SMS-Based Stolen Vehicle Rescue System

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ABSTRACT

Recovering a snatched vehicle is extremely difficult in most cases once the robber has successfully escaped with it because a lot of alterations and modifications would have been done thereafter. Sometimes, stolen vehicles are dismantled and sold in parts. In this regard, a technology that prevents a vehicle snatcher from absconding with the vehicle should be embraced. The SMS-Based Stolen Vehicle Rescue System presented in this paper is all about using any mobile phone to immobilize a snatched vehicle. It is primarily made up of a GSM modem, a PIC microcontroller, and electromagnetic relays. The GSM modem which contains a valid SIM card was used to establish communication between any mobile phone and the microcontroller. It sends AT command to the microcontroller which has been programmed to control some relays through the driver-circuits on its ports. The relays were used to open/close the vehicle ignition circuitry. While someone was driving a car in which the device has been secretly installed, an assumed car-snatch victim sent SMS message to the car and its engine suddenly stopped. Efforts to quickly restart it was abortive until when another SMS message was sent by the owner to reactivate the ignition system. With the implementation of this system, it is not going to be business as usual for vehicle snatchers as it will go a long way in reducing the incidences of car-snatch on our roads. The resources expended in search of missing vehicles would also be utilized for national development.

Keywords: Ignition, Rescue, Vehicle, Relays.

1. INTRODUCTION

Vehicles in this paper refer to automobile like cars, buses, vans and trucks. Vehicle snatching is a popular societal menace that involves trickily/forcefully taking over possession of someone's vehicle. Robbers often use it as an alternative in situations where it is difficult to defeat some of the modern security measures put in place by vehicle owners such as the Alarm Systems, Steering Wheel Locks, Finger Print Locks, Face/Voice Recognition System, Gearstick & Handbrake Locks, etc. (Stauffer & Bonfanti, 2006). Trying to act smarter or argue with a car snatcher could be a risk of the highest order. Cars are sometimes snatched by robbers just for the purpose of using them to commit crime and create an illusion. Therefore, vehicle snatching is not restricted to flashy or expensive cars and should be a subject of concern to every vehicle owner (Roberts, 2012). When a car is snatched sometimes, babies and more valuable/adorable items go with it. "In December 2016, data from the National Bureau of Statistics (NBS) showed that 2,544 vehicles were stolen between 2013 and 2015, out of which 1,377 vehicles were recovered, and this brings the national recovery rate to 54 per cent" (The Punch Newspaper: April 9, 2017).

This data shows that the nation's stolen vehicle recovery capability was about 5 out of every 10 stolen vehicles. Meanwhile, the resources (money, time, and man-power) expended in search of the missing vehicles would have been channeled towards the economic growth and development of our country.

Car snatchers are devising new techniques every day. They sometimes take advantage of a gridlock where they would storm the road and fired gun shots in the air sporadically such that motorists would flee the scene abandoning their vehicles, after which the robbers would do away with the cars of their choice. Deliberate car bashing is another strategy. Here the bandit would drive faster and hit the targeted car from behind expecting the owner to stop and rush out for an argument. Once the motorist walks closer to the rear of the car to examine the extent of damage, the car would be zoomed off by the robbers. Ladies are sometimes used as bait for male motorists. In this tactic, a pretty-looking lady would stand by the roadside, pretending to be waiting for a commercial vehicle and when she succeeded in enticing a male motorist, her destination made known to him is the location where members of her gang would be waiting to snatch the car.

Disguising as a mechanic to help stranded motorists fix their vehicles is also a strategy used by car snatchers. In the process of putting the vehicle in shape, they gain access to the car key and zoom off. Car snatchers even go to the extent of disguising by the road sides as men of God or somebody in critical health situation to arouse sympathy of unsuspecting motorists but after being offered a helping hand, they reveal their true identity and take over ownership of the car forcefully. (Linden & Chaturvedi, 2005). Considering all of these car snatching strategies it is understandable that no matter how smart and careful a motorist could be, the chances of falling a victim is still very high.

1.1 Stolen Vehicle Recovery Techniques

Retrieval of stolen vehicles is actually tedious and time-consuming. However, there are certain methods through which stolen vehicles can be recovered. Though none of them has come without its own ugly side. In this subsection, we shall quickly make a review of some of these techniques.

