Travolution-An Embedded System in Passenger Car for Road Safety

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***Abstract*— Each year, there are thousands of highway deaths and tens of thousands of serious injuries due to "Run-Off-Road" accidents. Everything from simple driver inattentiveness, to fatigue, callousness, to drunk driving, is responsible. Simple sensors can be fitted inside vehicles embedded with various features like, automatic collision notification, vehicle security, speed control which can give impetus to an efficient road safety system. The features that are proposed in this work are: Automatic collision notification that gives notification to the victim's relative, Red light traffic control makes sure vehicle doesn't break signal, Speed control alters speed in different zones, Horn control prevents honking in horn prohibited zone, Alcohol detection detects drunk driving and Vehicle security is used to prevent theft.**

Keywords- Road safety, Embedded System, Collision Notification, GSM (Global System for Mobile Communication), GPS (Global Positioning System).

I. INTRODUCTION

Road traffic crashes are one of the world's largest public health and injury prevention problems. According to the World Health Organization (WHO), more than a million people are killed in road accidents, each year, all over the world [1]. A report published by the WHO in 2009 revealed that more people die on roads in India than anywhere else in the world [2]. The statistics for India are chilling. At least 13 people die every hour in road accidents in the country; the latest report of the National Crime Records Bureau reveals [2]. In 2007, 1.14 lakh people in India lost their lives in road mishaps [3]. Poor road infrastructure, failure to comply with speed limits, growing drinking and driving habits are among the main factors contributing to deaths from road crashes, WHO said in its report on 'Decade of Action for Road Safety 2011-2010' [3].

Currently Road safety systems are available in high end luxury cars such as Audi, Mercedes Benz etc. to name a few.
Example: OnStar Corporation provides subscription-based communications, in-vehicle security, hands free calling, turn-by-turn navigation, and remote diagnostics systems throughout the United States, Canada and China. A similar service is known as Chevy Star in Latin American markets. OnStar FMV became available to the public on July 24, 2011. It provides some of the features an OEM system has, such as Automatic Crash Response, Stolen Vehicle Tracking, Turn-by-Turn Navigation, and Roadside Assistance [15].

The motivation behind the project Travolution is an attempt to make an embedded system which is to bring a positive difference in the field of road safety and road discipline. The project tackles some major causes of road accidents such as breaking traffic signals and drunken driving. It also has a major objective of exercising road discipline such as speed control in different areas and horn control in horn prohibited zones.

The requirement of embedded systems is the need of the hour in developing countries & especially with the grim statistics of our country, the need is imminent. Thus incorporation of these features should be mandatory in all cars in the near future without cutting into the customer or the manufacturer's pockets.

The features added in this work are:
Vehicle Speed Control in Variable Zone- in this feature, speed of the vehicle is controlled in different areas such as flyovers, bridges, highways, schools, cities and internal areas.
Horn Control of Vehicle in No Honking Zone- Control unwanted disturbances in horn prohibited zones such as hospitals, public libraries, courts, schools etc.
Red Light Traffic Control- In this feature the vehicle is controlled on traffic signal, when signal is red the vehicle is automatically stopped.
Automatic Collision Notification- In this feature when vehicle meet with an accident, the system of this project sends messages (SMS) via GSM Modem to control room and the nearest relative of the victim.
Vehicle security- In this feature, if the vehicle is stolen or someone tries to break in, theft sensor is activated and message is sent to the police control room and to the owner if the vehicle via GSM modem.
Alcohol Control- The alcohol sensor prevents the ignition key from working if the driver breathes into it and a significant quantity of alcohol is detected. Consequently message is sent to the RTO.

II. MATERIALS AND METHODS

In this work the chips and ICs used are- encoder chip, decoder chip, Transmitter-Receiver module, microcontroller, relay driver, alcohol sensor, relay contactor, GSM modem, GPS receiver and LCD display.

A. Hardware Details

1) HT 12 E:

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HT12E is a 212 series of encoder used for remote applications and RF applications. It forms a pair with HT12D decoder IC. It has a wide voltage range from 2.4Volts-12 Volts and has a built in oscillator which requires a small external resistor.It encodes the 12 bit parallel data into serial data for transmission through an RF transmitter. These 12 bits are divided into 8 address bits and 4 data bits [4].

