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Instructor name: Dr-Raed Jaber
Student name: Eman Alawnah

Registration number :11820476

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Thank you.

DISCLAIMER

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Abstract:

The Vehicle Tracking Based on GSM&GPS project brings together innovative approaches combining both GPS &GSM technology to create a vehicle tracking system that is both efficient and practical. Its functioning relies on a smartphone and the Arduino UNO, offering cost-effective usage in numerous industries.

By using GPS tech, our Vehicle Tracking System tracks the vehicle's movement—accurately determining longitude and latitude data. This information is then transmitted through the GSM network which uses cellular towers- sending & receiving data in text message form; this includes identifying visualizations of each respective location on a map.

Adding an ignition sensor provides a level of security. It sends a text message warning whenever someone tries to steal the vehicle acting as a deterrent, against theft. This aligns with the goal of reducing vehicle theft as it gives users a way to monitor, control and protect their vehicles.

The incorporation of a control system, for a DC motor into the framework of an Arduino Uno, GPS GSM module and an ignition sensor signifies an approach to managing vehicles. This system allows users to have control over the DC motor by sending SMS commands. The simplicity and ease of use of this mechanism is demonstrated by instructions like "turn vehicle on" which activates the DC motor.

The data is sent in as a text message, which includes the longitude, latitude, and location on the map. The message can be received on a mobile phone or any device capable of receiving text Messages. This project holds particular significance in detecting stolen vehicles, as it enables swift and precise recovery of the vehicle.

Overall, Vehicle tracking systems have many applications today and will continue to develop in the future due to the value of the service they provide in terms of tracking vehicles and knowing their location at any time.

Chapter 1: Introduction

1.1 Evolution and Advancements in Tracking Systems: From Visual Cues to Satellite and Wireless Technologies

The evolution of tracking systems over time is noteworthy, as it has progressed from simple techniques centered around visual cues to a more intricate methodology incorporating advanced wireless communication and satellite technologies.After the initial tracking systems were used for hunting and warfare, with hunters and soldiers using visual cues to track prey or enemy movements. The use of animals, such as dogs, was also common in these early tracking systems. Over time, tracking systems evolved to include more sophisticated techniques, such as the use of traps, snares, and bait.

In our modern era, tracking systems have advanced significantly and have been used in various fields, including logistics,transportation and law enforcement. The introduction of radio frequency identification (RFID) technology in the 1960s was a major milestone in the development of tracking systems.in RFID technology Objects can be tracked using radio waves, thereby eliminating the need for visual cues and other physical tracking methods.The greatest development and revolution in tracking systems was when satellite-based navigation systems were introduced in the seventies, such as GPS thes technology enabled accurate tracking of objects and vehicles using satellite signals, which could be received by GPS receivers. This technology was initially used in military applications but has since been widely adopted for civilian use in transportation, logistics, and other industries. In recent years, wireless communication systems, such as GSM and CDMA, have been integrated with GPS technology to develop advanced tracking systems.

These systems enable real-time tracking of vehicles and objects, making them highly useful for logistics and transportation management. Furthermore, they provide valuable insights into the movement and behavior of objects and vehicles, which can be used for optimization and efficiency improvement.

tracking systems have come a long way from the early days of visual cues and animal tracking. The development of advanced technologies, such as RFID and GPS, has enabled the creation of sophisticated tracking systems with practical applications in various industries. The integration of wireless communication systems with GPS technology has further enhanced the capabilities of these systems, providing real-time tracking and valuable insights into the movement and behavior of objects and vehicles. The future of tracking systems is likely to involve continued advancements in technology and increasing integration with other systems and technologies.

Contrasting this advancement from what was previously simple visual cues is revolutionary, from rough infrequent sightings to today's highly developed means utilizing RFIDs or GPSs cutting-edge approaches common across all fields impacted by regulatory changes demanding higher standards nowadays.

1.2 history of vehicle tracking systems: From Military Logistics to Commercial Transportation and Fleet Management

During World War I the German military utilized a basic vehicle tracking system to observe the movements of their vehicles in combat. This involved installing radio transmitters and receivers in the vehicles allowing for long distance tracking. Though this approach had flaws it highlighted how vehicle tracking systems can enhance military logistics and supply chain management. Following the war there were few advancements in vehicle tracking systems until the 1970s when satellite technology led to the development of Global Positioning System (GPS). The GPS made it possible to track vehicles in real time and became an indispensable tool for military logistics and transportation management.

By the 1980s and 1990s GPS based tracking systems started being implemented by commercial transportation companies such as FedEx and UPS. These companies used these systems for monitoring their fleets, which improved efficiency while cutting costs.

Today many different industries utilize vehicle tracking systems including but not limited to transportation, logistics, and law enforcement.

While it is true that first-ever vehicle tracking systems pale in comparison to current day advancements, it cannot be denied that these significant developments led us towards creating more advanced technologies which reshaped logistic and transportation management. Without these systems managing military logistics and supply chains along with commercial transportation would be near impossible. The history of vehicle tracking systems is a testament to the importance of innovation and technological advancements in shaping the world we live in today.

The inception of rudimentary vehicle-tracking paved the path for cutting-edge technologies that took over worldwide transportation operations single-handedly; these new technologies streamlined logistics operations within supply chains individually creating marked shifts throughout various industries expressing how crucial innovation plus tech-incorporation is regarding shaping our modern world as is known today reliably throughout countless applications globally! Originating during WWI where Germany prevailed upon simple ways to track their vehicles resulting from these occurrences, GPS technology came to fruition in the 70s allowing vast applications both within transportation management and military logistics. The commercial transport industry has since adopted GPS-enabled vehicle-tracking systems reducing costs and enhancing efficiency significantly. This technological advancement exhibited every day illustrates the indispensable impact of improved tech in our society.

The use of vehicle tracking systems has gained popularity in recent years due to their numerous advantages, such as enhancing safety reducing fuel consumption and improving fleet management. These systems work by using various technologies like GPS, GSM, and RFID for tracking and monitoring the location and status of vehicles.

