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An Intelligent Anti-theft Control System Using Gsm and Can Technology

Renjini R.* and J. Subhashini**

ABSTRACT

Background/Objectives— Advanced security systems are continuously developed to prevent automobile theft. This paper, deals with the design & implementation of an intelligent theft control system, which is being used to prevent/control the theft of a vehicle. The system proposed makes use of an embedded system which makes use of Global System for Mobile communication (GSM) technology along with CAN bus. *Findings*—The proposed system makes use of an android phone that is embedded in the vehicle and is interfaced to an Engine Control Module(ECM) through Control Area Network(CAN) Bus, which in turn, communicates to the ECM. The vehicle afraid to be stolen can be stopped by using GPS feature of mobile phone embedded, and the owner uses this information for future processing. The owner then sends the message to the mobile which is embedded in the vehicle which in turn controls the vehicle's engine by controlling the fuel injection to the engine & locking the working of the engine immediately. *Application/Improvements*—The proposed system accepts the message and is broadcasted to the Vehicle Control Network through CAN Bus. The locking and unlocking of the system is checked and verified through working of a fuel valve. Thus unlike the existing systems, this improved system not only tracks the lost vehicle, but also stops/controls further movement of vehicle.

Index Terms: Antitheft system, CAN protocol, Engine control module, GSM modem, GPS technology, Theft control module.

1. INTRODUCTION

Growing automobile industry is the direct measure of national economy. Cars became a part and parcel of vehicles for human transportation. However, due to the development of modern technology modern security system are continuously developed to prevent car theft, but crimes become smarter and the automobiles stolen events more frequent. Electronics antitheft security is the most widely used, further more reliable system has to be developed.

Hui song et al. developed a sensor network based anti-theft system using the parked location, it will send message to the security in case of unauthorized vehicle movement[1]. An automobile anti-theft system was was developed by Lili Wan et al based on short message services (SMS) over GSM network [2]. The idea of using passive RFID and CAN bus to provide security and key less entry was innovated by Guo Hongzhi et al[3].

A system that makes use of a mobile phone with an interfacing to Engine Control Module (ECM) through Control Area Network (CAN) Bus that is embedded in the vehicle is proposed by Manjunath.T.K, but with the drawbacks being, not providing streetwise address location for tracking[4]. The vulnerability of the system is that the speed of the vehicle and engine is no way controlled by the existing systems, thus providing only tracking.

* Department of Electronics and Communication Engineering, SRM UNIVERSITY, Kattankulathur, Chennai, India, *Email: renju.r.tvm@gmail.com*

** Department of Electronics and Communication Engineering, SRM UNIVERSITY, Kattankulathur, Chennai, India, *Email: subhashini.j@ktr.srmuniv.ac.in*

Ambade Shruti Dinkar designed the system which assumes very little processing and communication requirements of the sensor and pointing out current location of vehicle using GSM/GPS technology[5]. Huaqun Guo, Jun Jie Ang and Yongdong presents the details of building both hardware and software that interface and directly communicate with CAN network embedded in the automobile. A reliable route for messages is obtained by the extracted CAN messages from automobiles in order to reach its destination [6]. Thus, most of the works referred reduce the system just to a vehicle tracking system since the engine controlling part has been omitted.

2. DESIGN OF PROPOSED EMBEDDED SYSTEM

Anti-theft vehicular systems, available commercially are found to be very expensive. This paper act towards the prevention/control of theft of vehicle by designing a Theft Control System for an automobile. The proposed system, installed in the vehicle can be easily controlled by the owner of the vehicle from a remote place by sending a message from his/her mobile to the vehicle engine by interfacing with CAN bus and GSM modem.[7]

The vehicle owner uses the information from the GPS satellites, once the vehicle is afraid to be stolen, whereby from a remote place, a message is sent to the GSM modem[8] which is interfaced with the ECM that is installed in the vehicle. By reading the signals received from the mobile, the engine is correspondingly locked/unlocked automatically and speed of the vehicle is reduced/increased. That is, to stop the vehicle, owner sends a message to the control system placed in vehicle and an ECU automatically stops the fuel flow into the vehicle by sending message through CAN Bus thus reducing engine speed to zero. Again it resumes to normal operation only after owner enters a secured password through message.

