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Locking and Unlocking of Theft Vehicles Using CAN

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Abstract:

Avoiding Vehicle Theft is making buzz in presentautomobile industry. Design and development of a theft control system for an automobile, can be achieved by making use of GPS feature of mobile phone. 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 vehicle being stolen can be stopped by using GPS feature of mobile phone and this information is used by the owner of the vehicle for future processing.The owner sends the message to the mobile which is embedded in the vehicle which has stolen which in turn controls the vehicles engine by locking the working of the engine immediately. The developed system accept the message and broadcasted to the Vehicle Network through CAN Bus. The engine can be unlocked only by the owner of the vehicle by sending the message again. The goal behind the design is to develop security for vehicles and embedded system to communicate with engine of the vehicle.

Keywords:

Controller Area Network Bus ; Engine Control Unit; Vehicle Network ; Mobile Phone ; GPS ; GSM ; Theft Control Unit.

I.INTRODUCTION:

Today's Automobiles, invariably comply with digital-control systems as a consequence of constant growth in technology. Recent Vehicles contains large number of Electronic Control Systems and already there are large numbers of Electronic Control Units present [1]. The growth of automotive electronics is the result parties of the customers wish for better safety and greater comfort and also for other requirements like improved emission control and reduced fuel consumption.

Electronic Control Units (ECUs) are increasingly being deployed in automobiles to control one or more electronic subsystems to realize various functions .When someone drives a car there are many signals that are passed between the various ECU's embedded inside the car. Output signals from an Electronic Control Unit contain information about the current state of the car as the driver interacts continuously with the car.A modern day automobiles can consists up to 80 ECU's, sensing and taking tabs of the various parameters of the automobiles [2]. This rapid and complex exchange of signals ensures the proper functioning of the car.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 [2].A vehicle tracking system combines the installation of an electronic device in a vehicle, or fleet of vehicles, with purpose -designed computer software atleast at one operational base to enable the owner to track the vehicle's location. Collecting data in the process from the field and deliver it to the base of operation. The terms cover a range of products which, by use of communications technology, or a combination of technologies, identify a stolen vehicle and its real-time location and present this information to a Systems Operating Centre (SOC) or to the police. Tracking systems also continue to update the data and differentiate between a particular stolen vehicle and all other vehicles, which may or not be stolen. It is recognized that such systems may be a facility within fleet management/logistics systems or part of services known as vehicle telemetric. Modern vehicle tracking systems commonly use GPS technology for locating the vehicle and also other types of automatic

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vehicle location technology can also be used. Vehicle information can be viewed on electronic maps via the Internet or specialized software.

II.CONTROLLER AREA NETWORK (CAN) BUS:

Controller Area Network (CAN) is a serial data communications bus for real-time applications, developed by engineers at Bosch [5]. Evaluated existing serial bus systems regarding their possible use in passenger cars and found that none of the available network protocols were able to fulfill the requirements of the automotive applications in 1980's. CAN is based on the "broadcast communication mechanism", which is based on a message-oriented transmission protocol. The Controller Area Network (CAN) is used in a broad range of embedded as well as automation control systems. Application of CAN includes in the area of CAN in cars & Truck Engine, Maritime Applications, Avionics System Networks, Building Automation etc.

A. CAN Network in Automobiles:

The use of a CAN Bus in Automobiles makes it possible to network electronic devices such as control units or intelligent sensors, provides the following advantages for the Vehicles as an overall system:

1)Data exchange between control units take place on a uniform platform.This platform is called a protocol. The CAN Bus acts as a so-called data highway.

2)Systems involving several control units, e.g. ESP, can be implemented efficiently.

3)System expansions are easier to implement in the form of optional extras.

4)The CAN Bus is an open system which permits adaptation to various transmission media such as copper or optical fibre cables.

5)Control units are diagnosed via the K-wire. Inside the car, diagnosis already takes place via the CAN Bus in some cases (for example the airbag and the door control unit).In this context, this is called a "virtual K-wire". In future cars, there will be no K-wire.

