

Remote vehicle shut off system for controlling Vehicle Ramming Attacks

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Abstract— *The main goal of this paper is to propose a low cost and efficient system which will control vehicle ramming attacks. Now days, the vehicle ramming attacks are mostly used by terrorist and became an important security threat to the world. So, this paper presents the system in which the transmitter, real time monitoring module will send the commands remotely and the receiver section will performs the necessary actions to shut off the engine of specific vehicle using GSM, GPS and Microcontroller.*

Index Terms— Ignition System, GSM, GPS, Microcontroller, Power amplifier, RS232 interface, Relay driver circuit.

I. INTRODUCTION

Recent vehicular attacks in US, Israel, France and Germany clearly highlighted the viability of vehicle ramming as a legitimate terrorist tactic and one that should be a focus for law enforcement, especially during special event planning. These attacks vividly demonstrate how challenging it can be to stop a vehicular attack once it has been launched. A **vehicle-ramming attack** [1] is a form of attack in which a perpetrator deliberately rams a motor vehicle into a building, crowd of people or another vehicle. The earliest known use of a vehicle-ramming attack in its current form was the 2001 Azor attack by a Palestinian terrorist. According to Stratfor Global Intelligence analysts, this attack represented a new militant tactic which is less lethal but could prove more difficult to prevent than suicide bombings. According to the American Federal Bureau of Investigation, the tactic has gained popularity because "Vehicle ramming offers terrorists with limited access to explosives or weapons an opportunity to conduct a homeland attack with minimal prior training or experience. The summary of last 17 years vehicular attacks are shown in table 1.

This paper suggests a solution to government transportation regulatory bodies and vehicle manufacturing companies to overcome on these kinds of attacks.

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II. RELATED WORK

A major research work has been carried out for vehicle tracking, Vehicle antitheft by using GPS and GSM Modules by using integrated embedded systems. These systems are capable of shutting off the vehicle by using DTMF tones

Year	Country	Description
2001	Israel	Azor attack, ramming people, mostly soldiers(7)+1 civilian, 26 injured
2002	France	Lyon car attack, building ramming & fire
2006	US	UNC SUV attack, University of North Carolina, ramming people
2007	UK	Glasgow International Airport attack, building ramming & detonating gas cylinders
2008	Israel	1. Jerusalem vehicular attack, ramming vehicles and people 2. Jerusalem bulldozer attack, ramming people
2011	Israel	1. Tel Aviv truck attack , ramming vehicles and people 2. Tel Aviv nightclub attack, ramming & stabbing
2013	UK	Murder of Lee Rigby, ramming and stabbing
	China	Tiananmen square attack, ramming people & bursting into flames
2014	China	Ürümqi attack , ramming & throwing bombs off the vehicle
	Israel	1. Jerusalem tractor attack, ramming people & bus 2. Jerusalem vehicular attack (October) , ramming people 3. Jerusalem vehicular attack(November),ramming & hitting with a metal crowbar
	Canada	Saint-Jean- sur-Richelieu ramming attack
	France	1. Dijon attack 2. Nantes attack , ramming people
2016	France	Nice attack , ramming people & gunfire
	US	Ohio State University attack, ramming & stabbing
	Germany	Berlin attack, shooting truck driver & ramming people
2017	Israel	Jerusalem truck attack, ramming people
	UK	1. Westminster attack, 2. London Bridge attack 3. Finsbury Park attack, ramming & stabbing
	Sweden	Stockholm attack ,ramming people
	France	1. Champs-Élysées car ramming attack , ramming a police car 2. Levallois-Perret attack , ramming soldiers
	US	Charlottesville attack , ramming people
	Spain	Barcelona attack , ramming people
2017	Canada	Edmonton attack, ramming & stabbing
	US	New York City attack ramming cyclists and runners

Table. 1 Last 17 years vehicular attack history [2]

generated by mobile keypads. The 8051 microcontroller is used by Pritpal Singh, Tanjot Sethi, Bibhuti Bhusan Biswal, and Sujit Kumar Pattanayak [9] with IR sensors, GPS, GSM to track the vehicle as well as shutoff the vehicle. The system

is useful for individuals or owners of vehicles for antithefting of vehicles.

Authors in [10] are proposing a system to turnoff the engine by disconnecting the power of fuel pump and ECM, this system is controlling the vehicle engine by using SMS sent through vehicle owner. For the accuracy of the GPS location, the system is using Kalman filter for the correction the GPS co-ordinates.

Authors in [11] are proposing a system comprises of GPS, GSM and microcontroller which is mounted on vehicle under observation, also a special security button is provided for the owner of vehicle for security of parked vehicle, when this button is pressed, the security system becomes active and system will continuously monitors vehicles movement and if movement is sensed by system, ignition switch will be automatically turned off.