The proposed embedded system uses the main idea of introducing mobile technologies into it. The unit proposed is a cost effective one.

2.1. Existing System

In all the existing systems, we can analyze that vehicle tracking integrates the GPS tracking system[9] with existing vehicle alarm or provide alarm features when someone is tampering with vehicle. Before the vehicle is driven away, security threat is detected and the vehicle is able to be tracked over the internet which is done by utilizing Global Positioning Satellites. Through which, data such as Global Position, including latitude and longitude are transmitted over the Cellular network[10].This information transmitted from the tracking device is stored in your private confidential account or sent over the wireless network. The data is cross referred on a street level map for viewing.[11]

2.2. Drawbacks of existing system

The crucial disadvantage of the existing system is that the system does not provide street wise address and speed of the vehicle and engine is no way controlled by the existing systems, thus exposing the vulnerability of a system that provides only tracking.[12]

2.3. Theft Control Unit and Engine Control Unit

The proposed system, has two modules, the theft control and the engine control modules, the theft control module retrieves the geographical location of the vehicle, and correspondingly activates the engine control unit to control the fuel flow to the engine system. Thus, the proposed theft control system not only retrieves a geographical address but also provides a technique to control the further movement of the vehicle, by controlling the speed of the vehicle by locking/unlocking.

2.4. Proposed Block Diagram

The block diagram of the proposed system is as shown in Figure 1. The design & development of the proposed system carried out in two modules, first module, the theft control module deals with the retrieval of the vehicle location and second one, the engine control module to control the vehicle engine by either locking or unlocking the engine by sending ON/OFF message from the user.

The practical way of implementing the system is that, when the vehicle is started, a message with the GPS coordinates that is, the latitude and longitude of the location of the vehicle is sent as an SMS to the given (owner's) number. On receiving the message the owner analyzes it and then sends a reply to lock or unlock that is stop the vehicle or allow the vehicle to run.

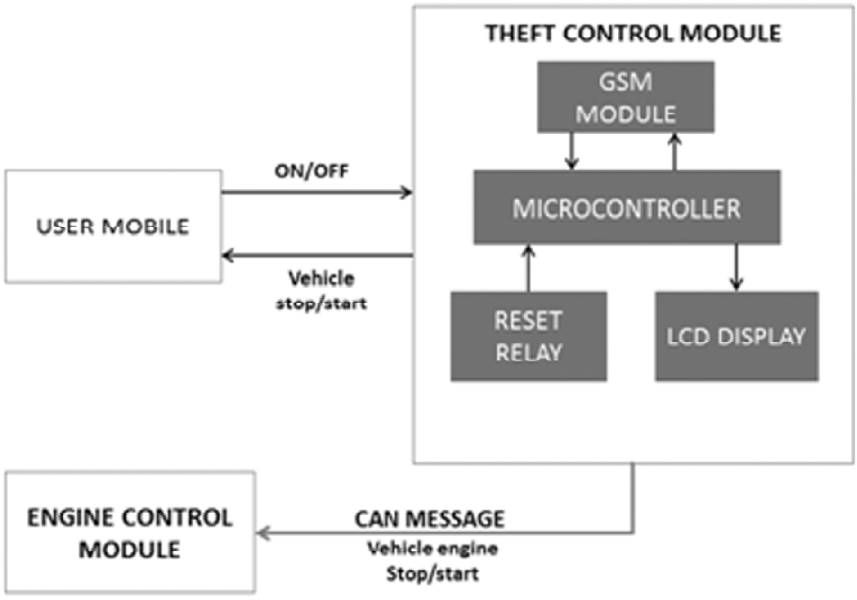

Figure 1: Proposed Block Diagram

3. CONTROLLER AREA NETWORK

Controller Area Network (CAN) which is used for real time applications is a serial data communications bus developed by engineers at Bosch. Evaluating existing serial bus systems regarding their possible use in automobiles, it is found that none of the already available network protocols were able to fulfill the requirements of the automotive applications.[13]

CAN is based on the "broadcast communication mechanism", which is based on a *message-oriented transmission protocol*. The CAN is used in a broad range of embedded as well as automation control systems. Application of CAN includes the area of CAN in Maritime Applications, cars & truck engine, Avionics System Networks, Building Automation etc.[14]

3.1. CAN Networks in automobiles

CAN Bus in Automobiles is used to connect electronic devices such as control units or intelligent sensors. This provides the following advantages for the Vehicles as an overall system:

The CAN bus acts as a data highway for exchange of data between control units; thus several control units can be implemented efficiently, thus the system becomes more flexible and scalable so that extra features can be easily added.

