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Design of Event Data Recorder for Vehicle Monitoring and Crash Analysis System

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Abstract: This paper describes the effective way of collecting the vehicular data and retrieves it after the happening of the extreme condition. The Event Data Recorder (EDR) is one of the favorable solutions for public safety. The Event Data Recorder is useful in collecting valuable parameters of vehicle such as vehicle speed, engine temperature, airbag status, etc. More and more car black boxes are installed for accident evidence is on a rise in number. In the past days as due to unavailability of accurate information about a car crash, the liability was often based on presumption of crash with least or without actual facts. A victim sometimes mistaken as an offender. The vehicle EDR accurately and extensively records the inside and outside of a car. So due to these reasons the vehicular monitoring and the evidence collecting system becomes the need of the hour. The vehicular monitoring and tracking system consists of many sensors installed in it and having the GPS system for its real time tracking. These sensors are used to sense the various conditions continuously. While the next part of evidence collection and analysis of crash can be done by the information which was saved in the SD card mounted in the EDR.
Keywords: Event Data Recorder, Temperature Sensor, Accelerometer, GSM, Vehicle Monitoring, Evidence Collection.

Introduction

Safety systems have been a very high rate of development for the ground running vehicles during this decade. An Event Data Recorder is a device installed in vehicles to record information related to vehicle conditions crashes or accidents. Event Data Recorder is also commonly known as the "Black-Box", installed in vehicles like trucks, cars etc[4]. Black boxes are activated or triggered by the problems sensed by the electronic components like sensors. These problems also known as the electronically sensed problems. The problems in the engine often called as faults. More of those conditions may occur because of an accident. The main application of this system is tracking the vehicle and giving the information about various parameters like engine temperature, wheel rotation status, acceleration and deceleration, slip angle using various sensors. Also, the position of the vehicle in altitude and latitude is traced by using the GPS system in the EDR[6]. Figure 1. Shows the actual flow from data collection of sensors, its recording in event data recorder (EDR) & evidence collection system [1] for to find the exact causes of crash/accident.

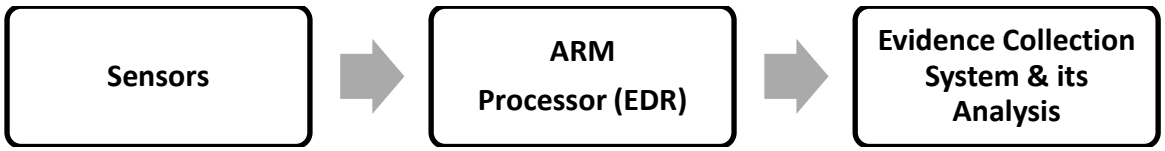

Figure 1. Flow of data recording & collection system

Black Box preparedness to collect the statistically applicable crash information to enhance the safety of the vehicles. This also helps to demonstrate the effectiveness of traffic rules and laws, to allow immediate notification of the crash or an accident to emergency station. Second half of the paper is about evidence collecting system & its analysis. The external card reader connected at the output side of the system collects the data from various sensors. The data information in the EEPROM flash Card can be redeeming with the help of card reader. Here reader connected to the ARM7 Processor reads the information from the EEPROM card and these various parameters will be sending to the processing systems such as the computer using the RS232 interface. The system front end is designed by using the VB interface useful to generate the graphical representation and event logger of the acquired data[9].

This paper proposes the safety measurements for the vehicles by using the various sensors to avoid the consequences of the crash also in the extreme condition occurrence i.e. accident the reality check can be carried out through the evidence collection and crash analysis from Black-box [3].

Integrated Design Solution

A. Vehicle Monitoring

The data collection layer present in the system is responsible for collection of number of various driving signals and the status information of the vehicle in the Event Data Recorder. The system design includes event UART, A/D converter and I/O interface. The unit consists of all the sensors connected to the ARM7 processor. Here we will follow the three system structures so that we can clearly understand the basic functioning and the difference in these three systems. These systems are much similar to each other but certain parameters present in these systems make a big difference in their functioning and each has its own specialty of different data representation.