6) A cross-system diagnosis is possible across several-control units.

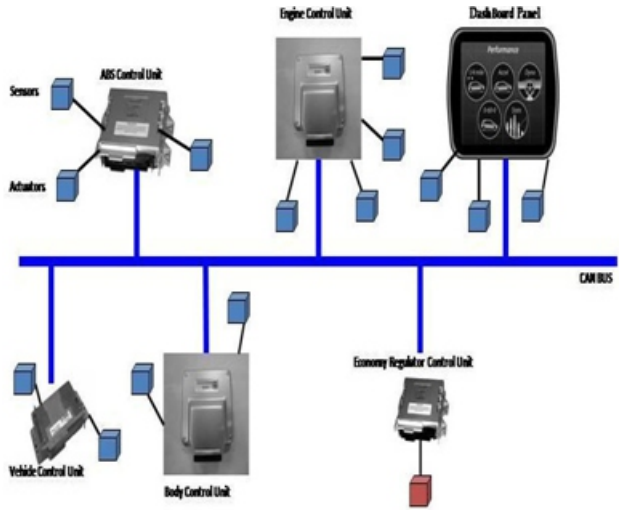

Fig. 1.Overview of Controller Area Network

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. Note that in the Figure 2 all CAN nodes are fitted with a mandatory transceiver chip that connects it to the CAN bus.

B. CAN Principle:

CAN is based on the "broadcast communication mechanism". This means that all nodes can "hear" all transmissions. There is no way to send a message to just a specific node; all nodes will invariably pick up all traffic. The CAN hardware, however, provides local filtering so that each node may react only on the interesting messages. Therefore, CAN is based on a message-oriented transmission protocol. Every message has a message identifier, which is unique within the whole network since it defines the priority of the message. The basic system of CAN in any vehicles is shown in Fig. 2.

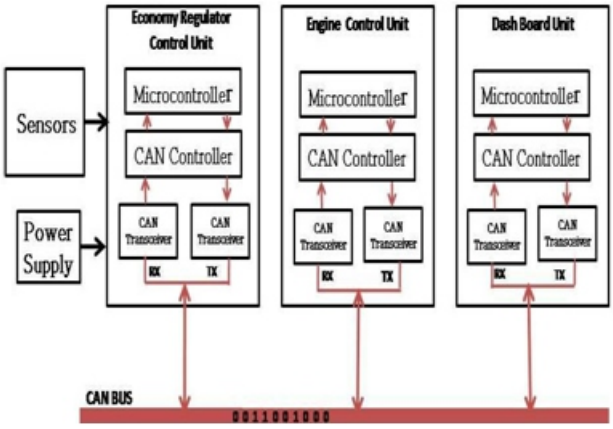

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Fig. 2. Information Exchange of a message on the CAN Bus (Broadcast Principle)

Exchange of information is referred to as messages. Any control unit can send or receive messages. A message contains physical values such as the engine speed (2000 rpm, 1800 rpm).The engine speed in this case, is represented as a binary value as shown in Figure 2.For example: The engine speed of 1800 rpm is represented as 00010101 in binary notation. Before sending, the binary value is converted into a serial bit stream called as CAN Message. The bit stream is sent over the TX line (transmit line) to the transceiver. The transceiver converts the bit stream into voltage values which are then sent over the CAN Bus line one by one. In the reception process, voltage values are converted back into a bit stream by the transceiver and sent over the RX line (receive line) to the control units. The control units then convert the serial binary values back into messages. For example: (the value 00010101 is converted back to the engine speed 1800 rpm).A message sent is received by all control units by administering message broadcast by using CAN protocol. The idea is derived from a transmitter which broadcasts a program me which any tuner (receiver) can receive. The broadcasting process ensures that all control units connected to the bus have the same information status.