One more notable advantage of the CAN bus is that, since it is an open bus system, adaptability to various transmission media such as copper/optical fiber cables is increased.[15]

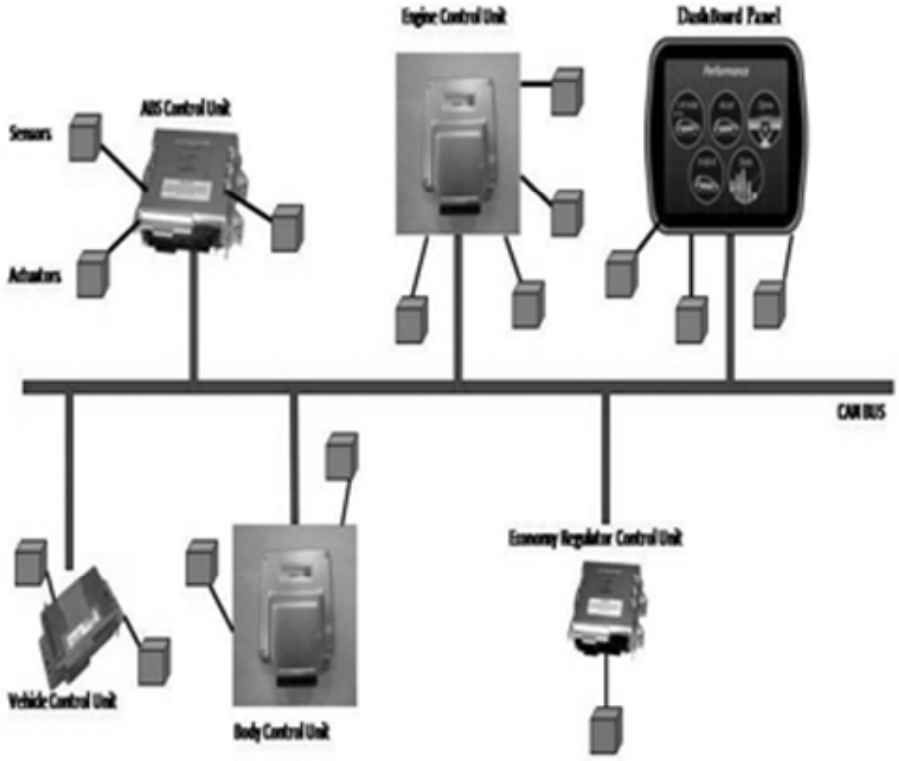

Figure 2: Overview of CAN

Figure 2 shows that the CAN network topology, follows the bus network topology, which gives it the advantage of easily adding new CAN nodes to an existing network. The standardization of the protocol means all ECUs will conform to the CAN standards while transmitting data.

4. DEVELOPMENT OF TCM

The Theft Control Module (TCM) comprises of microcontroller, GSM/GPS module, which is used for retrieval of vehicle location. The Figure 3 shows the block diagram of theft control module.

4.1. The Microcontroller (PIC)

For this model, PIC microcontroller is used because of following advantages of PIC

1. Many interrupt sources, so need more interrupt pins
2. Very high speed
3. Must be fully compatible with CAN (CAN enabled)
4. 2 UARTS for serial communication
5. It is having low-power consumption

The PIC controller used in the design is dsPIC30F4011, which is a CAN enabled 40 pin IC.[13]

4.2. GSM Module (SIM 900)

The SIM900 which is used in the proposed system is a complete Quad-band GSM/GPRS solution which can be easily embedded in the customer applications.[17]

The useful and attractive feature of SIM900 is that it delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption.

