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Design and development of Automotive Black Box

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Abstract: The proposed paper is torecord informational data, such as engine, speed and its temperature, etc. to revolutionize the field of motor vehicle accident investigation. It can also be used for vehicle mapping and accident alert with the help of GPS and GSM technology. This paper is designed with the use of embedded systems. Embedded systems are playing important role in our lives every day, even though they might not necessarily be visible. An embedded system can be defined as a control system or computer system designed to perform a specific task and also be defined asa single purpose computer. Some of the embedded systems we useevery day are menu control system on television, the timer in a microwave oven and so on with some amount of intelligence built-in. Also with the introduction of this novel designs there is an ample scope to distinguish the erring drivers from the rest. Presently the most manufacturers of automobiles have introduced a good number of safety devices and in conjunction with safety devices, this device articulated by the present researcher may complements the entire safety mechanism thoroughly.

Keywords: Vehicle, Black box , GPS, Microcontroller, Data storage device.

I. INTRODUCTION

Advanced countries like USA are currently implementing Black box technology statutorily in all automobiles as the safe and secure travel to the passengers becomes the motto of the Government. These car black boxes only records important information such as vehicle speed, temperature, location constantly.The data recorded by car black box is help full for better car crash investigation and crash management. The researcher feels that the development of Black Box for automobilesmay go long way to serve the travelling public to destinations in safer mode. According to the World Health Organization, more than a million people in the world die each year because of transportation-related accidents. In order to react to this situation, the black box system draws the first step to solve problem. Like flight data recorders in aircraft, "Black Box" technology can now play a key role in motor vehicle crash investigations. A significant number of vehicles currently on the roads contain electronic systems that record in the event of a crash. That is why it is so important to have recorders that objectively track what goes on in vehicles before, during and after a crash as a complement to the one used. Subjective input that is taken usually from victims, eye witnesses and police reports. By implementing the system crash investigation can be taken to a higher level in which proper cause of the crash can be revealed. Automotive electronics simply known as Autotronics play an important role in bringing Black Box technology to automobiles. This unique system is mainly committed to two sections. The first one is how to detectand collect the information from the vehicle. The second is how to present the data to the user in a simplified way. To implement the first section many components and various types of sensors are used. While the second section was implementing by using a USB module in which the data can be stored with the help of a pen drive or memory stick with which logged data obtained. There are two main parts forthis system. One is to record speed, temperature, time and location of your car and second one will help to retrieve exactly what happened during the crash from the data stored in hard drive.

II. HARDWARE ASSETS

(a) TEMPERATURE SENSOR

The LM35 series 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 sensorscalibrated in ° Kelvin, as the user is not required to subtracta 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 trimmingand 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 drawsonly 60 μA from its supply, it has very low self-heating, lessthan 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).

(b) PIEZO-ELECTRIC SENSOR

Piezo-electric sensor is a device used to sense the collision. Piezo-electric sensor produces a high voltage DC current during the impact. It uses the piezoelectric effect to measure pressure, acceleration, strain or force by converting them to an electrical charge. Piezoelectric effect plays a vital role forthe respective measurements.

(c) IR SENSOR

The IR sensor is used as a complementary element to ensurebetter safety of the passengers travelling in a vehicle. Though modern high end cars have lane detection and objectdetection systems, majority economy class wouldn't afford to buy those expensive cars. The IR sensor solves this issue by implementing it on the economy cars at low cost. This requires another circuit. IR sensor constantly emits infra red light and sense the duration of this light to reach the sensor from other object far away. But when this light hit the sensor back from the object in a short duration which means there is an object close to the vehicle and there is a chanceof being hit by the object. Then the provided Buzzer will sound to notify the driver by beep sound and helps not to hit the object which can save lives from a possible crash situation.

(d) GPS RECIEVER

Global Positioning System (GPS) satellites broadcast signalsfrom space that GPS receivers, use to provide three-dimensional location (latitude, longitude, and altitude) plus precise time. GPS receivers provides reliable positioning, navigation, and timing services to worldwide users on acontinuous basis in all weather, day and night, anywhere on or near the Earth. Sunrom's ultra-sensitive GPS receiver canacquire GPS signals from 65 channels of satellites and output position data with high accuracy in extremely challenging environments and under poor signal conditions due to its active antenna and high sensitivity. The GPS receiver's - 160dBm tracking sensitivity allows continuous position coverage in nearly all application environments.

(e) GSM MODEM

GSM/GPRS MODEM is a class of wireless modem devices and they are designed for communication of a computer with the GSM and GPRS network. It requires a SIM (Subscriber Identity Module) card just like mobile phones toactivate communication with the network. This system can feature all the functionalities of a mobile phone throughcomputer like making and receiving calls, SMS, MMS etc. the process of communication been performed through RS232 port and GSM/GPRS module demonstrates the use of AT commands.

