SMART VEHICLE SECURITY AND TRACKING SYSTEM

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SMART VEHICLE SECURITY AND TRACKING SYSTEM

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Submitted by **Yasir Isam AL-ADHAMI**

Approval of the Graduate School of Natural and Applied Sciences, Çankaya University.

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ABSTRACT

SMART VEHICLE SECURITY AND TRACKING SYSTEM

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In this thesis, we design a smart vehicle security and tracking system for tracking and monitoring vehicles. It is a simple system device. Users can install this system device in their vehicles and use it without any difficulty. It is active for any smartphone that can use Google Maps, and send and receive SMS.

The smart vehicle security and tracking system consist of two parts: the hardware and the software. The hardware consists of five units: a GSM modem, a microcontroller, a GPS modem, an Ultrasonic Sensor and an RFID modem.

The first important component of the hardware is the microcontroller, which is the brain of this system. All hardware units connect to this microcontroller. The Arduino Mega 2560 and Arduino UNO are used to build this system.

The second device is the SIM900 GSM/GPRS modem. This modem is used to connect to the GSM network and is responsible for sending and receiving instructions and alerts.

The third device in the system is the GPS modem. This modem obtains vehicle position and sending this information to the vehicle owner’s mobile phone.

The fourth device is the Ultrasonic Sensor. This sensor is used to stop a vehicle when it unsafely approaches any object such as another car, tree, wall, or person if the driver is busy, loses concentration or has a heart attack or any event that causes the driver to be unable to drive.

The fifth device in the system is the RFID. This device is used as a security device in cases where the vehicle door is opened illegally without the use of the RFID card system. This device will send an alert to the owner.

The software is the second part of this system. The purpose of the software is to control and monitor the system.

Keywords: Vehicle Tracking, Smart Vehicle, Security Vehicle.

ÖZ

AKILLI ARAÇ GÜVENLİK VE TAKİP SİSTEMİ

AL-ADHAMI, Yasir Isam
Yüksek Lisans, Electronik ve Haberleşme Mühendisliği Anabilim Dalı
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Akıllı araç sistemi basit bir sistem aygıtıdır. Kullanıcılar bu sistem aygıtını kendi araçlarına kurabilirler ve herhangi bir zorluk çekmeden kullanabilirler. Sistem, Google Maps kullanılabilen ve ayrıca SMS alıp gönderebilen bütün akıllı telefonlar için etkin/aktiftir.

Akıllı araç güvenlik ve takip sistemleri 2 bölümden oluşur. Bunlar donanım ve yazılımdır. Donanım bölümü ise kendi içinde 5 birimden oluşur: GSM modemi, mikrodenetleyici, GPS modemi, Sesüstü Algılayıcı (ultrasonik sensör) ve bir de RFID (radyo frekansı ile tanımlama) modemidir.

Donanım bölümünün ilk önemli bileşeni mikrodenetleyicidir. Mikrodenetleyici bu sistemin beynidir. Donanımın bütün birimleri bu mikrodenetleyiciye bağlanır. Arduino Mega 2560 ve Arduino UNO bu sistemi oluşturmak için kullanılır.

SIM900 GSM/GPRS modem ise ikinci bileşendir. Bu modem, GSM şebekesine bağlanmak için kullanılır. Ayrıca talimatları alma, gönderme ve uyarmakla sorumludur.

GPS modem bu sistemin üçüncü bileşen aygıtıdır. Bu modem aracın pozisyonunu alır ve bu pozisyonun araç sahibinin cep telefonuna gönderilmesini sağlar.

Ultrasonic algılayıcı sistemin dördüncü aygıtıdır. Bu sensör, eğer sürücü meşgulse, konsantrasyonunu kaybederse, kalp krizi geçirirse ya da sürücüyü aracını süremez hale getirecek herhangi bir nedenden dolayı aracın herhangi bir objeye (araba, ağaç, duvar, insan, …) güvenli olmayan bir biçimde, tehlikeli olarak herhangi bir yaklaşımı olursa aracı durdumak için kullanılır.

Donanım sisteminde beşinci aygıt olarak ise RFID (radyo frekansı ile tanımlama) kullanılır. Bu bileşen ise aracın kapısı, RFID kart sistemini kullanmadan, illegal olarak açıldığı zaman güvenlik cihazı olarak kullanılır. Bu cihaz, aracın sahibine bu gibi durumlarda uyarı mesajı yollar.

Yazılım bu sistemin ikinci parçasıdır. Yazılım sisteminin amacı ise sistemi kontrol etmek ve gözlemektir.

Anahtar Kelimeler: Araç Takip Sistemi, Akıllı Araç/Araba, Araç Güvenliği.

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LIST OF ABBREVIATIONS

NCIC	National Crime Information Center
GSM	Global System for Mobile Communication
GPS	Global Positioning System
SMS	Short Message Service
IDE	Integrated Development Environment
RFID	Radio Frequency Identification
SIM	Subscriber Identity Module
ID	Identity
LEDs	Light Emitting Diode
IBM	International Business Machines
PIC	Peripheral Interface Controller
USB	Universal Serial Bus
FTDI	Future Technology Devices International
DFU	Device Firmware Upgrade
PCB	Print Circuit Board
SMT	Surface Mount Technology
VIN	Input Voltage
GND	Ground
TTL	Transistor Transistor Logic
MOSI	Master Out Slave In
MISO	Master In Slave Out
SPI	Serial to Peripheral Interface
SCK	Slave Select
ICSP	In Circuit Serial Programming
TWI	Two Wire Interface
AREF	Analog Reference

CHAPTER 1

INTRODUCTION

1.1 Introduction

In spite of the various technologies that have been developed in recent years to prevent auto theft and to track auto theft, vehicles all around the world are still stolen every year. In accordance with (NCIC), in 2006, 1,192,809 engine vehicles were registered as stolen; the loss was $7.9 billion.

A variety of safety and monitoring systems has been designed to help businesses administer and manage a significant number of vehicles. A system for fleet management can lower the cost and efforts of employees to complete assignments on the road in a minimum time. In addition, tasks may be programmed while in progress based on actual vehicle location. Therefore, the central leadership of the fleet is essential for large companies to meet various customer requirements and enhance productivity [1].

However, there are still some security loopholes where these technologies do not prevent auto theft. Some of these security loopholes do not help to recover vehicles or allow users to know the state of their vehicles. The proposed security system herein is designed to monitor and control vehicles that are used by individual parties for a particular purpose, to slow and disable the vehicle in the event of theft and to track it online for retrieval. This system is the integration of several modern and integrated communication technologies [2]-[3]. To provide the location and time anywhere on Earth, the GPS is used to acquire the receiver signal position. Using Google Maps, the owner can display location information. In wireless data transport, GSM and SMS technology are standard features with all mobile phone service providers' networks [4]-[5]. The use of SMS technology has become popular because it is reliable, cheap, convenient and an affordable way to transfer and receive data. [6] Fig.1 shows the system that we introduced, consisting of a GPS modem, a GSM modem, [7]. Google Earth plays a role to stop any fleet vehicle in cases of auto theft; other pertinent information for each vehicle in the fleet can also be viewed [8]-[9].

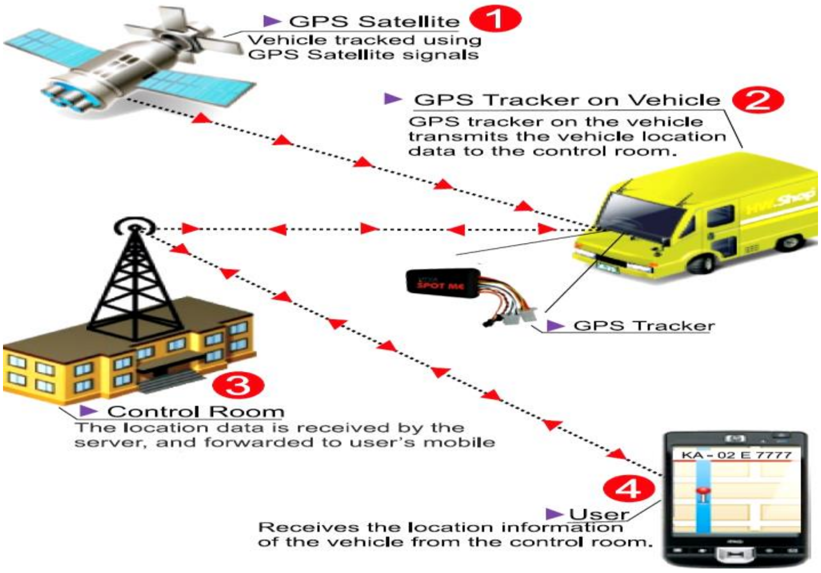

Figure 1: Vehicle tracking system operation steps [3]

As shown in Fig. 1, when the car is launched, the client receives a confirmation SMS, which is running now. If this operation is illegal or an intruder attempts to operate the car; the owner may send an SMS to disable the car. When the system receives a message from the owner, the system will do a security check for the number that received the message. If this message is received from the owner, the microcontroller will send an instruction to turn off the engine. When the owner wants to know the vehicle position, an SMS with a special message is sent. Then the vehicle owner will receive an SMS showing the location and position of the vehicle. The owner can communicate with the vehicle via the mobile phone to follow the vehicle. Google Earth and the monitoring system that implements security can be used to control different parameters related to safety, theft, emergency services and engine shut down. This thesis shows implementation of many modern technologies to accomplish a desirable objective of monitoring and vehicle management.

1.2 Literature Survey

Javed Parvez [10], 2010, in his project paper, shows that the concept of a car tracking system depends on the mobile phone and network. The software in this system proposes to send an individual request to the cellular network (GSM) to reach and call a private car ID. The car ID, in fact, is a special SIM kept in a secret device inside the car. This device can receive and send messages and receive phone calls automatically. When a call is setting up, the private data will be ready for the BSC, which is passed to the software. Depending on the data and information which is collected, the software will dissect and analyze the cell information and take the data along with the Global Positioning System (GPS) locations for this cell, and determine the position of the vehicle.

