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ARM7 Processor based Event Data Recorder using CAN For Vehicular Systems

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Abstract— In the recent decades the vehicular systems i.e. various automobiles became the constitutive part of our daily life. As the number of vehicles has grown tremendously, the world has completely reliant on the vehicles for the transportation purpose. But this rise in the number of the vehicles also results in the some serious issues like heavy traffic, improper driving habits, vehicle condition instability etc. Sometimes this leads to the fatal crashes and accidents causing the large amount casualties. This may not only include loss of life but also the major financial losses. These mishaps can't be eradicated but can be reduced to a greater extent using the Event Data Recorder (EDR) technology. The EDR technology for the ground vehicles is adopted from concept of "Black-Box" in the aviation field where the complete plane data like flight attendant voice, engine conditions, positions etc. are stored in the black-box non volatile memory storage system. The EDR not only records the data comprehensively and accurately in real time but can efficiently reconstruct it, if necessary. Thus, there is the necessity of the controller based high performance EDR. The need of safety demands the smart systems which are able to sense the various data related to the vehicular systems. These data can be vehicular health parameters, driver health parameters or the vehicular environmental parameters. These parameters can't be stable and uniform throughout the travel. So to keep a track on these parameters certain electronic components i.e. sensors are used. In this paper we are describing the EDR with the Controller Area Technology (CAN) using the ARM7 processor for performance enhancement with the availability of the required data in the memory storage system.

Keywords— *ARM7; Controller Area Network (CAN);* Event Data Recorder; Vehicle data recording; Sensors; CAN controller MCP 2515

I. INTRODUCTION

The event data recorder is much useful technology for the vehicular safety to prevent any type of mishap on the time or in case of the mishap, collision the actual cause can be easily confirmed without much technological difficulties. An Event Data Recorder is a processing device installed in vehicles to record information related to vehicle conditions, crashes or accidents and collisions. In earlier days due to the non availability of the EDR technology in the vehicles many a times a victim is considered to be the offender and the actual cause remains undefined. In recent time the various ground vehicles like buses, trucks, and other transportation vehicles are equipped with the EDR. This Event Data Recorder (EDR) thus senses vital vehicular parameter information in every fixed stipulated time using the sensors which senses these conditions and respective parameters. This data is saved in the data memory card and can be accessed easily.

II. SYSTEM STRUCTURE

Event Data Recorder are generally equipped with the number of best of the sensing components which are activated or triggered immediately with the earlier possibility of the problem which will may be going to occur or abrupt changes in the conditions and characteristics like temperature, speed, break status and displacement of the vehicle from its path. These sensors are also capable of

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the electronically sensed problems determination. The vehicle monitoring and security system can also be added up with the EDR with enhancing and adding wireless based vehicle tracking system that is used for security applications can play a huge role along with event data recorder for the vehicle safety. But sometimes the technologies used for the EDR are complex which may fed up the some performance of the EDR system.

EDR is the essential part for the vehicle condition monitoring and some lag can cause a major problem during the vehicular movement. Using copper wires for the connection of the sensors with the defined processor or controller is the vastly used connection method in EDR. But the higher number of the sensors can prompt the delay in the data transfer from sensors to the processor and can also skip some data during transmission process due to the single channel characteristic of the metal wire. Sometimes this causes the error in the data mapping and processing with the higher data lengths and load. For this problem reduction CAN protocol enhanced CAN bus is much useful due to the single cable consists of multichannel characteristics of the Controller Area Network Bus or Cable. Using CAN bus reduces the data congestion in the channel up to the processor and also confirms the data authenticity.

The LPC2148 i.e. ARM7 processor is one of the best ARM processor with 32bit processing capability. The addition of the coprocessors is also the much important technological concept in the ARM7 for the processing ability enhancement, if required. As compared with the other processors and controllers like 8051, PIC, AVR where ARM7 uses 1 cycle for the execution of instruction while PIC, AVR, 8051 takes more than 1 cycles for the same.