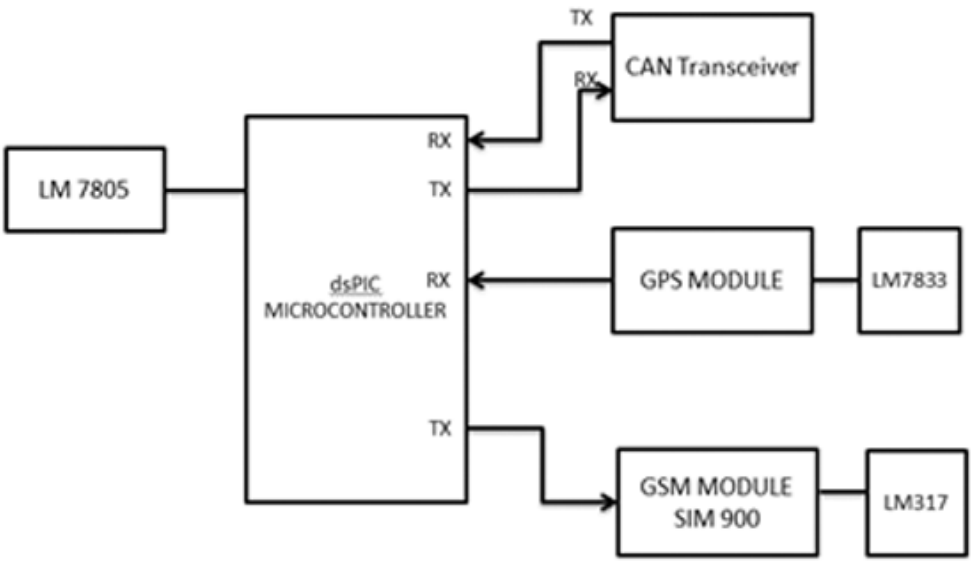

Figure 3: Block diagram of TCM

The main reason for using it in the proposed system is that, with a tiny configuration of 24mm x 24mm x 3 mm, SIM900 can fit almost all the space requirements in the application, especially if the system demands slim and compact design.[14]

4.3. Retrieval of vehicle

For locating a vehicle a two way process is adapted. Initially latitude and longitude of the vehicle is obtained from the satellites. The owner can retrieve the location only upon sending a solitary message which is set by the owner before deploying the system.[16] Location retrieval of the vehicle is explained in the activity diagram shown in Figure 4.