2) RF TX/RX Module:

The transmitter/receiver (TX/RX) pair operates at a frequency of 433 MHz. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.[5]

3) MQ3 Alcohol sensor:

This alcohol sensor is suitable for detecting alcohol concentration on your breath, just like your common breathalyzer. It has a high sensitivity and fast response time. Sensor provides an analog resistive output based on alcohol concentration.

4) Relay Contactor:

Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.A type of relay that can handle the high power required to directly control an electric motor is called a contactor [7].

5) RLZMMOPA9 GPS:

It is a POT(Oatch On Top) GPS. It provides a solution in urban conditions and has high speed, sensitivity and accuracy as well as high sensitivity and tracking capabilities in urban conditions. The GPS Chipset inside is designed by Media Tek Inc.

6) GSM 300:

This GSM Modem can accept any GSM network operator SIM card and act just like a mobile phone with its own unique phone number. Advantage of using this modem will be that you can use its RS232 port to communicate and develop embedded applications. Applications like SMS Control, data transfer, remote control and logging can be developed easily.

GSM300 is a low cost solution for cellular/ remote control projects. The modem comes with RS-232 for interfacing with computers and the TX and RX pins are provided for interfacing with SPDuino and other microcontrollers [8].

7) Max 232:

MAX232 is a 16 pin IC. It converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals [10].

8) Limit Switch:

Limit Switches are used for control of a machine, as safety interlocks, or to count objects passing a point. A limit switch is an electromechanical device that consists of an actuator which is mechanically linked to a set of contacts. When an object comes into contact with the actuator, the device operates the contacts to make or break the electrical contact. Thus, this device proves to be very useful for safety purposes.

9) Bumper Switch:

Bumper switch is a very effective sensor for collision detection. Bumper switch works as a pushbutton i.e. it gets activated when pressed and the microcontroller then performs the necessary action for this condition. This sensor is a very simple way to test collision detection function in any locomotive.

B. Design details

There are 2 modules - Transmitter and Receiver Section. Receiver module will be placed on the car and the Transmitter module can be fitted on a sign board. Following are the circuit diagrams:

To transmit the information, RX TX module is needed.
In this circuit, 433 Mega Hertz frequency transmitter is being used.
Parameters: ASK modulation and transmission range is 100-300 square feet (10-15 feet).
There are 4 pins:
1. Antenna: there is a built in helical antenna
2. Data Pin-To receive Data for transmission
3. Ground pin-connected to ground
4. VCC - 3 Volts Power Supply

a. Encoder:

HT 12 E Encoder is used.

There are 4 data lines D0, D1, D2 and D3. On Data Lines, 4 switches are connected. This will generate the data for the project and will be decoded on vehicle side. On receiver side, each switch closure will have a particular meaning. There is a TE pin which is active low, when this pin goes low, transmitter is enabled.

The data out pin is connected to data pin of TX. Here pulse stream is generated and given to TX. This pulse stream will consist of 8 bit address and 4 bit data.

