Implementation of CAN protocol for alerting of vehicle accident using GSM and GPS

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Abstract— According to records obtained by study conducted by world health organization, lots of the human lives are being lost every year due to vehicular accidents. Many campaigns are being conducted for causing awareness in the public about the frequent disasters occurring due to over speed vehicular movement on the road, but yet the number of injuries and loss of lives are increasing day by day. In order to overcome this situation, a wireless monitoring system along with accelerometer and GPS tracking system with CAN protocol is developed. At the occurrence of the accident, the wireless device will send information in the form of message to predefined phone numbers for immediate medical help. The exact location of the vehicle is traced using GPS tracking system and Google Earth.

Keywords—MEMS (Micro electromechanical sensor), GSM (Global system for mobile), GPS (Global positioning system), LCD (Liquid crystal display), CAN(Controller area network), SPI(Serial peripheral interphase), SMS (Short message service).

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INTRODUCTION

Now-a-days lots of accident occur on highways due to increasing traffic and rash driving of the vehicle. The accident may be driving the vehicle with insufficient sleep, driving with alcohol intake. In order to decrease the number of vehicular accident many campaigns are being conducted to create public awareness regarding safety measures that are to be kept in mind during driving. In many situations the immediate medical assistance to the victim by healthcare service cannot be provided due to not getting information about the accident in time**..**This project provides method for detection of the vehicle using GPS and GSM modem along with CAN bus to avoid such incidents.

This paper presents the enhancement and application of driving system for the vehicle to detect the vehicle in case of any accident. An ARM based data acquiring system works without any wire connection. The information about the accident is sent in the form of message using GSM and information can be displayed using LCD installed in the system. The communication method employed in this embedded networking is done by CAN protocol. Additional data for example speed, threshold value of the vehicle can also be extracted. The arrangement consists of GPS tracking system which is used to detect the exact location of the vehicle.

SYSTEM OVERVIEW

Here the system consists of supportive devices such as ARM cortex microcontroller, MEMS accelerometer device , GSM device, and GPS tracking system at the transmitter side**.** The receiver constitutes web server and mobile phones. MEMS is an Micro electro mechanical sensor, which consists of highly sensitive sensor devices used for detecting the inclination of the vehicle in front portion, rear portion, left as well as right directions. Rash driving of the vehicle can be detected with an accelerometer.

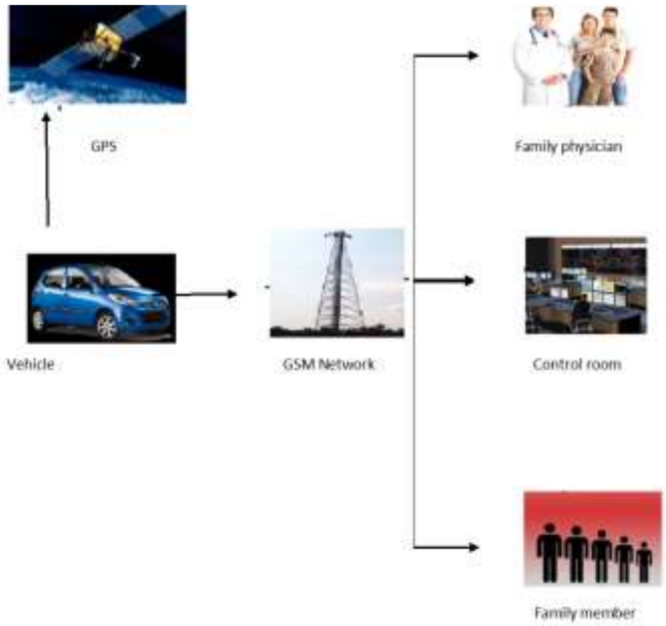

Figure 1: System overview

It can also be used for recording the speed of the vehicle at the time before and after the crash. ARM Cortex-M3 are microcontrollers that are used for applications developed for embedded environment has high level of integration and low power consumption features. ARM used is a 32 bit microcontroller that can store and process real-time signals from accelerometer. The GPS tracking system provides some of the parameters such as longitude, latitude, speed. Upon occurrence of the accident, the information is sent in the form of message to control room or a rescue team or family person by using GSM for immediate medical help for the injured. At the receiver the web server maintains the database that consists of time, speed, longitude, latitude that are provided wirelessly by GSM.