Vehicle tracking systems are based on the principles of satellite navigation and wireless communication. Specifically GPS technology helps locate the exact position of a vehicle while GSM and RFID transmit this information to a control unit or a mobile device. Previous research has investigated several aspects of vehicle tracking systems. For example they have been found effective in reducing vehicle theft by providing real time data on the location as well as instant alerts in case of any unauthorized movement. Moreover these technologies improve driver behavior by enabling monitoring and reporting on factors like speed limit adherence or fuel consumption rate. This information can be used to identify areas for improvement and develop more efficient driving practices. In terms of fleet management purposes vehicle tracking systems offer plenty of information that is instrumental in optimizing routes while reducing fuel consumption rates.

Finally vehicle tracking systems allow real time monitoring of maintenance requirements that enhance operational efficiency while decreasing downtime risks that could result from part failure or general wear and tear over time.

1.3 The Significance of the Vehicle Tracking Based on GSM&GPS

In today's world, vehicle tracking systems play an integral role within organizations aiming towards enhancing vehicle safety measures while reducing cases related to theft. These systems also come with added benefits like improving driver behavior and facilitating optimal fleet management practices- all leading towards increased productivity levels at workplaces. Previous studies show that these solutions deliver as promised; likewise expected upgrades suggest evidence-based improvements will further enhance such capabilities going forward.

One initiative worth noting within such a space is Vehicle Tracking Based on GSM&GPS project- it presents firms with affordable options for accurately tracing vehicles' locations via maps- a feature vital across industries where real-time data proves critical- including transportation/ logistics fields and fleet management divisions.

Implementation of such projects by organizations leads to improved operational functions via correct monitoring of vehicles' movements, ultimately facilitating better efficiency levels, asset management practices, and enhanced safety measures across various industries. For instance, vehicle tracking systems may prove useful in the transportation sector to prevent delays by tracking delivery trucks strictly. In contrast, fleet managers can use these tools as an anti-theft measure or to monitor unauthorized activities concerning company vehicles- leading towards cost-reduction benefits. Given increasing demands for real-time tracking solutions across sectors these days, it is no surprise that market projections reveal a growth trend trajectory within the vehicle-tracking industry. Thus, the Vehicle Tracking Based on GSM&GPS project has significant importance and relevance in addressing the current and future needs of various industries that require accurate and efficient vehicle tracking solutions.

Chapter 2: Theoretical Background and Previous Work

With the help of technology like vehicle tracking systems, it is now possible to track and monitor all aspects of a vehicle's location. By using satellite-based navigation and wireless communication principles in conjunction with global positioning system (GPS) technology for accurate location determination and transmission of this data both to a mobile device or the central control unit - these systems operate efficientl.Vehicle tracking platforms primarily utilize GPS technology among other key technological advancements, and the employment of GPS technology into vehicle tracking systems has made it possible to track vehicles precisely and gain knowledge about their locations and speed.

These are some of the studies that have been done in this field:

2.1 Research(1):A real-time GPS and GPRS-based tracking system for individuals using an Android

This is an individual's real-time tracking system that uses GPS and GPRS technologies on an Android platform through the use of Java programming language. With this solution comes effective storage through integration to PHP and MySQL backends.With location tracking enabled in real-time and a mapping interface offered by the system administrator can keep an eye on individual's movements, lower monthly costs are achievable for users by leveraging free Google maps and transmitting their data through HTTP protocol which provides both security measures as well as easy-to-use features.

The system stipulates that it must have both internet access as well as a suitable mobile device running on android software engineered for specific purposes related to transmission plus reception--this requirement might additionally cause changes to such variables like startup expenditures ,size or electromotive force. However, the outline of what was suggested for the system can be viewed in Figure 1.

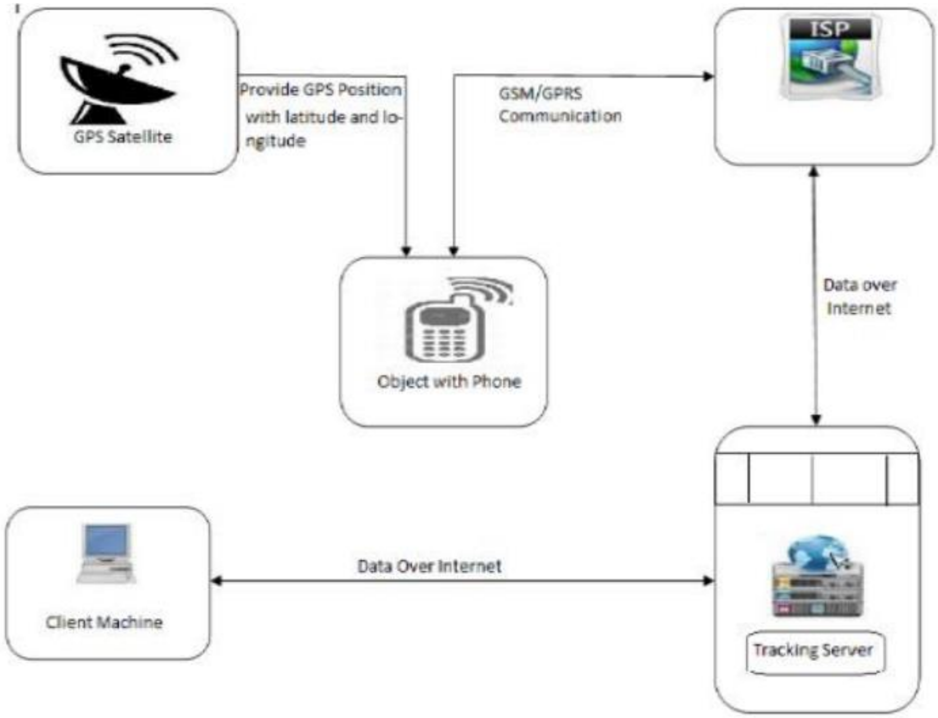

Figure 1: The structure of the proposed system in the research1

2.2 Research(2):GPS-Based Real-Time Tracking System with HSDPA and EDGE Technologies

The research introduces a GPS-based tracking system that determines real-time location and transmits it using HSDPA and EDGE technologies, in addition to using messaging. The system is a single device for location tracking and is capable of handling Android devices and a web application simultaneously. Moreover, the Android device can function as both a receiver and transmitter. This system comprises three main components: the transmitter, the tracker (the person carrying the device), and the receiver, as illustrated in Figure2 . The transmitter acquires the location from the satellites and sends the coordinates.