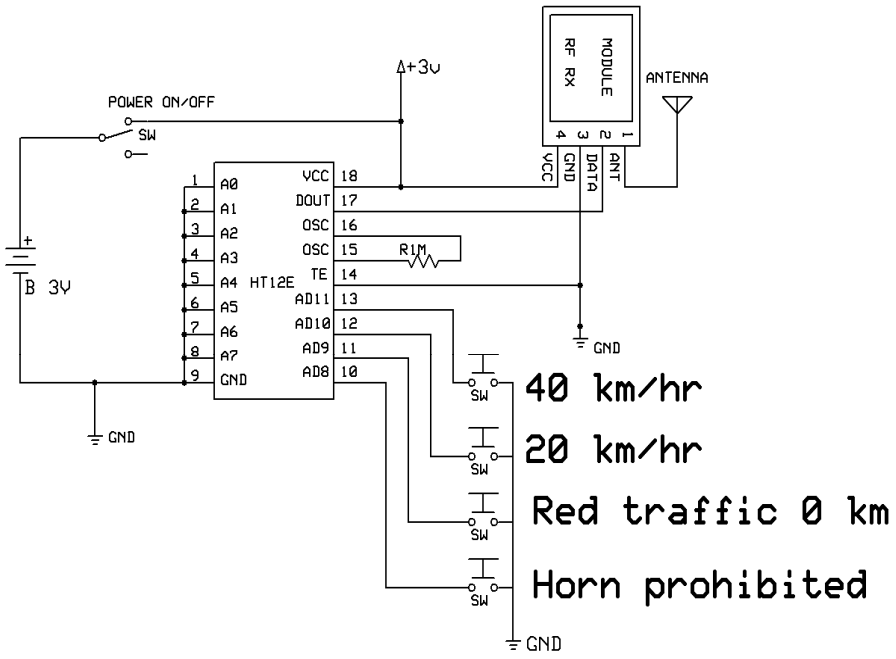

Fig. 1. Transmitter Circuit

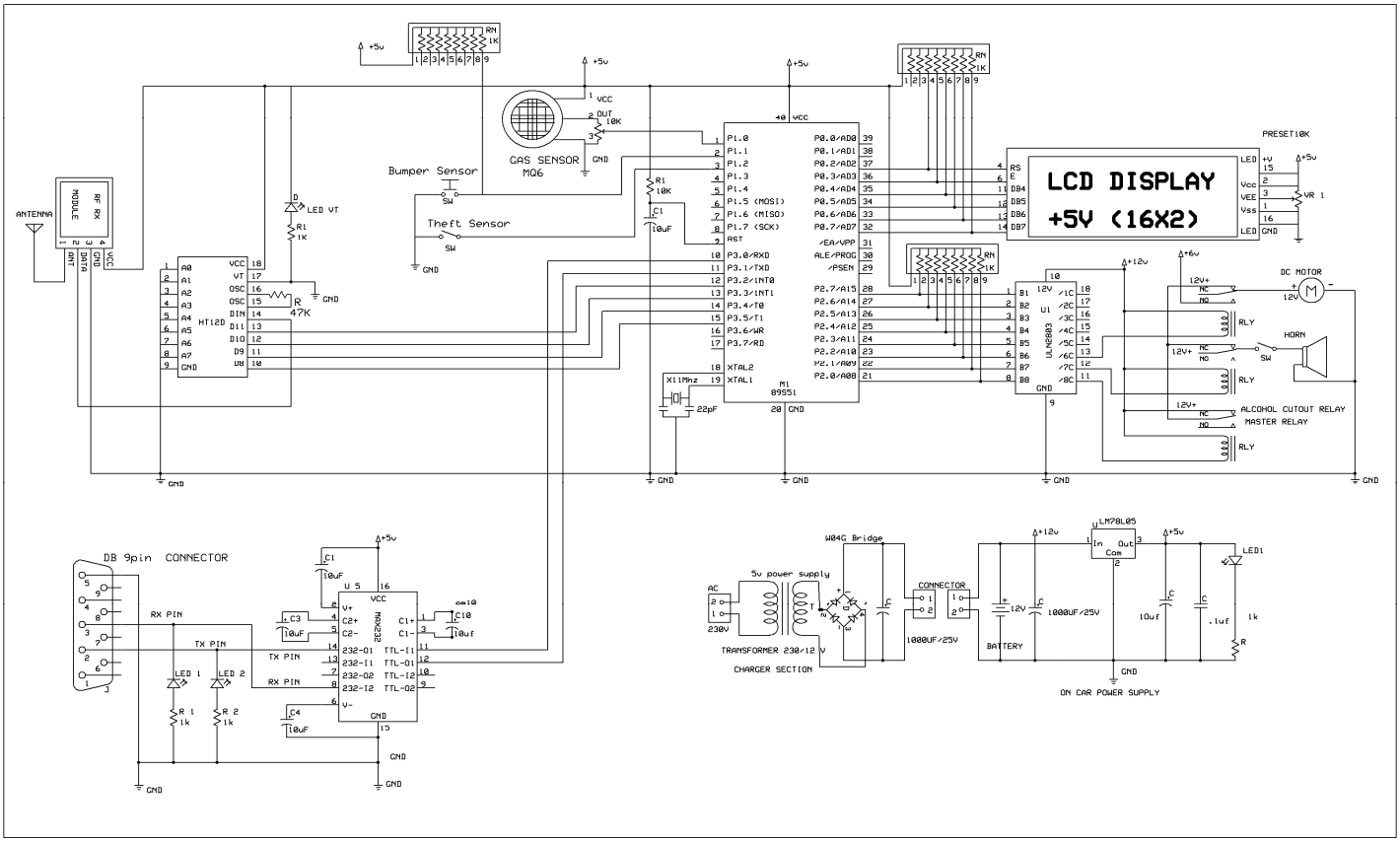

Fig. 2. Receiver Circuit

b. Receiver Module:

89s51 Microcontroller is being used and this IC has a flash memory of 4KB. S stands for ISP (In System Programmable) technology which means the IC 89s51 operates and it can also be programmed at the same voltage of 5 V.

This Microcontroller is a 40 pin device. Pin 40 is connected to 5 V power supply and pin 20 is connected to Ground. Pin 9 is reset pin. As soon as microcontroller is switched on, it is reset.

There are 4 ports- P0, P1, P2 and P3. All are 8 pin bidirectional ports. To receive the data from the road side transmitter, RF Receiver is needed. RX will have 4 pins same as that of Transmitter.

HT 12 D decoder IC is used. D0, D1, D2 and D3 are the data lines, so whatever information is received from the transmitter is fed to these data lines that are connected to P3.

The output of RF RX is fed to the Data In pin of the Decoder. VCC is connected to 5 Volts.

Valid Tone Pin goes high on receiving data. To indicate reception of data, LED is connected to Valid Tone pin.

Alcohol sensor MQ3 is connected to P1. It has 2 heater plates and a sensor plate. Sensing plate is connected through a variable resistor to the controller which controls the sensitivity. Gas ions will fall on the sensing plate and will generate the electron current flow that will be given as voltage and this voltage will be sensed by the controller.

So whenever alcohol is sensed, it will give a high logic output which will stop the car and send SMS to RTO along with the location of the car i.e. its latitude and longitude.

The bumper switch is connected to P1 and is used for collision detection. When collision is detected, SMS is sent to the Emergency room along with the GPS location of the car.