2.1. Structure Representation

The structure of the system always depends upon the technologies and the electronic components used for the system. It is not always necessary to the system to be complex structured but replacing the complex structured design with the equally responsive and efficient design always increases the favors for that technology or structure. So it becomes much necessary for the system to be easy to construct and assemble with the same high performance throughout the working duration and active life which should be undoubtedly higher. The system should also be equipped with the understandable block diagram with the functioning flow chart of the respective system or technology. It helps in the getting clear view and idea about the system functioning even though without having the complete knowledge of the system design or the placement of the electronic components in the system structure.

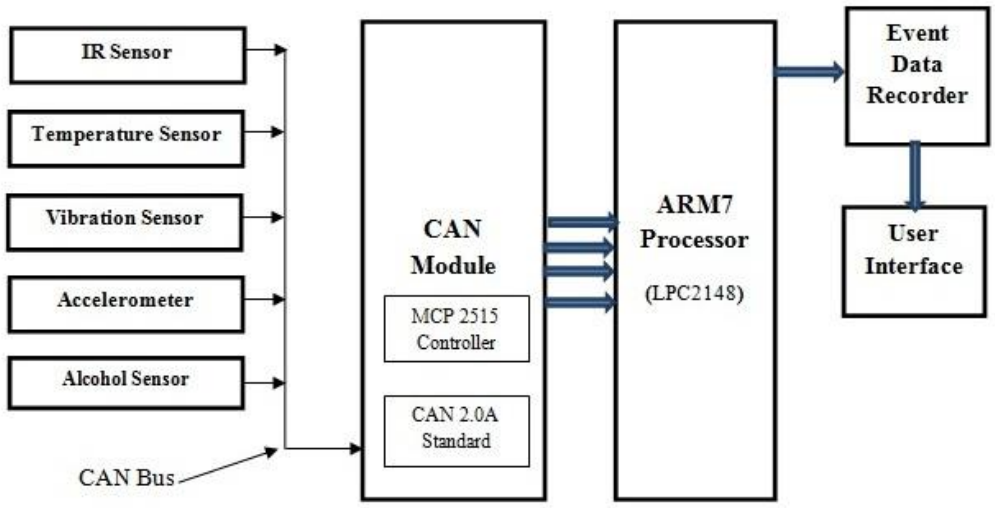

Figure 1. Block Diagram for the system.

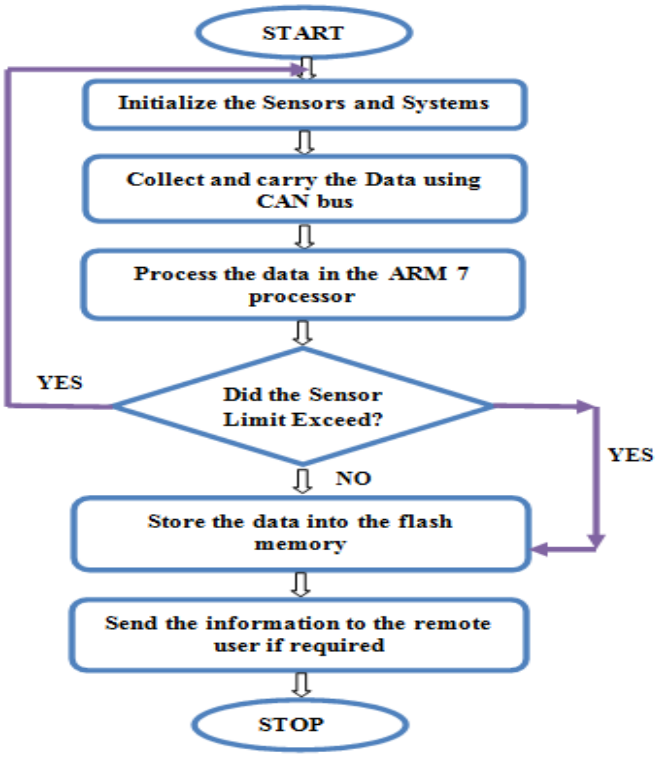

Figure 2. General flow chart of the system.