Figure 2. Shows the first system. In this complete hardware implementation of Event Data Recorder connected with GPS module (for latitude & longitude) and sensors like Alcohol detection Sensor (alcohol concentration for drunk drivers), Temperature Sensor (engine temperature), PIR Sensor(for to check the vicinity of nearby vehicle). It make use of ARM LPC 2148 which has inbuilt SD card mount provision. Here, each sensor already been specified by its threshold limit. When threshold limit of each sensor crosses, then its value is displayed on LCD mounted to ARM and act as warning system to driver[10].

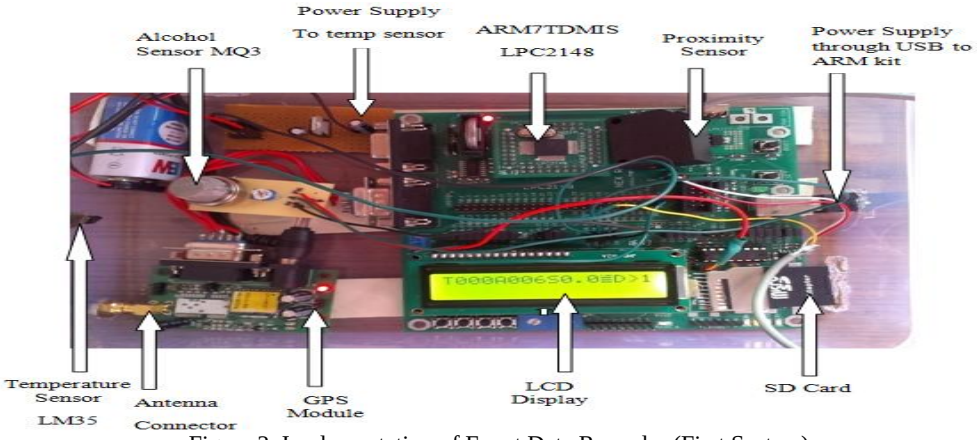

Figure 2. Implementation of Event Data Recorder (First System)

Figure 3. Shows the Second system. In this complete hardware implementation of Event Data Recorder connected with GPS as well as GSM module and sensors like Accelerometer (for to calculate vehicle speed), Gyro Sensor (to calculate slip angle), seat belt arrangement (to check the status of driver's seat belt position), Object Sensor (to check for incoming object). Here GSM module is used on both at transmitter & receiver end. Transmitter end also consist of keypad unit from which authorize person can insert mobile number of police data person. So that directly all data from various sensors will reflect on data base. Here CAN module is used for pre-processing purpose to avoid overloading of ARM processor[2][5].

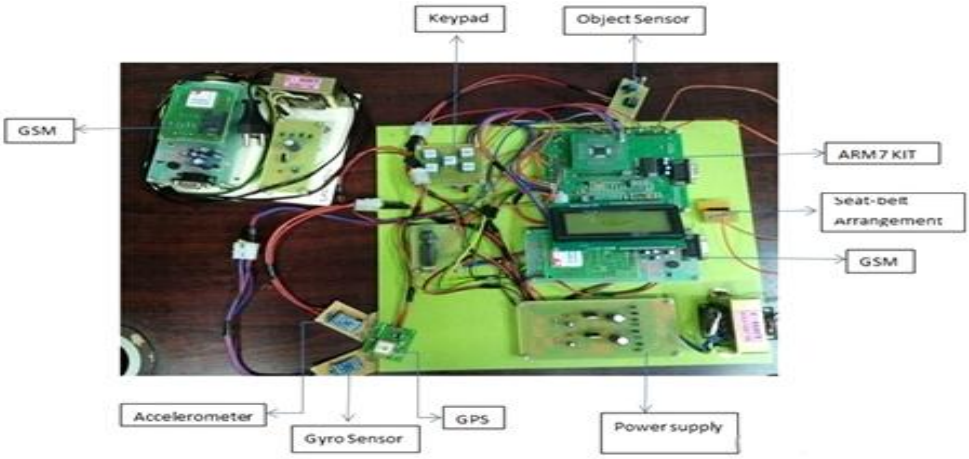

Figure 3. Implementation of Event Data Recorder (Second System)

Figure 4. Shows the Third system. In this complete hardware implementation of Event Data Recorder connected with GPS module (for exact position of vehicle) and sensors like Temperature Sensor (engine

temperature), Accelerometer (for to check the vicinity of nearby vehicle). It makes use of ARM LPC 2148. Here Temperature & Accelerometer sensor are designed. Whenever the sensor crosses the limit set during programming, it displays the message on LCD & stores the same in SD card.