The control unit receives signals from the sensors, processes them and passes them on to the actuators. The main components of a control unit are: a microcontroller with input and output memories and a program memory. The sensor values received by the controller, e.g. engine temperature or engine speed, are interrogated at regular intervals and stored in the input memory in their order of occurrence. This process corresponds to the principle of a mechanical step-by-step system with a rotating input selector switch. The microcontroller links the input values based on the program configuration. The results of this process are stored in each output memory and from there, they are sent to each of the actuators. In order to process CAN messages, each control unit has an additional CAN memory area for received and sent messages. The CAN module controls the data transfer process for CAN messages. It is divided into two sections, the receive section and the send section. The CAN module is connected to the control unit via the receive mailbox or the send mailbox. It is normally integrated in the chip of the control unit microcontroller.

III.PROPOSED SYSTEM:

Commercially available anti-theft vehicular systems are very expensive. The paper act towards with the design & development 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 n GSM /GPS technology. The proposed system, installed in the vehicle can be easily controlled by the owner of the vehicle by sending a message from his/her mobile to the vehicle engine by interfacing with CAN bus and GSM modem.Once, the vehicle is being stolen, the information is being used by the vehicle owner for further processing, where by sitting at a remote place, a message is sent to the interfacing GSM modem that is interfaced with the ECU which is installed in the vehicle. By reading the signals received by the mobile, the engine is locked automatically and speed of the vehicle reduced to zero. Again it will come to the normal condition only after entering a secured password by the owner of the vehicle.

The main idea behind the design is to introduce the Mobile technologies into the embedded system. The designed unit is very cost effective. The entire designed unit is on a single chip (ECU). When the vehicle is stolen, owner will send a message to the mobile which is embedded in the car showing the exact location using GPS. To stop the vehicle, owner sends a message to control system placed in vehicle as an ECU that automatically stops the flow of the fuel in the vehicle by sending message through CAN Bus thus automatically engine speed reduce to zero.Many modern vehicle tracking devices combine both active and passive tracking abilities. The proposed system is very reliable, when a cellular network is available and a tracking device is connected it transmits data to a server; when a network is not available the device stores data in internal memory and will transmit stored data to the server later when the network becomes available again. Vehicle tracking has been accomplished by installing a box into the vehicle, either self-powered with a battery or wired into the vehicle's power system. For detailed vehicle locating and tracking it is still the predominant method but many companies are increasingly interested in the emerging cell phone technologies that provide tracking of multiple entities, such as both a salesperson and their vehicle. These systems also offer tracking of calls, texts and Web use and generally provide a wider range of options.

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A. Existing System:

Unit racking Vehicle Tracking Unit has the ability to integrate the GPS tracking system with existing vehicle alarm or provide alarm features when someone is tampering with owner vehicle. It allows detecting the security threat before the vehicle is driven away and gives the ability to track the vehicle over the internet. The ability to track the vehicle over the internet is done by utilizing Global Positioning Satellites. Data such as Global Position, Speed Velocity and Time (PVT) are transmitted over the Cellular network. The information transmitted from the tracking device is disseminated and stored on your private confidential account or sent over the wireless network. The data is cross referenced on a street level map for viewing. The positioning information provided is cross reference to the closest geographic address and displayed in residential / commercial address format.

B. Drawbacks of Existing System:

The main disadvantage of the existing system is that the system 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 the existing systems, thus exposing the vulnerability of a system that provides only tracking.

C. Theft Control Unit (TCU):

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.

IV.DESIGN& DEVELOPMENT OF TCU:

The block diagram of the proposed system is as shown in Fig. 3.The design & development of the proposed system carried out in two modules, first the design of module to retrieve the location and second module to control the vehicle engine by either to lock or unlock the engine by sending ON/OFF message from the user to the Theft Control Unit.

