Travolution-An embedded system in passenger car for road safety

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Abstract- **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, Speed control alters speed in different zones, Alcohol detection detects drunk driving, and Vehicle security is used to prevent theft. An Alarm indication if the driver does not wear Seatbelt.**

Keywords: ARM CORTEX M3, GSM module, GPS module, MEMS, Alcohol detection, Seat belt detection, Zone alerts, RF TX& RX.

I. INTRODUCTION

Road traffic crashes are one of the world's largest public health and injury prevention problems. According to WHO, more than a million people are killed in road accidents, each year, all over the world. A report published by the WHO in 2009 revealed that more people die on roads in India than anywhere else in the world. 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. In 2007, 1.14 lakh people in India lost their lives in road mishaps. 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'.

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 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.

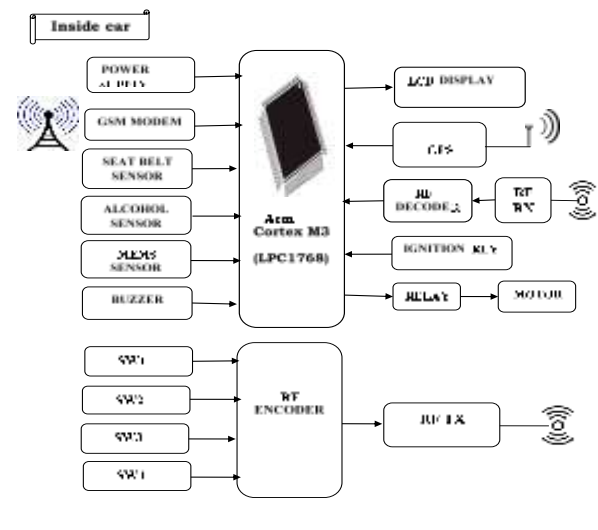## II. DESIGN OF PROPOSED HARDWARE SYSTEM

Fig.1.Block Diagram

In this project the vehicle is monitored to provide a more accurate detection. The features added in this work are

*(i)Vehicle Speed Control in Variable Zones-*in this feature, speed of the vehicle is controlled in different areas such as flyovers, bridges, highways, schools, cities and internal areas.

(ii)Automatic Collision Notification- In this feature when vehicle meet with an accident, the system of this project sends messages (SMS) to control room and the owner of the vehicle via GSM modem .

(iii)Vehicle security- In this feature, if the vehicle is stolen or someone tries to break in, if we give a miss call to the registered number automatically GPS tracks the vehicle and message is sent to control room and the owner of the vehicle via GSM modem.

(iv)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 and the message is sent to control room and the owner of the vehicle via GSM modem.

(v)Seatbelt alert- Alarm indication which means Buzzer rings if the driver does not wear seat belt.

III.THE HARDWARE SYSTEM DETAILS

The various components that are used in the implementation along with the important considerations are explained in detail.

A. ARM CORTEX-M3 (LPC1768)

The ARM Cortex-M3 is a next generation core that offers system enhancements such as enhanced debug features and a higher level of support block integration. The LPC1768 is an ARM Cortex-M3 based microcontrollers for embedded applications featuring a high level of integration and low power consumption. . The LPC1768 operates at CPU frequencies of up to 100 MHz.Cortex-M3 is a 32-bit microprocessor The ARM Cortex-M3 CPU incorporates a 3-stage pipeline and uses Harvard architecture with separate local instruction and data buses as well as a third bus for peripherals. The ARM Cortex-M3 CPU also includes an internal pre-fetch unit that supports speculative branching. The LPC1768 is pin-compatible to the 100-pin LPC236x ARM7-based microcontroller series.It has a 32-bit data path, a 32-bit register bank, and 32-bit memory interfaces. For complex applications that require more memory system features, the Cortex-M3 processor has an optional Memory Protection Unit (MPU), and it is possible to use an external cache if it's required. The Cortex-M3 processor includes a number of fixed internal debugging components. These components provide debugging operation supports and features, such as breakpoints and watch points.

Fig.2.LPC1768 IC

B.ALCOHOL SENSOR

Sensitive material of MQ-3 gas sensor is SnO_2, which with lower conductivity in clean air. When the target alcohol gas exists, the sensor's conductivity is more high along with the gas concentration rising.MQ-3 gas sensor is highly sensitive to Alcohol, and has good resistance to disturb of gasoline, smoke and vapor. The sensor could be used to detect alcohol with different concentration, it is with low cost and suitable for different applications.

Fig.3.Alcohol sensor

C. SEATBELT SENSOR (LM 358)

LM 358 consist of two independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltage. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage Application areas include transducer amplifier, DC gain blocks and all the conventional OP-AMP circuits which now can be easily implemented in single power supply systems.