All these systems are useful for antitheft of the vehicles or tracking of vehicles, but these systems are operated by individual users or vehicle owners from their mobile phones. So these kinds of systems would fail in vehicle ramming attacks. Where, any vehicle could be used by terrorists and it will be difficult for security agencies to control the vehicle.

System and System Components:

For smooth functioning and control over engine, there are many blocks or parts associated with it, like fuel injection system, engine control module, electronic control unit, ignition system and different types of sensors. But out of all, the ignition system is a most important system associated with the engine. To track & stop the vehicle under attack, we need to shut off the engine and this paper suggests a solution to shut off the engine of vehicle by disconnecting battery from ignition system.

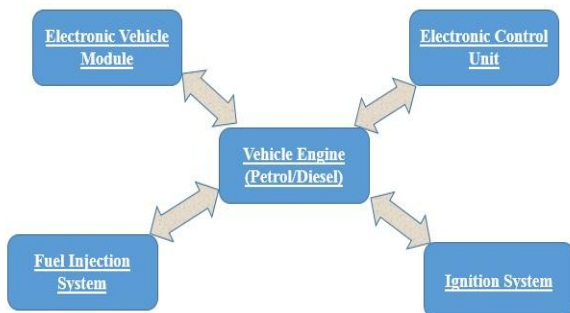


Fig. 1 General Block Diagram of vehicle engine

If we take an example of a 4 cylinder internal combustion engine, then fuel and air combusts inside the engine block to move the piston in to and fro motion which will eventually rotates the crankshaft. But a sparking is required for the combustion of oil and air mixture. Because sparking occurred within compressed mixture of air and fuel give rise to a limited power explosion within the block. This sparking is generated by an ignition system of vehicle. Therefore to shut off a vehicle one needs to turn off the ignition system.

Ignition System:

Fig.2 Shows Battery ignition system of vehicle, which includes a battery, Ignition coil, condenser or differential

voltage detection circuit, voltage distributor and Spark plugs. The aim of ignition system is to generate sparking in engine blocks for piston strokes. Spark plugs will generate this sparking sequentially or in synchronization with fuel injection cycle. A very high voltage is required for the operating of spark plugs, so initially battery provides a voltage to the ignition coil. Here ignition coil is generally a step up transformer which is responsible for boosting of voltage. This boosted voltage is applied to the distributor circuit.

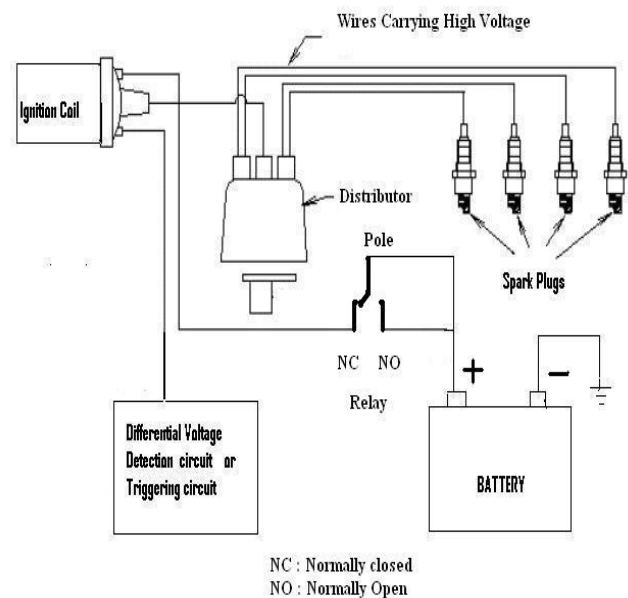


Fig. 2 Battery Ignition System with Relay [3]

Role of distributor circuit is distributing the boosted voltage among four spark plugs in synchronization with fuel injection cycle. So four connections are made from distributor to spark plugs.

So this paper proposing an electronic system for remote shutoff of the engine. Basically this system comprises of two modules 1) Transmitter module and 2) Receiver Module

a) Receiver module:

The block diagram shows transmitter module consisting of 3 blocks

- 1) Real time vehicle monitoring system
- 2) Graphical user interface for control system
- 3) GSM Module

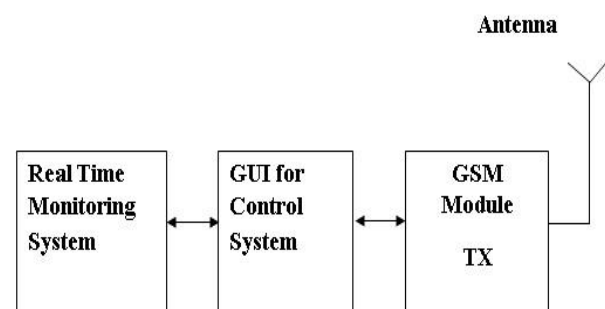


Fig.3 Transmitter module of Remote Vehicle Shut off System

1) Real time vehicle monitoring system: This system contains all the data regarding vehicles such as Vehicle registration number, GSM module number of the vehicle to be controlled, and a security code provided by manufacturer. This system is interfaced with a GSM module using a GUI, which will be used for data and command transfer between GSM module and Real time monitoring system.

