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Design & Development of Evidence Collection System fromVehicular Data Recorder for Data Analysis

Dr. Pankaj H. Chandankhede
Assistant Professor
Department of Electronics & Telecommunication Engg, G H Raisoni College of Engineering Nagpur, Maharashtra, India

I. INTRODUCTION

Initially EDR was implemented in aeroplanes and called as flight data recorder. But, for safety purpose it is also being implemented in vehicles. This Event Data Recorder has various sensors mounted on it. Different sensors like Accelerometer to measure Speed, Pressure sensors to measure Brake pressure, Impact, Tire pressure, Temperature sensor, GPS for recording of location of vehicle in form of latitude and longitude are on EDR.

The EDR are of different working types like records the data until the event and stops, record the data after some time of the event and then stops after a declared time and some records continuously until the authorized person stops it.Some EDR's record data of each and every second. While some EDR's record after some pre-defined time duration. This is because to utilize available memory space very efficiently. Obviously, memory requirement for recording data by every second will be high. Some EDR's store recorded data in EEPROM while some store it in secondary storage device like pen drive or micro SD memory storage card.

Evidence Collection System plays significantly in case of crash analysis in case of cars. Figure 1 shows currently use methods for analysis of cases of accidents.Now clear evidences are required to analyze cases regarding crash analysis.It may include witness (Physically) present by side of accident place and slide-trace marks done by vehicle etc. Such cases is depicted in figure 1.

Fig. 1. Current methods for accident analysis
(http://www.vcrashusa.com/validation/#validation-vc)

Application of such system can be used to :

- Investigation for crash
- Collection of samples that can act as evidence
- Driver training& monitoring
- Purpose of safety
- Insurance Claim Purpose
- Issuing Drivers license case
- Reconstruction of Accidents

Here, building up event data recorder system for monitoring of vehicle with different sensors and providing security to the sensed data by implementation of security algorithm is proposed. 'Advanced RC6' algorithm is proposed here as cryptographic technique along with data mining technique called as 'Top K values' for data extraction and lastly analysis to predict about future anomalies. The proposed Efficient EDR system gives or delivers data about velocity of vehicle and real time location and status about temperature of engine, about acceleration status, front obstacle detection and alcohol detection. All the sensed data is gathered by ARM 7 Processor and send to monitoring station and displayed

on GUI.Research carried deals with design of CAN based system for event data recorder & analysis of data received as parameters.

Design methodology has following subcomponents

- Design of EDR
- Design of Evidence Collection System
- Analysis of Data

There are four main components in EDR, a sensor package, processor, storage of sensor generated data & a retrieval (fetching) mechanism.

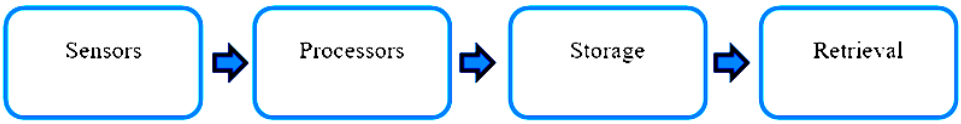

Fig. 2. Block diagram of EDR

II. EVENT DATA RECORDER

In day today life, it has been a problem to acquire information regarding crash events; it is being difficult to judge when and where it happened. In order to save life of victims during the crash event, it is essential that people should notice out the victim at right time, problem occurs with the arrangement of ambulance, with distant areas. So for that event data recorder is constructed which gives information about how accident occurred but in this proposed system event data recorder is constructed to give fault protection messages on the LCD display according to the respected extreme conditions for the sensors so that the accident can be avoided. Overcome these, GPS technologies are used. The vehicle equipped with position &location crash recognition component consist of GPS modem & vibration sensor linked with microcontroller. At time of accident, as vibrations are sensed by use of vibration sensor, this useful information is given to micro-controller then the data is screened on LCD.