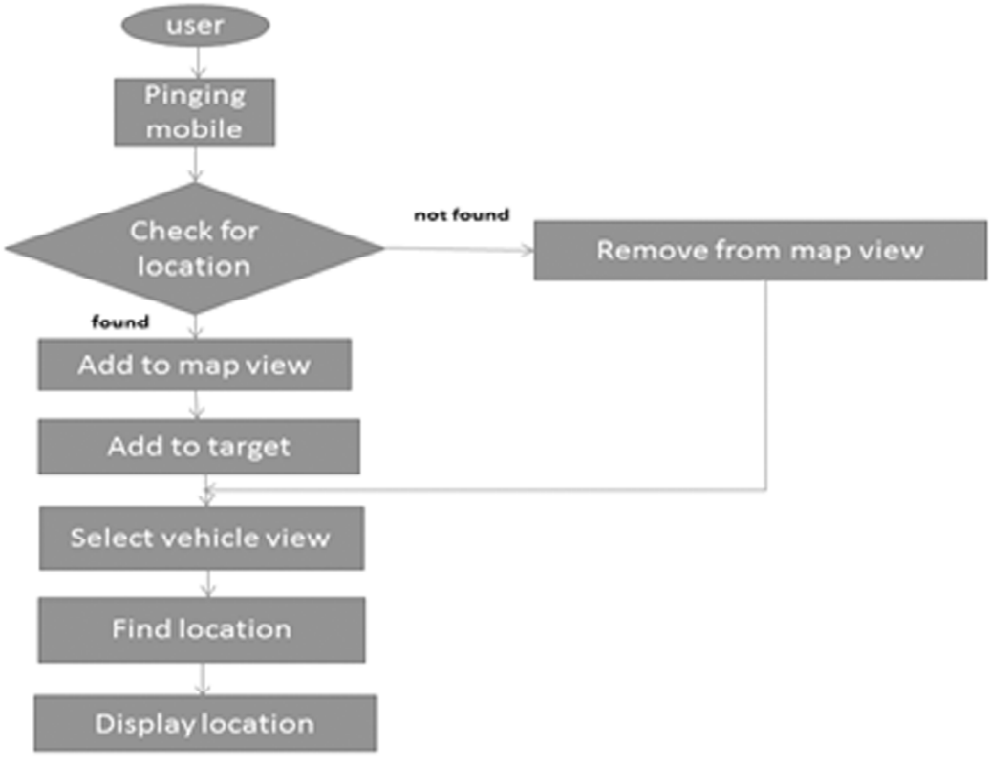

Figure 4: Activity Diagram of vehicle retrieval

5. DEVELOPMENT OF ECM

The Engine Control Module locks/unlocks the vehicle engine by sending text message through mobile to CAN Bus from the owner's mobile through GSM. It consists of CAN Transceiver and the vehicle controls (fuel control). The block diagram of ECM is shown in Figure 5.

5.1. CAN Transceiver (MCP2551)

The MCP2551 used in the system is considered to be a high-speed CAN, which is a fault-tolerant device that serves as the interface between a CAN protocol controller and the physical bus. The MCP2551 provides differential transmit and receive capability for the CAN protocol controller, which serves as its biggest advantage and it also includes 12/24V requirements. Also, it operates at speeds of up to 1 Mb/s. Each node in a CAN system will have a device to convert the digital signals generated by a CAN controller to signals suitable for transmission over the bus cabling (differential output). The transceiver used also provides a buffer between the CAN controller and the high-voltage spikes that can be generated on the CAN bus by outside sources (electrical transients etc.).

The RS pin, shown in Figure 6 allows three modes of operation to be selected, which are namely as follows.

