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Design and Implementation of a Vehicle Theft Control Unit using GSM and CAN Technology

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Abstract: *This project deals with the design & development of a theft control system, which is being used to prevent/control the theft of a vehicle. The developed system makes use of an embedded system based on Global System for Mobile communication (GSM) technology with CAN bus along with RFID system. The RFID reader will be interfaced with the microcontroller through serial interface to detect the hospitals, hotels, petrol bunks, temples etc. The developed system makes use of an mobile phone that is embedded in the vehicle with an interfacing to Engine Control Module(ECM) through Control Area Network(CAN) Bus, which is in turn, communicated to the ECM. The proposed system can be implemented using keil software.*

Keywords: *Vehicle theft controlling unit, GSM, GPS, CAN, Mobile phone, Engine control unit.*

1. INTRODUCTION

These day's car theft cases are higher than ever, give your car an excellent protection with the only reliable anti-theft device. Car Electronic control unit ensures the best guarantee to protect your car from different kinds of theft cases. It is a car security device that offers excellent protection to your car. A car with Electronic control unit security system helps the user to lock and unlock doors at the press of a button. Mainly two types of Electronic control unit are used in Auto industry -Automatic Electronic control unit and Manual Electronic control unit that ensures smoother and secured operation. Again this system could not prove to provide complete security and accessibility of the vehicle in case of theft. So a more developed system makes use of an embedded system based on GSM technology. The designed & developed system is installed in the vehicle.The main concept in this design is introducing the mobile communications into the embedded system.Automotive industry uses Controller Area Network (CAN) as the in-vehicle network for the Engine Management, the body electronics like door and roof control, air conditioning and lighting as well as for the entertainment control. Nowadays all most all car manufacturers have also started implementing CAN based vehicle automation. CAN networks used in engine management to connect several ECUs.Based on the discussion and data related to stolen cars, it is observed that the car theft is a global problem. Nobody likes his or her car to get stolen. The car manufacturers installed a minimum standard security system such as an alarm-based security system. Due to the inefficient conventional car security alarm system, the possibility of the car can be stolen is high However, this device is not effective enough. It does not have any pager system attached to it. The car thief takes only a few minutes to deactivate the security system. Furthermore, nobody will pay an attention when the car alarm goes off. Based on these reasons, it is proposed that a GSM-based vehicle anti-theft system development is designed and developed to improve the performance of the current vehicle security system. Somehow if there is another way of transmitting the alarm to the car owner that is not limited to the audible and line of sight, the system can be upgraded. SMS is a good choice of the communication to replace the conventional alarm, because it can be done and does not require much cost. Although most of people know GPS can provide more security for the car but the main reason people does not apply it because the cost. Advance car security system is too expensive. Cost for the gadget is too high. Besides that, people also must pay for the service monthly. The main objective of this project is to design, construct and test a GSM-based vehicle anti-theft system that can be used to improve the performance of car security system. The proposed system also allows the user to lock

and unlock the engine of the vehicle remotely using the mobile phone. The objective of the project is to build an additional feature to the present security system that will warn the owner of the vehicle by sending SMS when there has been an intrusion into the vehicle. To provide a solution to avoid car stolen in the lower cost than advance security car system (GPS). In this project, the RFID reader will be present at the underneath of vehicle to trace out the places, which are landmark to the present place like schools, hospitals petrol bunks and temples etc. Every road will be attached with a RFID tags. These RFID tags will contain the information like name of the places around it.

The proposed theft control system retrieves a geographical address and provides a facility to control the further movement of the vehicle. The system is intended to provide a feature that would control the speed of the vehicle by (engine lock/unlock) only upon receipt of a predefined code from the owner, who may be at a remote place by using mobile phone technology. The rest of the paper is organized as follows: section II gives the complete details about the design and working principle of CAN bus. Section III gives the complete details about the implementation of existing approach. The complete details about the design and implementation of the proposed approach are illustrated in section IV. Section V gives the details about the results and finally section VI concludes the paper.

2. CAN BUS

CAN bus (for controller area network) is a vehicle bus standard designed to allow microcontrollers and devices to communicate with each other within a vehicle without a host computer.CAN bus is a message-based protocol, designed specifically for automotive applications but now also used in other areas such as aerospace, maritime, industrial automation and medical equipment. CAN is a multi-master serial bus standard for connecting ECUs.