Iman M. Almomani [11], 2011, in his project paper, shows that the Global Positioning System (GPS) is popular and is used for tracking and monitoring vehicles. Many systems have been created to provide these services to make them attractive and more necessary than ever. In this work, a "control system GPS vehicle" is proposed. This system is used to monitor the behavior of employees; moreover, this system is used to prevent theft. As a recovery device, in addition to working as a safety system, alarms are combined with the car. The main job of this work is to provide two types of end-user applications: a web application and a mobile application.

Atso Yao Nelson [12], 2012, in his project report paper, shows the development and design of GPS (Global Positioning Systems) and how GSM (Global System for Communication) depends on car tracking and alarm. This systemiguer elps transport companies to reach and track their vehicles at any time and an alarm system is used to provide information about any armed robbery or accidents.

Pham Hoang oats [13], 2013, in this project paper, shows the design of vehicle tracking and monitoring system hardware. These systems obtain the position of the vehicle through GPS and transmit it via the GSM modem attached to the owner's cell phone via the local mobile network. The principal element parts of the equipment in this system are the GPS modem, GSM modem and microcontroller.

Ahmad Fuad Muhammad Ridwan [14], 2014, in his this paper and project, shows the design of an observing and monitoring system that uses GSM and Google Maps remotely. The GSM acquires the position via SMS and then updates the information in a database on the website when the information is acquired. The coordinates of the car are determined via the Google Maps application. The website design and development help cars owners to track and monitor their cars. Owners are able reach this website at any time and in any place if they have an Internet connection.

Montaser N. Ramadan [15], 2012, a security system that apply efficiency car theft. The main system consists of the GPS (Global Positioning System) and GSM (Global System for Mobile). Customers respond by using this system in their cars to find their position using Google Maps. (Moreover, car owners can determine the coordinates and current location of their cars by using Google Maps using the GPS locator, via the SMS (Short Message Service) from the GSM network to a GSM modem attached to a laptop or PC. Using a wide Kalman filter straightens the location of the GPS. This system is very effective and reliable and informs the user if there is an emergency, accident or a problem in the engine.

CHAPTER 2

BACKGROUND

2.1 Introduction About Arduino

The Arduino is a microcontroller device. This microcontroller is a free source device that was developed to make easy connections with different sensors (to register and know user input), and to execute and action, give responses from the hardware devices such as through LEDs, speakers and motors.

The history of the Arduino and its features are explained in this chapter. The most important feature is the simplicity of its programming. Therefore, anyone with little experience can program and work on it. In addition, it facilitates the work of artists and designer [16].

Computer engineers developed the first microcontroller used in the scientific, military and business sectors. An analysis of needs led them to manufacture a new group of microcontrollers for hobbyists, designers, and artists. The computer, as we know it, is a device used for processing and storage of data and displaying information [17]. The concept of the computer originated from the first calculation device that was developed in 2300 BC, and the mechanical gears that were developed by Blaise Pascal [18].

The first computing device, Charles Babbage's Analytical Engine, consisted of wholly of what can be considered modern computer elements, such as memory, input data and a screen,. The computer as we now know it was developed in 1940 out of necessity by the military during World War II for the manufacture of munitions, and decryption of Nazi code contacts, which led scientists, researchers and engineers at that time to develop the computer [19].

When vacuum tubes were the new technology, the first mercantile electronic computer, Univac (USA, 1951), was constructed . Previously, people used cards and tapes to store important data. However, after that mercantile electronic computers were used to store important data. It was the first in the field to store programs. The IBM 702 was the rival of the Univac. This was new in the computing field. Statistical analyses and data processing were necessary in work environments and in the financial world. These computers became omnipresent in these fields.

Solid-state computers, such as the IBM 1401, were developed in the 1960s. This saw an explosion of development in computing in the 1960s. Earlier, vacuum tubes were used for storage but were replaced by magnetic core memory. Moreover, in the 1960s, transistors began to be used for processing operations in computing. Magnetic core memory and transistors are important for hardware because they increase the density of hardware. the last ten years, programming languages were improved, which is considered to be a significant improvement during these years, especially in the field of symbolic language for basic/simple English. In this way, programs can be understood by everyone since the computer code is understandable (as the language of older devices includes only letters and numbers instead of words). This development enables people not expert in some computer operations to check code. During this time, two essential languages were presented: FORTRAN, a language for scientific computing, and COBOL, a language for business applications. Another important improvement/development occurred when Jack Kilby developed the united circuit in 1959. This saw the development of integrated circuits and transistors on small chips of silicon and other semiconductor substances. With this innovation, many elements of the computer were miniaturized.

The microprocessor was released in the first years of the 1970s. During this time, it was considered an important innovation in the contemporary history of the computer. The hardware elements were the main processing parts and were considered to be the brain of the computer. The microprocessor was reduced in size and became the brain of a computer. Moreover, it was put onto one small integrated circuit. Instead of a miniaturized microprocessor, the microchip is more commonly used. In addition to all of these developments, the microchip became an important component for microcontrollers (such as the Arduino), which usually comprises of the hardware output/input sensors, a microchip and memory storage hardware. It has a useful small shape. Thus, the microprocessor has been used in numerous fields such as electronic machines (computers, calculators) for a long time [20].

If improvement of the microcontroller is desired (on the known bases of microcontrollers from the first electronic computers), then recent microcontrollers should be examined. To supply the needs of a user with some technical information (such as the simple needs of advertising, academic fields and business), and to supply the needs of the normal user, the latest microcontrollers are envisaged. In 1985, General Instruments presented the PIC microcontroller [21]. Nowadays, the Arduino is the device of choice for electronics admirers. However in the past, the PIC microcontroller held a level of popularity similar to that of the Arduino today. The PIC microcontroller was suitable for sensors and input and output tools (LED, motors). Moreover, it was easy and quick to program the board by the way of PBP, which is one of the easy languages. In addition to these reasons, it had ample memory to keep programs on board via flash memory (on-chip). In this way, there should be something to do it (that is not wanted) and can be deleted and can be programmed repeatedly at any time. Other popular fans together to include the BASIC Stamp (Parallax Inc., 1990) [22], and wiring (one of the first microcontroller board designed specifically for electronic art and explorations of tangible media) [23].

“DIY” means “do it yourself.” Quick modeling boards, such as PIC, have been developed and are known by everyone as a favorite. Due to these known quick modeling boards, “DIY” was created. Besides all these, the Arduino Project was improved this way. Designers and artists require the Arduino because their work interrelated and thus they needed to carry out their work as smoothly when modeling.

For this reason as already mentioned, the Arduino Project improved. Many academicians and professors have attempted to develop the Arduino, some work of which proving useful. Nevertheless, people still try to improve it. In addition, it has some features including a USB port. The card can be programmed via the USB port. It is a cheap device. In addition, it has many different areas to use for project works. For instance, the Arduino Lily pad that can be used for entertainment and in the project sector. The smaller model Arduino Mini is useful for small objects, and the Arduino BT contains a Bluetooth connection. As can be seen from its improvement, the Arduino is a very important device, and it is used everywhere with increasing sales day by day.

Nowadays, the importance of the Arduino microcontroller increases day by day because of its use as a substructure for the most favorite building models. Moreover, it is used in fields such as business, science and the military to create new and unique applications in software and hardware technologies. In addition, people finding something new in their fields (new media design and art, for example) require some assistance. As already mentioned, these three fields can be used repeatedly to meet these requirements using computers. A MiniArduino , which is smaller than others Arduino; is useful for small objects, and the Arduino BT has a Bluetooth connection. As it can be seen from its improvement, the Arduino is a very important device, which is used everywhere with increasing sales day by day.

2.1.1 Arduino UNO

The Arduino UNO modem is an open source programming system. It consists of two parts, the Arduino IDE Integrated Development Environment and the board. The Arduino UNO board has an ATmaga microcontroller. With the Arduino board, engineers and hobbyists can connect to the microcontroller and use it easily.

The ATmaga microcontroller is the heart of the Arduino. We can communicate with this microcontroller through the micro C programming language. The micro C programming language is a well-known language that engineers and hobbyists can use easily.

The Arduino UNO microcontroller board consists of a number of pins, 14 of which are digital and used for input/output, and six of which are used for analog inputs. This microcontroller has a USB connection to communicate with a computer and supply the Arduino with power. This Arduino supports the microcontroller with everything that the microcontroller needs. The Arduino UNO differs from other Arduino microcontrollers such that it does not use a USB to serial FTDI chip. Moreover, it uses the Atmega16U2 program to convert from USB to serial.

The Arduino UNO also has SCL and SDA pins beside the AREF and two pins beside the RESET pin. One of these pins is the IORF pin. The main work of this pin is to allow the modem to acquire the voltage from the board.

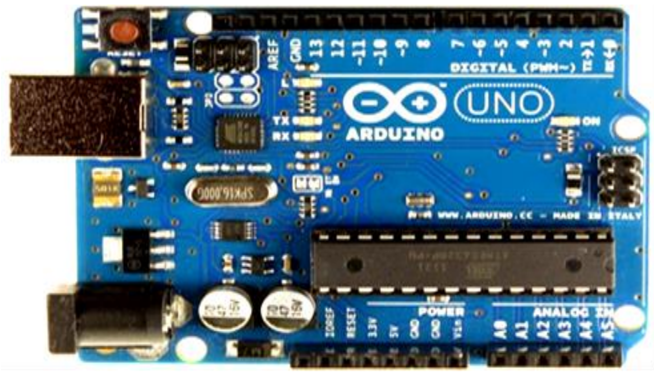

Figure 2: Arduino UNO board [16]

In Fig. 3, we can see the Arduino IDE. The IDE is environment of software to build the program call “sketches,” it will be implemented by the hardware of the Arduino. The IDE job is to define the C program language to write, analyze, and send the code for microcontroller board. The microcontroller usually uses the C program language.

The IDE supports the user that can work on C program language, by big libraries. These libraries have many numbers of functions.