A) GPS/GSM Based Vehicle Tracking System

This system provides real time information about the whereabouts of a stolen vehicle. It combines the use of GPS (Global Positioning System) technology for finding the location of a vehicle and GSM (Global System for Mobile Communication) technology for reporting the information to a base station. In order to determine the location of a vehicle, the GPS needs a clear line of sight to three satellites. (Ashwini, 2016). This means that the GPS Module will not be able to find a vehicle's location in situation whereby the snatched vehicle has been driven away and parked in a place that blocks the sight lines such as concrete structures. This tracking system will also fail whenever the snatched vehicle is being driven to "dead spots" (places where cell phone service does not work). Therefore, the GPS/GSM Based Vehicle Tracking System is better implemented in developed countries. It also attracts monthly subscription charge which hinders its affordability.

B) VHF-Based Vehicle Tracking System

This technique addresses the challenges in the use of GPS technology. It uses FM radio frequency technology. The VHF systems can locate a stolen vehicle even if it is hidden in an underground car park or storage container. (Bhanu & Sirisha, 2014). However, this technology is not an assurance for immediate retrieval of stolen vehicles.

C) VIN Etching

This is the process of stamping a car with its identifier. Every vehicle has a unique 17-digit VIN (Vehicle Identification Number) assigned to it. Vehicle owners sometimes etch this number onto both visible and invisible parts of their vehicles. Actually this will not stop the vehicle from being snatched but the visible etchings will serve as a warning that snatching such a vehicle would require replacement of so many parts despite the fact that the tendency of being caught eventually still remains very high. The spare wheel, jack and other similar equipment kept in vehicles are also marked using ultra violet pen as a security measure that makes vehicles more recoverable if stolen. (Ashwini, 2016). Though, it entails a lot of effort/time to recover a vehicle through its etched VIN.

2. METHODOLOGY

The stolen vehicle rescue gadget requires a mobile station for its operation. It consists of a GSM modem used to allow communication between a mobile station and the snatched vehicle. The modem was configured to send specific AT-commands to a microcontroller immediately it received certain SMS message from the mobile station. The microcontroller on the other hand was programmed such that its dedicated output ports go LOW or HIGH depending on the commands it received from the GSM modem which also depends on the content of the text message sent from the mobile station. Electromagnetic relays were connected to the output port of the microcontroller through relay driver circuits. These relays were used to open or close the ignition circuit based on the status of the microcontroller output ports. When the ignition circuitry of a vehicle is opened, the entire ignition system will not work or stop functioning due to lack of continuity in the wiring.

2.1 System Overview

A) **The Mobile Station**: This is the means through which a car-snatch victim can quickly send an SMS message to the mobile number of the vehicle rescue device. Any cell phone containing a valid SIM and capable of sending text messages can serve as the mobile station.

B) **The GSM Network**: This consists of different elements that all interact together to permit communication between the two SIM cards involved in the design.