This system consists of three main components: the transmitter, the receiver (the person who wears the attachment), and the database. As illustrated in Figure 2, the transmitter obtains the location from the GPS satellites, and then sends the coordinates to be stored in the MySQL database by the receiver. The receiver, in turn, retrieves the data from the database and displays it on Google Maps.

The initial cost, size, and power consumption of this system depend on the type of phone used. The operating cost will be moderate due to the data being sent over the internet without compression techniques to reduce the data size. One of the drawbacks of this system is the need for an Android phone as the transmitter, which limits the options for the user.

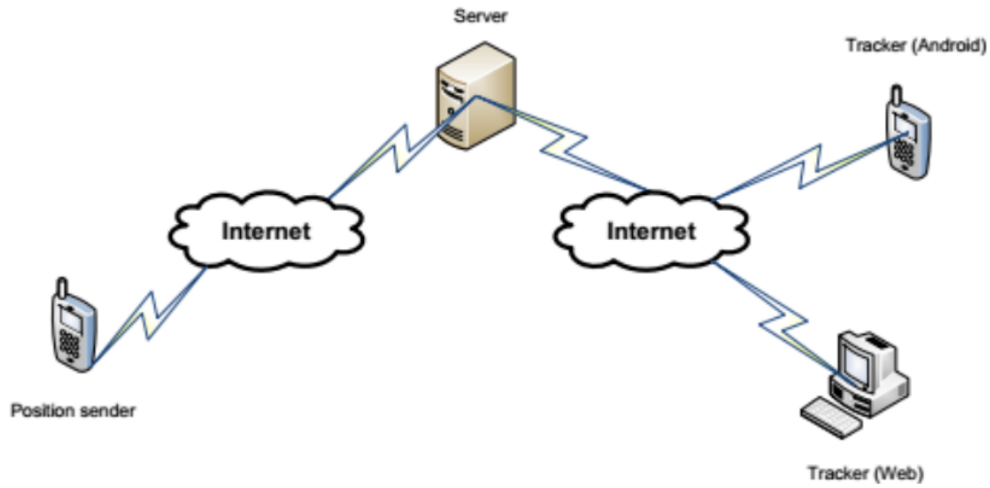

Figure 2: Sections of the system in the rsearch2

2.3 Research3: GPS and GPRS-based Vehicle Tracking System with Data Compression and Encryption

The research paper presents a GPS and GPRS-based vehicle tracking system using a technique to compress and encrypt location data before sending it to the server, in order to reduce the data size and associated costs. The user can access the vehicle tracker using a secure web interface, which allows monitoring and control of the system. The system consists of a server, a database to store location data obtained from the monitoring units installed in the vehicles, and the monitoring units themselves. These units are responsible for continuously obtaining location information and storing it in an internal database, which is then sent to the server periodically. The time interval between data transmissions can be adjusted to balance operation costs and data accuracy. The main benefit of this research is the data compression and encryption techniques used, which reduce operating costs and ensure high levels of privacy. However, the research does not mention energy consumption or system size, and the initial cost of receiving the data from the system could be moderate due to the need to reserve server resources.

Figure 3: The box diagram of the proposed system in the research3

2.4 Research4: "Simultaneous Tracking of Multiple Moving Targets using GPS and GPRS Technology: A #C Programming Approach"

The research presents a system for tracking and monitoring multiple moving targets simultaneously using the #C programming language to program the system components. Additionally, a web interface has been developed using net.ASP to facilitate user interaction with the system. GPS satellites send location data to the device attached to the target being tracked, and the device temporarily stores the data. The tracking device has a SIM card to connect to the local GSM network, and the data is sent from the device to the tracking server via the local network using GPRS.

A listener socket program is installed on the tracking server to collect data from the tracking device. The data is received in an unreadable format, and therefore a specialized program is used to convert the data into a readable format. The converted data is then stored in a database for future analysis.

One major drawback of this research is that it does not mention the database used to generate alerts and reports. Additionally, the initial cost, power consumption, and system size are not addressed. Furthermore, the operating cost of the system may be high due to the continuous transmission of data without the use of compression techniques. The operational efficiency of the system could be improved by implementing such techniques.

In summary, the research presents a system for tracking multiple moving targets simultaneously using #C programming language, GPS satellites, and GPRS technology. The system is a promising solution for various applications; however, further research is needed to address the limitations mentioned above.

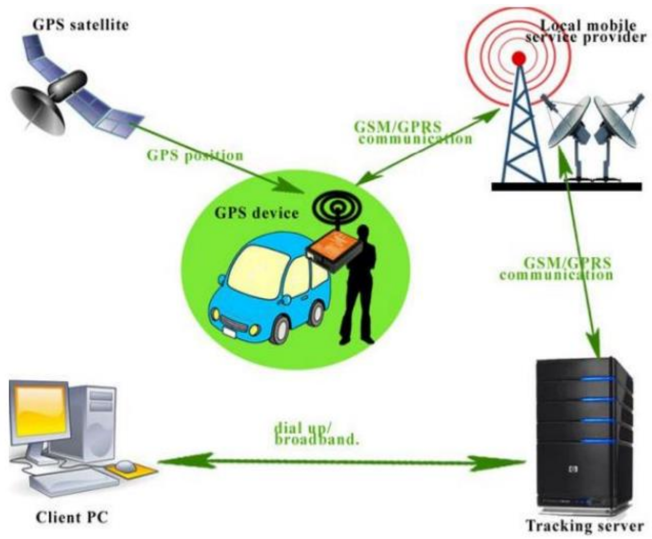

Figure 4:The working principle of the proposed system in the research 4

One widely utilized modern-day approach for any Vehicle Tracking system evolves around implementing Global System for Mobile Communication(GSM) Technology which facilitates wirelessly transmitting position as well as status details for vehicles to reach a control unit or mobile devices. In geographical contexts that enjoy wide-ranging GSM Network Coverage, tracking vehicles using this technology becomes practical and fairly reliable.

Radio Frequency Identification (RFID) sometimes comes into play in a Vehicle Tracking system for its ability to facilitate individual identification of vehicles through radio waves which help track as well monitor vehicle location and status.