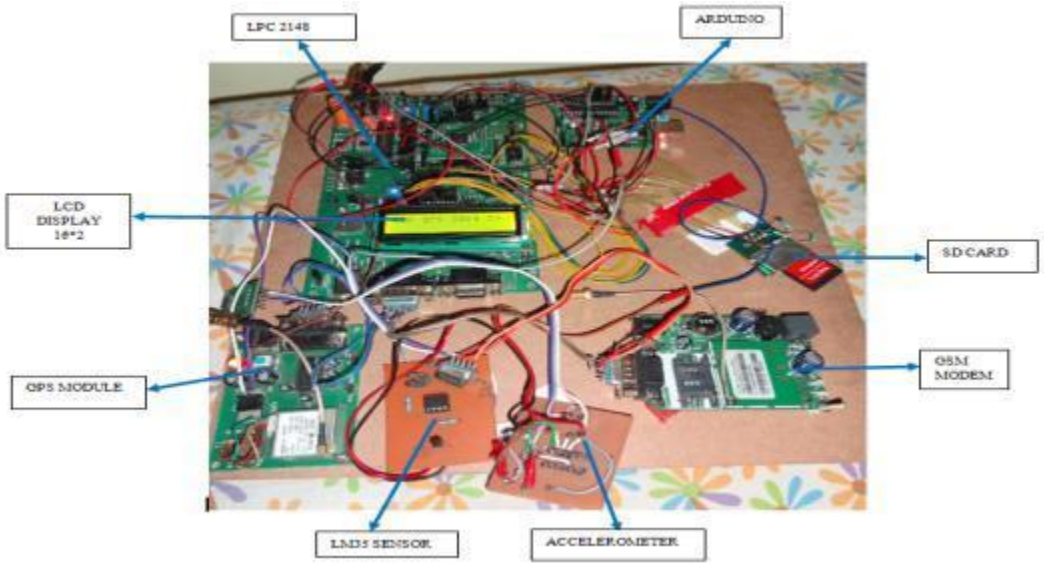

Figure 4. Implementation of Event Data Recorder (Third System)

ARM based LPC2148

The ARM7TDMI is a primary member of the ARM microcontroller family which is general-purpose 32-bit microprocessors. The ARM7 provides high performance in very low or negligible power consumption also having a small size. The ARM architecture is primarily based on the RISC principle The LPC2148 microcontrollers which are based on a 32bit or 16bit ARM7TDMI-S CPU with the real-time simulation and embedded trace support. This combines the microcontrollers with the high speed flash memory ranging from 32 kB to 512 kB embedded in the system. LPC2141/2/4/6/8 are best suitable for applications where small size i.e. Miniaturization is the important requirement.Figure 5. Shows the block diagram of ARM LPC 2148.