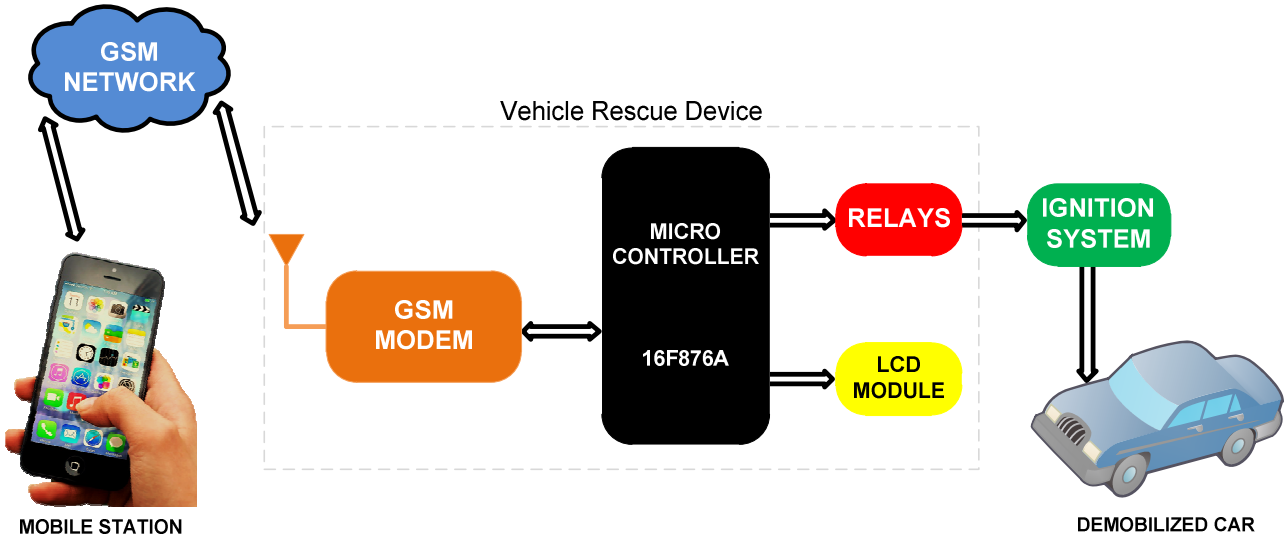

Figure 2.1: Architecture of the SMS-Based Stolen Vehicle Rescue System

C) The Vehicle Rescue Device: This is the designed gadget itself which is hidden in a vehicle to interrupt the ignition system. Some of its major constituents include:

1. **The GSM Modem**: This is a SIM300 Module that sends AT-commands to the microcontroller as soon as it received a text message from any mobile phone. The corresponding command sent to the microcontroller depends on the code received from the mobile station.
2. **The Microcontroller**: This is PIC16F876A microcontroller which energizes or de-energizes the electromagnetic relays in accordance with a set of programs written in C language.
3. **The Relays**: These are electrically operated switches. Their purpose in this design was to switch OFF/ON a relatively high voltage vehicle ignition system through a low power circuit.
4. **The LCD Module**: This is a 16 x 2 liquid crystal display module used to provide user interface and for debugging purpose. It displays information about the status of the GSM module or any on-going process in the microcontroller during implementation and testing of the system.

D) The Ignition System: This part of an automobile is essential for starting the engine as well as maintaining its activeness. Whenever the relays are energized by the microcontroller, the NC contacts open and the ignition system will be switched-off thereby immobilizing the vehicle.

2.2 Implementation

The desired result is achievable only when the microcontroller is able to communicate with the other hardware involved. Therefore, interfacing of the GSM modem as well as the relays with the microcontroller is very crucial for the accomplishment of this project. However, either of these interfacings most begin with that of the LCD. The programs for interfacing each of these hardware with the microcontroller were written in C language, while Keil µVision5 was used to create hex file (machine language) from the C code and ProgISP was used to load the hex file on to the chip.