Above ***Figure 1.*** represents the block diagram of the mentioned EDR system with the block representation for the modules and components to be used. It is the best way to describe the system effectively to the one without knowledge of the technology but having enough information about the electronic components which are or going to be used. The system consists of the various electronic sensors like IR sensor, temperature sensor, vibration sensor, accelerometer, alcohol sensor. Various sensors can also be connected with the system depending on the sensor connection capability of the processor which will be used in our system ARM7. These sensors are connected with the CAN module which consists of the CAN bus and controller. The event data recorder block consists with the module with the data conversion in required format and storage system.
Figure 2. represents the functioning flow chart for the system describing the procedure of the system working step-by-step. It gives the clear idea for the inner functioning or conditions for the data flow in the system.

2.1.2. System Components

A. ARM7 Processor (LPC2148)

The ARM7TDMI (LPC2148), a primary member of the ARM microcontroller family related with general-purpose 32-bit microprocessors. ARM7 provides high performance with very low or negligible power consumption also having a small and compact size enabling establishment on any type of small board. The ARM7 architecture is primarily based on the RISC principle i.e. Reduced Instruction Set Computer (RISC) principles which use less instruction set for the programming as compared with the other processors or controllers working on Complex Instruction Set Computer (CISC) principle. The LPC2148 microcontrollers based on a 32bit or 16bit ARM7TDMI-S CPU with the real-time simulation and embedded trace support. ARM7 processor is Von Neumann structure where the instruction set and data set i.e. RAM shares the same memory space reducing any type of processing delay. As compared with many processors taking multiple cycles for instruction execution, ARM7 completes it in single cycle.

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B. Controller Area Network(CAN)

CAN is an integrated circuit and stand alone controller based microchip technology's device dominant in implementation of the CAN specification in the system. This controller can effectively and efficiently receive and transmit the extended and standard data frames. CAN Module used to implement the CAN specifications mainly includes the CAN protocol masks, engine, filters, buffers for transmission and reception of the data efficiently. Data are transmitted by initially loading the appropriate and suitable message buffer and control registers. CAN bus generally consists of Can high and CAN low buses with standards CAN 2.0A and CAN 2.0B used for the CAN implementation. CAN controller MCP 2515 is the integral part of the CAN system. CAN controller is capable of receiving the all serial bits up to the complete acceptance of the message which can be fetched at a single cycle by the corresponding processor. It uses the data link layer ISO11898-1 for data transmission.

The two CAN standards CAN 2.0A and 2.0B plays an important role in the data carrying capacity. In CAN 2.0A there are 11 identifiers while in CAN 2.0B has 29 identifiers. Identifiers define the number of message addresses supported by the system. In CAN 2.0A can carry 2048 i.e. 2^{11} message identifiers while CAN 2.0B provided for 537 million message identifiers which is 2^{29}. CAN controller is also used to interrupt or trigger the data flow from the sensors for certain conditions like after achieving the extreme level value switching off the system. The data transmitted and accepted by the CAN controller generally uses the Non-Return to Zero (NRZ) type.

C. Electronic Sensing Components (Sensors)

The electronic sensing components are the considered to be the important system attribute. These are also commonly known as the sensors. The sensors are to be used are explained follows

- Accelerometer:

An accelerometer is a device that measures the acceleration of motion of mobile vehicles. Being an electromechanical device it measures acceleration forces in the forward direction. These forces can be varying which can be of dynamic type which is caused by moving or vibrating or static vehicle. This sensor senses the acceleration for the vehicle in running time.

- Temperature Sensor:

The temperature sensor used to sense the current temperature of the vehicle engine. Many a times the constant rise in temperature also causes some vehicular mishaps. So it is also necessary to keep the constant records of the temperature varying with the various conditions, vehicular or environmental.

- Vehicular Vibration Sensor:

The vehicular shock sensor is much useful to detect the shock or the displacement of the vehicle from its path. The general range of the shock sensor is 2g to 200g. This sensor is used to measure the various triggered vibrations and shocks which may be due to small potholes or due to collision ranging from minor to extreme. The readings will be saved or displayed according to the intensity of the vibrations occurred at the certain time.