III. EVIDENCE COLLECTION SYSTEM

Recorded data by vehicular event data recorder need to be analyzed in all aspects to find actual or exact cause of accident .This Reports produced by evidence collection systems could be proof presented in court & actual culprit can be arrested. By checking parameter such as data when distance between our vehicle and adjacent vehicle, brake pressure applied, High speed driving, etc. guilty can be caught based on evidence collected.Consider the case if someone is driving by speed higher than normal & if suddenly some obstacle comes then driver must need to apply hard brakes at critical case. But if he fails to do so then evidence collection system will help us to find what went wrong.

If behavior model for driver crosses threshold limit for any sensor e.g speed. Then this speed parameters can be considered as evidence and can be used to set speed limit in specific or sensitive areas. Thus these models will be useful in private or public transport services. So this facility can be used to analyze owners of Transport Companyabout how their drivers behave in various cases while providing service to public sectors.

IV. DATA ANALYSIS

Data Analysis consist of two parts

- Analysis through graphical user interface displaying overall result as a combined graph with conclusion
- Analysis through graph of time Vs parameters of various sensors.

This part will deals with finding exact cause of accident depending on graphical user interface. GUI will display exactly what happed to vehicle just prior to accident.

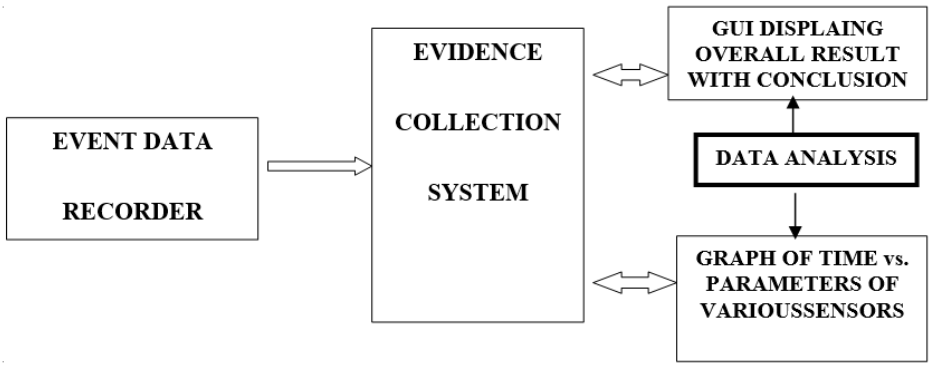

Fig. 3. Block diagram of Evidence Collection System

Fig. 3 shows general working of system. Here Event Data Recorder can also be abbreviated as Car Black Box. It is use to store vehicle data that is recorded from various sensors to storage device. For that sensors are mounted on vehicle. Sensors are speed measurement using accelerometer, Brake Pressure using pressure sensor, severity of Impact &tire pressure and for location determination -GPS and for measuring Engine Temperature,temperature measurement sensor is used.

Evidence Collection System getssensor data from data recorder & processes it. This data is recorded & stored in excel file which can be fetched with GUI. Now this is query based system& data analytics part. As per the data required by investigation team, that data can be reproduced in terms of graphs and based on that final reason of accident can be predicted.

Fig. 4 shows flowchart of entire system, we initialize event data recorder by initializing various sensors used in a system. Some standardization is required to sense & collect data from various sensor. Sense data is collected in message format. Here, data from sensor is recorder in continuous fashion. Different status of sense data from sensor is recorded.

So if vehicle under observation meets with an accident, authorize person can collect data from recording device. This data recorded act as a key witness to accident. Data prior to accident, during accident & after accident is recorded.

Data mining tools are used to fetch the data. Also used of modern tools are used to make GUI user-friendly. These evidences are required to analyze the exact cause of accident. It tells what went wrong prior to accident, during accident, or after accident.