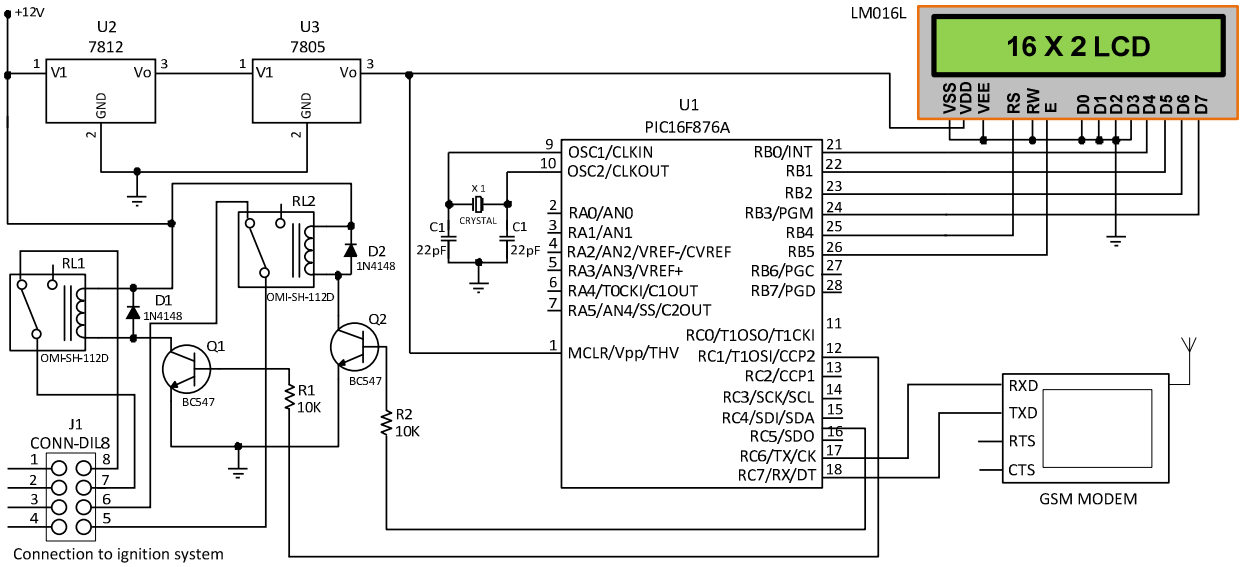

Figure 2.2: Circuit Diagram of the Vehicle Rescue Device

LCD Interfacing with PIC16F876A Microcontroller

In the connection of the display unit, VSS, VDD and VEE were used as power pins, while RS, R/W, and E were the control pins and D0 to D7 were wired as the data pins. In the program for this interface, pin 4 & 5 of port B on the microcontroller were declared as control pins. Therefore the control lines of the LCD (RS and E) were connected to RB4 and RB5 respectively. Similarly, pins 0 to 3 of the same port were declared as the data pins and the data buses of the LCD (D4 - D7) were connected to the corresponding pins of the microcontroller. (*Figure 2.2*). The LCD module has an in-built HD44780 controller with which the PIC communicates in order to display character on the screen. This controller must be initialized before sending data to the LCD module. In the HD44780, data can be sent in either 4-bit 2-operation or 8-bit 1-operation. Hence this controller can interface to both 4 and 8 bit MPUs. The 4-bit 2-operation implies that data transfer between the HD44780 & the MPU is done by transferring 4-bit data twice if the interface data is 8 bits long. Data of the higher-order 4 bits (contents of D4-D7) is transferred first before data of the lower-order 4 bits (contents of D0-D3). In this project, data was transferred using only 4 buses (D4-D7) while D0-D3 were not used (*Figure 2.2*). The 8 data buses (D0-D7) are preferably used when interface data is 8 bits long.

GSM Modem Interfacing with PIC16F876A Microcontroller

The SIM300 module used in this project has RXD and TXD (with GND) pins on board, which makes is capable of working at TTL (Transistor-Transistor Logic) logic and eliminates the use of MAX232 IC to connect serial port to the microcontroller. In the program for this interface, we declare the TX and RX pins and initialize asynchronous reception and transmission at 9600 baud rate and 8-bit mode. A GSM modem requires a wired connection at one end and wireless at the other. Therefore, the RXD of the GSM modem was connected to TX (pin 17) of the PIC microcontroller, while TXD of the modem was connected to RX (pin 18) of the microcontroller. (*Figure 2.2*). A serial connection was then established between the GSM modem and the microcontroller such that the RXD and TXD could be used for receiving and transmitting data continuously. The modem and microcontroller were also connected to a common ground.

Interfacing the Relays with PIC16F876A Microcontroller

The electromagnetic relays are activated by energizing a coil wounded on a soft iron core. They were not connected directly to the microcontroller for two main reasons. Firstly, a negative voltage which may affect the microcontroller is produced in the relay coil due to its back EMF when energized. Secondly, the microcontroller is not capable of supplying the current required for operating the relays. The maximum current a microcontroller can source or sink is 25mA, while a relay needs about 50-100mA current. Therefore, two driving circuits were developed for interfacing each of the relays with the microcontroller. The circuit consists of NPN transistors Q1 and Q2 (BC547) which were connected as switches that carry the current required for operating the relays. It also consists of diodes D1 & D2 (freewheeling diodes) which were used to protect the transistors as well as the microcontroller from back EMF generated in the relays coil. 1N4148 was used because it is a fast switching diode with peak forward current of 450mA. In the program for this interface, pins RC0 and RC1 were declared and outputs from these pins were connected to the base of the transistors (*Figure 2.2*) because a very small current flowing from base to emitter causes a large current to flow from collector to emitter.

2.3 Testing

The entire hardware were assembled inside a covered 4 by 4 PVC box to make a compact device which can be part and parcel of a vehicle. The rescue gadget was then fitted on to a car in such a manner that it is not visible to anyone inside or outside the car. This was carefully done to enable the device, which receives power supply indirectly from the car battery, operate as a covert unit.