DESCRIPTION OF CAN

In this paper implementation of CAN communication transmission system in vehicles is being done. The system is capable of sensing obstacles and has speed sensor. The data will be transmitted over CAN bus and will be displayed on LCD. Controller Area Network (CAN) is a serial data communications bus developed by Robert Bosch GmbH in mid-eighties for the German car industry. The CAN protocol is an ISO standard (ISO 11898) for serial data communication. The protocol was developed mainly for automotive applications. CAN has also been found its usage in industrial automation as well as in automotives and mobile machines. The CAN protocol implementation is done using silicon. This makes it likely to combine the error handling and fault confinement feature of CAN with a high transmission speed. The method used for allocating messages to the suitable receivers contributes for making use of the available bandwidth. This requires a simple transmission medium such as a twisted pair of wires.

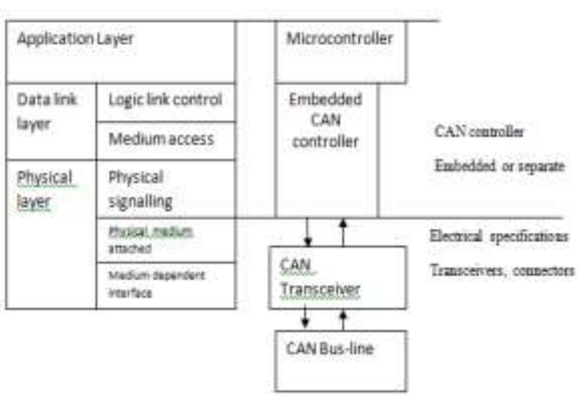

Figure2: Standard layer ISO 11898 architecture

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The CAN is a serial communication bus protocol defined in International Standards Organization (ISO). A serial communication bus fundamental use is in data transfer form one point to another point in duplex mode. It was developed as an alternative of complex wiring with two-wire bus for the automotive industry. CAN decreases the electrical interference and noise interference to the signal in the network. CAN introduce an error detection and correction mechanism in the network which is very effective.

CAN bus node:

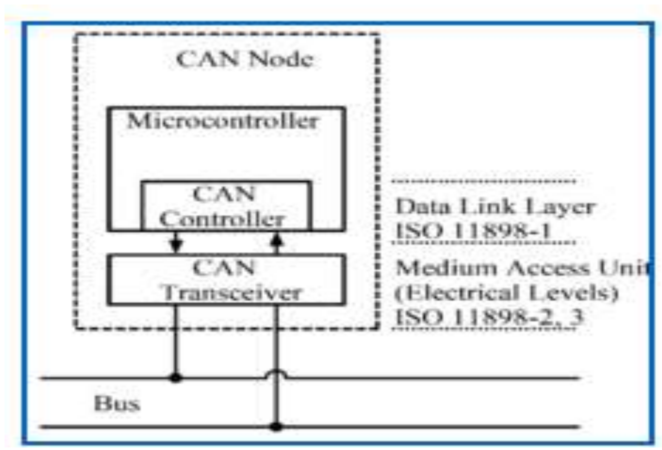

Figure 3: CAN bus node

Central processing unit or host processor consists of the host processor which analyses the meaning of the received messages and what messages is to be transmitted. Sensors, actuators and control devices can be connected to the host processor**.** CAN controller is the vital element of the microcontroller At the receiver the CAN controller stores the received serial bits from the bus until an entire message is available. At the transmitter the host processor sends the transmit message to the CAN controller, which transmits the bits when the bus is free serially onto the bus. Transceiver is defined by ISO 11898-2/3 Medium Access Unit [MAU] standards. At the receiver the conversion from data stream of CAN bus levels to levels that the CAN controller uses is done. Generally it consists of a protective circuitry to protect the CAN controller. At the transmitter, it converts the data stream from the CAN controller to CAN bus levels.