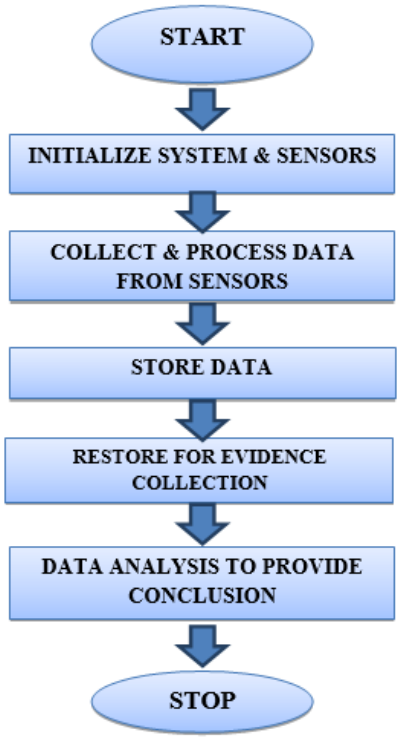

Fig 4: Flow chart of design

Based on request done by user, algorithm produces key. In this query (request) date and time are mentioned. This date & time belongs to accident date & time. B-Tree algorithm is used. As this algorithm works first on root node, date key is searched first in data base. If date matches then it search in next inter-node and its leaves. Similar, matching on that date is done for time. If both date and time on that date gets matched, all data stored in that time instant gets fetched & is available in GUI. As in B-Tree algorithm, data gets stored at leaves so, algorithm finds exact matched data in quick suggestion &results is displayed in GUI.

As there are many other algorithms which can be used in this system then, question arises why to use B Tree algorithm? As discussed previously, B tree is a balanced structure and due to this, it requires less time to access data.As from below table, Time complexity of Red Black&B Tree are equal and quite small.Genetic Algorithm required more time to access large data sets. So, as per performance criteria, B Tree is much better than others.

Table 1. Comparison of B Tree with others Searching Techniques

Parameters	Breadth First Search	Genetic Algorithm	B Tree	Red Black Tree	Divide & Conquer
Time-Complexity	O (V+E)	O(n)	O(log n)	O(log n)	O(n log n)
Nature	Un- balanced	Un- balanced	Balanced	Un- Balanced	Un- Balanced
Code Complexity	Average	Complex	Average	Average	Average

RC6 algorithm is block cipher used for protection of data involves 3 process, they are Expanding of keys, encrypting as well as decryption of the data need to be secure.. The rc6 algorithm depends on 3 parameters: -w the word size ; r is the no of rounds which are non- negative ;b is the size of key used in bytes for encrypting the data. This algorithm utilize information relied rotation.

V. SYSTEM DESIGN

System design implementation here deals with first interfacing various sensors with processor through controller area network, their storage depending on threshold conditions, retrieval & evidence collection system.