A. Location Retrieval of the Vehicle:

Location of the vehicle is a two way process. Initially latitude and longitude of the vehicle is to be obtained from the satellites. Obtained latitude and longitude is used for further computation of geographical address by invoking goecoder. The owner can retrieve the location only upon sending a solitary message. This solitary message is set by the owner before deploying the system. Retrieval of the vehicle's location is explained in the activity diagram shown in Fig. 4.

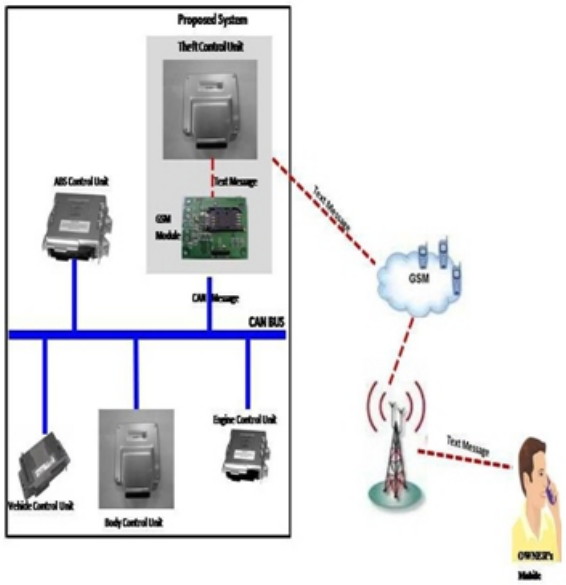

Fig. 3.Overview of the Proposed System.

Only upon receipt of corresponding message code, the application would start the service. As an acknowledgement, the owner is sent with latitude, longitude and the geographical address. Mobile network is a matter of concern as only in presence of substantial network coverage solitary message and its receipt is possible. Design of location retrieval module takes into consideration both the network factor and user code authentication. Only upon receiving an authenticated code that has been defined earlier, the owner is sent the location. Hence user code authentication is also considered.

B. Ignition/fuel flow Control of the Vehicle:

Design of ignition/fuel flow control module involves a stimulus to drive the process. This stimulus is obtained through an owner's message.

ISSN No: 2348-4845
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Upon receiving the location of the vehicle, the owner can either stop or start the ignition of the engine. The design parameter that is considered in this module is receiving a message from the owner to perform further action. Another design parameter considered is authenticating the genuine nature of the message. Design involves processing the message only if it is from the owner. Even if the locking code is known to others, locking cannot be performed. Owner thus has a discrete control over the ignition of the engine. The crux of the design involves controlling the ignition the engine being at a remote place by sending a message.

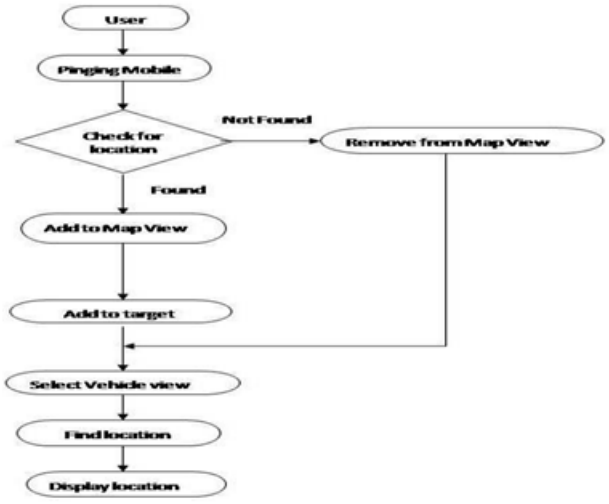

Fig. 4. Activity Diagram to Retrieve the Location of the Vehicle.