Frame format:

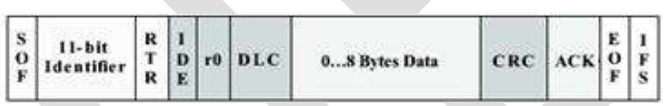

Figure 4: Standard CAN 11 bit identifier

- SOF–It is single dominant start of frame (SOF) bit Message in CAN starts with SOF.
- Identifier-The Standard CAN 11-bit identifier. The priority of the messages can be established using identifier.
- RTR–Remote Transmission Request (RTR)
- IDE–A dominant single identifier extension (IDE) bit. If this bit is enabled it means that a standard CAN identifier is being transmitted without any extension
- r0–Reserved bit
- DLC–The 4-bit data length code (DLC). It consists of number of bytes of data which are supposed to be transmitted.
- Data–Up to 64 bits of application data may be transmitted.
- CRC–The 16-bit (15 bits plus delimiter) cyclic redundancy checks (CRC). It contains the checksum of message
- ACK = Acknowledge bit
- EOF– End-of-frame (EOF) Bit ,
- IFS–This 7-bit interframe space (IFS)

Extended CAN

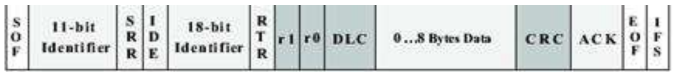

Figure 5: Extended CAN 29 bit identifier

The Extended CAN message is the same as the Standard message with the addition of:

- SRR–Substitute Remote Request (SRR) bit. It replaces the RTR bit in the standard message
- IDE–A recessive bit in the identifier extension (IDE). It indicates that more identifier bits follow. The 18-bit extension follows IDE.
- r1–Following the RTR and r0 bits, an additional reserve bit has been included ahead of the DLC bit.

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When the CAN transmits the data, addressing of the stations is not done instead the content of the message will be designated by the identifier. The identifier which is unique throughout the network defines the content along with the priority of the message. This is essential for allocation of the bus when several stations are competing for bus access.

If the CPU of a station requires to send a message to other station it transfers the data to be transmitted to their respective identifiers which is already assigned to the CAN chip. The message thus received is constructed and transmitted by CAN chip. As the bus allocation is done to the CAN chip the data is transmitted to all other stations on the CAN network. After receiving the message by the receiving station an acceptance test is done to check for if the message received is correct or not. If the received information is right than the station does the suitable process otherwise ignores.

CAN broadcast multiple messages in a single instance of time. The USB and Ethernet protocols utilize blocks of data to transfer form one node to another node due to which rate of data transfer is less compared to CAN which does not utilize block of data but attain high signalling rate. In a CAN network, many short messages such as temperature can be broadcasted to the entire network. This provides data consistency and accuracy to each node of the system.

DESIGN IMPLEMENATION

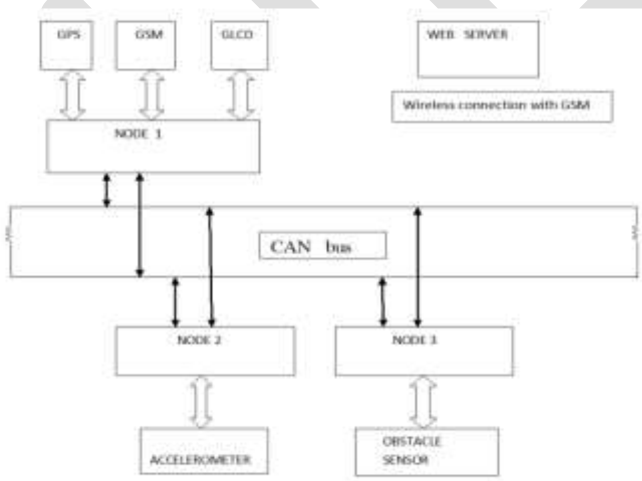

Figure 6: CAN bus system for transmitter section.

The organization contains a master node and two slave nodes. Each node consists of an ARM Cortex M3 LPC1768 processor. The node 1 acts as the main node consisting of GPS, GSM and graphical LCD connected. Node 2 contains MEMS three dimensional accelerometer ADXL362 that measure physical acceleration experienced by an object connected. The interfacing of the MEMS accelerometer to ARM processor is done using SPI. SPI is an serial peripheral interface which is an interface bus frequently used to send data between microcontrollers and small peripherals such as sensors, shift registers. It uses separated clock and data lines along with select line to choose the device. Node 3 consists of ultrasonic obstacle sensor that emits an ultrasonic wave in one direction and would return immediately when it encountered obstacles on the way. The communication technique employed between the nodes is done using **C**AN bus controller. Polysilicon springs suspend the MEMS structure above the substrate such that the body of the sensor can move in the X , Y, and Z axes. Acceleration causes deflection of the proof mass from its centre position. The sensing method has the ability of sensing both dynamic acceleration such as shock or vibration and static acceleration such as inclination or gravity. At any instant of time if there is any static or dynamic changes in the accelerometer detected it is measured. If the measured value is above the threshold value then the signal is send to the main node1. Where at the main node the GSM sends alert message to the predefined numbers and web server. Similarly, whenever the ultrasonic sensor detects the obstacle e within 3 m range it sends signal to the main node. At the main node the graphical LCD displays the message obstacle. The main node transmits the alert message through GSM to the predefined numbers and sends message to the web server instantaneously. The longitude and latitude information is obtained by GPS device. The web server can locate the position of the vehicle by the longitude and latitude data provided by GPS through GMS and by Google Earth application we can get the location of the vehicle.