To detect car theft, limit switch is connected to the doors. When someone attempts to break in the vehicle, the lever of the limit switch is pressed thus making contact. This gives a logic high signal to the microcontroller hence indicating car theft.

To show the driver the exact condition by which the vehicle is being controlled, the LCD display is connected on port 0.

LCD display is 16 characters by 2 rows.

To control the vehicle, on port 2, three relay contactors are connected to control the motor of the vehicle.

Relays have two sets of contacts- normally open and normally closed.

The first relay is connected such that when it is normally closed, motor operates at 12 V and in normally open it operates in 0 V. This relay halts the vehicle in case of collision detection and when alcohol is sensed by the MQ3 Sensor.

The second relay is connected such that when it is normally closed, motor operates at 6 V and in normally open it operates in 0 V. It is used when speed limit condition is receipted by the receiver circuit. The car will move at half the voltage.

The third relay is used for horn control. When horn prohibition condition is receipted, this relay's normally open contact is active thereby which the buzzer will go off.

On port 3, GSM modem and GPS are connected. GSM modem has its own antenna, 5V supply and SIM card slot. The number of the modem being used is GSM-300.There is a 9 pin serial port for serial communication.

It is a serial port and serial port works on RS232 protocol. To interface these two, Max 232 IC is connected having 5V power supply and ground. GSM is used for sending SMS to the intended people in case of collision, car theft and drunken driving. GPS is used to send the location for the same.

III. SOFTWARE SPECIFICATIONS

A. Windows Bascom Compiler:

It is Basic compiler for Intel's MSC-51 microcontroller family [9]. It is an easy to use compiler. It gives fast machine code instead of interpreted code.

