using wrong path alert mechanism. The proposed system plays an important role in real time tracking and monitoring of vehicle by updating vehicle real time information on the server side after certain interval of time in order to monitored vehicle continuously. Whenever driver drives vehicle on the wrong path or in case of vehicle's accident situation occurs, the proposed system provides the vehicle's current location, speed to the vehicle owner's mobile. Hence this benefits to track the vehicle as early as possible. Student's safety mechanism also gets provided using temperature and LPG gas leakage sensors. In this certain situations, as per student's safety concern, the proposed system also gives alert massage on student parents mobile so that parents also know about their children's safety.

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