Fig.4.LM 358 IC

D. MEMS SENSOR

The Free Scale Accelerometer consists of a MEMS capacitive sensing g-cell and a signal conditioning ASIC contained in a single package. The sensing element is sealed hermetically at the wafer level using a bulk micro machined cap wafer. The MMA7660FC is a ±1.5 g 3-Axis Accelerometer with Digital Output (I2C). It is a very low power, low profile capacitive MEMS sensor featuring a low pass filter, compensation for 0g offset and gain errors, and conversion to 6-bit digital values at a user configurable samples per second. The device can be used for sensing data changes, product orientation, and gesture detection through an interrupt pin (INT). This device is sensitive to electrostatic discharge. Although the Free scale accelerometer contains internal 2000 V ESD protection circuitry, extra precaution must be taken by the user to protect the chip from ESD. A charge of over 2000 V can accumulate on the human body or associated test equipment. A charge of this magnitude can alter the performance or cause failure of the chip. When handling the accelerometer, proper ESD precautions should be followed.

E. MAX 232

MAX232 is a 16 pin IC. It converts signals from an RS232 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.

F. 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.

G. *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.

H. 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

I. BUZZER

A piezoelectric element may be driven by an oscillating electronic circuit or other audio signal source. Sounds commonly used to indicate that a button has been pressed are a click, a ring or a beep. Electronic buzzers find many applications in modern days.

Fig.5.Buzzer

J. LIQUID CRYSTAL DISPLAY (LCD)

LCD is a flat panel display, electronic visual display that uses the light modulation properties of liquid crystals. Liquid crystals do not emit light directly. LCD's are available to display arbitrary images or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

Fig.6.LCD Display

K. GPS

The Global Positioning System (GPS) is a U.S. space-based radio navigation system that provides reliable positioning, navigation, and timing services to civilian users on a continuous worldwide basis freely available to all. For anyone with a GPS receiver, the system will provide location and time. GPS provides accurate location and time information for an unlim-ited number of people in all weather, day and night, anywhere in the world.GPS technology became a reality through the efforts of the American military, which established a satellite-based navigation system consisting of a network of 24 satellites orbiting the earth. GPS is also known as the NAVSTAR (Navigation System for Timing and Ranging). GPS works all across the world and in all weather conditions, thus helping users track locations, objects, and even individuals, GPS technology can be used by any person if they have a GPS receiver.
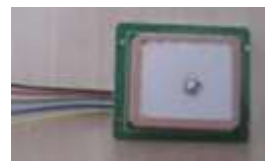

Fig.7.GPS Module

L. GSM

GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services.

Fig.8.GSM Modem

GSM supports voice calls and data transfer speeds of up to 9.6 kbps together with the transmission of SMS. By having harmonized spectrum across most of the globe, GSM's international roaming capability allows users to access the same services when travelling abroad as at home.

IV. 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 - 3Volts Power Supply.

A. RF TRANSMITTER SECTION

In this section, 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.

The STT-433 is ideal for remote control applications where low cost and longer range is required. The transmitter operates from a1.5-12V supply, making it ideal for battery-powered applications. The transmitter employs a SAW-stabilized oscillator, ensuring accurate frequency control for best range performance. Output power and harmonic emissions are easy to control, making FCC and ETSI compliance easy. The manufacturing-friendly SIP style package and low-cost make the STT-433 suitable for high volume applications.
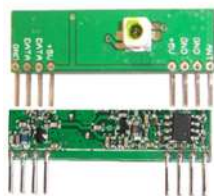

Fig.9.RF TRANSMITTER

B. RF RECEIVER SECTION

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. 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 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 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 1, two 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 STR-433 is ideal for short-range remote control applications where cost is a primary concern. The receiver module requires no external RF components except for the antenna. It generates virtually no emissions, making FCC and ETSI approvals easy. The super-regenerative design exhibits exceptional sensitivity at a very low cost. The manufacturing-friendly SIP style package and low-cost make the STR-433 suitable for high volume applications.
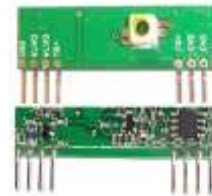

Fig.10.RF RECEIVER

V. RESULTS

The system is implemented in a toy car and tested. This method causes less mental or physical loads to drivers and is advantageous for long-term driver monitoring purpose.

➢ `For collision detection, Bumper switch is used. Bumper switch has "ON" and ʺ OFF" condition. The tension which triggers the bumper switch is approx.144gms. 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.

➢ For the Alcohol Detection, 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 LCD.

➢ When the vehicle enters the zonal areas such as school, military, flyovers, the speed of the vehicle is controlled by using relays so that the motor speed reduces automatically in the vehicle. 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

➤ Before entering into the particular zone the driver is notified by an SMS through GSM and the location is predicted before entering into the zone by using GPS wireless communication system.

➤

Fig.11.Design of Proposed Hardware System

VI. CONCLUSION

The project "**Travolution- an embedded system in passenger car for road safety"** has been successfully designed and tested. Integrating features of all the hardware components used have developed it. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced IC's and with the help of growing technology the project has been successfully implemented.

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