B. Express PCB:

Express PCB is easy to lean and fast to use. It is an all in one freeware in which schematic as well as PCB layout can be made [11].

C. µc Flash:

It is used to burn the .hex file generated by the compiler into the IC. This is done by using the hardware kit wherein the IC is placed. It is then connected to the PC via its serial port for burning the code [22].

D. Hayes AT Commands:

AT commands is used to control MODEMS [14]. AT commands with a GSM/GPRS MODEM or mobile phone can be used to access following information and services:

1. Information and configuration pertaining to mobile device or MODEM and SIM card.
2. SMS services.
3. MMS services.
4. Fax services.
5. Data and Voice link over mobile network.

For the project Hayes AT is used for programming the GSM Modem so that on occurrence of accident, drunken driving or car theft, the GSM Modem sends an SMS to the pre assigned numbers.

IV. RESULTS

A. Environment:

In real life it is not possible to show the demo of this project on roads, highways using real vehicle as a car's actual internal circuitry cannot be modified, except by the company. Hence, decision is made to demonstrate in the college corridor.

A toy car is used with the receiver circuit placed on it and the transmitter with a range of 10 feet for implementing various features of the project.

B. *Collision Detection:*

For collision detection, Bumper switch is used. Bumper switch has "ON" and ˝"OFF" condition. The tension which triggers the bumper switch is approx.144gms [21]. On being triggered i.e. on the event of a collision, it sends

a Binary 1 signal to the microcontroller thereby which the car is halted and "Collision Detected" is displayed on the screen.

SMS is sent to the number that is pre fed. In real life SMS would be sent to the nearest relative of the person and the control room along with the GPS location of the vehicle.

Fig. 3. SMS sent for rescue along with GPS co-ordinates

C. *Red Light Traffic Control:*

On the transmitter circuit a red LED is used for indicating red traffic signal. When it glows i.e. when switch is put on to display Red Light condition, signal is transmitted to the receiver which is given to the microcontroller on the receiver circuit. The car remains in halt position as long as the red LED is on.

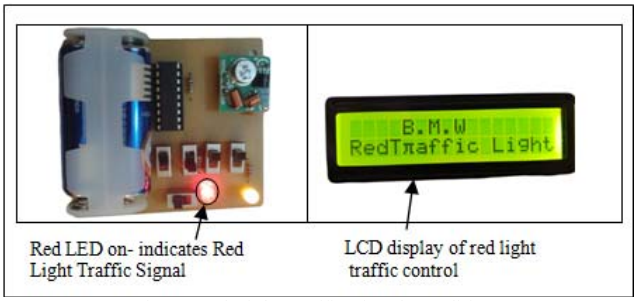

Fig. 4. Red Light Traffic Signal Condition

D. *Speed limit Control:*

To control the speed of the toy car, relays have been used to control the motor. In Normally closed state, Car is driven by the complete 12V of the motor. In normally open state the car is halted because motor is brought to 0 V. Motor will operate at 6V if speed limit condition is transmitted.

The transmitter sends the signal alerting that this area's speed limit is 40 Kmph as example. The toy car initially runs in full speed. When this condition is transmitted, the receiver receives the signal, gives to microcontroller which then directs the relay to reduce the motor speed. Thereby the toy car runs at a visibly lesser speed as compared to the initial speed. In the code written to operate the microcontroller, to test this feature, 40 Kmph and 20 Kmph have been used as examples.