FLOW OF OPERATION

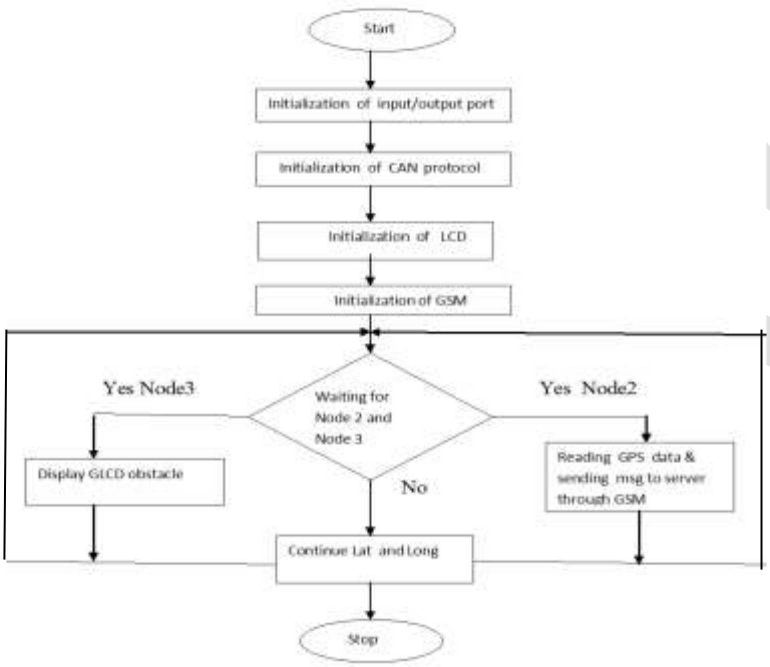

Figure 7: Flowchart for working of main node

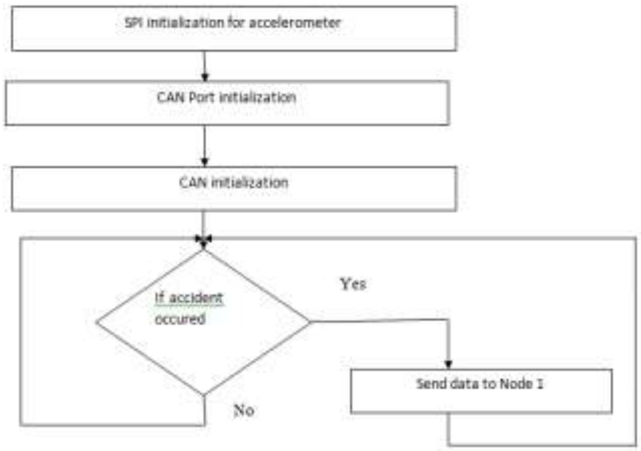

Figure 8: Flowchart of working of Node2(MEMS accelerometer)

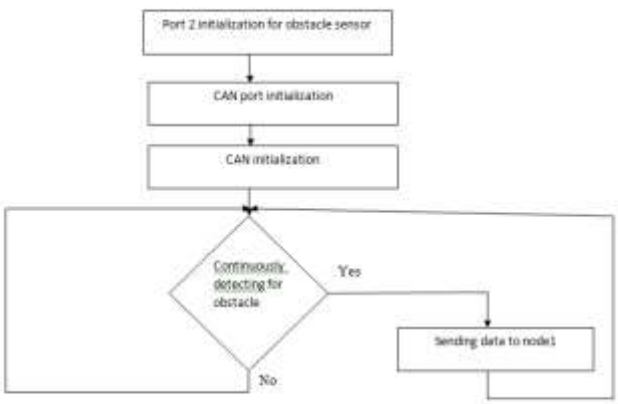

Figure 9: Flowchart of working of Node 3(ultrasonic sensor)