To grasp the fundamentals of any vehicle tracker system, understanding the theories involved in satellite navigation, wireless communication technologies related to data processing can never be overlooked. This drives the creation of sophisticated algorithms & software programs needed to process data generated via GPS, GSM & RFID technologies.This facilitates real-time reports and alerts being generated based on situations observed from the data generated.

Vehicle tracking system research has concentrated on different aspects such as fleet management, safety & security while operational effectiveness & cost savings are being most prevalent among them., Among several researchers who attempted to understand its impact on transportation facilities are Hu et al.(2015). They concluded that Vehicle Tracking Systems come with Benefits improving Fleet utilization , Fuel Consumption & Maintenance expenses as well.

Ensuring the safety & security measure is also among top-notch priority where they found Kung et al.(2015) stated that Vehicle Tracking System has played its part significantly in reducing Emergency Response time specifically related to accident cases along with preventing Vehicle Theft which has been seen an increasing phenomenon lately,

Another aspect gaining considerable interest using Tracking Systems is the improvement in Logistics and Supply Chain management. These improvements offer enhanced planning accuracy, efficiency leading to satisfied clients with lower expenses as highlighted in research conducted by Huang et al. (2016).

Recent Advances in this technology are worth a mention as Machine Learning Algorithms are integrated to analyze the data collected from these vehicle tracking systems providing real-time monitoring, Driver Behavior Analysis Route Optimization which can lead to Insightful results.

Further Integrating Tracking Systems alongside other technologies for instance Dashboard cameras or sensors will provide more comprehensive insights into various aspects of Car Operations without significant investment making the overall implementation process relatively smooth & faster.

Moreover, the use of Internet of Things (IoT) technology has enabled the development of smart tracking systems that can automatically detect and report issues such as engine faults and fuel leaks, as well as monitor the condition of goods being transported. These advancements are expected to further enhance the capabilities and benefits of vehicle tracking systems, making them an indispensable tool in the transportation industry.

2.5 vehicle tracking mobile applications:

The use of GPS technology allows mobile apps to track vehicles and display their location in real-time, while the server receives location information from an application which may then be accessed via both web and mobile interfaces.

In addition to standard functions provided by the app, such as keeping a log of your trips' history or tracking your movement with the help of geofencing, it may offer additional services. Moreover, you can be notified for activities like an unpermitted use of vehicle or maintenance-related problems. Controlling specific vehicle features such as locking and unlocking doors or starting the engine can be done using some apps that offer remote access

The usual requirement for using such apps is to have a GPS tracking device installed in the vehicle which may either be internal or external.The device communicates with the app through a wireless network, such as GSM or GPRS, to send location data to the server.

Overall, vehicle tracking mobile applications provide a convenient and efficient way for users to monitor their vehicles' location and activity, as well as to ensure their safety and security.

An advanced tools to manage th transportation needs quickly and efficiently, there is an array of options available such as **Waze, Google Maps Fleetio , GPSWOX , Verizon Connect ,and Telenav Track** . These cutting-edge technologies offer a wide range of features like real-time traffic updates on routes to avoid (such as Waze), turn-by-turn navigation capabilities (as seen with Google Maps), vehicle location tracking along with fuel consumption monitoring (offered by Fleetio), geofencing technology mixed with route optimization(Delivered by GPXWOX), driver safety monitoring along with vehicle diagnostics technology which is provided by Verizon Connect ,and fleet management options designed specifically for businesses-looking or efficient ways to track drivers behavior(tracking as well of fuel cost management) as seen in Telenav Track . By utilizing these tools individually or collectively business owners can successfully streamline the daily transportation requirements catered towards individualor business user respectively.

MapMyTrack - Permits people to follow their open air exercises like running, cycling, and climbing, and offer their area with loved ones continuously.

Chapter 3: how gps works with gsm

3.1 GSM (Global System for Mobile communication):

When we say GSM technology, we refer to Global System for Mobile communication- an innovative digital cellular communication system meant mainly to transmit both mobile voice and data services effectively. Its development took place at the European Telecommunications Standards Institute (ETSI), where in 1991 it was first introduced commercially after diligent innovation processes were put in place concerning how best available frequency spectrum could undergo time slots or channel division through combinations of Time Division Multiple Access (TDMA) along with Frequency Division Multiple Access (FDMA) techniques.

Mobile phones communicate with nearby cell towers qualitatively by producing efficient radio signals in a GSM network. The signals are transmitted over the airwaves, eventually fetched by the nearest cell tower and trip transferred to the mobile switching center (MSC) through interconnected base stations. The MSC is bestowed with thoroughly efficient duties that involve routing calls or messages together with other related data services to their respective destinations. These may be other mobile phones, landlines, or prevalent data networks anywhere across the globe.

GSM technology has wide popularity as it's available in more than 200 countries worldwide, being a noteworthy advantage. Besides, security and encryption features have been utilized effectively to ensure reliable user personal privacy protection while supporting voice calls, SMS messaging, MMS messaging coupled with fascinating mobile data services. Digitizing and compressing user data is something GSM does explicitly by transmitting different streams of information on separate channels operating at either 900 MHz levels or 1,800 MHz frequency band.

GSM, together with other technologies, is part of the evolution of wireless mobile telecommunications that includes High-Speed Circuit-Switched Data (HSCSD), General Packet Radio Service (GPRS), Enhanced Data GSM Environment (EDGE) and Universal Mobile Telecommunications Service (UMTS).

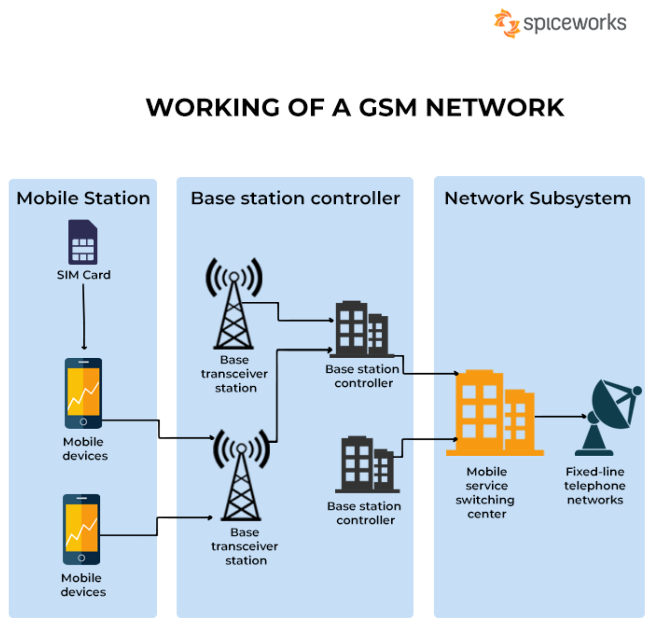

Figure 5: work of a GSM network

3.2 GSM (Global System for Mobile communication) technology has many applications, but here are the top four:

1. For rapid communication between mobile phone users, GSM technology provides SMS messaging options that allow sending and receiving messages of up to 140 octets—saving time on both ends.