(f) BUZZER

Buzzer is an audio signalling device which may beMechanical, Electro-mechanical or piezoelectric system. Buzzer been used in alarm devices, timers and confirmation of user input such as a mouse click or keystroke. Buzzer performs a key role through its audio alert signals.

(g) LIQUID CRYSTAL DISPLAY (LCD)

The LCD module is a dot matrix liquid crystal display that displays alpha numeric, characters and symbols. The built incontroller HD44780 and driver LSI's provide convenient connectivity between the dot matrix and most of the microcontrollers. All the functions required for the dot matrix display are internally provided. Internal refresh is provided by the display module. The CMOS technologymakes the device ideal For applications in hand held, portable and other battery powered instruments with low power consumptions.

(h) USB MODULE

USB module is used to get out put files stored in a pen driveor external storage device.

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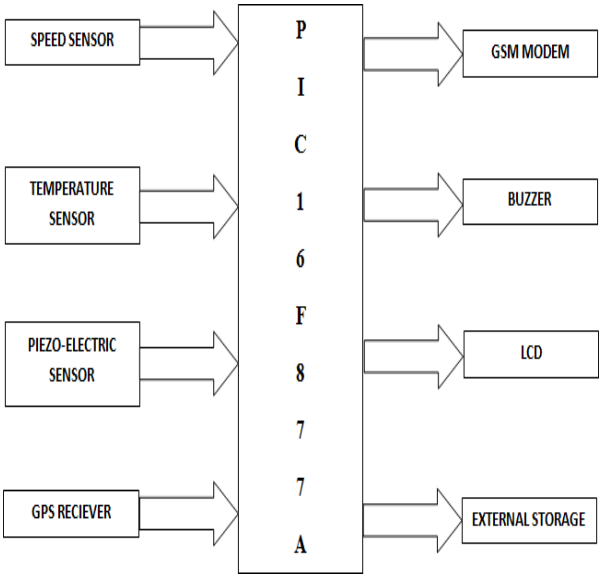

Fig.1 Block diagram of PIC

(i) PIC 16F877A

PIC 16F877A is 40 pin 8 bit CMOS flash microcontroller device. Peripheral interface controller been abbreviated as PIC. PIC16F877A is a quite commonly used device for the purpose of serial programming in all fields of science. It is a 40 pin device of operating speed DC - 20MHz clock input with Operating voltage range – 2V to 5.5V. It contains inherited Flash memory of 8k and Data memory 368 bytes with Electrically Erasable Programmable Read Only Memory (EEPROM) of 5 ports from A to E. It is a high speed encoded device and it been utilized for specified functions for storing multiple attributes with separate codes with unique serials. PIC16F877A is a quite commonly used device for the purpose of serial programming with high compatible features.

DATA STORAGE AND RETRIEVEL

The black box always monitors and stores the informational data from sensors for further use. After a crash, the investigating team can actually use this data to get a clear picture of accident scene with the logged data stored in the data storing device. This makes crash investigation efficient and accurate. Black box stores the data from various sensorsin a pen drive with the help of USB module from sun rom technologies. This will help to maintain the data about vehicle in a logged manner. From this data driving habit of drivers could be found out and that is an important lead in crash investigations. The logged data is retrieved byconnecting the pen drive/hardware storage device to computer. The pen drive will contain a file named BLACK.txt which is in .txt extension format. This file contains all the informational data needed. The black box stores data because of the program written in PIC microcontroller. Microcontroller take different inputs in its pin and produce out put through different pins to store the data in a pen drive and show the data at real time in a LCD panel.

III. RESULTS

(a) Speed Sensing

Speed is measured by using an electric motor. When electricmotor rotates it generates electricity in its coil like one in speedometers. By sensing the amount of electricity produced in poles the microcontroller converts it to what speed the motor/vehicle wheel spinning. Then this rotationis converted to KMPH to get the speed of vehicle. This data is stored in hard drive and can be seen in live on LCD.