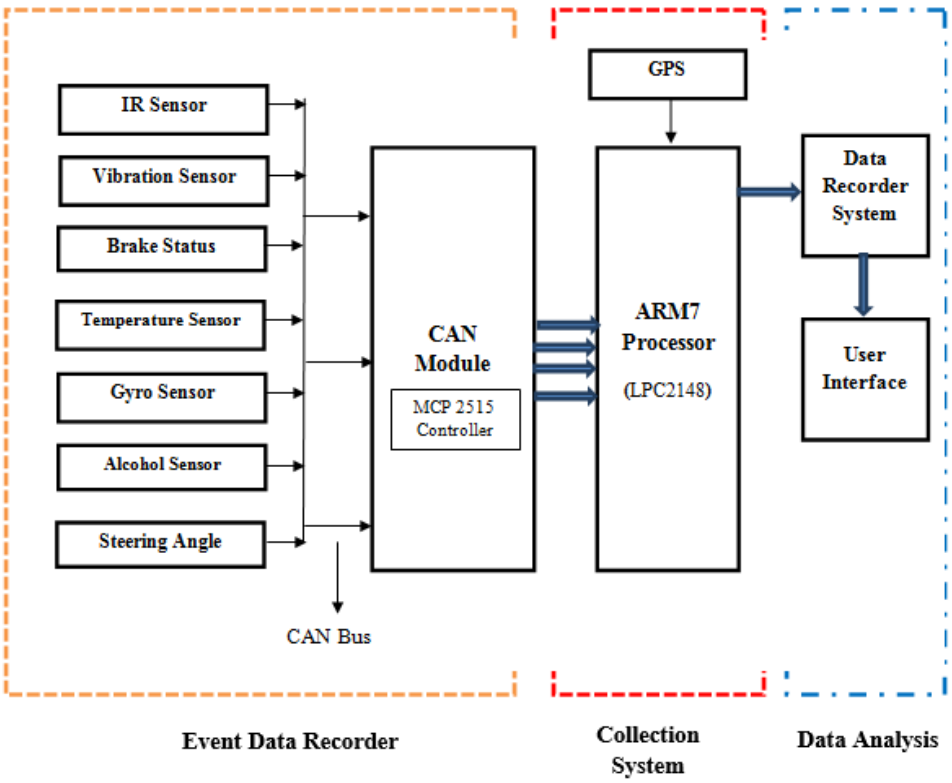

Fig 5: Block diagram of system design

Figure 5.1 shows block representation x`of designed system. As shown in figure, complete block diagram is divided into three sub blocks.

- Event data recorder
- Collection system
- Data analysis

Any system is represented by the types of the components and their numbers actually used. It consists of the various technologies which are implemented or going to be implemented to enhance the performance. The vitality of any system depends on the actual ease in use to the normal person. The system performance completely depends on the error free information transfer and reception from one component to another or from one part of the system to the

processor. This data transfer is takes place with the help of the various layers which tends to carry out the given work completely and with little distraction. The main types of layers which enable the system to communicate are

- Physical
- Data Collection
- Data Processing

Physical-layer is usedto store the physical addresses. It is responsible for the bit by bit data translation into or from the hardware specific operations. This layer provides the information about the procedural and electronic interface with the transmission medium in the system.
Data Collection Layer enables the collection of the signals from the various sensors, status of the sensors and the vehicle parameters in the Event Data Recorder. The system mainly depends on the functioning of the I/O interface, UART and Analog to Digital Converter (ADC).
Data processing is the most important function in any system. The Data Processing Layer receives the data information from the data collection layer. Mainly consists of the storage unit and processing unit this layer is present in the processor of the system. The processed data from this layer is forwarded towards the data recorder system which stores the data into the SD card.