2. Mobile usage requires robust data security systems; as such, GSM provides safety measures such as signal encryption for maximum data control at all times—even remotely controlling household appliances through the appliance control subsystems—alongside alert subsystems that automatically monitor potential threats while relaying SMS notifications accordingly.

3. Handovers are inevitable during cell switching processes which the GSM network notably allows four different kinds: intra-cell, inter-cell, inter-BSC, and inter-MSC - improving connection performance metrics via immediate data transfer protocols.

4. In addition to these essential features mentioned earlier: in emergencies within healthcare settings or when patients need to reach out to health professionals for consultations; telemedicine services facilitated by GSM technology's functionalities prove beneficial offering instant transmission options including video conferencing with physicians or transmitting medical records through applicable channels thereby providing swift access necessary for improved patient care at all times.

3.3 How GPS Works (Step-by-Step)

GPS is an essential navigation network that entails over thirty communication based satellites traveling around the globe consistently. Each satellite transmits navigation data which is received by GPS receivers placed in various electronic devices such as smartphones. Once these signals are intercepted by a receiver and its distance has been calculated with four or more satellites' help it determines your precise geographic position.

Currently there are thirty one functioning GPS satellite networks that make our everyday lives easier; they serve as tour guides when driving vehicles and assist us using mapping on our mobile phones primarily due to their accuracy. Owing to these advancements in technology involving this system locating oneself has become almost unfeasible nowadays. A smartphone containing an integrated

GPS receiver ensures an uninterrupted connection through exact positioning regardless of wherever you may find yourself globally.Additionally the Global Positioning System (GPS) is composed of at least twenty four navigation based satellites that rotate around Earths orbit at approximately 12,500 miles (20,000 km) without hindrance from environmental factors and is accessible to users worldwide without any charges or setup fee.

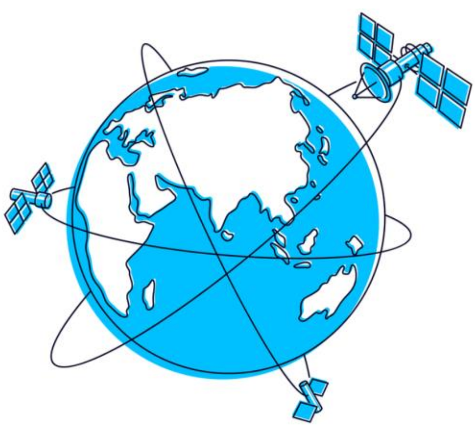


Figure 6: GPS satellites in orbit above the earth.

GPS (Global Positioning System) is a complex system that comprises three key components:

1-The first component is a backbone of **GPS - Satellites**; these reference points positioned in medium Earth orbit (MEO) continuously transmit signals essential for establishing users' locations using GPS receivers' help on Earth. There must be at least 24 functional satellites for full global coverage which is currently surpassed by having 31 operational ones in place.

2-The second component is **Ground Control Stations**- which exist globally manages all aspects of monitoring & controlling GPS Satellites through tracking them via established infrastructure networks that interact them across locations uploading/ updating entirely new sets of data from around the globe & ensures maintenance/diagnostics performed during handover periods.

3-Lastly, the third competent here includes technological devices called **GPS Receivers** - they vary based on needs from small handheld mobile products to intricate military/commercial complexes that facilitate precision towards location determination on earth through accepting multiple satellite signal inputs applying methods like trilateration that can provide pinpoint accuracy down to a few centimeters.

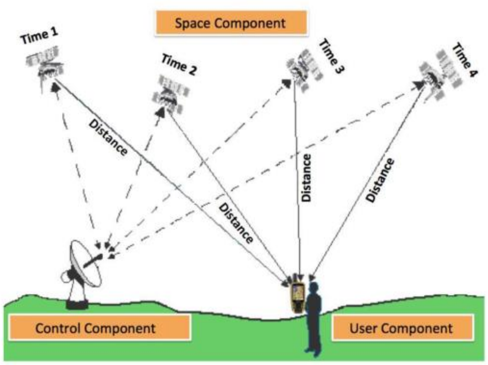

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Figure 7: gps receivers receive the signal from multiple satellite

The effective usage of global positioning hinges on proper comprehension and application of fundamental principles like that of The Doppler Effect. Within all functions related to The Global Positioning System (GPS), reliance on this phenomenon remains essential when calculating distances between numerous GPS receivers and satellites connected with routing process transactions. Essentially operating on measuring time intervals when signals travel from various far away satellites back towards corresponding receivers- any shift arising due to movement amongst those same objects set up vital presence plays its part -that strange alignment commonly referred by many scientists through decades as 'Doppler Effect' significantly impacts functionality within our collective global positioning system. By measuring this shift in frequency, the GPS receiver can determine the relative speed and distance between the satellite and the receiver.

The GPS receiver acquires data from a variety of satellites to establish its specific location on the planet. This data is then utilized to provide reliable and accurate location and positioning information for various applications such as navigation, surveying, and mapping. Currently GPS offers two levels of service:

1-the Standard Positioning Service (SPS)

2-the Precise Positioning Service (PPS).

- It is important to note that only US federal agencies the Armed Forces and governments are permitted to use PPS; in contrast individuals may freely use SPS without incurring any charges for a GPS receiver.
- civilians have greater access to GPS receivers than military personnel do. While early civilian models were bulky and imprecise advancements have been made over time.
- To secure these navigation details from unauthorized use dithering was employed by the US government. People gained access to global positioning systems in the 2000s.