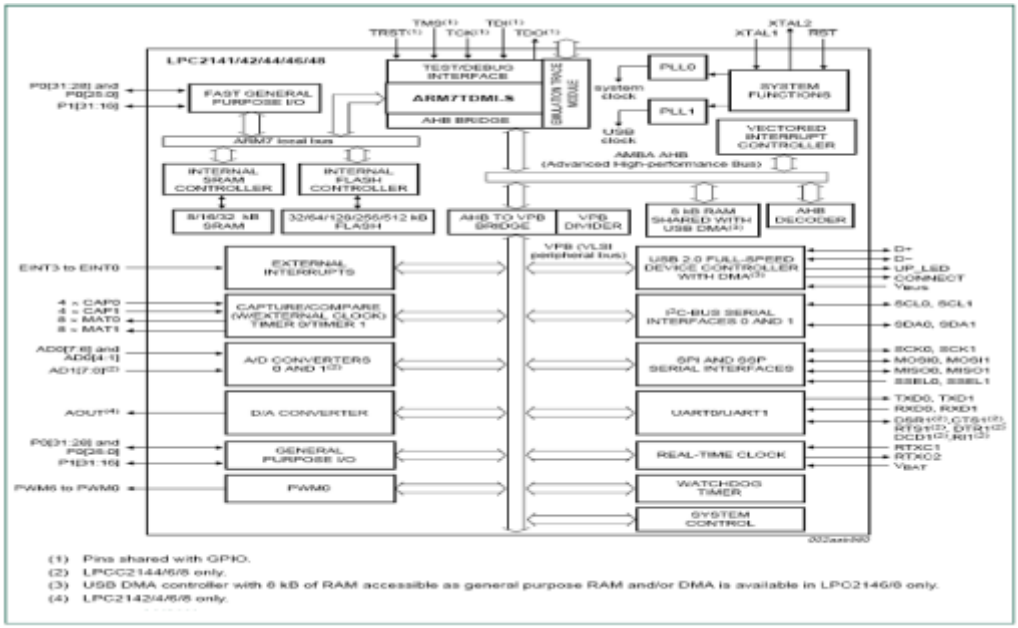

Figure 5. Block diagram of LPC 2148

System Flow Chart

System flow is shown in figure 6. Here at the start, sensors are initialized and parameters are sensed. Sensors are connected via CAN bus to avail the advantages of CAN protocol. Now sensors sense parameters from various parts of the system. ARM is programmed to check for extreme conditions of sensors. If limit exceeds

then send the data through CAN module to storage card. Also this data is send via GSM mode to police or authorized person (predefined). If value of sensors is under limit then it goes to sensing mode. System Stops when Vehicle with EDR stops.

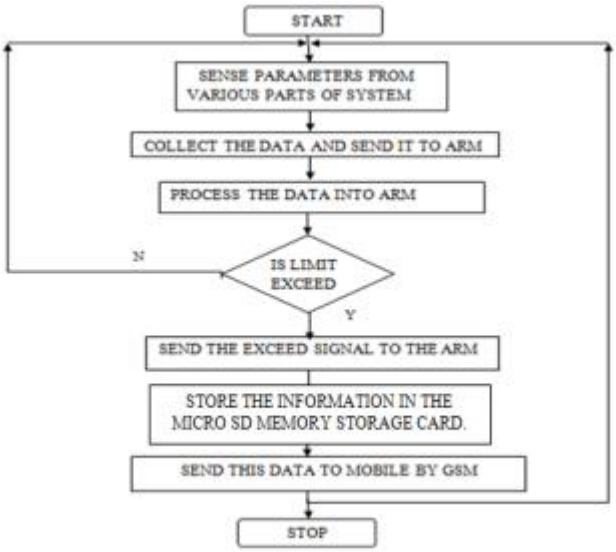

Figure 6. Flow chart of System

CAN Module

CAN Module is an integrated circuit which is stand alone controller microchip technology's device important in implementation of the CAN specification. As shown in Figure 7, this controller can efficiently transmit and receive the standard and extended data frames. CAN Module mainly includes the CAN protocol engine, buffers, filters, masks for transmission and reception of the data efficiently[7]. The CAN module handles all the functions for the CAN bus aiming of reception and transmission of the data. Data or Messages are transmitted by first loading the suitable and appropriate message buffer and control registers. The CAN controller is a control logic used to configure the device and the device operation by interfacing to the other device blocks to pass the information and control. Interrupt pins are used to provided the greater system workability. One multi-purpose interrupt pin is present for each of the receive registers which can be used to replicate a valid message which has been received and has to be loaded in one of the receive buffers[8].