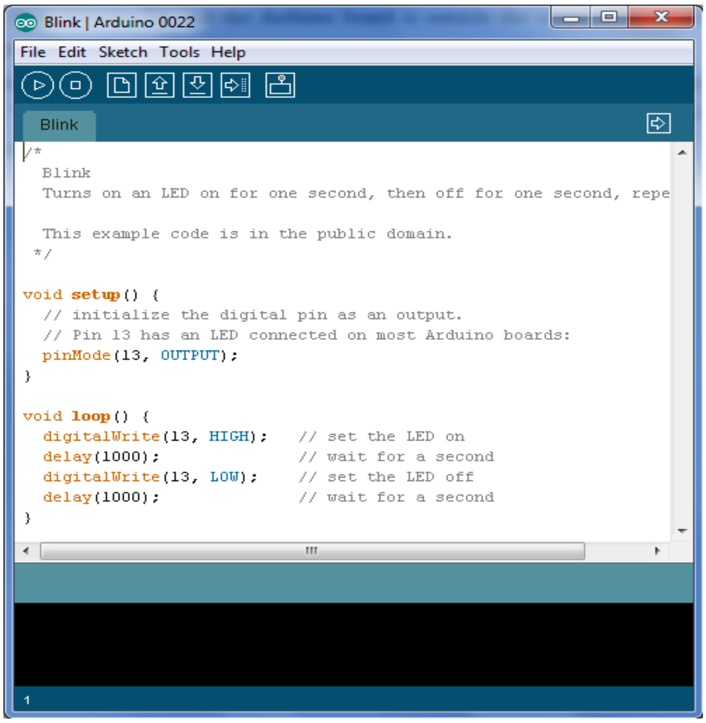

Figure 3: Integrated development environment

2.1.2 A Comparison between Arduino Mega and Uno

Hardware Components	**Arduino Mega 2560**	**Arduino Uno**
Microcontroller	ATmega1280	ATmega328
Operating Voltage	5V	5V
Input Voltage(recommended)	7-12V	7-12V
Digital I/O Pins	54	14
Analog Input Pins	16	6
Flash Memory	128 KB	32 KB
SRAM	8 KB	2 KB (ATmega328)
EEPROM	4 KB	1 KB (ATmega328)
Clock Speed	16 MHz	16 MHz

Table 1: Comparison Between Arduino UNO and Arduino Mega

2.2 GPS

GPS is an acronym for the Global Position System. There is no other GPS system today that can determine our position on Earth in any place, at any time, and under any weather condition. They always check at ground stations existing around the world. GPS satellites send signals that can be received by any person with a GPS receiver [24].

In 1973, the GPS was developed in the USA. The defense department in the USA uses it as a global navigation and positioning resource for both military and civilian use 24 hours per day under any weather condition [25]. NAVSTAR GPS is made up of 27 satellites.

The GPS system uses 24 satellites and three spare satellites. These satellites orbit at an altitude of 20,200 kilometers in 6 different orbits. Each orbit has four satellites, and each satellite maintains a constant distance from other satellites. The GPS satellites transmit two signals L1 and L2, where L2 = 1227.6 MHz and L1 = 1575.42 MHz. L1 is reserved for civilian use, whereas military applications use L2. These two types of signal are modulated with two codes – C/A code and P-code – and a navigation message.

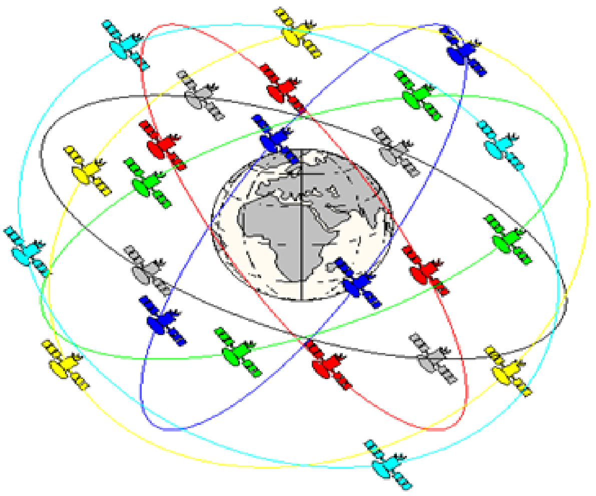

Figure 4: GPS satellites around the earth [24]

2.2.1 How Does GPS Work

The main work of this system is to find and measure distances between satellites and receivers. Receiver devices receive information from satellites and do some calculations to determine the exact receiver position. The satellites will give us information about their position from their orbits.

If we acquire the correct distance from two satellites, locations can be precisely determined. When these two signals that the satellites send intersect in the receiver device and, if we receive more signals from more satellites, a more accurate position can be determined. Fig. 5 shows the instructions of the GPS satellites in the receiver devices.

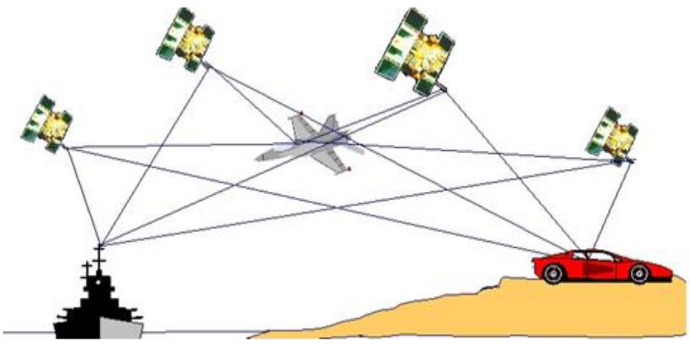

Figure 5: Receivers devices receive the satellites signals [24]

The GPS system satellite sends signals to earth station equipment. These satellites continuously send radio signals to the ground station. Moreover, these radio signals transmit to the earth at a constant speed (186,000 miles per second). Each satellite has atomic clocks used for generating radio signals. The GPS receiver receives the radio signal and calculates the distance to each satellite based on the equation below.

$$\text{Distance} = \text{Velocity} * \text{Time} \tag{2 . 1}$$

Velocity is the speed of the radio waves (186,000 mi/sec).

Time is the difference between the satellites that send the radio signals and a GPS receiver as shown in the equation.

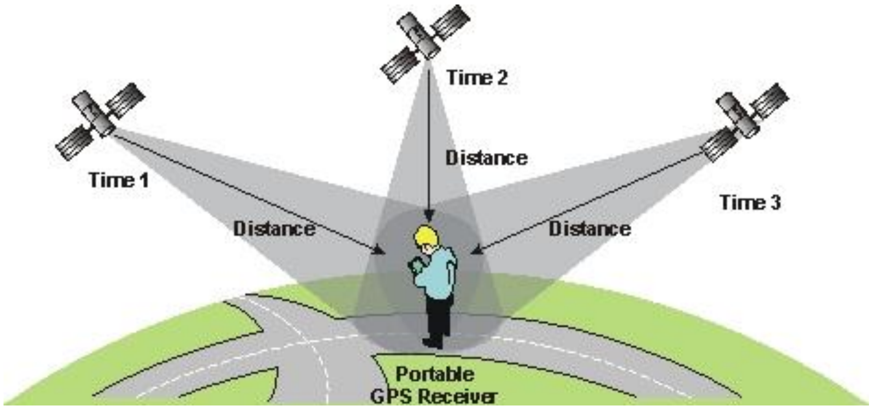

Figure 6: Different times and distances for GPS signals [25]

2.3 GSM

Second only to mobile phones, GSMs are the most widely used devices. Three billion people around the world in different countries use the Global System for Mobile Communication. In any place around the world, GSM enables global roaming between operators and mobile phones; therefore, users can use their phones in many countries. Speech and signaling channels of GSM are digital; therefore, GSM is different from the previous phone system and is considered to be the second generation (2G).

The GSM network operates at different kinds of frequencies. Moreover, frequency ranges differ from country to country. Second generation networks operate in a frequency range of the 900 MHz or 1800 MHz band. However, the USA and Canada use the 1900 MHz and 850 MHz bands. In Europe, the third-generation network operates in the 2100 MHz band [26].

The GSM-900 uses the frequency range between 890 MHz and 915 MHz to transmit data from the station of the mobile to a base station in a procedure called an uplink. The frequency range of 935 to 960 MHz is used to send data from the base station to the mobile station, and this operation is called a down link; this provides (0-124) RF channels.

2.3.1 How Does GSM Work

Consider the city a large cell and divide it into smaller cells; this is the central idea of the cellular phone. Therefore, we can reuse the same frequency everywhere in the city and many persons can use cell phones at the same time [27].

Across the city, the cell-phone carrier receives about 800 frequencies that are being used. The carrier divides the city into cells. The size of each hexagonal cell is 26 square kilometers, as shown in Fig. 7.

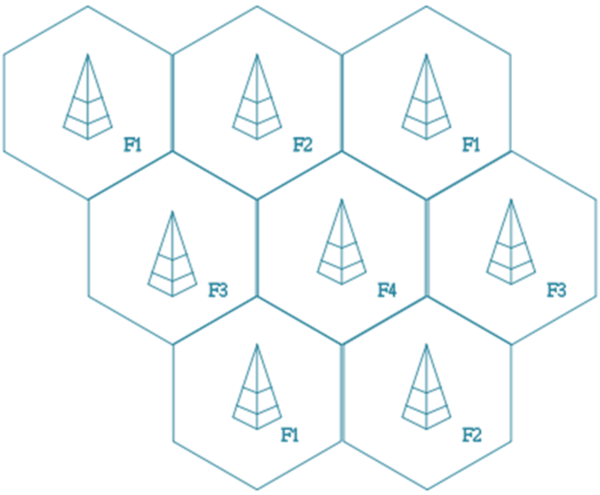

Figure 7: Same frequencies use in different cells [27]

In this system, the same frequency in a non-adjacent cell can be used due to the low power transmitters being used by the base station and cell phone. Every cell consists of a base station, and this base station has a tower and a small room with radio equipment. When a person uses a cellular phone and moves from a cell and enters another cell, the call will be transferred to the other cell and not end the call when the caller is outside the coverage area of the first cell.

2.4 RFID

The RFID is a device that uses radio frequency for identification. In this technology, the RFID reader uses the radio waves to receive the digital encode data by using the RFID card. The RFID technique is similar to the bar code method; however, the RFID uses radio waves to receive a digital signal from a smart card. Bar code technology is used to scan the label for the bar code. Therefore, the RFID technique is more advantageous than the bar code technique [28].