VI. DESIGNED MODULE DESCRIPTION

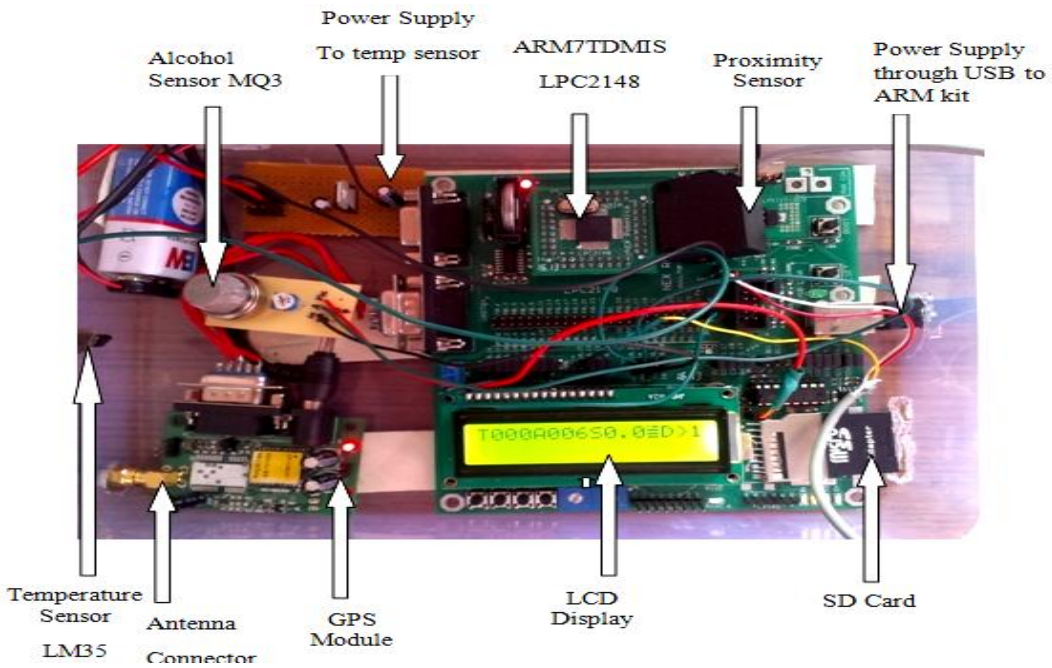

Fig. 6: Implementation of Module

As shown in fig. 6, the processor used for configuring above module is ARM 7 LPC2148. The system starts with the initialization of different on chip peripherals that include GPIO, UARTO and ADC0. This module implementation includes sensors named as;

- GPS Receiver
- MQ3 Alcohol Sensor
- LM35 Temperature Sensor
- PIR Sensor

1. Alcohol Sensor MQ3 has 3 pin outs as +VCC, A.OUT and GND. The +VCC is connected to on chip +5V power supply, A.OUT is provided to the pin no.29 on ADCO,GND connected to ground pin.
2. Temperature sensor LM35 has 3 pin outs as +VCC, A.OUT and GND. The +VCC is given by power circuit, as shown in figure 5.7, A.OUT is provided to pin no.28 on ADCO. GND is connected on power circuit.
3. Front obstacle detector PIR sensor has 3 pin outs. +VCC, OUT, GND. +VCC and GND are connected to ARM7 pins of +5 and grounded respectively. OUT is connected to switch pin no.15 on PORT 0.

4. GPS module which detects speed and location of vehicle.LPC2148 having two UART which is UART0 and UART1. Moreover RS-232 is used as the UART0. TXD pin of UART0 is connected to 8^{th} pin of port0 which is TDX1 of the processor and RXD pin of UART0 is connected to 9^{th} pin of port0 of the processor. It has antenna through which signals are received from satellite and provided to UARTO of ARM7 which gives speed and latitude and longitude and consequentlythe data is stored into the SD Card.

Events of Extreme Condition

1. Engine temperature exceed 100^{o}c. In this condition, consequentlystatus about Alcohol sensor, Proximity sensor, Speed & Position of the vehicle is detected & stored into SD card.
2. Alcohol is detected about 0.2 mg/L. In this condition, the status about Engine temperature sensor, Proximity sensor, Speed & Position of the vehicle is detected & stored into SD card.
3. If Obstacle is detected in the range less than 1 feet. In this condition, the status about Engine temperature sensor, Alcohol sensor, Speed & Position of the vehicle is detected & stored into SD card.
4. Either vehicle is in moving or Stationary condition the Speed & location detected

In this condition, the status about Engine temperature sensor, Alcohol sensor, Proximity sensor of the vehicle is detected & stored into SD card.

VI. RESULTS

Initially select file needed to be analyze. To choose file, one can access desired location on computer. After that figure 7 window opens. Uploaded data storage device is shown in figure below.Data shows live data recorded when vehicle was in motion. Ordinarilythree choices were given for Search-To search in data base, Check Accident-check accident occur or not on that date or not and Driver Behaviour-It is in terms of graph. For Search button, following fig. 8 opens.

Figure 9 shows merge (combined) graph. Here, all graphs are merged in one graph. Each showing it delta change with respect to time.