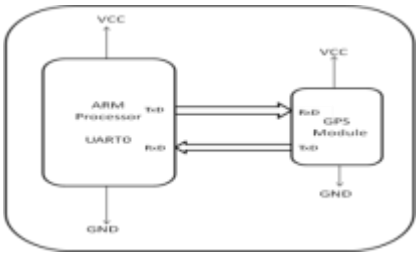

Figure 7. Interfacing of CAN module with ARM7

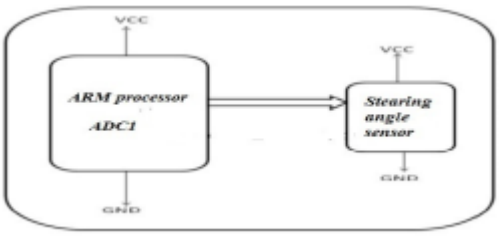

Figure 8. Interfacing of Gyro Sensor with ARM7

Gyro Sensor

The steering angle sensor (SAS) is another important sensor of the system that measures the rate of turn of the steering and steering wheel position angle. The Steering Angle Sensor is placed in a sensor cluster present in the steering column as shown in figure 8.

Accelerometer

An accelerometer is a device that measures the acceleration or vibration of motion of a vehicle. An accelerometer is an electromechanical device which measures acceleration forces. These forces may be dynamic which are caused by moving or vibrating vehicle or static, like the constant force of gravity pulling. Here, gyro sensor also provides the accelerometer information. As shown in figure 8.

UART (Universal Asynchronous Receiver Transmitter)

UART consists of 16 byte Transmit and Receive FIFO's. It also has built in components for baud rate generation. UART0 Register locations are considered and confirmed by the 550 industries. LPC2148 consists of two UARTs which are UART0 and UART1.RS-232 is mainly considered as the UART0.TXD pin of UART0 chip is in connection with the 8th pin of port0 is TDX1 of the processor. While its RXD pin is in connection with the 9th pin of port0.

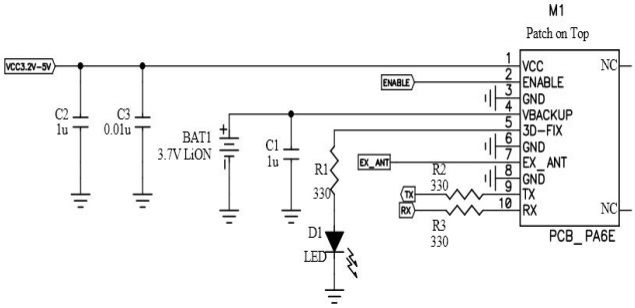

Figure 9. UART interface with ARM

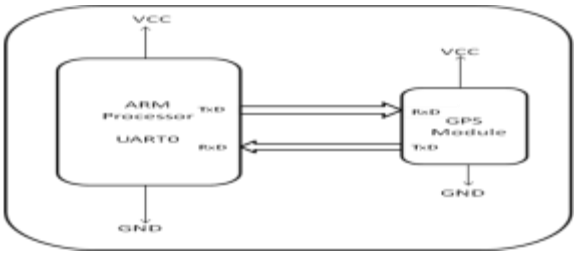

Figure 10. Interfacing of GPS with ARM UART0

Next is execution of the most important step of the system. It consists analysis and retrieval of whatever data collected by the sensors and stored in EDR (Event Data Recorder). This retrieved information can be used in different cases like crash analysis report, Police Investigation purpose, driver training purpose, Insurance department etc. As these sensors collect data before, during and after accident, crash analysis becomes much easy. This saves time and money of police department required for investigation.

This system implements continuously recording based EDR. This may need large amount of memory to store data. But, by generation of log files this problem is solved. Then also we are using micro SD memory card of largest storage capacity to store this data. Data retrieval and analysis of recorded data is done through GUI which is prepared from Microsoft Visual Basic .Net (VB .NET). All information collected by sensors is shown by this GUI. This EDR system works at three interdependent levels.

Data Collection Level: At this level, data from different sensors are collected and stored in SD card. For this ARM processor is interfaced with al sensors.

Data Processing Level: This is the main level where data from SD card is retrieved and processed. Various information required for post crash analysis is obtained here.