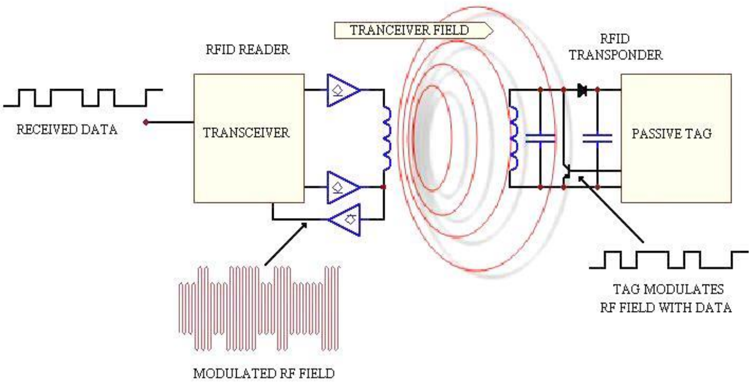

Figure 8: RFID technique operation [28]

2.4.1 How Does RFID Work

RFID is made up of three different parts:

1. An antenna for scanning.
2. A transmitter and receiver device with a decoder.
3. A responder.

The antenna that is used for scanning emits signals of the radio-frequency close range. Radiation of the RF does two jobs:

1. Find a way to communicate with the responder (RFID card); and
2. Supply the RFID card with power for communication.

The RFID card does not require a battery; therefore, it can be used for a long time. The antennas that are used for scanning are attached to the surface permanently. Handheld antennas are also available [29]. We can use them in different shapes as needed, and we can attach them to the doorframe in order to accept information for an object or person that will pass through them.

When the RFID card is within the coverage area of the scanning antenna, it will register a positive signal from the antenna, thus activating the RFID chip sending the data on its microchip to the antenna. There are two kinds of RFID cards: active and passive, as shown in Fig. 10.

Because an active RFID card has its own power source, it does not need power; the advantage of the active RFID card is shown by virtue of the fact that when the card is at a greater distance from the reader, it will still receive the signal. Although RFID cards are designed and developed to last up to ten years, they have a limited period life. A passive RFID card does not require a battery, so the passive card does not have a specified life expectancy. This means that the passive card will last longer than the active RFID card.

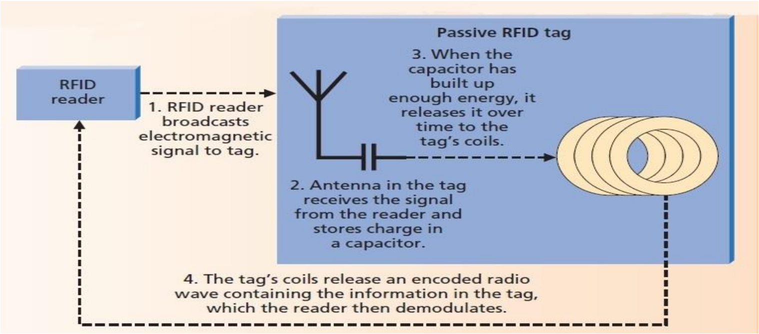

Figure 9: RFID steps operation [29]

2.5 Ultrasonic Sensors

The ultrasonic sensor is a sensor used to measure distance between a target object and the sensor by using mechanical and electrical energy. This sensor transmits ultrasonic waves and waits to receive reflected ultrasonic waves from detected objects. The ultrasonic sensor measures distance by timing how long the ultrasonic wave takes to return to the receiver.

2.5.1 How Does Ultrasonic Sensors Work

Fig. 10 shows how sensors are used for the measurement of distance between the sensor and an object, by using the speed of sound. When the sensor transmits ultrasonic waves, it will wait to receive a reflected ultrasonic waves and inform the object. The ultrasonic sensor measures the distance by timing how long the ultrasonic wave takes to return to the receiver [30]. Three meters is the coverage distance of this sensor. Ultrasonic sensors are used in different fields such as medicine and security. In this thesis, an ultrasonic sensor is used in emergency cases to decelerate or stop vehicles. Emergency cases may include the driver being unable to drive or the vehicle in an imminent collision with an object due to its unsafe proximity to that object.

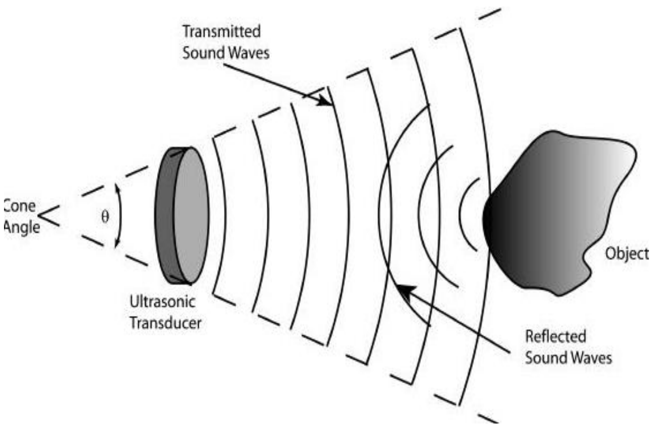

Figure 10: Ultrasonic main operation [30]

CHAPTER 3

SYSTEM DESIGN ARCHITECTURE AND CONNECTION

3.1 Introduction

The smart vehicle security tracking system consists of two parts: hardware and software. The hardware consists of many units: the microcontroller, GSM modem, GPS modem, RFID modem and Ultrasonic Sensor.

The most important piece of hardware is the microcontroller. The microcontroller is the brain of this system; all these hardware units connect to the microcontroller. In this system, In addition, the SIM900 GSM/GPRS modem is used to connect to the GSM network. This modem functions to send and receive instructions and alerts.

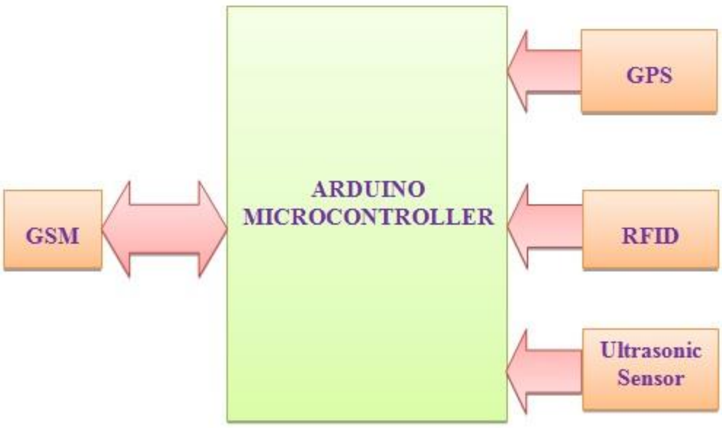

Figure 11: System design architecture

The RFID is the first security step in our system. When a thief attempts to open the vehicle door without using an RFID card, the door will send an alarm to the microcontroller and the microcontroller will send an SMS to the vehicle owner's phone via the GSM modem that connects to the microcontroller in our system.

The PING SENSOR is a second step for security and safety. It is used in cases where the driver is unable to drive, or if the vehicle approaches precariously close to any object. This sensor sends an alarm to the microcontroller. The microcontroller will immediately reduce the speed and bring the vehicle to a complete stop.

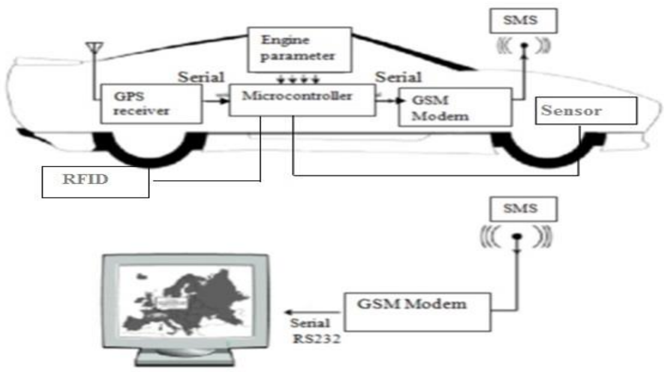

Figure 12: Security tracking vehicle design

The role of the GPS modem is to determine the vehicle position. It is employed when the vehicle engine runs without using the RFID card. The system will send an SMS to the vehicle owner's phone to inform the owner that the vehicle has been stolen. The owner then sends an SMS to the Arduino via the GSM modem to ask for the vehicle position, disable the engine and lock the door. The Arduino will send the position that the GPS modem obtains from the GPS satellite to the owner's phone.

To make a connection between the microcontroller unit and the mobile station, the Sim900 GPRS/GSM modem is used. Its role is to send information and instructions. Information is sent by the microcontroller to the mobile station and instructions are sent by the mobile station to the microcontroller.

Instructions that are sent by the user from the mobile station are executed by the microcontroller. In addition to the microcontroller unit, the second unit of the system is a mobile station, which is just a mobile phone. It does not require any special feature or any special application for a mobile phone to be a part of the system. Any mobile phone supporting the messaging application is suitable for the system. Instructions to the microcontroller are sent using text messages and the alert from the microcontroller is received as a text as well.

The second part of this system is the software. This software is written in the micro C program language, made active by and connected to the microcontroller. The system acts as a smart car system providing security to the car as well as providing a remote management system for the engine.

3.2 GSM/GPRS Modem

The GSM\GPRS shield is a device can make the Arduino like a mobile phone. The GSM\GPRS shield can make the Arduino connection to the Internet by using the GPRS network. When we plug in the GSM\GPRS shield to the Arduino board, and insert the SIM card into this shield, it will start to operate.

This modem is used to connect to the GSM network, which is responsible for sending and receiving instructions and alerts. The GSM modem receives instructions from the microcontroller. After the GSM receives instructions from microcontroller, it sends a message in SMS form to the vehicle owner.