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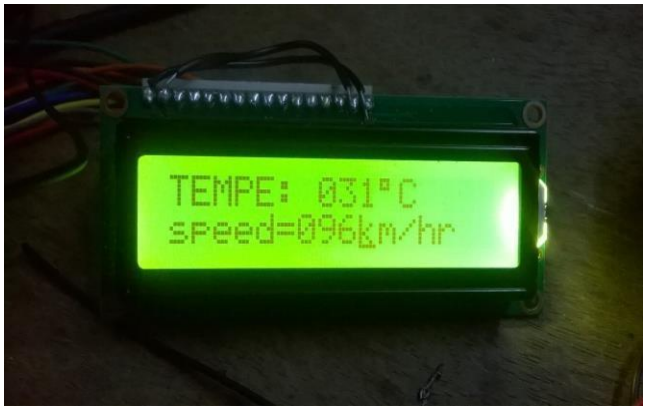

Fig.2 Real time Speed on LCD

```
TEMPERATURE=031Degree centigrade
speed=096km/hr
TEMPERATURE=031Degree centigrade
speed=096km/hr
```

Fig.3 Logged data from Pen drive

(b) Temperature Sensing

Temperature is an important thing in a vehicle engine. The engine should be operated in optimum temperature for betterperformance and fuel efficiency. Any damage to the cooling system can lead to abnormal temperature rise in engine this may lead to engine failure even to the extend to get fire. So the black box will always records its engine temperature andshows in LCD display as well as stores in the hard drive.

Fig.4 Real Time Temperature

```
TEMPERATURE=031Degree centigrade
speed=000km/hr
TEMPERATURE=056Degree centigrade
speed=000km/hr
TEMPERATURE=039Degree centigrade
speed=000km/hr
TEMPERATURE=063Degree centigrade
```

Fig.5 Logged data from pen drive

(c) GPS&GSM Technology

Whenever an accident occur the black box will store thedata last available before the crash with coordinates of location where the vehicle travels. It also sends an SMS to a predefined number that set in its memory that the alerting accident happened at the location. When collision occurs themicrocontroller detect it from sensor and as pre- programmed it will sends an SMS alert to the predefined number with the location coordinates of crash site. With thissystem it is highly possible to find the precise location of crash with ease and thus enables emergency unit to respond and reach the site within short time.

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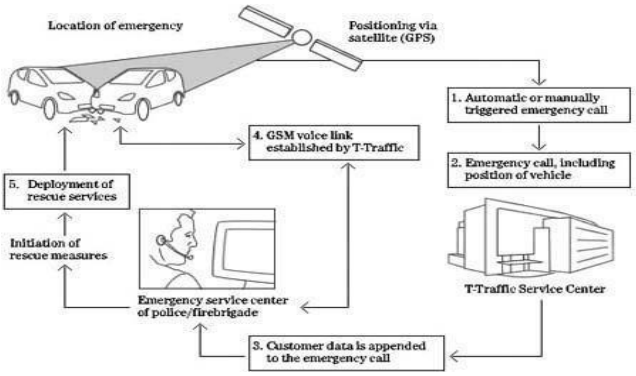

Fig.6 Accident alert and GPS tracking

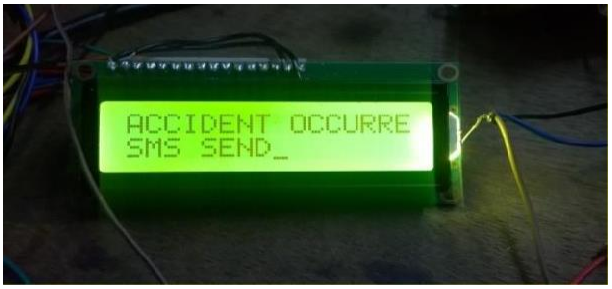

Fig.7 Accident Detection and SMS alert

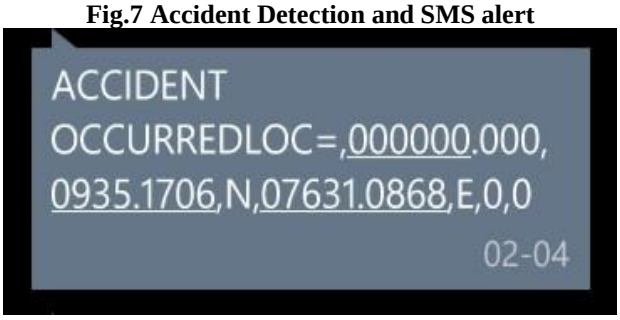

Fig.8 SMS Alert

IV. CONCLUSION

A full and detailed description was made for every part of this system. This paper has also offered a user friendly embedded program to analyse the data of the accident. The Black Box system built can be implemented in any vehicle. As soon as the driver runs the motor, this system will begin saving the events of the corresponding vehicle. The black box can be fitted in any vehicle for better safety and management if produced commercially. This prototype design helps to realise how important it is to have a black box on board of a vehicle.

V. FUTURE EXPANSIONS

This system can integrated to existing safety control devices thus reduce cost. Getting all the information to ECU will help to store all the data related to vehicle's mechanical, electrical and electronics systems to black box thus reducingthe extra sensors and actuators needed for black box. Avideo recording device will help for better overview of crash.

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