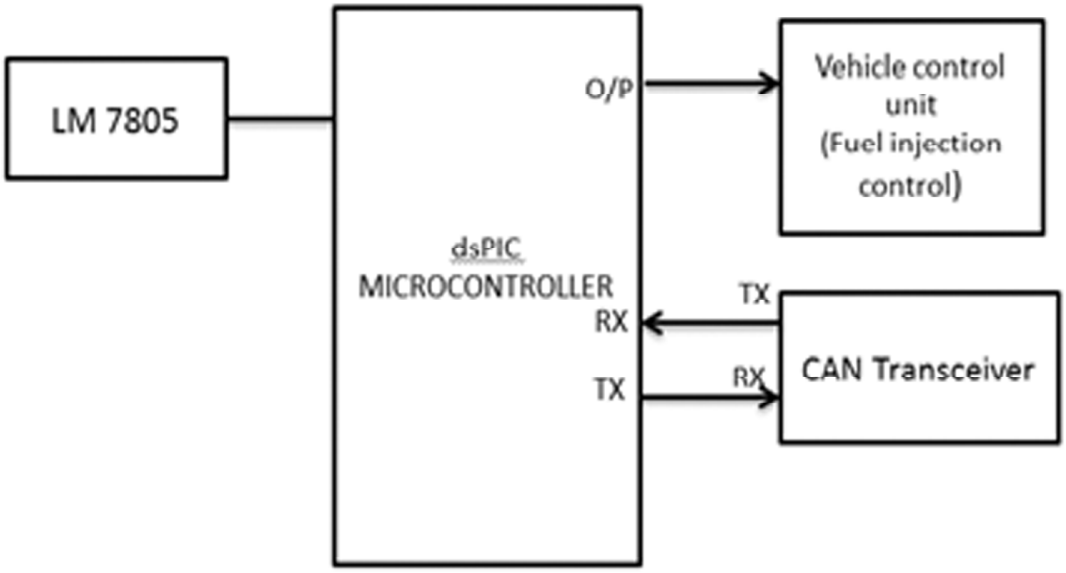

Figure 5: Block diagram of ECM

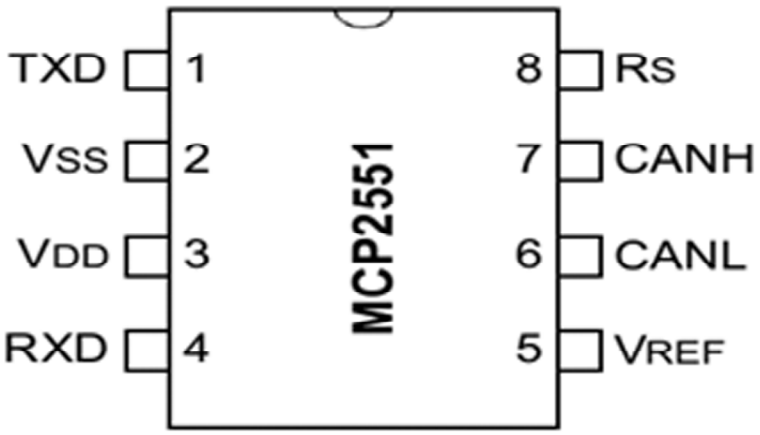

Figure 6: MCP2551

- High-Speed
- Slope-Control
- Standby

The first one, High-speed mode is selected by connecting the RS pin to VSS. Here, fast output rise and fall times are shown by the transmitter output drivers to support high-speed CAN bus rates in this mode. The second one, Slope-control mode is used for further reducing EMI by limiting the rise and fall times of CANH and CANL. And by connecting an external resistor (REXT) between RS and VOL (usually ground) the slope or slew rate can be controlled. A certain slew rate is achieved by applying a respective resistance since the current is primarily determined by the slope-control resistance value REXT. Thirdly, by applying a high-level to RS, the device may be placed in standby or SLEEP mode and here the transmitter is switched off and the receiver operates at a lower current thus saving power in the sleep mode. The receive pin on the controller side is still functional but will operate at a slower rate. Monitoring the receiving pin for CAN bus activity and placing the transceiver into normal operation via the RS pin is done by attached microcontroller. Hence for its versatility and operation in different power saving modes, the proposed system uses this transceiver.

5.2. Vehicle control unit

The locking/unlocking of the vehicle engine is done in the vehicle control unit. Output of the controller is connected to this unit; the fuel injection is controlled and hence the speed of the vehicle. For ease of demonstration, this unit is replaced by dc motor to depict the speed control.

A brief overview of entire system is given in Figure 7.

Only after receiving a corresponding message code, the system application is initiated and started. The owner is sent an acknowledgement with the latitude, longitudinal address. The main matter of concern is the Mobile network as only in presence of substantial network coverage sending and receiving solitary message is possible. Network factor is also considered for the design of location retrieval module.

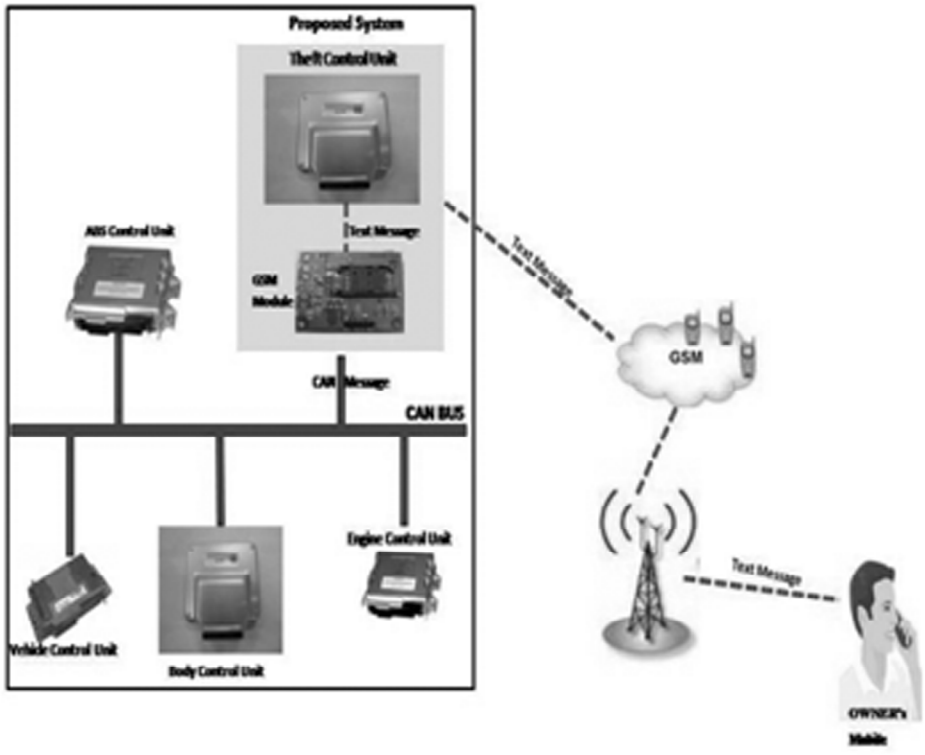

Figure 7: Overview of the system

After receiving the message and verifying its authentication, the micro controller installed on the vehicle acts upon the relay to lock or unlock the engine and a SIM card on GSM module in the vehicle would receive the message and would forward it to the micro controller.