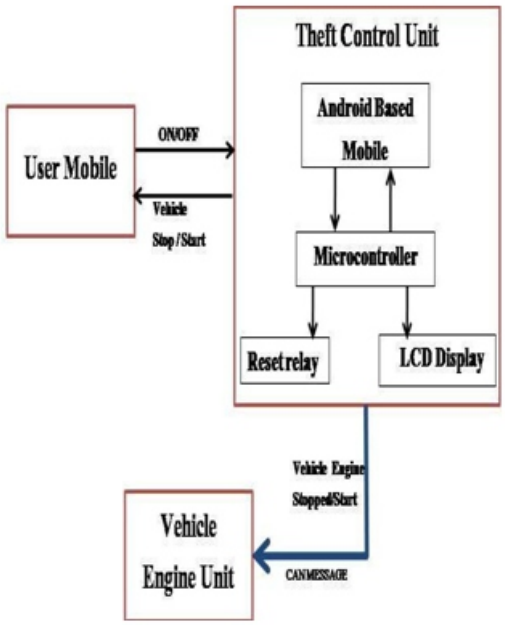

Fig. 5. Block Diagram of the engine ignition control module

Upon receiving the message and verifying its authentication, the micro controller installed on the vehicle would 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 micro controller.

A MAX232 would perform the action of both driver and receiver to forward the message to and from the micro controller as shown in Fig. 5.An LCD display is used to notify the changes. Corresponding messages would be display on the LCD when a new message is received, when locking or starting the engine is performed. This kit however is not essential for actual deployment of the system and is used only for demonstration purpose.

V.EXPERIMENTED RESULTS:

The results are obtained after carrying out the experimentation by using the following hardware components. The component includes Android Based Phone, ARM Controller, Relay Circuit, GSM Module, and LCD Display.Fig. 6 shows 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.

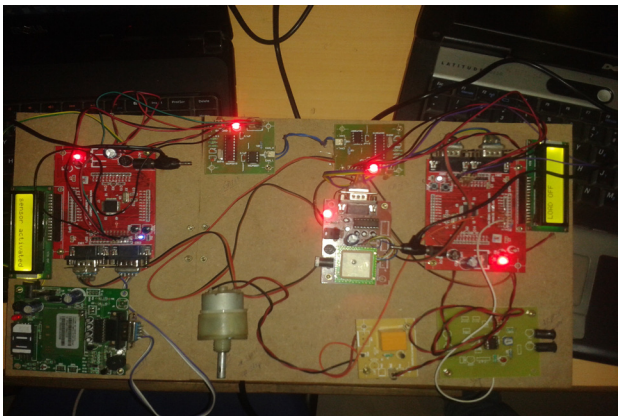

Fig. 6.Hardware Kit embedded to the vehicle

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(a) 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.

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Similarly when "ON" 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(b) 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.

Fig. 7.(a) LCD displaying "SENSOR ACTIVATED" message, (b) LCD displaying "LOAD OFF" message.

The values of the vehicle like Speed, Rpm, Gear and Signal are analyzed along with the experiment conducted and these values are recorded in the form of table as shown below.

TABLE 1: shows the values of speed, rpm, and gear values of vehicle when signal 0 and 1 are sent

Speed	Rpm	GEAR	Signal
0	90	10	0
10	95	10	0
15	100	10	0
20	150	10	0
20	200	10	0
20	250	10	0
20	300	10	0
20	350	10	0
20	90	20	0
25	95	20	0
30	100	20	0
0	150	20	1
0	200	20	1
0	250	20	1
0	300	20	1
0	350	20	1
0	90	30	1
0	95	30	1
0	100	30	1
0	150	30	1
0	200	30	1
60	250	30	0
65	300	30	0
65	350	30	0
40	90	40	0
50	95	40	0
60	100	40	0
70	150	40	0
80	200	40	0
0	250	40	1
0	300	40	1
0	350	40	1
0	90	50	1
0	95	50	1
0	100	50	1
0	150	50	1
90	200	50	1
100	250	50	0
110	300	50	0
120	350	50	0

Messages "OFF" and "ON" are converted into signal 1 and 0. When signal=1, it means engine is locked, speed of the vehicle is reduced to zero irrespective of drivers input. If the signal=0, it means engine is unlocked it behaves normally as per the drivers input. This illustrated by plotting a graph as shown in Fig. 8 by the considering the values present in Table 1.When engine is in normal condition, speed of the vehicle depends on drivers input but when the engine is locked, speed of the vehicle is 0 but it cannot be changed by the drivers input.