Human interference window: At this stage all processed data is made available for manual analysis. A separate GUI is constructed for this.

Results:

System 1:

Here results of three systems shown above are depicted.

Warning from Alcohol detection Sensor

Figure 11. Message by alcohol detection sensor on LCD

Warning: Alcohol detected for examining person, Alcohol content is: 058

Maintaining proper distance DRIVE SLOW, Distance > 1 Ft

Speed and location determination by GPS

Latitude: 2106.7314

Longitude: 07903.2125

Figure 12. Message from Temperature detection sensor

Warning: temperature exceeded threshold value, Temp is: 139

Maintaining proper distance DRIVE SLOW, Distance > 1 Ft

Alcohol content: 012

Speed and location determination by GPS
Latitude: 2106.7279
Longitude: 07903.2106

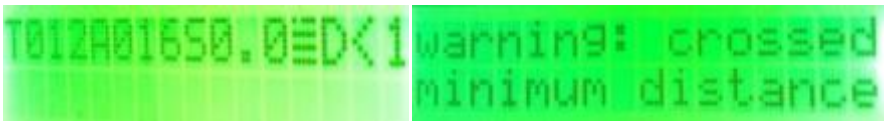

Figure 13. Message for distance

Warning: Crossed minimum distance DRIVE SLOW, Distance < 1 Ft
Alcohol content: 012
Temperature is: 016
Speed and location determination by GPS
Latitude: 2106.7283
Longitude: 07903.2116
Like this, whichever sensor crosses it's extreme condition, warning message is displayed with the cause. By this, message including warning and values of all sensors is stored in SD card.

System 2:

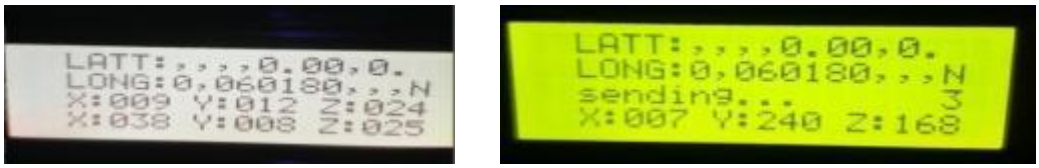

Figure 14. Message displayed on LCD

This system sends a message as soon as any of the sensors crosses its extreme value. This message is sent to mobile number which we had already entered.

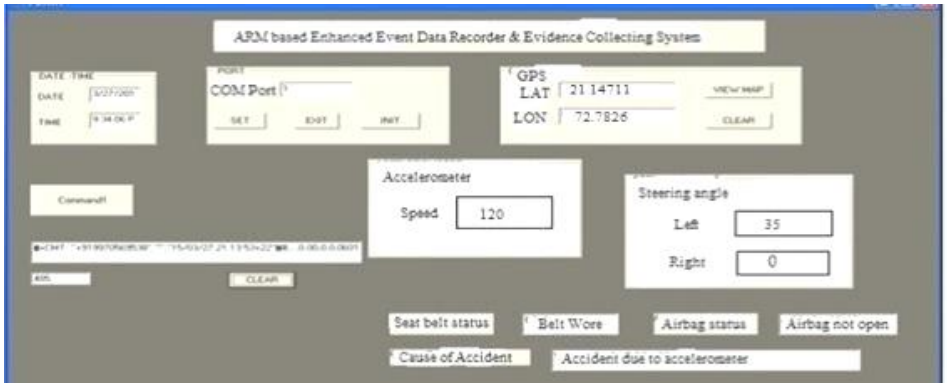

Figure 15. GUI displaying extreme condition of accelerometer

When accelerometer exceeds its threshold value, system will send a message shown in figure 15 mentioning cause of accident as accelerometer.