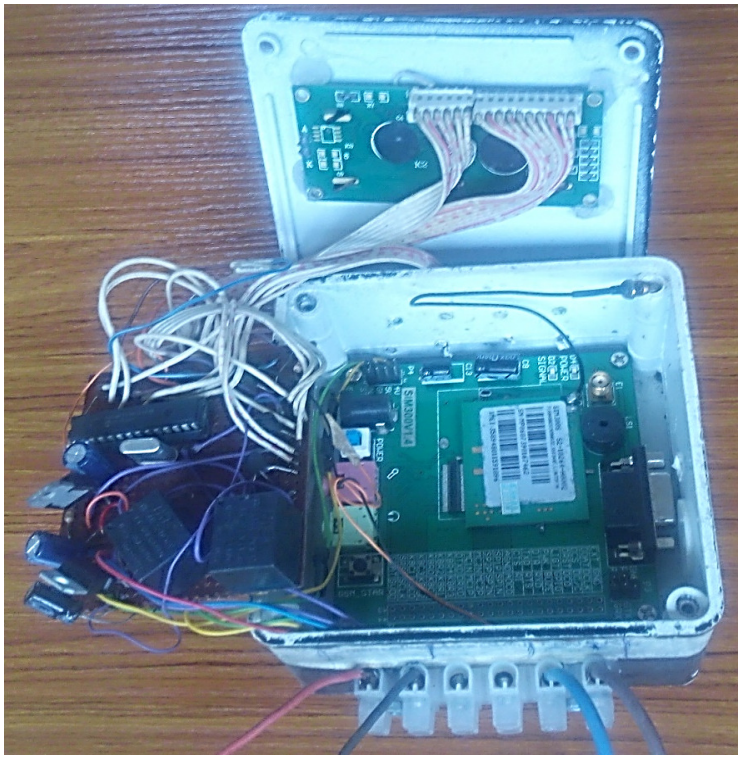

Figure 2.3: Internal View of the Vehicle Rescue Device

The gadget was connected by interrupting the ignition system of a car. Cables running between the ignition switch and the starter were broken at a "difficult to reach" point. Thereby creating an open circuit in the ignition wiring. Then, cables emanating from the electromagnetic relays of the rescue device were connected at that point to bridge the intentionally created gap. The whole idea here was to ensure that current cannot get to the starter except through the rescue device. In spite of this interruption in the ignition system which has brought the rescue device connected in series with the ignition circuitry, continuity was still maintained in the overall wiring because the normally closed (NC) contacts of the relays were used. Although a mechanical ignition system has been used for testing the device, it is applicable to any other type of ignition system since they all work on a similar principle.

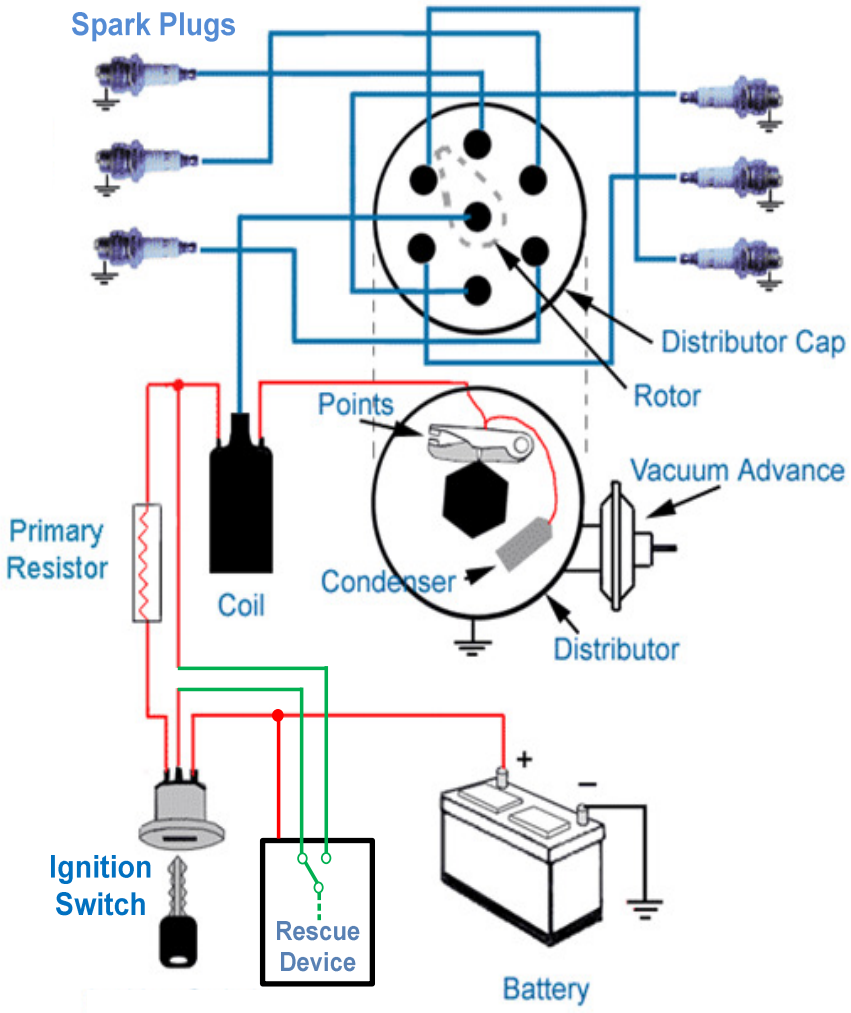

Figure 2.4: Wiring Diagram of a Car Ignition System Incorporating the Rescue Device