GPS Satellite Functionality:

Each GPS satellite sends a unique signal to allow a GPS receiver to decode and calculate the exact location of the satellite. The signals move at the speed of light, the GPS receiver knows this, and this helps in the mathematical calculation to determine its position.

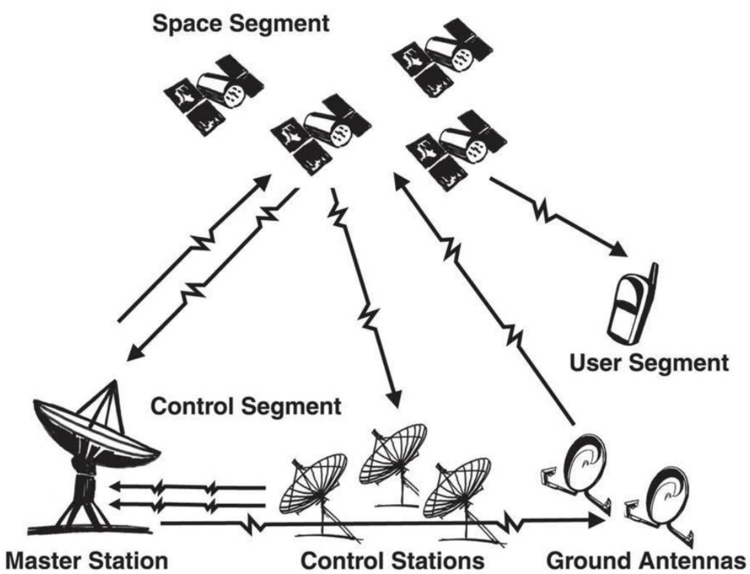


Figure 8: signal movments

Source:

To identify your current location while using a GPS receiver data collected through a technique called 'Trilateration' is used to provide you with comprehensive information through your electronic device. How does this work? By gauging how long it takes signals transmitted from various sources (GPS satellites) reach your device.

Using this type of measurement helps identify distance between those objects far away from you creating further accuracy upon calculation for movement tracking along with your two dimensional position which altogether requires gathering information from at minimum three separate ones among these devices working up to four or more would better solve for providing in depth details about which side you're facing in regards to Earths axis so your three dimensional placement could be more accurately calculated. It should be noted that receivers systems are typically designed with capacity to track eight or more GPS satellites however possible variations in location availability or time of day could affect the number of devices signal that you are able to access.

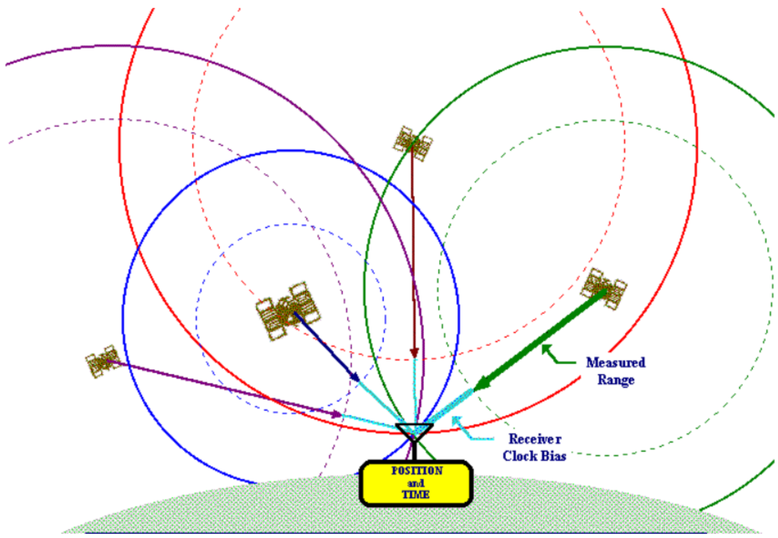


Figure 9: how can the GPS receiver calculate the exact location

To complete the mathematical calculation; the GPS receiver uses the correct position of at least four satellites. The distance to each satellite estimates four crucial values:

- Earth latitude
- Earth longitude
- Elevation
- Time

Once a GPS receiver identifies the user position, it can calculate other metrics based on the next position and subtracting time and distance, such as:

- Trip distance
- Speed
- Bearing
- Distance to destination
- Track
- Sunrise, and sunset time

Distance travelled (m) = Speed (ms-1) x Time (s)

To determine your location on Earth using trilateration, knowledge of both the GPS satellite positions and their distance from you is necessary. However since direct measurement of this distance isn't practical or even feasible in most cases we rely on information about signal speed and timing instead. Luckily for us GPS satellites are constantly transmitting electromagnetic signals. Receiving a single signal alone won't help us find our exact position - all it tells us is that our device could be anywhere along a sphere with a radius equivalent to its calculated distance from that particular satellite. Having two signals improves our odds - it means our device must be somewhere within an overlapping circle between two spheres (those described by both satellite signals). But receiving three distinct signals allows us to precisely pinpoint our devices single intersection point.

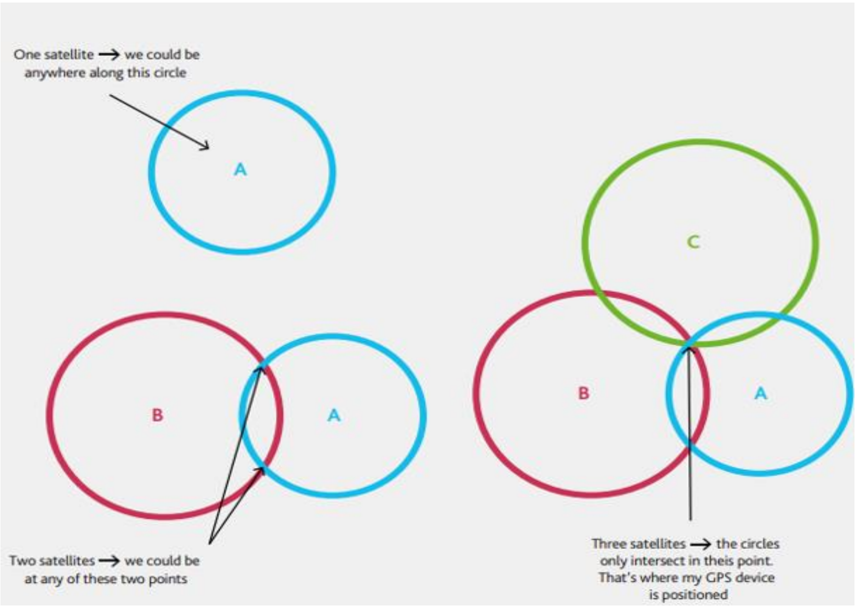


Figure 10: Trilateration to calculate the position

Ensuring GPS positioning accuracy means leveraging a network of signals transmitted from several different GPS satellites at any given time. Each signal needs to be analyzed by the receiver and carefully timed in order to sync up properly and provide highly specific location information.