6. EXPERIMENTAL RESULTS

The project is at the final stage of implementation. After carrying out experimentation, favorable results are obtained by using the following hardware components.

The components include Android Based Phone, PIC Controller, CAN Transceiver, GSM/GPS Module, and fuel control valve.

Figure 8 shows the final hardware setup which includes theft control unit containing PIC Controller, GSM/GPS Module which are embedded on a single board and which is incorporated into a vehicle as a control unit and the engine control unit, which is activated by message from the owner through CAN bus, turning on/off (lock/unlock) of fuel control valve shown. It can be understood that, thus by cutting off the fuel to the engine, the engine can be controlled by the owner according to his wish, preventing detected theft.

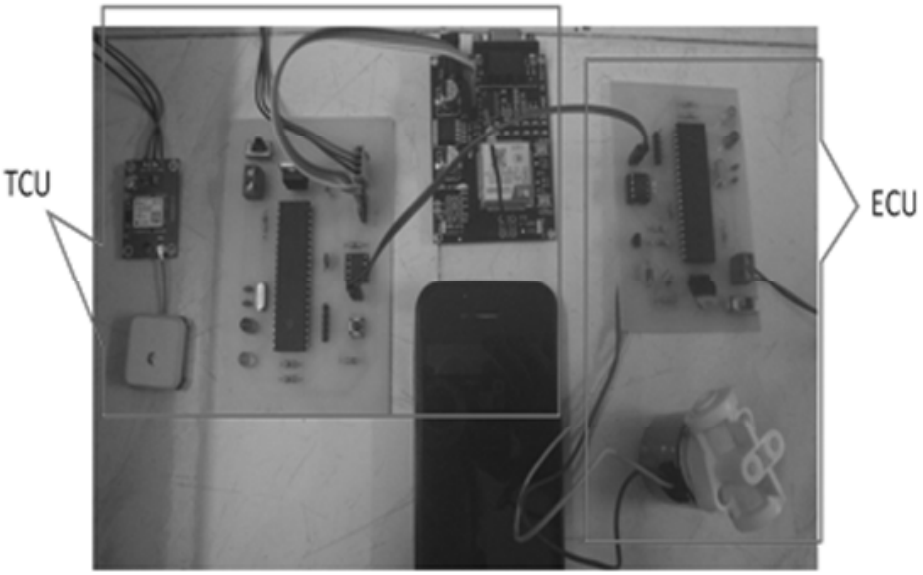

Figure 8: Hardware setup

Figure 9: Sample text message sent to owner

Figure 9 shows the sample text message received in the owner's android phone, which indicates when break in is detected, the owner then retrieves the present location/position of vehicle by sending the command, "MOT POS". After tracing the location making sure of theft, the owner can lock the engine(close fuel valve) by sending command "MOT ON" to the embedded system and according to his wish he can unlock the engine (open fuel valve) whenever needed, by sending command "MOT OFF" to the embedded system.

7. CONCLUSION

In this paper, a novel method of designing a low-cost, compact intelligent, theft control system for a vehicle is designed & discussed. This work is an ultimate threat for vehicle thieves. Nowadays, the vehicles are least secured when it is stolen by thieves. By this work which is presented in this paper, it is very easy to track the vehicle at a higher degree of accuracy, since it is based on GSM/GPS Technology, which is very developed now, at the same time it is very much easy to control further movement of the vehicle, by controlling the fuel supply to engine thus performing locking and unlocking engine through a predefined command message from the authentified owner's mobile.

The crux of the work is that not only the vehicle location is traced, but also further movement of the engine is controlled by using CAN bus, at the least possible cost and it is almost accommodable to the practical implementation.

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REFERENCES

[1] Huaqun Guo, et al. An automotive security system for anti-theft. *Proceedings of the Eighth International Conference on network.*, Gosier,Guadeloupe, pp. 421-426, March 2009.