2) Graphical User Interface: GUI contains control buttons that will give information regarding vehicle and buttons that will send commands (On/Off) to the receiver module.

3) GSM Module (TX): GSM (Global System for Mobile Communication) module is a device which will be used to transmit as well as receive the information in the form of electromagnetic signal or SMS. This module has 10 digit unique numbers for identification.

b) Receiver module:

The block diagram shows receiver module comprising of following blocks.

- 1) Power amplifier
- 2) GSM Module
- 3) GPS Module
- 4) RS 232 interface
- 5) Microcontroller
- 6) Relay driver circuit
- 7) Switching circuit

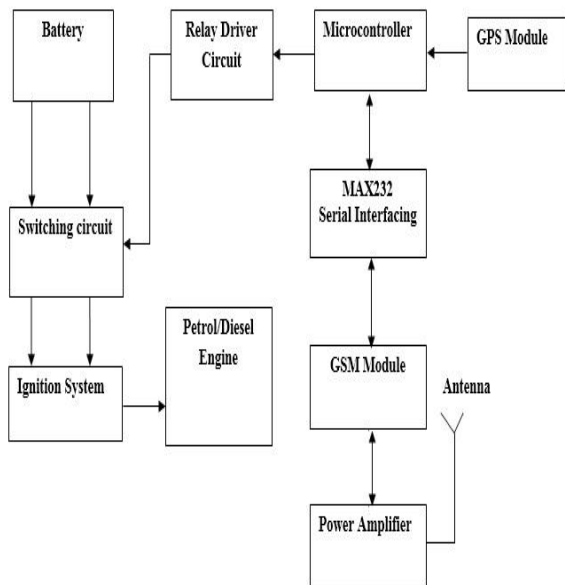


Fig.4 Receiver module of Remote Vehicle Shut off System
The details of each block are given below

1) Power amplifier:

Since the Receiver module is mounted in remote vehicle, there is possibility that vehicle may pass through an area where signal strength would be low. So to increase the strength of signal, power amplifier is used, whose output is connected with the GSM module. [4]

2) GSM Module (RX):

This GSM module is used to receive commands from transmitter (TX) as well as to send the exact location and status of the vehicle under monitoring.

3) GPS (Global Positioning System) module:

By using this system we can continuously monitor the exact location of the vehicle. This information is useful to understand the status of vehicle after emergency shut off. [6][7]

4) RS 232 module:

IC MAX232 is used to interface GSM and GPS module with microcontroller. RX and TX Pins of MAX 232 IC are connected with serial port of microcontroller.

5) Microcontroller:

AT89S52 microcontroller is used to control switching of relays based on commands coming from GSM module. A memory is also interfaced with the microcontroller to save the security code provided by manufacturer of the vehicle and commands.

6) Relay driver circuit:

According to the commands given by TX module, microcontroller makes and breaks the contact between battery and ignition system by using switching relays, which will eventually, shuts off the vehicle engine. Since relays are electromagnetic devices, they require a sufficient amount of current for switching; therefore the output of microcontroller is connected with relay driver circuit.

7) Switching Circuit:

The switching circuit contains required number of relays, which will make and break the contact between battery and ignition system to shut off the vehicle.

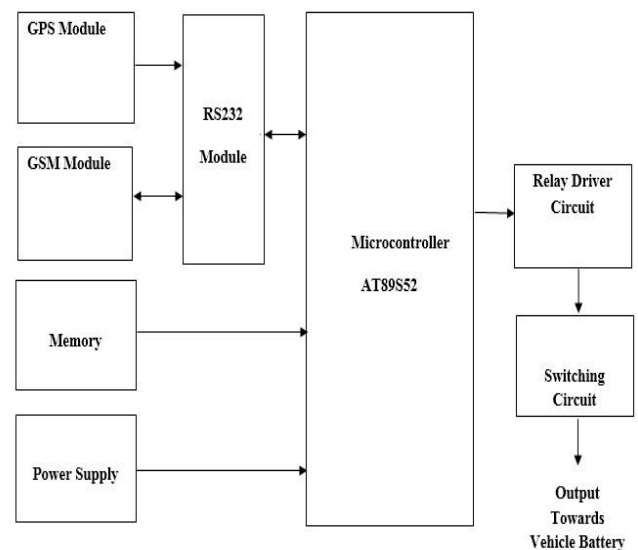


Fig. 4 Interfacing of Different hardware modules with Microcontroller

Fig. 4 shows interfacing of different hardware modules with microcontroller. Here GPS module is continuously monitoring location of vehicle and accordingly sending it to the microcontroller and microcontroller sends this data through GSM module. Both GSM & GPS modules are interfacing with controller by using RS232 serial communication protocol.