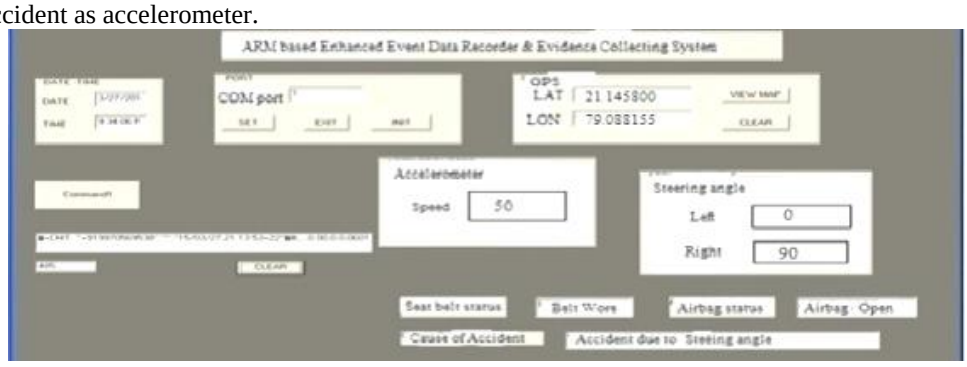

Figure 16. Output on webpage at extreme condition of steering angle

If accident causes due to extreme conditions of steering wheel, GUI with Figure 16 message will appear.
Figure 17. shows snapshot of the data stored in micro SD card. In SD Card, data is stored in log. file (.txt) file generally. For each date one log file is created. Event occurred during a day are appended one after another.

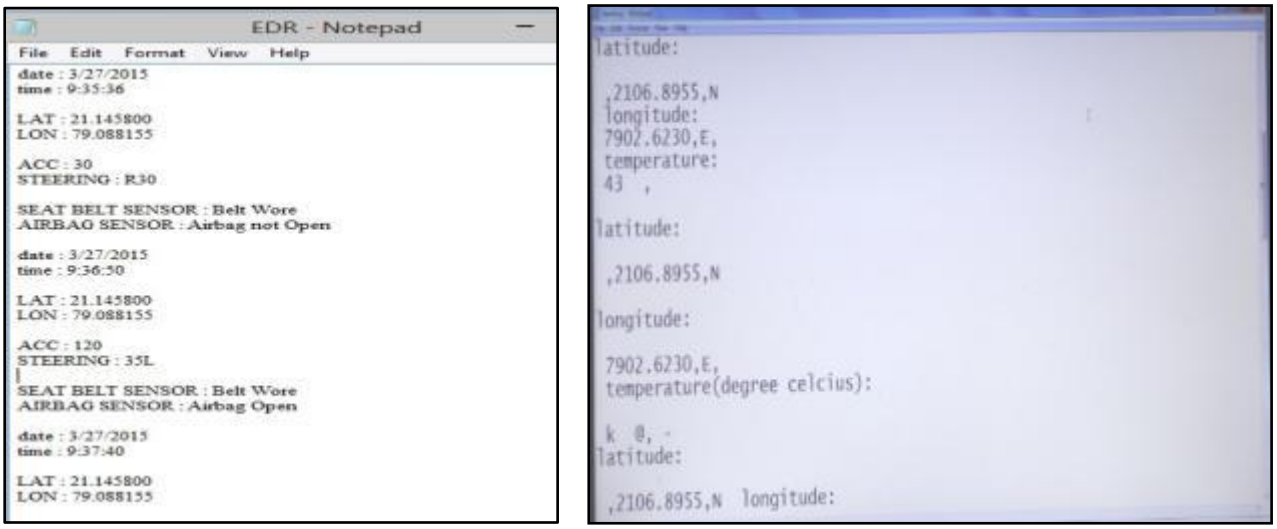

Figure 17. Data stored in memory card

Software Description

A] Keil µVision 4:

The system software is applied in C language using the Keil µvision along with flash magic. The C programming language is one of the most popular programming language for programming in the embedded systems. Objective which has to be completed should be described by the system. . Many free C compilers are offered for a wide change of development in programming. C language use increases transferability of the data as the C language code can be compiled easily for the varying types of processors.