2.1. CAN architecture

Each node requires a

- Central processing unit or host processor
  - The host processor decides what received messages mean and which messages it wants to transmit itself.
  - Sensors, actuators and control devices can be connected to the host processor.
- CAN controller; hardware with a synchronous clock.
  - *Receiving:* the CAN controller stores received bits serially from the bus until an entire message is available, which can then be fetched by the host processor (usually after the CAN controller has triggered an interrupt).
  - *Sending:* the host processor stores it's transmit messages to a CAN controller, which transmits the bits serially onto the bus.
- Transceiver
  - *Receiving:* it adapts signal levels from the bus to levels that the CAN controller expects and has protective circuitry that protects the CAN controller.
  - *Transmitting:* it converts the transmit-bit signal received from the CAN controller into a signal that is sent onto the bus.

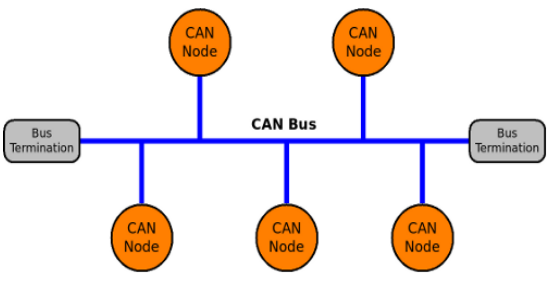

Fig1. *Overview of Controller Area Network*

Each node is able to send and receive messages, but not simultaneously. A message consists primarily of an ID (identifier), which represents the priority of the message, and up to eight data bytes. The improved CAN FD extends the length of the data section to up to 64 bytes per frame. It is transmitted serially onto the bus. This signal pattern is encoded in non-return-to-zero (NRZ) format and may be received by all nodes.The devices that are connected by a CAN network are typically sensors, actuators, and other control devices. These devices are not connected directly to the bus, but through a host processor and a CAN controller.

Fig. 1 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. Furthermore, the standardization of the protocol means all ECUs will conform to the CAN standards while transmitting data.

2.2. Working Principle

Data messages transmitted from any node on a CAN bus do not contain addresses of either the transmitting node, or of any intended receiving node. Instead, the content of the message is labeled by an identifier that is unique throughout the network. All other nodes on the network receive the message and each performs an acceptance test on the identifier to determine if the message, and thus its content, is relevant to that particular node. If the message is relevant, it will be processed; otherwise it is ignored.

Each CAN message has an identifier which is 11 bits (CAN specification part A) or 29 bits (part B). This identifier is the principle part of the CAN arbitration field, which is located in the beginning of each, CAN message. The identifier identifies the type of message, but is also the message priority. The bits in a CAN message can be sent as either high or low. The low bits are always dominant, which means that if one node tries to send a low and another node tries to send a high, the result on the buses will be a low. A transmitting node always listens on the bus while transmitting. A node that sends a high in the arbitration field and detects a low knows that it has lost arbitration. It stops transmitting, letting the other node, with a higher priority message, continue uninterrupted. Two nodes on the network are not allowed to send messages with the same id. If two nodes try to send a message with the same id at the same time arbitration will not work. Instead, one of the transmitting nodes will detect that his message is distorted outside of the arbitration field. The nodes will then use the error handling of CAN, which in this case ultimately will lead to one of the transmitting node being switched off (bus-off mode).