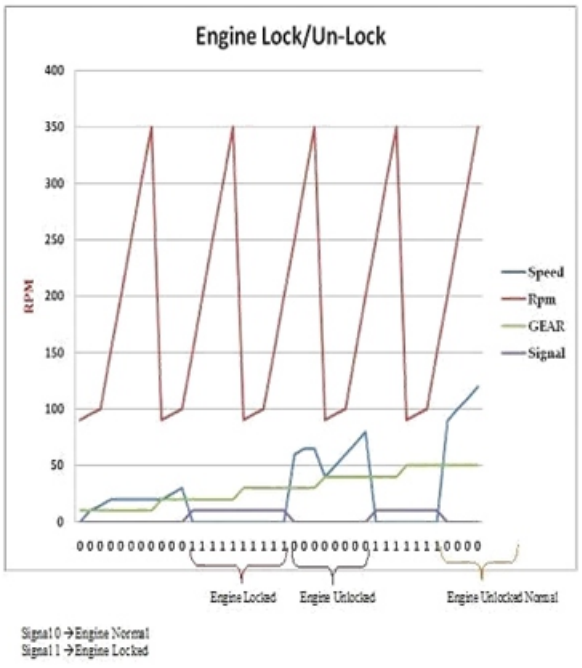

Fig. 8.Graph representing Engine status of a vehicle

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The Fig. 9 shows the typical message sent by the Android mobile to the owner mobile when there is a network, by invoking Vanet app in Android mobile and hence displaying the location in terms of latitude, longitude and geo-graphical address of the location.

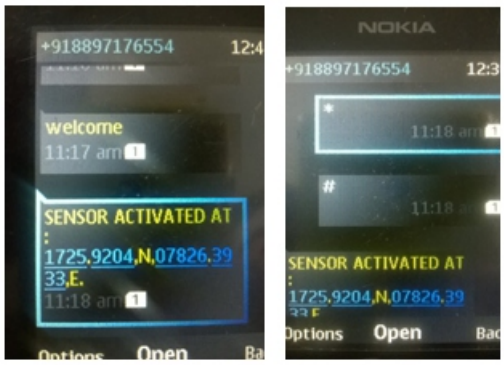

Fig. 9.Location details received on owner mobile

VI.CONCLUSION:

The Proposed System Theft Control Unit can be implemented in any automobiles as one of the vehicle's electronic control unit which will be connected to the CAN Bus as one more node. The developed system is less expensive vehicle tracking control system that could be implemented on any vehicle since the system is developed by using mobile and GSM technology which is operated by sending and receiving messages. The vehicle engine ignition system can be controlled by reading the message received.The system consists of two modules one is GSM module and the other is Android module. The owner of the vehicle interacts with GSM module by sending and receiving messages.

The Android module uses GPS system to retrieve the location details of the vehicle. So that the owner can get location details and using which the owner could track the vehicle easily. GSM module is the simple communication channel that uses existing network providers. So, mobile network is essential for the functioning of the system.Theft Control Unit installed, controls the vehicle engine unit when it receives message through from owner through CAN Bus. Since the CAN Bus is used as in-vehicle network, the transfer of data from one unit to another unit reliable and efficient. Therefore, the integrated system handles different functions such as locking vehicle engine by stopping fuel flow in to the engine, getting location details through GPS network and sending it to owner of the vehicle.

The Proposed system can be deployed on any automobile, less expensive and ignition of an engine can be controlled being at the remote place, encompasses some advantages of the system. Therefore, the Mobile based Vehicle Theft control Unit (TCU) provides an easier and featured tracking system. Also helps the owner of the vehicle to have an easy remote control of the theft vehicle.

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