B] Visual Basic:

VISUAL BASIC also known as VB is a high level programming language. It is evolved from the earlier programming language in the DOS version called as the BASIC. BASIC is the abbreviation for Beginner's All-purpose Symbolic Instruction Code. The Visual Basic programming codes resembles the English language. Different software companies generate the different versions of BASIC like Microsoft GWBASIC, QBASIC, QUICKBASIC, IBM BASICA and many more. It is easy programming language to learn and for anybody interested in programming but have a less knowledge of professional training in software engineering.

Conclusion/Future Work

This paper deals with the implementation of advanced Event Data Recorder for fault protection in vehicle to get data recorded and get alert message on LCD screen. Also this paper aims to provide the actual cause of the accident or crash of the vehicle by retrieving the data from the EDR. In this paper the detection of critical as well as the extreme conditions like recording, continuously sensing the various parameters' data such as speed, temperature, wheel rotations etc. are recorded.

The system is also combination of the GSM, GPS technology and other sensors to monitor the number of vehicles such as moving objects like motorcycles, cars, personnel, boats etc. management services as well as alarm monitoring for regulatory authorities. It also enables the authority to analyze the data after the occurrence of extreme condition. This will help the vehicle companies also to improvise the new parameters if there is any lag about it.

References

[1]. Kangsuk Chae, Daihoon Kim, Jaeduck Choi and Souhwan Jung, "Evidence Collecting System from Car Black Boxes," 7th IEEE Consumer Communication & Networking Conference (CCNC), 2010

[2]. S. Jankovic, D.Kleut, J. Blagojevic, V.Petrovic & V.Sinik, "Controller Area Network Based Monitoring of Vehicle's Mechatronics System ", IEEE 9th International Symposium on Intelligent Systems and Informatics (SISY 2011) , September 8-10, 2011, Subotica, Serbia.

[3]. Chulhwa Hong, Kangsuk Chae, and Souhwan Jung, "Evidence Collection from Car Black Boxes using Smartphones" , The 8th Annual IEEE Consumer Communications and Networking Conference – Demos,2011.

[4]. Hitoshi Arakawa, Toyohiro Hayashi, Masashi Ishikawa and Eitaku Nobuyama, "Development of Event Data Recorder for Pedestrians for Analysis of Traffic Accidents ", Fifth International Conference on Sensing Technology,2011.

[5]. Kent How Teh, Wei Lun Ng and Nor Kamariah Noordin, "Home Appliances Management System using Controller Area Network (CAN)",17th Asia-Pacific Conference on Communications (APCC, Sutera Harbour Resort, Kota Kinabalu, Sabah, Malaysia, 2011.

[6]. A. B. M. Rezbaul Islam, Surafel Teshome, Se Jin Kwon, Tae-Sun Chung, Shin-Kyung Lee, Jeong-Woo Lee, and Oh-Cheon Kwon, "Efficient Black-Box Maintenance Scheduler and Rescue System", the 2nd International Conference on Next Generation Information Technology (ICNIT), 2011

[7]. Ricardo Pinto, Jose Rufino & Carlos Almeida, "High Availability in Controller Area Networks", EUROCON-International Conference on Computer as a Tool, 2011

[8]. J. E. Pacheco, E. Lopez, "Monitoring driving habits through an automotive CAN network", Universidad de las Américas Puebla, Mexico in 2013 IEEE International Conference on Electronics, Communications & Computing, Cholula, pp 138-143, 11-13 March 2013.

[9]. Aruna Kommu & Raghavendra Rao. Kanchi , "ARM based Temperature Measurement and Processing to Remote Computer using Fiber Optic Cable", Department of Physics, Sri Krishnadevaraya University, Anantapur, A.P., INDIA , International conference on Communication and Signal Processing, April 3-5, 2013, India

[10]. Saurabh S. Chakole, Prof. Vivek R. Kapur & Prof. Y. A. Suryawanshi, "ARM Hardware Platform for Vehicular Monitoring and Tracking", Dept. of Electronics Engineering Y.C.C.E. (An Autonomous Institution) Nagpur, India in 2013 IEEE International Conference on Communication Systems & Network Technologies, Gwalior, pp 757-761, 6-8 April 2013