[2] Hui Song,Sencun Zhu,Guohong Cao. SVATS: A sensor-network-based vehicle anti-theft system. *Proceedings of the 27th Conference on Computer Communications*. pp. 2128-2136, May 2008.

[3] Wan Lili, Chen Tiejun. Automobile anti-theft system design based on GSM. *Proceedings of International Conference on Advanced Computer Control*. pp. 551-554, January, 2009.

[4] Manjunath.T.K & N Maheswari. Locking and Unlocking of Theft Vehicles Using CAN. *Proceedings of 2013 International Conference on green high performance computing* .IEEE 2013.

[5] Ambade Shruti Dinkar and S.A Shaikh. Design and Implementation Of Vehicle Tracking System Using GPS. Journal of Information Engineering and Applications; ISSN 2224-5758 , Vol 1, No.3, 2011.

[6] Huaqun Guo, Jun Jie Ang and Yongdong Wu. Extracting Controller Area Network Data for Reliable Car Communications.; I Proc. IEEE,2009,pp.1027-1032.

[7] B.G. Nagaraja , Ravi Rayappa, M Mahesh, Chandrasekhar M Patil, Dr. T.C. Manjunath. Design & Development of a GSM Based Vehicle Theft Control System.;IEEE,2008 DOI 10.1109/ICACC.2009.154

[8] Longinus S. Ezema, Cosmas I. Ani. Multi Linear Regression Model for Mobile Location Estimation in GSM Network. Indian Journal of Science and Technology. 2016 Feb; 9(6), Doi no:10.17485/ijst/2016/v9i6/75195.

[9] Feng Huang, Shanyu Tang, Senior Member, IEEE, and Jian Yuan. Vehicle Location Based System. IEEE June,Transactions on noinformation forensics and security, vol.6, 2, 2011.

[10] Jing Xu, Tao Lu, Lingling Gao. Design and Application of In-Vehicle Terminal for Car Netwotk System Based on ARM9.IEEE InternationalWorkshop on Education Technology and Training,2008,p.324-327.

[11] S. Dhananjeyan, K. Mohana Sundaram, A. Kalaiyarasi, P. G. Kuppusamy. Design and Development of Blind Navigation System using GSM and RFID Technology. Indian Journal of Science and Technology .2016 Jan; 9(2), Doi no:10.17485/ ijst/2016/v9i2/85809.

[12] P. Eswaran, P. Muthukumar. Design of Auto-guard System Based on ZigBee and GSM Network. International Journal of Applied Engineering Research. ISSN 0973 -4562 Vol. 10 No.2 (2015) pp. 1276-1280 © Research India Publications.

[13] CAN in Automation (CiA),Controller Area Network (CAN) . Avaliable: http://www.can-cia.org/. Date accessed: 06/11/2015.

[14] Ashwini S. Shinde, Prof. Vidhyadhar B. Dharmadhikari. Controller Area Network for Vehicle Automation. International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459. Volume 2, Issue 2, February 2012.

[15] Vikash Kumar Singh, Kumari Archana. Implementation Of 'CAN' Protocol In Automobiles Using Advance Embedded System. International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 10- Oct 2013.

[16] Muhammad Ridhwan Ahmad Fuad and Micheal Drieberg .Remote Vehicle Tracking System using GSM Modem and Google Map. Conference on Sustainable Utilization and Development in Engineering and Technology, IEEE 2013.

[17] Bavya R, Mohanmurali. Next generation auto theft prevention and tracking system for land vehicles. ICICES2014 , IEEE 2014.

[18] Sahadev Roy, Rajesh Saha, Chandan Tilak Bhunia. A Secure Authentication Infrastructure for IoT Enabled Smart Mobile Devices – An Initial Prototype. Indian Journal of Science and Technology.2016 Feb; 9(9), Doi no: 10.17485/ijst/2016/v9i9/73250.

[19] D. Jinil Persis, T. Paul Robert. Ant Based Multi-objective Routing Optimization in Mobile AD-HOC Network. Indian Journal of Science and Technology.2015 May; 8(9), Doi no: 0.17485/ijst/2015/v8i9/59369.

[20] Md. Amir Khusru Akhtar, G. Sahoo. Behavior Based High Performance Protocol for MANET. Indian Journal of Science and Technology. 2013 Oct; 6(10), Doi no:10.17485/ijst/2013/v6i10/38794.