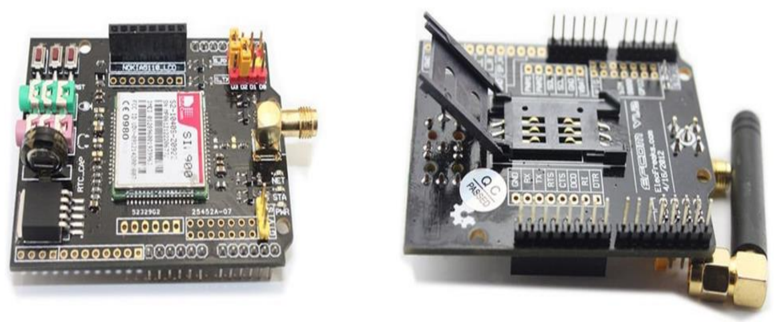

Figure 13: GSM modem [31]

3.2.1 Connecting the GSM/GPRS Modem to the Arduino

At first, we need to insert the SIM card into the holder. Then, we put the GSM modem pins into their positions on the Arduino. We can use the USB to connect the Arduino to the computer. After connection, we upload the program to the Arduino to activate the GSM.

When the red LED turns on, it means the modem is powered on, and it directs its connection to the network. The GSM/GPRS has a number of pins. Digital pins 2 and 3are used to communicate with the M10. These pins are connected to the M10 Pin 2 TX Pin and Pin 3 RX pin. The PWRKEY pin for this modem is connected to pin 7 on the Arduino.

3.3 GPS Modem

In this thesis, the GPS modem is used to obtain vehicle coordinates. When the vehicle engine starts, the system will be active. The GPS will commence contact with the GPS satellite system to acquire information about vehicle position. When the GPS modem obtains the position, it will be sent directly to the microcontroller. Through the GSM modem, the position information that is received from the microcontroller is sent to the vehicle owner’s phone. With Google Maps, the owner can know the vehicle position. This operation occurs if the vehicle doors open without the use of the RFID card; otherwise, the GSM will not send the position unless the vehicle owner requests it.

The GPS modem is, in fact, a small printed circuit board. This board is 35 millimeters in length and 25 millimeters wide. The board is connected to the antenna by wire. The antenna is used to receive any information from the GPS satellites. The antenna is 25mm × 25 mm. The GPS modem board has a small battery, which is used to back up the GPS microchip. Furthermore, it has an EEPROM connection to the GPS chip.

Figure 14: GPS modem

3.3.1 Connecting GPS to Arduino

The GPS modem board has four output connectors: VCC, GND, TX, and TR. The GPS modem can receive power from the Arduino boards; therefore, it has a regulator to change the voltage from 5V from the Arduino board to 3.3V.

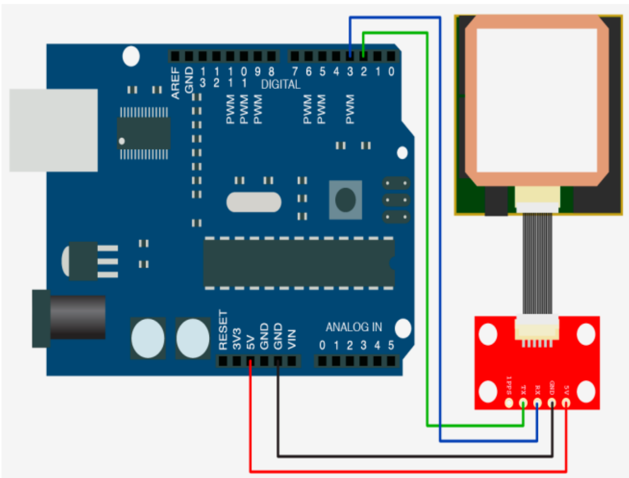

Figure 15: Connecting GPS to Arduino [32]

In this thesis project, the GPS modem is directly connected to the microcontroller (Arduino). Moreover, a jumper wire is used to make this connection to the Arduino. Also, a breadboard can be used to connect the GPS to the Arduino. The GPS modem has four input/output connectors, RX, TX, VCC and GND. We connected the GND pin in the GPS to the GND pin in the Arduino, and we connected the VCC pin in the GPS to the VCC pin on the Arduino to power the GPS. The RX pin is necessary for receiving information from and sending information to the Arduino. The RX pin for the GPS is connected to the TX pins on the Arduino. The TX pin for the GPS is connected to the RX pin on the Arduino, as shown in Fig. 15.

3.4 RFID

In this thesis, the RFID modem is used as a security device. The RFID reader is put into the vehicle door; the door cannot be opened unless one uses the legal RFID card. In addition, an RFID reader cannot read any other RFID card, except for an RFID card that we define in our system. When a thief attempts to open the vehicle door without using the RFID and start the engine, the system will send an alarm to the microcontroller. The microcontroller will send an alert to the GSM shield in the vehicle. The GSM shield will send a message in SMS form to the owner. The message content is “Your Car Door Is Open”.

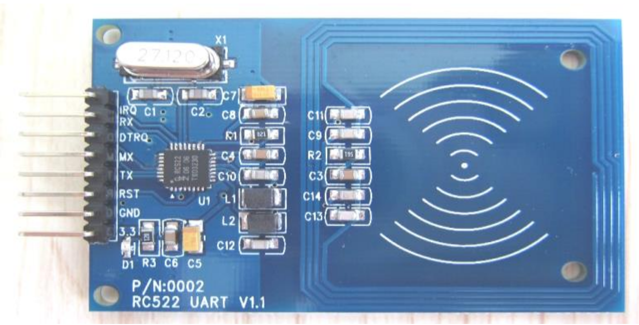

Figure 16: RFID reader modem

3.4.1 Connection RFID Modem to the Arduino

To connect this shield to the Arduino, seven jumper wires are needed for operation. We connect our RFID shield onto the breadboard, and from the breadboard it is connected to the Arduino. There is no direct contact with the GSM and GPS modems. The 3.3V pin of the RFID modem is connected to the 3.3V pin on the Arduino; the GND pin on RFID is connected to the GND pin on the Arduino board; the RX pin on RFID modem is connected to the TX pin on the Arduino; the TX pin on the RFID is connected to the RX pin on Arduino; the MOSI Pin is connected to the Pin 11 on the Arduino; the MISO Pin connects to Pin 12 on the Arduino and the SCK Pin is connected to Pin 13 on the Arduino.

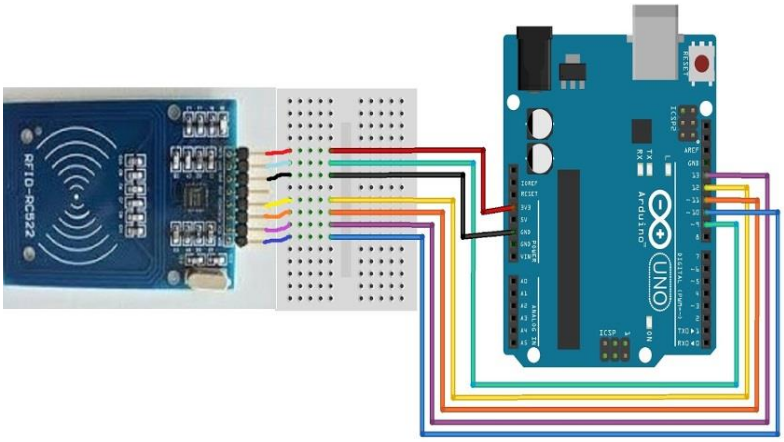

Figure 17: Connecting RFID reader to Arduino

3.5 PING Sensor

This sensor can be used to detect an object by calculating the distance between any object and the sensor. Objects that can be identified with this sensor range from 3 centimeters to 3 meters, and it is very easy to detect any objects whose distance is less than 1 centimeter.

Figure 18: Ping sensor

The PING sensor is used to measure the distance between the sensor and the object by using the travelling sound wave speed. This sensor has two holes in the foreground, one of which transmits the ultrasonic waves, and the other used for receiving the ultrasonic waves that reflect off the objects.

The PING sensor measures distance by timing. This shows how long the ultrasonic waves take when they are emitted and reflected off an object and return to the receiver.

$$D = T*S/2 \quad (3.2)$$

D= the Distance for object.

T= the time between when a wave transmits and when it is received.

S=Speed of light.

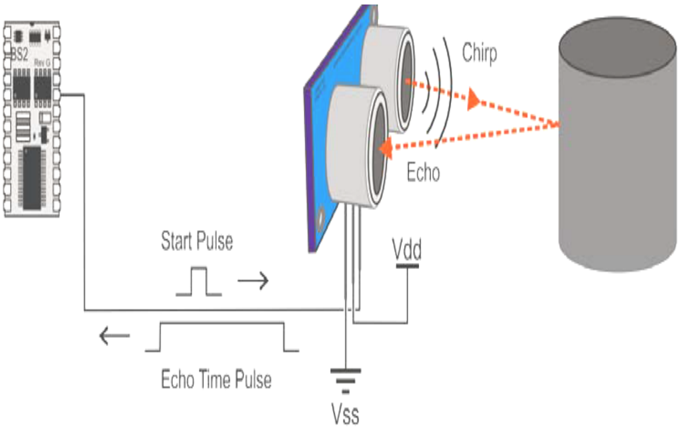

Figure 19: Ping sensor work [33]

3.5.1 Connecting PING Sensor to the Arduino

To connect this sensor to the Arduino we need four jumper wires to make it work. We connect our sensor on breadboard. It is like RFID modem not connected directly to the Arduino. The 5V pin in the PING sensor is connected in 5V pin on the Arduino board, the GND pin in PING sensor is connected into the Arduino board GND pin, Trigger pin on PING sensor is connected to pin 12, and the echo pin in PING sensor is connected to the pin 13on Arduino.