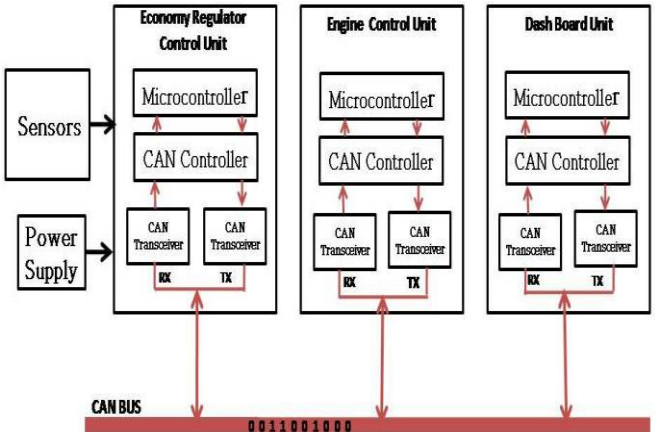

Fig2. *Information Exchange of a message on the CAN Bus (Broadcast Principle)*

3. EXISTING SYSTEM

Commercially available anti-theft vehicular systems are veryexpensive. Unitracking Vehicle Tracking Unit has the ability tointegrate the GPS tracking system with existing vehicle alarmor provide alarm features when someone is tampering withowner vehicle. It allows detecting the security threat before thevehicle is driven away and gives the ability to track the vehicleover the internet.The ability to track the vehicle over the internet is done byutilizing Global Positioning Satellites. Data such as GlobalPosition, Speed Velocity and Time (PVT) are transmitted over the Cellular network. The information transmitted from thetracking device is disseminated and stored on your privateconfidential account or sent over the wireless network. Thedata is cross referenced

on a street level map for viewing. Thepositioning information provided is cross reference to theclosest geographic address and displayed in residential /commercial address format.

The main disadvantage of the existing system is that thesystem provides only a broad layout of the geographical address, providing and does not provide street wise address.Speed of the vehicle and engine is no way controlled by theexisting systems, thus exposing the vulnerability of a systemthat provides only tracking.

4. PROPOSED DESIGN

This section gives the complete details about the design and implementation of a Theft Control System for an automobile,which is being used to prevent or control the theft of a vehicle.The developed system makes use of an embedded system and nGSM /GPS technology. The proposed system, installed in thevehicle can be easily controlled by the owner of the vehicle bysending a message from his/her mobile to the vehicle engine byinterfacing with CAN bus and GSM modem.The proposed system is very reliable, when a cellular network is available and a trackingdevice is connected it transmits data to a server; when a network is not available the device stores data in internalmemory and will transmit stored data to the server later whenthe network becomes available again.Vehicle tracking has been accomplished by installing abox into the vehicle, either self-powered with a battery orwired into the vehicle's power system. For detailed vehiclelocating and tracking it is still the predominant method butmany companies are increasingly interested in the emerging cell phone technologies that provide tracking of multipleentities, such as both a salesperson and their vehicle. These systems also offer tracking of calls; texts and Web use andgenerally provide a wider range of options.

4.1. Operating Principle

The block diagram of the proposed system is as shown inFig. 3.The design & development of the proposed systemcarried out in two modules, first the design of module toretrieve the location and second module to control the vehicleengine by either to lock or unlock the engine by sendingON/OFF message from the user to the Theft Control Unit. Fig.3 accomplishes the various control units of the vehicles areconnected to one another through CAN Bus.

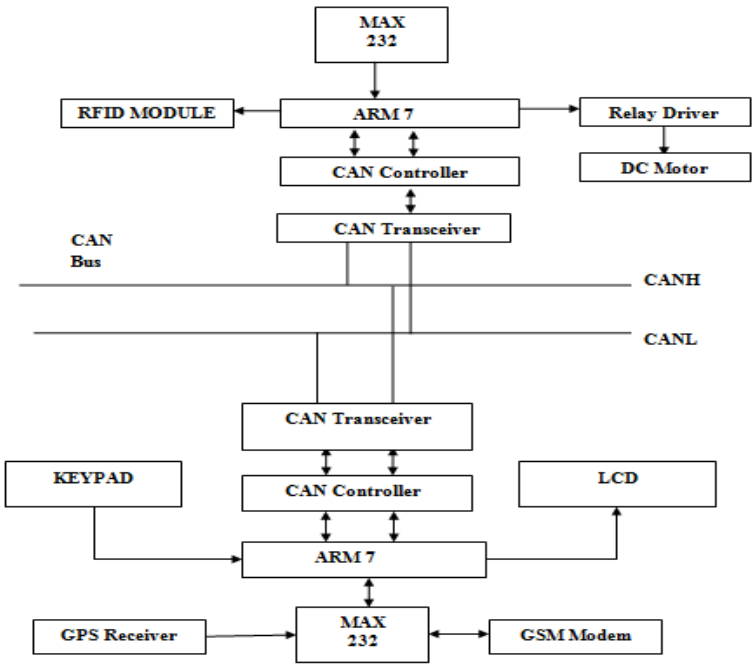

Fig3. *Block Diagram of the engine ignition control module*

Whenever the vehicle is started, a msg with the GPS coordinate of the location of the vehicle is sent as an SMS to the owner's number. An RFID device can be fixed to the vehicle to give the information about the particular places like hotels, hospitals etc., whenever the vehicle crosses that instance. On receiving the message the owner can send a reply to lock or antilock that is stop the vehicle or allow the vehicle to run through a keypad. The system at first checks and verifies