3. RESULT AND DISCUSSION

While someone was driving the car in which the rescue device has been installed, an assumed car-snatch victim sent the SMS message "MAOFF" to the car using a mobile phone and the engine suddenly stopped. Efforts to quickly restart the engine failed until when the SMS message "MAON" was sent to the car through another mobile phone. When the text message "MAOFF" was sent to the mobile number of the SIM card inside the GSM modem, the SIM300 module sends corresponding AT-commands to the microcontroller. Consequently, pin RC1 of the PIC microcontroller goes HIGH (1), the transistor Q1 turns ON and current flows through the relay RL1. Similarly, pin RC0 of the PIC microcontroller goes HIGH (1), the transistor Q2 turns ON and current flows through the relay RL2.

The relays become energized and the NC contacts become open (*Figure 2.2*). As the ignition circuitry of the car is opened, the entire ignition system stopped working and the car was thereby brought to a halt. By sending the other text message "MAON" to the car, the SIM300 module sends a reverse AT-commands to the microcontroller. Consequently, pin RC1 of the PIC microcontroller goes LOW (0), the transistor Q1 turns OFF and no current flow through the relay RL1. Also, pin RC0 of the PIC microcontroller goes LOW (0), the transistor Q2 turns OFF and no current flow through the relay RL2 (*Figure 2.2*). The relays become de-energized and assume their original NC contacts, restoring continuity in the ignition circuitry. The system was tested several times at different times of the day with the car at various locations and the assumed car-snatch victim at varying distances away. The SMS charge of ₦4 deducted by the network operator for the message sent is all it costs to rescue a snatched vehicle.

Table 3.1 Summary of the Test Outcomes

Trial	SMS Sent	Engine Off	Time Interval	Distance Apart	Region	Network
1.	10:14 a.m.	10:16 a.m.	2 minutes	1.5 kilometers	Urban	Same
2.	12:32 p.m.	12:33 p.m.	1 minute	450 meters	Urban	Different
3.	8:08 a.m.	8:11 a.m.	3 minutes	1 kilometer	Rural	Different
4.	5:26 p.m.	5:27 p.m.	1 minute	3 kilometers	Urban	Different
5.	8:47 p.m.	8:49 p.m.	2 minutes	120 meters	Rural	Same
6.	6:51 a.m.	6:52 a.m.	1 minute	2 kilometers	Rural	Same

4. CONCLUSION

Vehicles are investments and as such deserve the best in terms of security. When a car is snatched, more cherished belongings are also lost. The fact that a car is not flamboyant or deluxe does not mean it is free from being snatched. Vehicles are snatched sometimes just to create illusions after being used to commit crimes. Some people are facing robbery charges today because stolen vehicles were found in their custodies which they ignorantly purchase from fake car dealers. Considering these vices associated with car theft, this project was done to make it extremely difficult for robbers to escape with snatched vehicles. When the engine of a snatched vehicle suddenly stops, the criminals would panic. Even if they can somehow locate and bypass the rescue device, the extra time it would take will discourage them from making such attempt. The vehicle would definitely be abandoned as they run away with the thought that certain individuals could be tracing them.

With the implementation of this system, any victim of car-snatch can be rest assured of recovering the vehicle within the shortest time period, without much stress and at minimum cost. Similarly, there will be reduced rates on vehicle insurance since the tendency of losing a vehicle to robbers becomes very low. Deploying this technology would thus enhance our social-economic development as the resources wasted in search of missing vehicles would be productively utilized. The mobile number of the SIM inside the device remains the "rescue number" of the vehicle if snatched and should therefore be confidential and memorized. The advancements required on this work include incorporation of a vibration sensor to automatically send SMS message to designated mobile number(s) in case of accident. Also, establishing communication with the snatched vehicle without absolute reliant on network coverage of the mobile operator would be a great revolution in this research area.

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