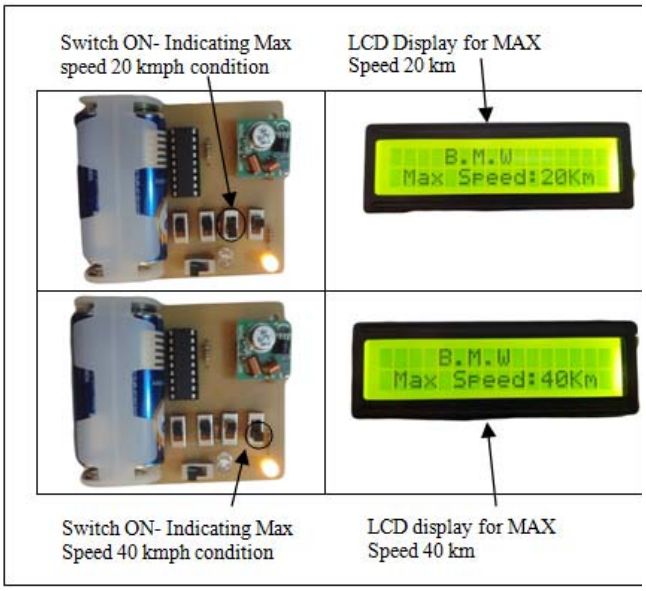

Fig. 5. Speed limit condition

E. *Car Theft Detection:*

A system operation is triggered when a limit switch is tripped. When the limit switch is pressed, theft alert is displayed on the LCD screen and SMS along with location of toy car is given to the number that is pre fed via GSM Modem. In real life SMS would be sent to the owner of the vehicle along with the location of the car.

Fig. 6. Car Theft Detection Condition

F. *Alcohol Detection:*

To test this feature, the MQ3 alcohol sensor is being exposed to a liquid solution that has 30% or more alcohol content in it. If detected, the buzzer rings, the car comes to a halt and "SMS to R.T.O "is displayed on the LCD screen. The SMS is sent to the number pre fed for this feature via GSM. "Alcohol Sensed" message is also displayed on the L.C.D.

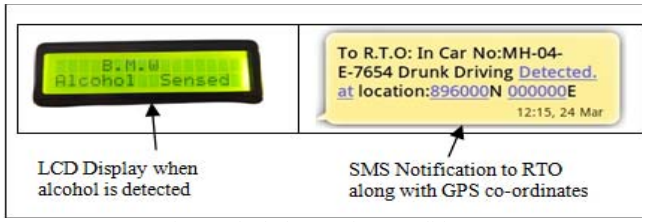

Fig. 7. Alcohol Detection Condition

G. Horn Prohibition:

The encoder will be fed that it is a no honking zone, so the transmitter will be transmitting the RF signal with the no honking condition among others such as speed limit etc. RF Receiver will receive signal which the decoder will decode and give to microcontroller. In the toy car a buzzer will be installed as a horn substitute. If buzzer is ON, and horn prohibition condition is being transmitted, the sound won't come.

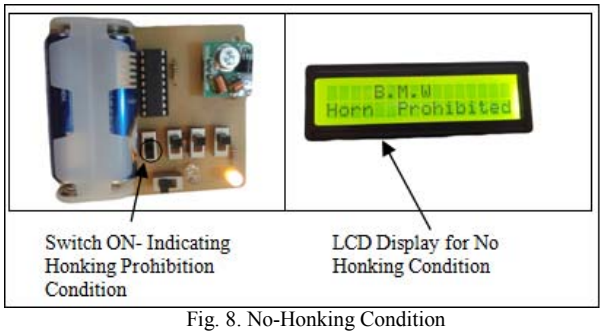

Fig. 8. No-Honking Condition

H. Final protopype:

Fig. 9. Toy Car with circuit

V. CONSTRAINTS

A. Extreme weather conditions affect RF Reception:

Rain fade refers primarily to the absorption of a microwave radio frequency (RF) signal by atmospheric rain, snow or ice, and losses which are especially prevalent at frequencies above 11 GHz. It also refers to the degradation of a signal caused by the electromagnetic interference of the leading edge of a storm front [13].

Rain fade usually does not last long. Once a heavy shower or squall has passed, normal communications returns. However, during tropical storms or severe winter storms at northern latitudes, fadeouts can persist for hours at a time [14]

B. System cannot perform collision avoidance:

The system is currently only concentrating on collision detection. Collision avoidance requires proximity sensors which have not been implemented in the circuit.

VI. CONCLUSION

With this prototype, a cost effective embedded system has been successfully implemented which helps in curbing road accidents and flouting of traffic rules while also providing security for the vehicle.

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