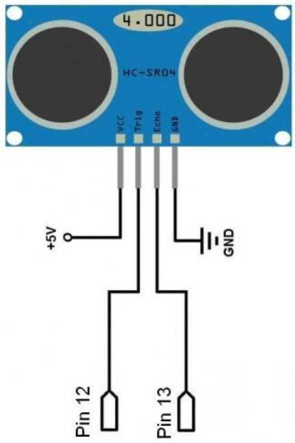

Figure 20: PING sensor pins

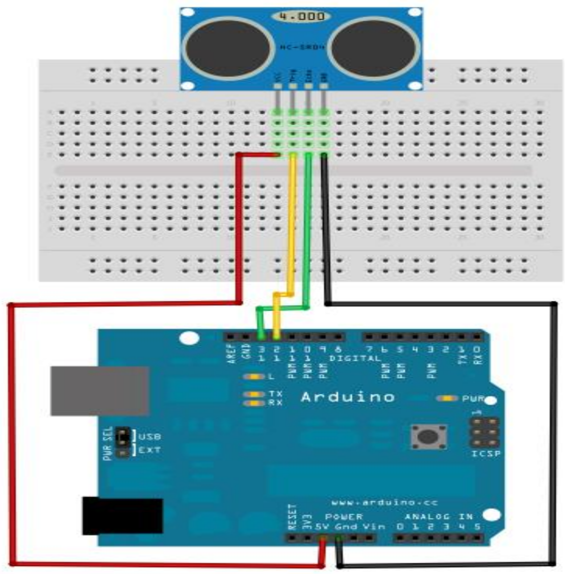

Figure 21: Connecting PING sensor to Arduino

3.6 System Code

3.6.1 GSM Code

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```
                    //{{{GSM code}}}//

#include "sms.h"
SMSGSM sms;
int numdata;
boolean started=false;
char smsbuffer[160];
char n[20];
char sms_position;
char phone_number[20];
char sms_text[100];
int i;
void setup()
{
     Serial.begin(9600);
     Serial.println("GSM Shield testing.");
     if (gsm.begin(4800))
     {
          Serial.println("\nstatus=READY");
          started=true;
     }
     else

          Serial.println("\nstatus=IDLE");
     if(started)
     {
          Serial.println("\nSMS sent OK");
       for(i=1;i<=20;i++)
         {
              sms.DeleteSMS(i);
         }
     }
     };
void loop()
{
     if(started)
     {

          sms_position=sms.IsSMSPresent(SMS_UNREAD);
          if (sms_position)
          {
               // read new SMS
               Serial.print("SMS postion:");
               Serial.println(sms_position,DEC);
               sms.GetSMS(phone_num)
               Serial.println(phone_number);
               // and SMS text in sms_text
               Serial.println(sms_text);
             if(!strcmp(sms_text,"Ron")){
             Serial.println("RED");
             digitalWrite(29,HIGH);//led PIR turns ON
             }
             if(!strcmp(sms_text,"Roff")){
             digitalWrite(29,LOW);//led PIR turns ON
             }
                    }
          delay(1000);
     }
};
```

3.6.2 GPS Code

```
                    //{{{GPS code}}}//

#include <Adafruit_GPS.h>
#include <SoftwareSerial.h>
Adafruit_GPS GPS(&Serial);
HardwareSerial mySerial = Serial;

#define GPSECHO  true
void setup()
{
  Serial.begin(115200);
  delay(5000);
  Serial.println("Adafruit GPS library basic test!");
  GPS.begin(9600);
  GPS.sendCommand(PMTK_SET_NMEA_OUTPUT_RMCGGA);
  GPS.sendCommand(PMTK_SET_NMEA_UPDATE_1HZ);
  GPS.sendCommand(PGCMD_ANTENNA);
  delay(1000);
  mySerial.println(PMTK_Q_RELEASE);
}
uint32_t timer = millis();
void loop()
{
{
  char c = GPS.read();
  if ((c) && (GPSECHO))
  if (GPS.newNMEAreceived()) {
    if (!GPS.parse(GPS.lastNMEA()))
      return;
  }
    Serial.print("Fix: "); Serial.print((int)GPS.fix);
    Serial.print(" quality: "); Serial.println((int)GPS.fixqualit
    if (GPS.fix) {
      Serial.print("Location: ");
      Serial.print(GPS.latitude, 4); Serial.print(GPS.lat);
      Serial.print(", ");
      Serial.print(GPS.longitude, 4); Serial.println(GPS.lon);
      Serial.print("Speed (knots): "); Serial.println(GPS.speed);
    }
  }
}
```

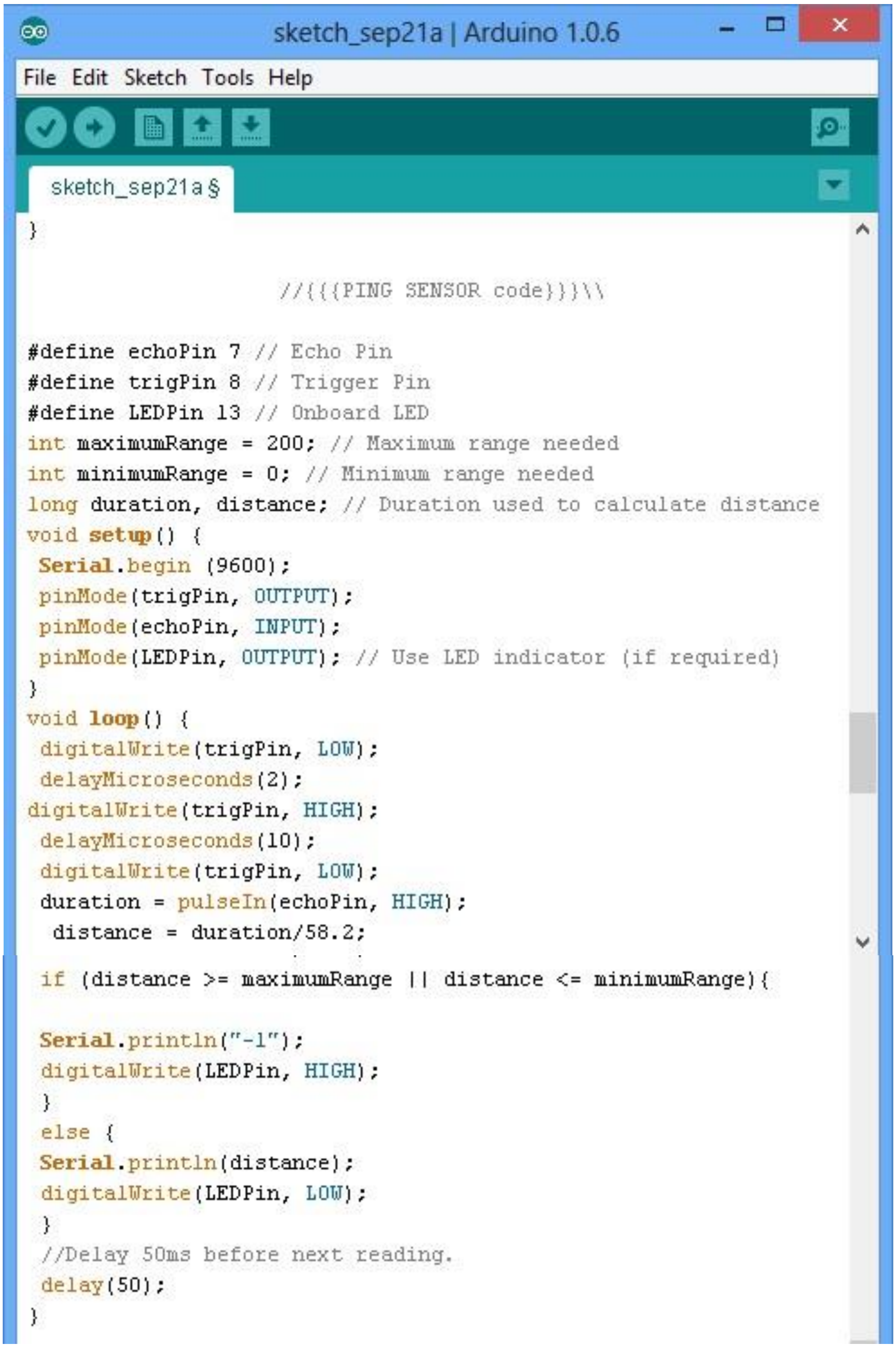
3.6.3 RFID Code


```
                    //{{{RFID code}}}\\

#include <SPI.h>
#include <RFID.h>
#define SS_PIN 23   //SDA
#define RST_PIN 22   //resset
RFID rfid(SS_PIN, RST_PIN);
// Setup variables:
    int serNum0;
    char stat;
void setup()
{
  Serial.begin(9600);
  SPI.begin();
  rfid.init();
}
void loop()
{
    if (rfid.isCard()) {
        if (rfid.readCardSerial()) {
            if (rfid.serNum[0] != serNum0
            ) {
                /* With a new cardnumber, show it. */
                Serial.println(" ");
                Serial.println("Card found");
                serNum0 = rfid.serNum[0];
                Serial.println(" ");
                Serial.println("Cardnumber:");
                Serial.print("Dec: ");
                        Serial.print(rfid.serNum[0],DEC);
                Serial.print("\n ON ");
          }
    }

    rfid.halt();
}
```

3.6.4 PING Sensor Code




```
}

                    //{{{PING SENSOR code}}}\\

#define echoPin 7 // Echo Pin
#define trigPin 8 // Trigger Pin
#define LEDPin 13 // Onboard LED
int maximumRange = 200; // Maximum range needed
int minimumRange = 0; // Minimum range needed
long duration, distance; // Duration used to calculate distance
void setup() {
 Serial.begin (9600);
 pinMode(trigPin, OUTPUT);
 pinMode(echoPin, INPUT);
 pinMode(LEDPin, OUTPUT); // Use LED indicator (if required)
}
void loop() {
 digitalWrite(trigPin, LOW);
 delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
 delayMicroseconds(10);
 digitalWrite(trigPin, LOW);
 duration = pulseIn(echoPin, HIGH);
  distance = duration/58.2;

 if (distance >= maximumRange || distance <= minimumRange){

 Serial.println("-1");
 digitalWrite(LEDPin, HIGH);
 }
 else {
 Serial.println(distance);
 digitalWrite(LEDPin, LOW);
 }
 //Delay 50ms before next reading.
 delay(50);
}
```

3.6.5 Arduino Code

```
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File Edit Sketch Tools Help
sketch_sep21a §

                    //{{{Arduino Code}}}//_
#include <SPI.h>
#include <RFID.h>

#define SS_PIN 23    //SDA
#define RST_PIN 22   //resset

RFID rfid(SS_PIN, RST_PIN);