- IR Sensor:

IR sensor abbreviated for the Infrared sensor is commonly used for the detection of the obstacles in front of the vehicles. These obstacles can be of various sizes like any solid block or another in front vehicle may be mobile or stationary. Thus IR sensor senses the minimum declared range in feet, if the obstacle is within that range then positive voltage is generated.

- Alcohol Sensor:

A common factor of collisions or accidents is also due to the driver's negligence like driving a vehicle in swill of alcohol. Alcohol sensor senses the alcohol presence in the vehicle which assimilates in air with driver's breath. Thus keeping the record of the alcohol level while driving can be proved much useful for further investigations in certain cases. The output from this sensor is in the voltage form depending upon the alcohol percentage in the air of vehicle.

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III. RESULTS

The success of any system depends on the result produced by the system. The result of the system is in the format of the log file which is a text file where all the information is stored which are sensed by the various sensors over the period of the time. This information is stored in the above mentioned file in the non volatile data memory card interfaced at the end of the system for the user interface with the system to access the data.

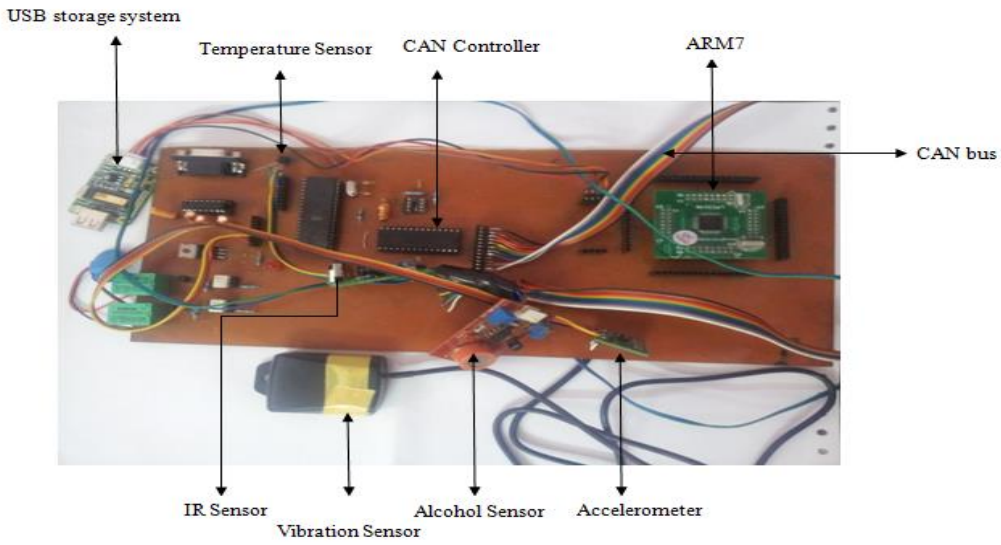

Figure 3. The hardware structure for the proposed system

Above ***Figure 3.*** represents the hardware structure for the system which acts as the working event data recorder to record the various parameters.