the owner number and if exact it checks the SMS sent and performs the corresponding action. All this process is achieved through vehicular network, CAN. When the engine is started it sends the information to the Master node in CAN which in turn fetches the location coordinates attached with it and generates the SMS. On receiving locking or anti-locking code it sends the respective command to the slave node which takes the intended action.If the vehicle is in danger then the speed of the car will be decreased by using dc motor. At a time buzzer also giving alert when the vehicle is in danger.

4.2. Location Retrieval of the Vehicle

Location of the vehicle is a two way process. Initiallylatitude and longitude of the vehicle is to be obtained from the satellites. Obtained latitude and longitude is used for furthercomputation of geographical address by invoking geo-coder.The owner can retrieve the location only upon sending asolitary message. This solitary message is set by the ownerbefore deploying the system. Retrieval of the vehicle's locationis explained in the activity diagram shown in Fig. 4.

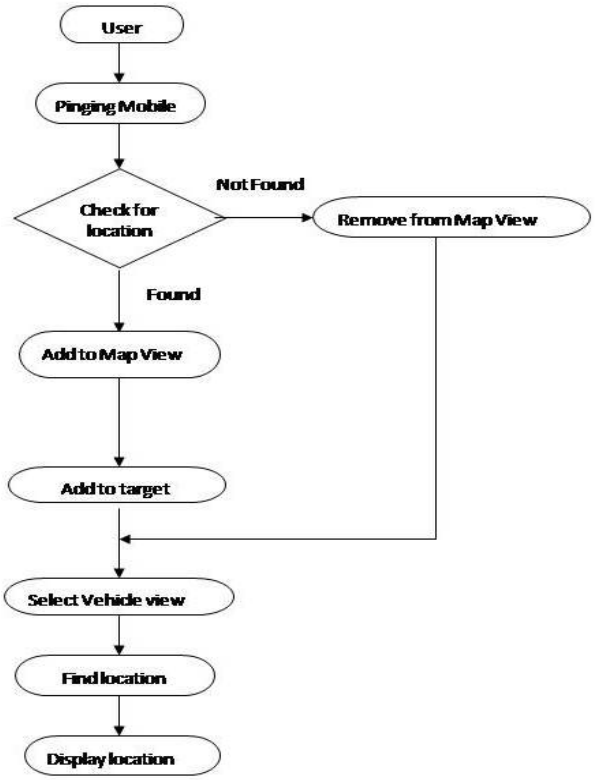

Fig4. *Activity Diagram to Retrieve the Location of the Vehicle*

Only upon receipt of corresponding message code, theapplication would start the service. As an acknowledgement, the owner is sent with latitude, longitude and the geographicaladdress. Mobile network is a matter of concern as only inpresence of substantial network coverage solitary message andits receipt is possible. Design of location retrieval moduletakes into consideration both the network factor and user codeauthentication. Only upon receiving an authenticated code thathas been defined earlier, the owner is sent the location. Henceuser code authentication is also considered.

4.3. Ignition/fuel flow Control of the Vehicle

Design of ignition/fuel flow control module involves astimulus to drive the process. This stimulus is obtained throughan owner's message. Upon receiving the location of thevehicle, the owner can either stop or start the ignition of theengine. The design parameter that is considered in this moduleis receiving a message from the owner to perform furtheraction. Another design parameter considered is authenticatingthe genuine nature of the message. Design involves processingthe message only if it is from the owner. Even if the lockingcode is known to others, locking cannot be performed. Ownerthus has a discrete control over the ignition of the engine. Thecrux of the design involves controlling the ignition the enginebeing at a remote place by sending a message.