To achieve this precision atomic clocks are present on each transmitter within these orbiting satellites. Specifically the cesium 133 atom has become our primary reference point - with its hyperfine transition generating a microwave spectral line that powers these advanced clocks. Thanks to this technology we've been able to redefine what constitutes a second - now defined as "the duration of 9,192,631,770 cycles of microwave light emitted or absorbed". If we didn't have access to such exact time measurements in place via satellite clocks - our corresponding data would be inaccurate.

Thankfully though mobile devices like smartphones can still tap into all this expertise despite not having atomic clock capabilities within them directly. This is because each individual satellites transmission contains not only location information but more importantly timing information as well - allowing for synchronized calculations across devices in use.

The quartz crystal of a commercial quartz clock vibrates at a frequency of 32,768Hz. Estimate the uncertainty on the distance between a GPS receiver and a GPS satellite, if we used a quartz clock on GPS satellites. We could calculate the period of one oscillation and use that to calculate the uncertainty of the distance between a GPS satellite and a receiver.

$T = 1/f = 1/32768 = 3.05 \times 10^{-5}$ s → uncertainty on distance = $T \times c = 3.05 \times 10^{-5}$ s x 299792458 ms^{-1} = 9149m

The joint use of GPS and GSM enables location tracking services. Learn about their collaboration in detail with this step-by-step guide:

1. A signal is transmitted from a satellite and picked up by a GPS receiver in a mobile or any GPS receiver device. Inside these signals are details on the status of satellites and where they are at any given moment.
2. Using this data from GPS receivers helps us find out accurate location details including latitudinal , longitudinal coordinates along with height or altitude.
3. Location information from a mobile device is transmitted to its GSM modem for reception and transmission of data via cellular networks.

4. The collection and storage of all device's locations on a connected network is performed by a mobile network's server after receiving their information from a GSM modem.
5. The requested application or service receives the location data sent through GSM network by the location server, which has the potential to be utilized as either a tracking program or a mapping platform.
6. Providing users with requested services can be done by exploiting their location information. Typically tracking apps allow you to view your whereabouts via GPS whilst applications that provide maps offer directions and suggest routes depending on where you are.

Overall, GPS provides accurate location data, while GSM provides the means to transmit that data over a cellular network to the location server and the application or service that needs it.

3.4 Systems that provide tracking and positioning can be classified into three categories based on their working principles

1. Real-time online systems designed for rental car companies collect satellite-based spatial information that is transferred quickly via channels such as GPRS/3G directly towards servers/devices for continuous monitoring purposes. Nevertheless, these effective methods incur the disadvantage of high procurements rates due to specialized software/hardware necessary for such online activity.

2. offline systems enable storage of satellite location inputs including speed and time internally within the system just like black boxes on airplanes that do not require any direct connectivity establishment from an end-user. This ensures there is no operational cost involved from the provider's end.

3. Semi-offline systems collect and store real-time spatial information, but only transmit it to users upon their request through communication channels such as GPRS/3G or SMS messages depending on one’s preference. Reduced net operational costs can be guaranteed by choosing these options for data transmission over continuous online methods.After conducting research, I found that semi-offline systems using SMS for data transmission and reception are most suitable for our proposed system. This system does not require continuous tracking, and SMS messages are both low-cost and highly reliable.

3.5 Components study in addition to simple simulation

Components needed for the project: 1-Arduino UNO Board

2- 16x2 LCD Display
3- SIM800/900 GSM Module
4- Neo-6M GPS Module
5- Connecting Jumper Wires
6- Breadboard 7- DC motor 8- relay 9- 9v power supply 10- LM2596 DC-DC