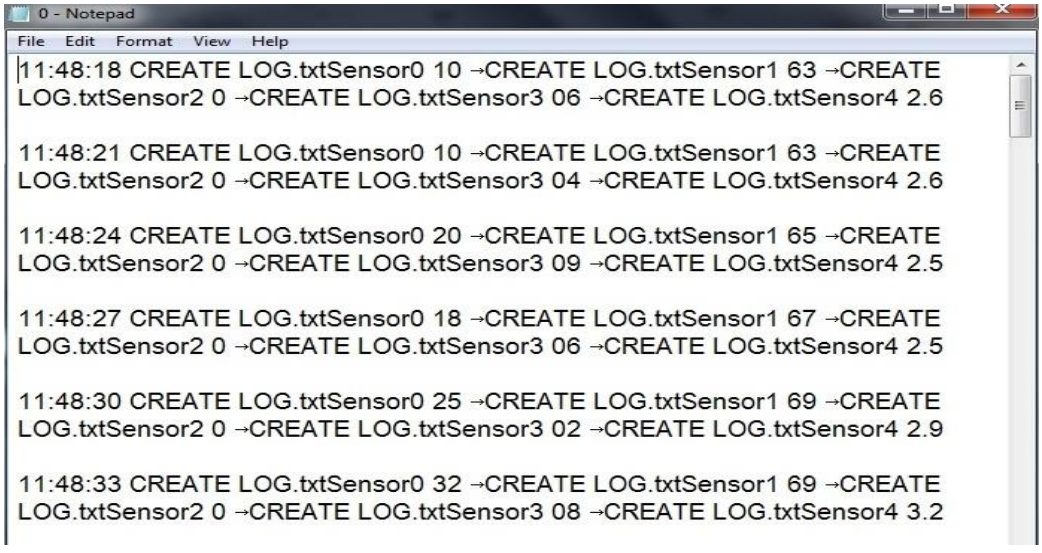

Figure 4. The log file format accessed from the system using data memory card

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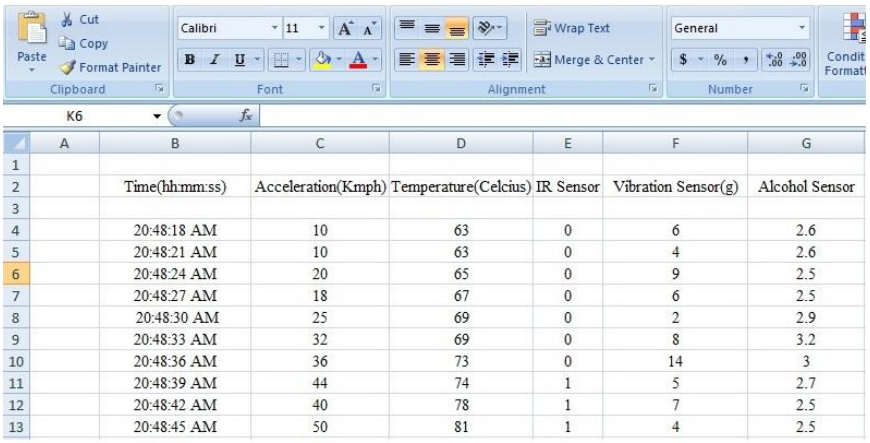

	A	B	C	D	E	F	G
1							
2		Time(hh:mm:ss)	Acceleration(Kmph)	Temperature(Celcius)	IR Sensor	Vibration Sensor(g)	Alcohol Sensor
3							
4		20:48:18 AM	10	63	0	6	2.6
5		20:48:21 AM	10	63	0	4	2.6
6		20:48:24 AM	20	65	0	9	2.5
7		20:48:27 AM	18	67	0	6	2.5
8		20:48:30 AM	25	69	0	2	2.9
9		20:48:33 AM	32	69	0	8	3.2
10		20:48:36 AM	36	73	0	14	3
11		20:48:39 AM	44	74	1	5	2.7
12		20:48:42 AM	40	78	1	7	2.5
13		20:48:45 AM	50	81	1	4	2.5

Table 1. Data arranged in the tabular form for parametric comparisons.

Above ***Figure 4.*** represents the result of the system in the text format accessed from the system where the output of the various sensors is noted time by time and saved in the storage device. This data can be used for the future use of analysis or for the data handling for system performance enhancements. ***Table 1.*** represents the data in the list form for the discrete comparison of the various parameters by importing the original data file.

IV. CONCLUSION

"ARM7 processor based Event Data Recorder using CAN for vehicular Systems" paper deals with the implementation of advanced Event Data Recorder for fault protection in vehicles and collection of the vehicular parameters. This paper aims to provide the data collection time by time which can be useful for the next level data analysis to get the actual cause of the accident or getting the discrete parameter at the required stipulated time. In this paper the detection of critical as well as the extreme conditions like data such as speed, temperature, alcohol level, vibration, proximity etc. are recorded.

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