Memory is interfaced with controller to permanently store security code and commands.

5V DC power supply is applied to microcontroller.

III. WORKING MECHANISM OF SYSTEM

- If vehicle ramming attack is taking place in any city or populated area, then most of the time police control room will get informed through the helpline. So obviously, Control room will get aware about the registration number of the vehicle.
 - By using vehicle registration number, control system operator can find out the other information regarding the vehicle conducting attack, such as GSM module number of the vehicle to be controlled, and a security code provided by manufacturer which is already stored in the memory interfaced with the microcontroller at receiver module.
 - By using the security code, control system operator will access the receiver module within the vehicle. After validation of receiver module, operator can directly send shut off signal to the receiver module.
 - To verify on/off status engine and movement of vehicle it is necessary to track the exact location of it, therefore the GPS module is also interfaced with the microcontroller by using RS232 protocol.
 - When shutoff signal is received by the GSM module at the receiving end by the antenna, it is applied to the power amplifier for enhancement of strength of the signal, so that problem of signal weakness in particular areas will get resolved.

- Now GSM module receives the amplified signal (shutoff Command) from power amplifier and sends it to the microcontroller through the RS232 module.
 - Microcontroller compares the command arriving from GSM module with the command stored in the memory for authentication purpose and sends engine shutoff signal to switching circuit if status of engine is ON.
 - When engine shutoff signal arrives from microcontroller, relays placed between battery and ignition system of vehicle breaks the electrical contact and spark plug of ignition system stops their working. So engine working cycle suddenly gets terminated.
 - To verify ON/OFF status or to monitor the further movement of the vehicle operator can check GPS signals coming from receiver within the vehicle.

IV. CONCLUSION

So, in this paper, the proposed system which remotely shut off the vehicle engine can be used to control the vehicle ramming attacks by terrorists. The system can be implemented efficiently with the specified algorithm, hardware and software requirements. The system is also the cost effective. Still there is scope to optimize the different methodologies and algorithm and can be used in wide variety of applications.

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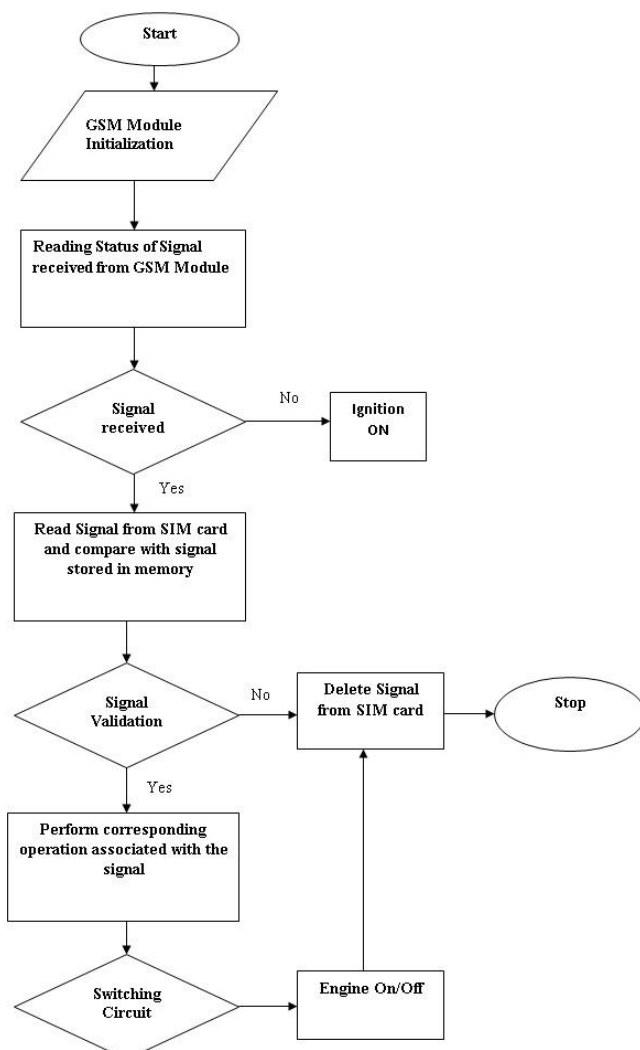






Fig 5. Flowchart of System Working Mechanism [5]

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