// Setup variables:
    int serNum0;
    char stat;
void setup()
{

  Serial.begin(9600);
  SPI.begin();
  rfid.init();

}

void loop()
{
    if (rfid.isCard()) {
        if (rfid.readCardSerial()) {
            if (rfid.serNum[0] != serNum0
            ) {


                /* With a new cardnumber, show it. */
                Serial.println(" ");
                Serial.println("Card found");
                serNum0 = rfid.serNum[0];
                Serial.println(" ");_
                Serial.println("Cardnumber:");
                Serial.print("Dec: ");
                        Serial.print(rfid.serNum[0],DEC);
                Serial.print("\n ON ");

          }
    }

    rfid.halt();
}
```

CHAPTER 4

RESULTS AND DISCUSSION

The smart vehicle system is a simple system device. Users can install this system in their vehicles and use it without difficulty. It is active for any smartphone that can use Google Maps as well as send and receive SMS. This system operates such that when a vehicle door is opened without the RFID, the door will send an instruction to the microcontroller to tell the microcontroller the vehicle door has been opened illegally.

The microcontroller will receive this instruction, analyze it and then send it to the GSM modem. When the GSM modem receives instructions from the microcontroller, it will send a message in SMS form to the vehicles owners' phone. When the owner receives a message from the GSM modem, a message is sent to the microcontroller via the GSM modem in order to shut off the engine and ask for the position of the vehicle. When the GSM modem receives the vehicle owner's message, it will send an instruction to the microcontroller. The microcontroller will analyze the instructions, send two instructions, the first instruction to the engine to turn it off, and the second instruction to the GPS modem to ask for the vehicle position.

The GPS modem will start to communicate with the GPS satellites and learn the position of the vehicle. When the GPS modem acquires the position of the vehicle, it will send an instruction to the microcontroller, and microcontroller will send the position of the vehicle via the GSM modem to the owner's phone. The owner will receive a message providing the location of the vehicle. When the owner presses on the message, Google Maps will open, and the position of the vehicle will appear.

4.1 Results

The first security step in our system is RFID. The RFID reader is installed on the vehicle door. If the vehicle door is opened without the use of the RFID card, the system will send a message to the vehicle owner's phone and inform the owner. Otherwise, the system will not send a message, as shown in Fig. 22.

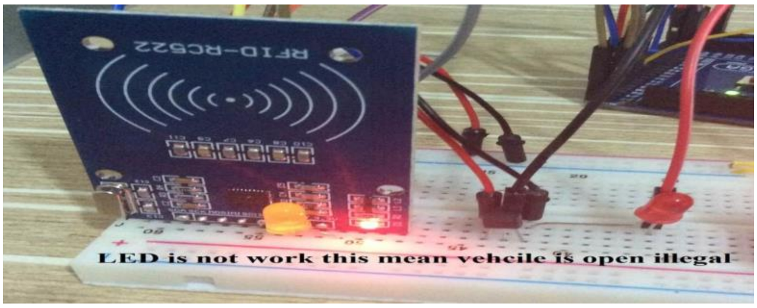

Figure 22: RFID reader recognize the door open illegally

When the door is opened illegally, the system will recognize that this is not the owner of the vehicle. The system will assume that the vehicle is stolen. The door will send instructions to the microcontroller, which in turn will send instructions to the GSM modem. The GSM modem will then send an SMS to the owners' phone, as shown in Fig. 23.

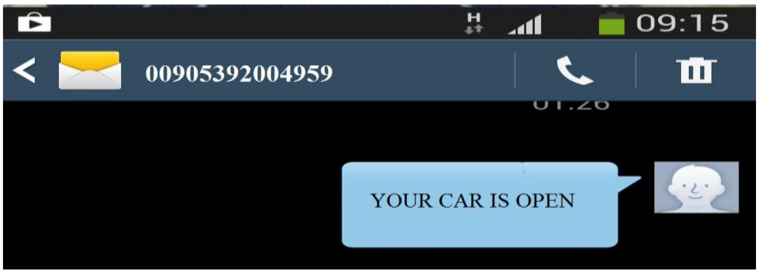

Figure 23: System send alert to owner

The GSM modem is connected to the Arduino directly; it is a very important part in the system with which a connection can be made between the system and the owner's mobile phone. When the system starts to operate, the GSM modem will begin to connect directly to the mobile network and start to send and receive messages. When the GSM modem connects to the mobile network, the red LED flashes, as shown in Fig. 24.

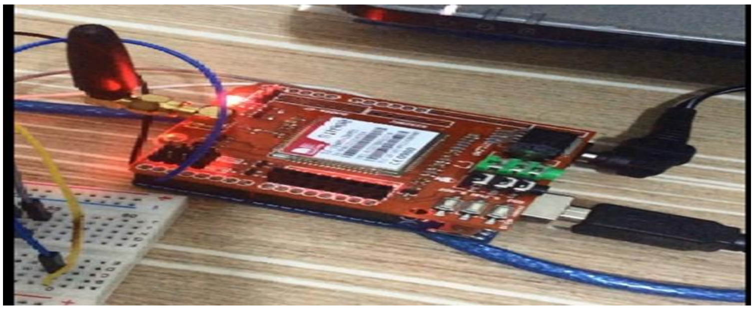

Figure 24: GSM modem start to work

After thieves start the engine, the engine will send instructions to the microcontroller. The microcontroller will send instructions to the GSM, and the GSM modem will send a message to the vehicles owner’s’ phone, as shown in Fig. 26.

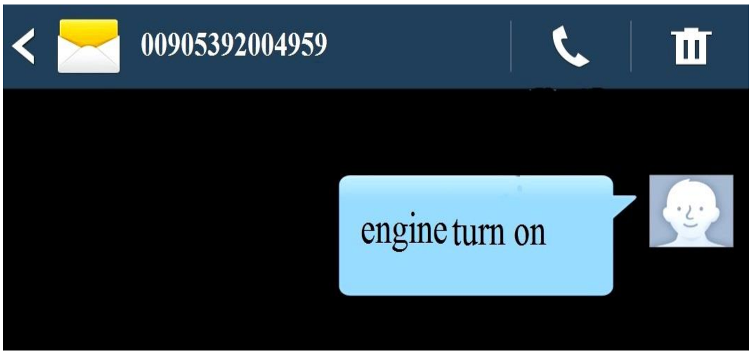

Figure 25: System sends SMS to owner when engine starts

Figure26: Engine turn on

After the owner receives a message from the system, a message is sent to the system to turn off the engine, and also to request vehicle position, as shown in Fig. 27.

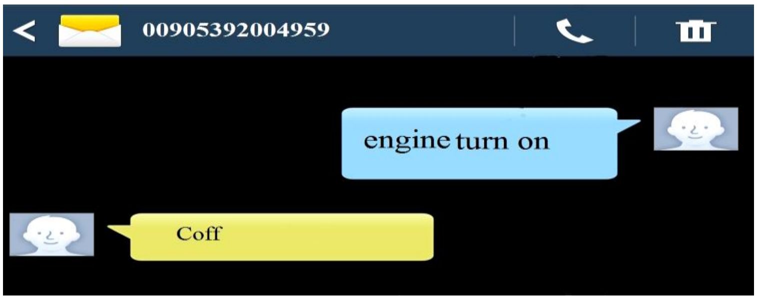

Figure 27: Owner sends an SMS to the system to turn off the engine

When the GSM modem receives a message from the vehicle owner's phone, it will send instructions to the microcontroller to shut off the engine, as shown in Fig. 28.

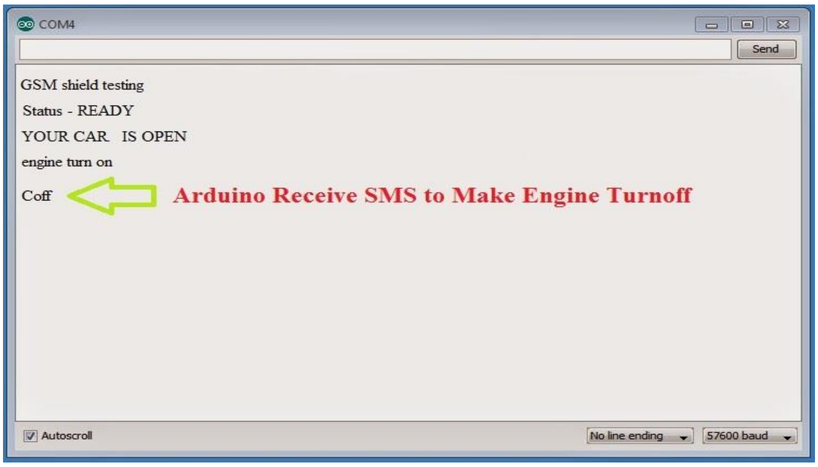

Figure 28: System receive the instruction successfully

When the microcontroller receives instructions from the GSM modem, it sends instructions to shut it off the engine. The engine will turn off directly, as shown in Fig. 29. The LED that represents engine status turns off.

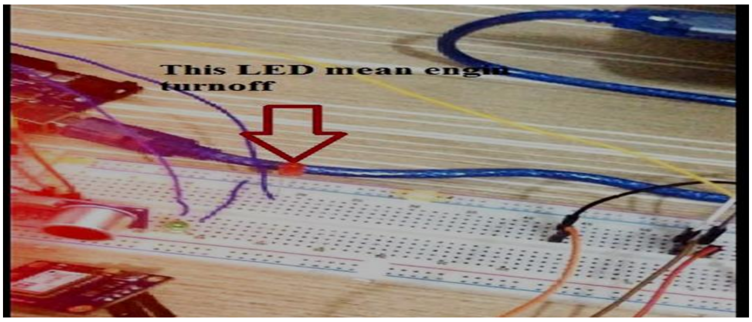

Figure 29: Engine turn off

At this time, the microcontroller will send instructions to the GPS shield and prepare it for sending and receiving information and connections to the GPS satellites, as shown in Fig. 30.

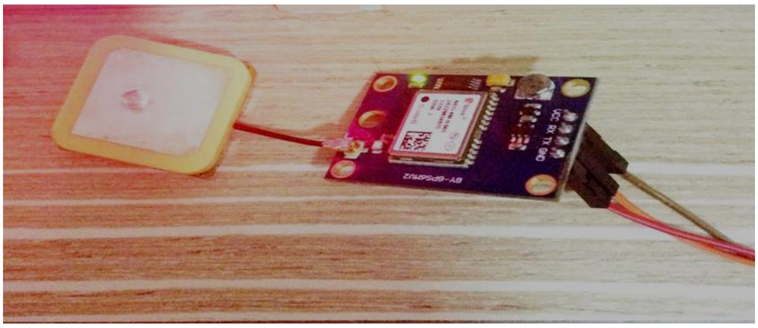

Figure 30: GPS modem commencing operation

When the GPS modem receives vehicle position data from satellites, it will send instructions to the microcontroller and the microcontroller will send instructions to the GSM modem. The GSM modem will send instructions to the vehicle owner. In Fig. 31, we show the microcontroller send the position to an owner.

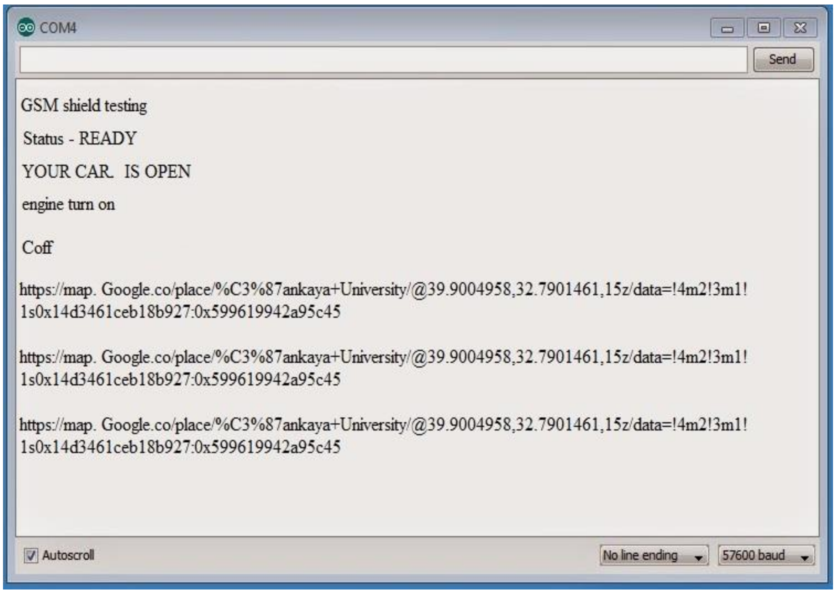

Figure 31: System sending the vehicle position

After system sends a message, the owner will receive it directly. This message contains the vehicle position. The message that the owner receives will be in link form to reach the Google map to show the vehicle position, as shown in Fig. 32.

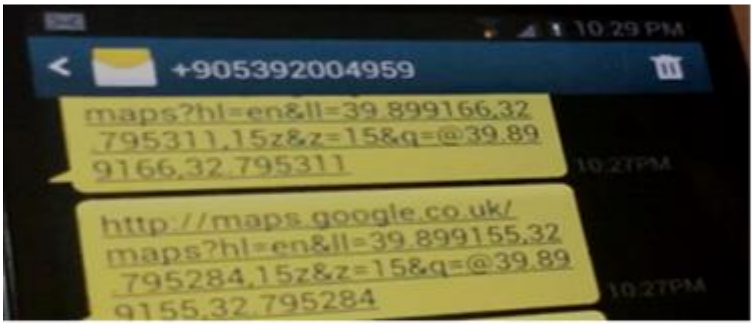

Figure 32: SMS contain the vehicle position

When the owner presses on the link, Google Maps will open, and the owner can directly know the position of the vehicle, as shown in Fig. 33.

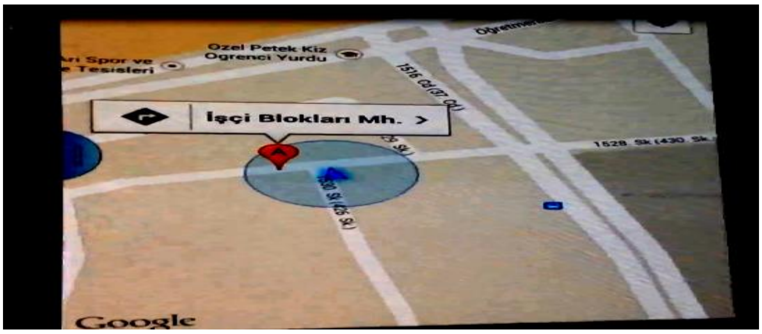

Figure 33: Vehicle position on the Google map