The above flow chart is converted in to embedded C program using µVision IDE from Keil and flash magic tools. The uvision IDE from Keil consists of project management, making use of the facilities, editing the source code, debugging of the program, and complete simulation in a strong setting. The µVision development platform is user friendly and helps to create embedded programs that works earliest. Flash magic is the tool used to program hex code in EEPROM of microcontroller**.** The microcontroller such as Philips and NXP are only supported. It can burn a hex code into those controllers which supports ISP (in system programming) .

EXPERIMENTAL RESULT AND ANALYSIS

Figure 10: Obstacle detected by ultrasonic sensor

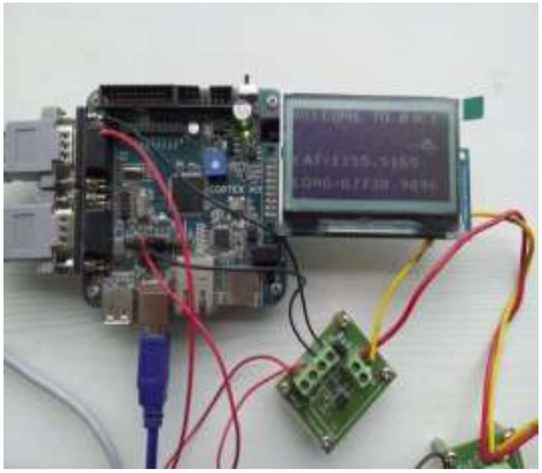

Figure 11: Longitude and latitude data provided by GPS and displayed GLCD

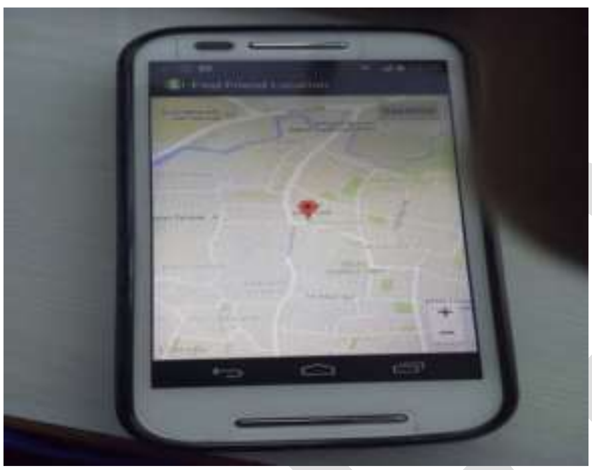

Figure 12: Location identified by predefined number by using message details sent by GSM

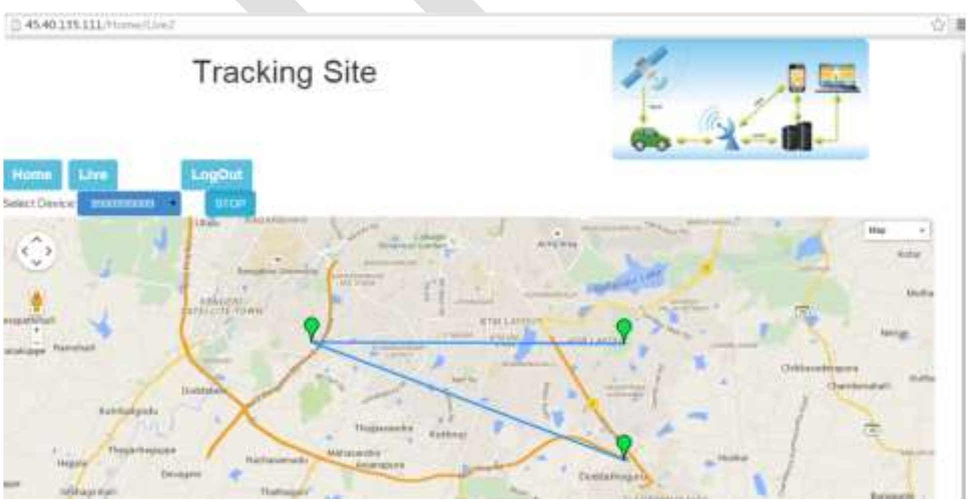

Figure 13: Web server displaying the location using GSM details

The experiments were done for the hardware testing of designed and implemented circuit The results of experiment for the designed circuit were obtained as above. Similarly, GPS module was tested and data transmitted from the GPS to the ARM Cortex M3 with the help of RS 232.ARM Cortex M3 received data serially on its RxD pin and display the same on LCD. At the same time the message was sent to the predefined mobile numbers.