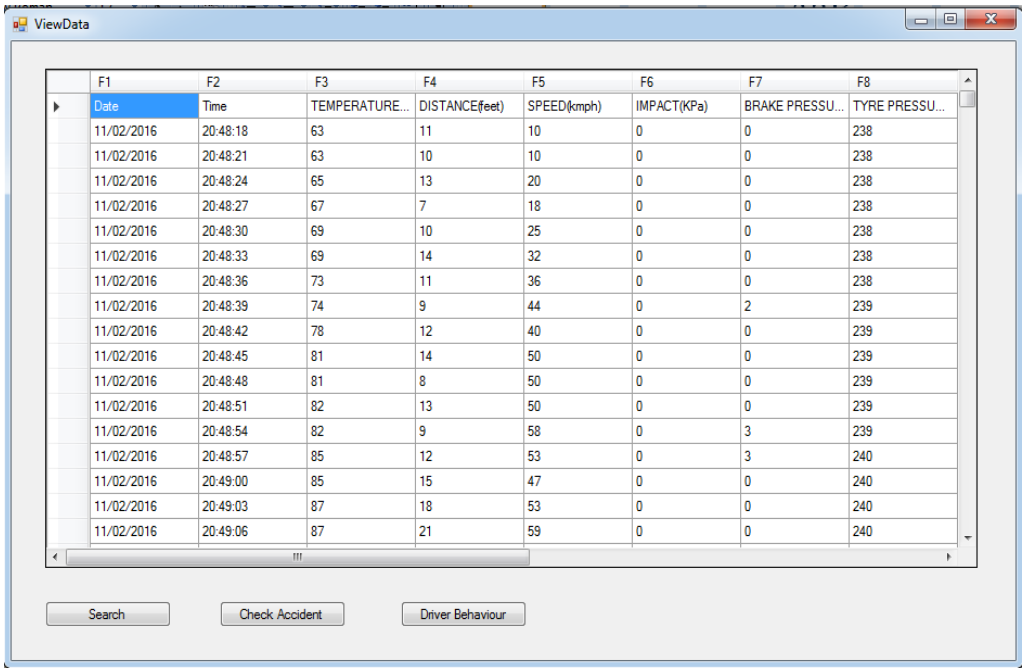

Fig. 7. File to be analyseuploaded in GUI

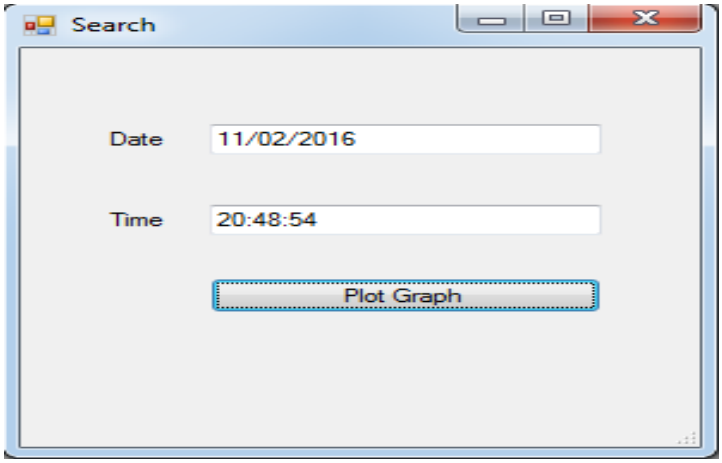

Fig. 8. Window for Date and Time

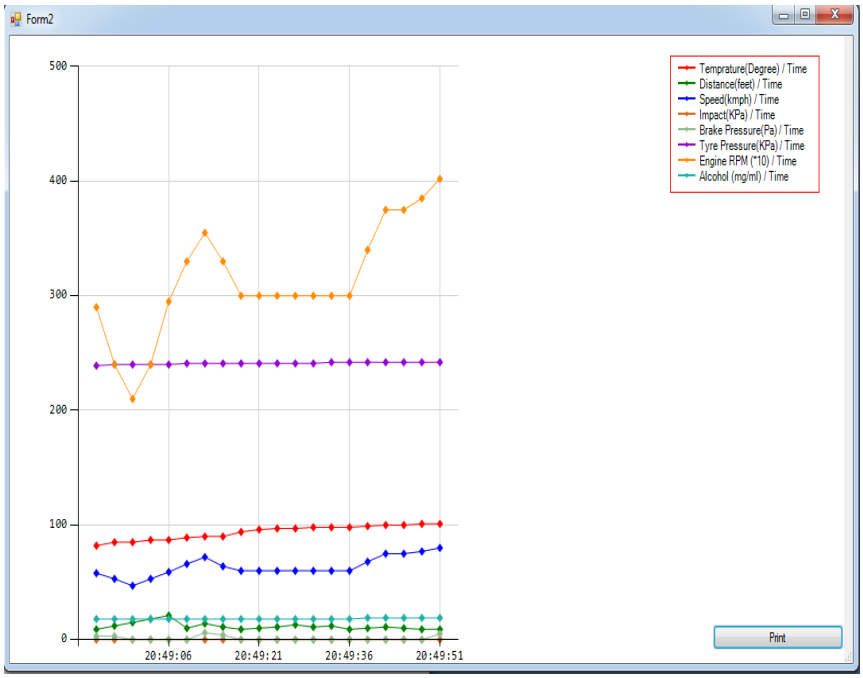

Fig. 9. Showing variations of all parameters under consideration Vs time

To interpret graph, button of "Check Accident" will tell cause of accident based on which sensor crosses threshold value. Figure 10 indicates sample case from data base were impact sensor exceeds threshold. Similar interpretation can be shown if any other or multiple sensors exceed set threshold.

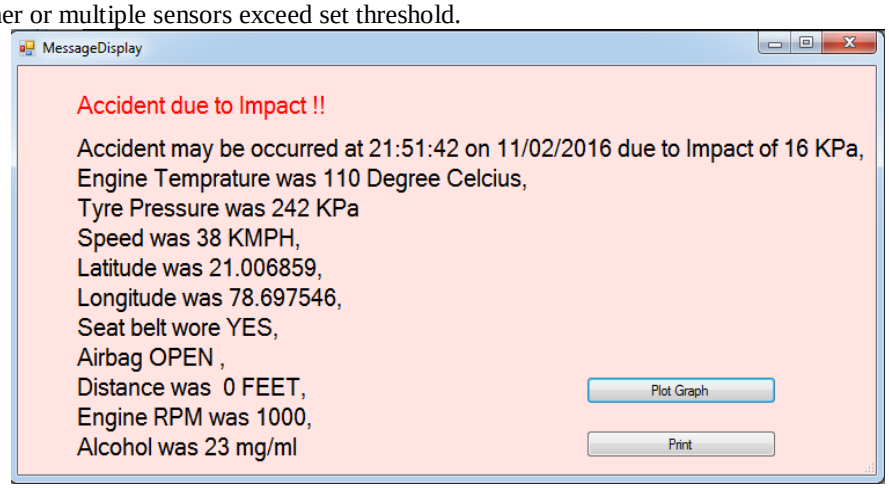

Fig. 10. Accident due to Impact case

Here, message with red highlighted color depicts main cause of accident. As shown in above figure 10 "Accident due to Impact!!" indicated that sensor value for impact crosses threshold and is indicated as main reason for accident.

VII. CONCLUSIONS

Controller area network based Event Data Recorder for vehicular system is designed. The processor used for the system is ARM7. The designed system aims to implementation of Event Data Recorder from fault protection and high speed data transfer using the CAN protocol. In this system the various working conditions like sensing the vehicular parameters using sensors, tracking the sensor conditions and recording the respective data into the flash memory is carried out.

The system is an integrated platform using various sensors to monitor the various moving vehicles such as cars, boats, motorcycles etc. The developed system is a simple solution for the vehicle monitoring, its condition and event storage to keep the record of vehicle health. The rapid storage, real time data processor has the ability of receive and transfer of data with the high speed, which is the primary requirement of any system working in the real time condition. As the continuous recording has takes place the high memory long term storage flash memory is required which stores the data without any damage for a long time. Thus, EDR maintains the vehicle data for a long time without any damage and lost without the authorized person's permission.

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