Now, the second step for security will be discussed, namely the PING SENSOR. This sensor is used to stop a vehicle when it approaches any object, such as another car, tree, wall, or person, if the driver is busy, not paying attention to the road, has a heart attack or an accident that makes driver unable to drive. This sensor gives instructions to the microcontroller in order to lower the speed of the vehicle and even stop the vehicle completely, as shown in Fig. 34, which shows how the yellow LED flashes when an object approaches.

Figure 34: PING sensor when working

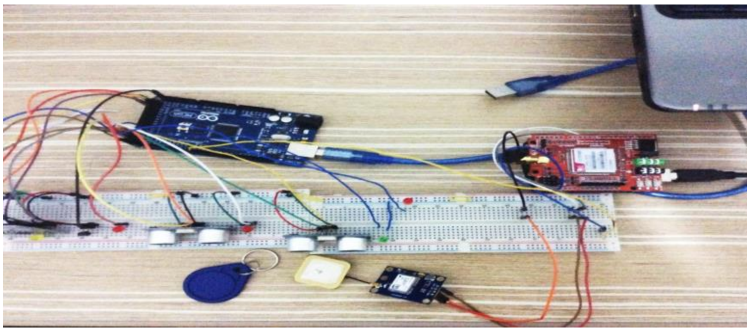

Figure 35: Final project

4.2 Discussion

The development that was occurring in the technological area changes human life. Technology has made life more developed and more comfortable. Therefore, people begin to depend on it in various areas of daily life. It can be said that a person cannot live without technology in this century.

Changes in traditional life style have occurred due to modern technological breakthroughs. For example, the reservation of airline tickets has become an electronic rather than a traditional affair. Moreover, ID cards for people have also become electronic rather than traditional paper. The idea of a simple car has also been changing into the idea of a smart car, and even the concept of the smart car has changed dramatically during the last decade.

A smart vehicle system controls the engine remotely with any cellular phone with vehicle tracking on Google Maps via a smart phone also prevents vehicle theft.

The smart vehicle security and tracking system consists of two parts: the hardware and software. The hardware consists of five modems, a GSM module, a microcontroller, GPS, an Ultrasonic Sensor and an RFID modem.

The Arduino Microcontroller is the heart of this system; all other modems connect to this Microcontroller. The system uses the Arduino UNO as a microcontroller.

The GSM modem is used to connect to the GSM network. This system uses the SIM900 to send and receive instructions and alerts.

The GPS modem is used to connect to the GPS satellite system. This system uses the GPS modem to acquire vehicle position and to send these data to the vehicle owner's mobile phone.

The RFID is used for security in order to prevent thieves from opening the doors of the vehicles.

The Ultrasonic Sensor is used to stop a vehicle when it is near to any object such as a car, tree, wall, or human, etc. in a situation where the driver is busy, does not look around, has a heart attack or is involved in any accident that makes the driver unable to drive.

The software is the second part of this system. We used the Micro C language for programming our modem and devices to make these devices and modems active with the microcontroller.

We controlled this system device by sending instructions via SMS and by receiving alerts by SMS, too. The GPS modem was used to determine vehicle position. Ultrasonics was used to halt a vehicle if the driver experiences any problems. Moreover, we use the Arduino UNO and Arduino mega as a microcontroller as well as the SIM 900 (GSM modem) for communication between the mobile station and microcontroller. The mobile phones required the Google Maps application to show vehicle coordinates. Furthermore, to control the alert for any mobile phone support, the SMS was used for the mobile station.

CHAPTER 5

CONCLUSION

5.1 Conclusion

The purpose of this project is to create a smart vehicle system to control the engine remotely via a cellular phone and tracking the vehicle via GPS using Google Maps. Furthermore, the prevention of vehicle theft was also an important factor. All objectives have been achieved successfully with a system yielding results as expected.

Users can control this system device by sending instructions and by receiving alerts by SMS. Users can determine the position of their vehicles via GPS, by using a smart phone in conjunction with the Google Maps application to show vehicle coordinates.

The smart vehicle security and tracking system uses the SIM 900 (GSM modem) for communication between the mobile station and microcontroller to send and receive instructions.

In order to halt the vehicle when drivers experience any problems, the system uses an ultrasonic sensor and to prevent vehicle theft, the system uses an RFID modem to open the doors of vehicles legally.

On the market, there are many smart tracking security systems for vehicles available at a high price. The smart vehicle security and tracking system will save money because it is cheaper than other systems with costs dependent upon the designer.

On the market, users can find vehicle security systems without tracking. Alternatively, they can find vehicle tracking systems without security. In this system, users can use both security and tracking at the same time.

The smart vehicle security and tracking system used RFID as a security measure. When the vehicle door opens without using an RFID card, the system sends an alert to a mobile phone, and the step concludes successfully.

Moreover, it uses the GPS modem to determine vehicle position by using the Google Maps application; the system sends the vehicle position to the mobile phone, and the step concludes successfully.

Additionally, it uses an ultrasonic sensor to stop the vehicle when the driver encounters a problem. A flashing LED represents the vehicle's stopping status when it detects objects, and this step concluded successfully.

Moreover, this system uses the SIM900 modem to send and receive messages. Instructions are sent from the system to a mobile phone and also received instructions from a mobile phone. This step was concluded successfully.

Finally, the system attains the results for a smart car system providing security to the car as well as providing a remote management system for the engine.

5.2 Suggestions for Future Work

This project can be more extended by using different technologies.

1. It can use the internet and control the vehicle from the website.
2. It can use the image processing technology for recognizing drivers when they sleep, or if they have a heart attack.

The concept and information used in this system design could be used for development of smart vehicle tracking and security system.

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APPENDICES A

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