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CONCLUSION

This project consists of embedded system with a combination of CAN bus which is an important criterion of recent technology. ARM cortex M3 is an embedded processor with high performance, low cost, high reliability features which can be used in modern automobile industry applications. The proposed high-speed CAN bus system solves the problem of automotive system applications with ARM as the main controller. The ARM along with CAN provides efficient data transfer applications. This project can be utilized for tracing the vehicle by transport companies and provides information in case of any delay may be due to breakdown or an accident.

REFERENCES:

[1] Benjamin C Kuo, M. Farid Golnaraghi, Automatic Control systems, Eight edition, John wiley & sons., Inc 2003.

[2] J. Fr¨oberg, K. Sandstr¨om, C. Norstr¨om, H. Hansson, J. Axelsson, and B. Villing. A comparative case study of distributed network architectures for different automotive applications. In *Handbook on Information Technology in Industrial Automation*. IEEE Press and CRC Press, 2004.

[3] D.Malan, T.R.F,Fulford-Jones, M.Welsh, S.Moulton, CodeBlue: an ad-hoc sensor network infrastructure for emergency medical care, in: proceedings of the Mobi-Sys 2004 workshop on application of Mobile.

[4] M. Lu, W. Chen, X. Shen, H.C. Lam and J. Liu, "Positioning and tracking construction vehicle in highly dense urban areas and building construction sites," Automation in construction, vol. 16, issue 5.pp.647-656, August 2007.

[5] Stephen Teang Soo Thong, Chua Tien Han and Tharek Abdul Rahman "Intelligent Fleet Management System with Concurrent GPS & GSM Real-Time Positioning Technology", IEEE ,Wireless Communication Centre (WCC), universiti Teknologi Malaysia (UTM), Malaysia in 2007.

[6] Wilfried Voss, A comprehensive guide to controller area network, Copperhill Media Corporation, 2005-2008.

[7] Dae Geun Lee, Se Myoung Jung , Myoung Seob Lim. "System on Chip design of Embedded Controller for Car Black Box". 2007 IEEE Intelligent Vehicles Symposium Istanbul, Turkey, June 13-15, 2007.

[8] Liewei Jiang and Chunxuan Yu. "Design and Implementation of Car Black Box Based on Embedded System". 2010 IEEE DOI 10.1109/iCECE.2010.860.

[9] Thuong Le-Tien, Vu Phung-The "Routing and Tracking System for Mobile Vehicles in Large Area", Fifth IEEE International Symposium on Electronic Design, Test & Applications Dept. of Electrical Electronics Engineering, HCM University of Technology, Vietnam in 2010.

[10] Chulhwa Hong, Truong Le, Kangsuk Chae, and Souhwan Jung. "Evidence Collection from Car Black Boxes using Smartphone's". 2011 IEEE, Annual IEEE Consumer Communications and Networking Conference.

[11] N.Watthanawisuth,T.LomasandA.Tuantranont, "Wireless Black Box Using MEMS Accelerometer and GPS Tracking for Accidental Monitoring of Vehicles", Proceedings of the IEEE-EMBS International Conference on Biomedical and Health Informatics (BHI 2012) Hong Kong and Shenzhen, China, 2-7 Jan 2012.

[12] T. Lomas, A. Tuantranont, "Wireless Black Box Using MEMS Accelerometer & GPS tracking for accidental monitoring of vehicles," Proceedings of the IEEE-EMBS International Conference on Biomedical & Health Informatics, 2-7 Jan 2012, Hong kong, China.

[13] Jing Yang, Student Member, IEEE, Edwin Hou, Senior Member, IEEE, and MengChu Zhou, Fellow, IEEE," Front Sensor and GPS-Based Lateral Control of Automated Vehicles", IEEE Transactions on Intelligent Transportation Systems, Vol. 14, No. 1, March 2013.

[14] http://www.can-cia.org

[15] Automobile Control System using Controller Area Network. International Journal of Computer Applications 67(18):34-38, April 2013