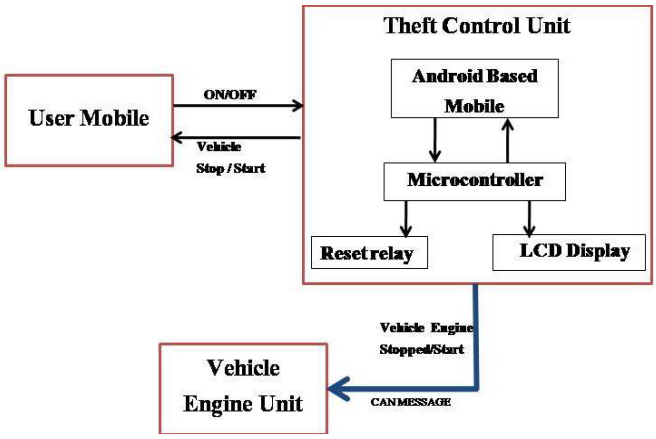

Fig5. *Block Diagram of the engine ignition control module*

Upon receiving the message and verifying itsauthentication, the micro controller installed on the vehiclewould send a signal to the relay to lock or unlock the engine.A SIM card on GSM module installed on the vehicle would receive the message and would forward it to the microcontroller. A MAX232 would perform the action of bothdriver and receiver to forward the message to and from themicro controller as shown in Fig. 5. An LCD display is used to notify the changes.Corresponding messages would be display on the LCD when anew message is received, when locking or starting the engineis performed. This kit however is not essential for actualdeployment of the system and is used only for demonstrationpurpose.

5. EXPERIMENTAL RESULTS

This section gives the details about the experimental results of the proposed approach. The implementation of realization of locking and unlocking of theft vehicles using can document is done successfully. The communication is properly done without any interference between different modules in the design. Design is done to meet all the specifications and requirements. Software tools like keil uvision simulator, proload to dump the source code into the microcontroller, orcad lite for the schematic diagram have been used to develop the software code before realizing the hardware.

Fig. 6 shows the hardware part of the project. This kit consists of an ARM Controller, Relay circuit, GSM Module and LCD Display are interfaced on a single board and embedded on single board which is embedded to a vehicle as a control unit. The relay is connected to the Vehicle Engine Unit of the Automobile.

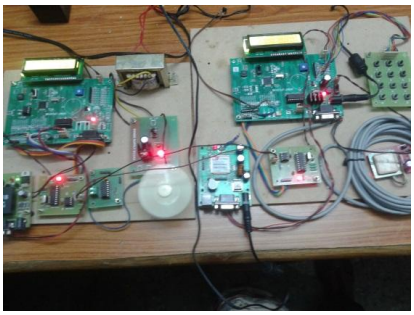

Fig6. *Hardware part of project*

When “OFF” message sent by the owner of the vehicle to the mobile embedded in the control unit, the controller displays the message in the LCD as shown in Fig.7 and invokes the relay that is connected to the vehicle engine which will stop fuel flow thus locking the vehicle engine by sending message through the CAN Bus in the CAN readable format.

Fig7. *LCD displaying "ENGINE OFF" message,*

Similarly when "ON" message sent by the owner of the vehicle to the mobile embedded in the control unit, thecontroller displays the message in the LCD as shown in Fig.8 and invokes the relay that is connected to the vehicle engine which will in turn allows the fuel flow by unlocking the vehicle engine by sending message through CAN Bus.

Fig8. *LCD displaying "ENGINE ON" message.*

Fig9. *Location details received*

The Fig. 9 shows the typical message displaying the location in terms of latitude, longitude and geo-graphical address of the location.

6. CONCLUSION

The developed system in this paper for avoiding vehicle theft makes use of anmobile phone that is embedded in the vehicle with an interfacingto Engine Control Module(ECM) through Control Area Network(CAN) Bus, which is in turn, communicated to the ECM. Thevehicle being stolen can be stopped by using GPS feature ofmobile phone and this information is used by the owner of thevehicle for future processing. The owner sends the message to themobile which is embedded in the vehicle which has stolen whichin turn controls the vehicles engine by locking the working of theengine immediately. The developed system accept the messageand broadcasted to the Vehicle Network through CAN Bus. Theengine can be unlocked only by the owner of the vehicle bysending the message again. The goal behind the design is todevelop security for vehicles and embedded system tocommunicate with engine of the vehicle.

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