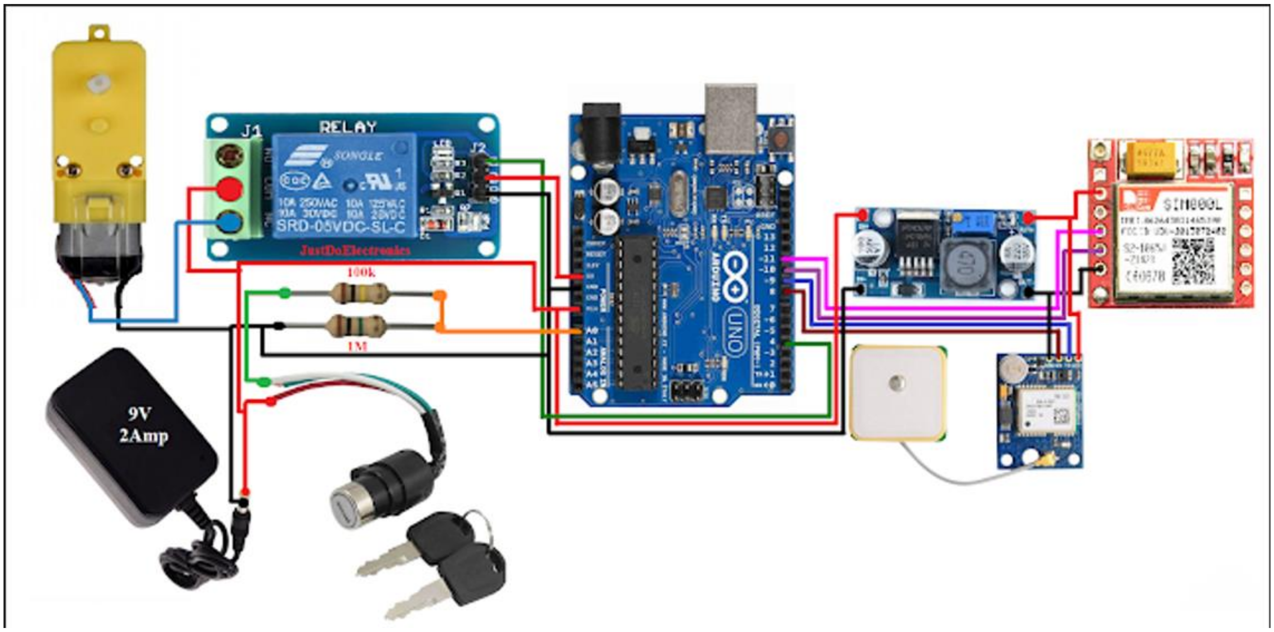


Figure 11:the project circuit diagram

1-Arduino UNO Board

it's open-source programming based on simple hardware and software. Available for anyone desiring to create fun projects in their leisure time or by profession such as artists and designers. Among several other microcontroller units created by Arduino lies the ATmega328P-based circuit board known as the Arduino Uno which comes with the following basic features: six analog inputs; fourteen digital pins for input/output use where six of them can work as Pulse-Width Modulation outputs; a reset button; sixteen MHz crystal oscillator; power jack plug-in head; ICSP header to facilitate communication through SPI bus protocol along with usb connection port.It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

Technical Specifications

• Microcontroller - ATmega328P

• Supply Voltage (recommended) - 7-12V

• Operating Voltage - 5V

• Maximum supply voltage (not recommended) - 20V

• In total there are 14 Digital I/O Pins available with this board and it is important to note that only six provide PWM Output

• Analog Input Pins - 6

• DC Current per I/O Pin - 40 mA

•DC Current for 3 is 3V Pin - 50 mA.

•On an ATmega328 board there exists approximately 31.5 KBs of usable flash memory given that about half a kilobyte has been allocated towards bootloading.

• SRAM - 2 KB (ATmega328)

• EEPROM - 1 KB (ATmega328)

• Clock Speed - 16 MHz

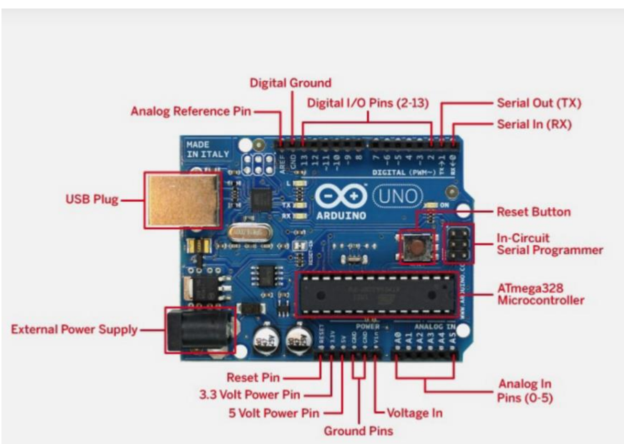


Figure 12: Arduino uno module

2-Neo-6M GPS Module

The Neo-6M module- The Neo-6M GPS module offers integration that is both user-friendly and easy in electronic projects given its miniaturized size equipped with a ceramic patch antenna capable of receiving GPS signals.

It transmits data through standard NMEA characterized by a typical serial interface typically UART, interconnecting a range of microcontrollers or devices thereof to achieve reliable results in capturing precise latitude, longitude, altitude alongside time stamp details which are pertinent in developing precise positioning strategies accompanied by tracking applications as well.

Onboard LED lighting indicates GPS signal status plus satellite locking accompanied potentially by storage options within onboard EEPROM overlaying backup power functionality that enables sustained satellite data functionality even when disconnected from main power switches. Please Note: with numerous versions available within the current market framework underpinned by differing functionalities alongside specifications it's essential always to consult developer documentation predetermine specific technicalities involving pinouts/usage instructions. accompanying it above all

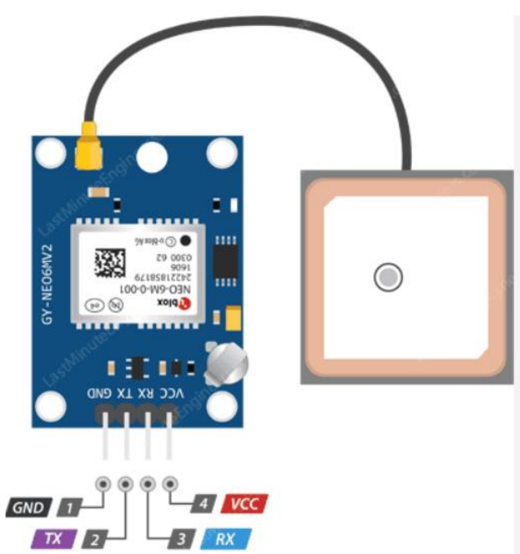


Figure 13: Neo-6M module

SIM800/900 GSM - The Sim800/Sim900 GSM modules are highly efficient communication chips widely considered by engineers in designing mobile-based applications that require real-time access regardless of where they are located. These modules have low power requirements and are capable of providing stellar support to multiple functionalities linked primarily around wireless connectivity capabilities.

Designed and manufactured by SIMCom Wireless Solutions; The SIM8500/900 series boasts an edge over other models regarding reliable support for cellular coverage transmission standards inclusive of 2G network infrastructure where users can efficiently access messaging services (SMS) and voice calls across global cellular service providers.

Integrating this small-sized chip into multiple electronics appliances is easy due to its pre-integrated SIM card slot. Alongside these capabilities, Sim800/Sim900 modules offer relevant functionality like five-band (EGSM850, EGSM900, DCS1800, PCS1900, EGSM850 and 1900) GPRS connectivity or even the EDGE data functionality, all compatible with any Microcontroller through UART communication channels accepting AT commands.

This module can process caller information swiftly, and users can enjoy DTMF decoding functionalities alongside audio recording/playback services. Integration of Sim800/Sim900 series with your device will only require connecting it via serial TX/RX pins to your microcontroller/Arduino board as well as providing the necessary consistent voltage supply coupled with sending the appropriate AT commands from your controller.

Figure 14: SIM800L module

This is a simple project simulation using proteus:

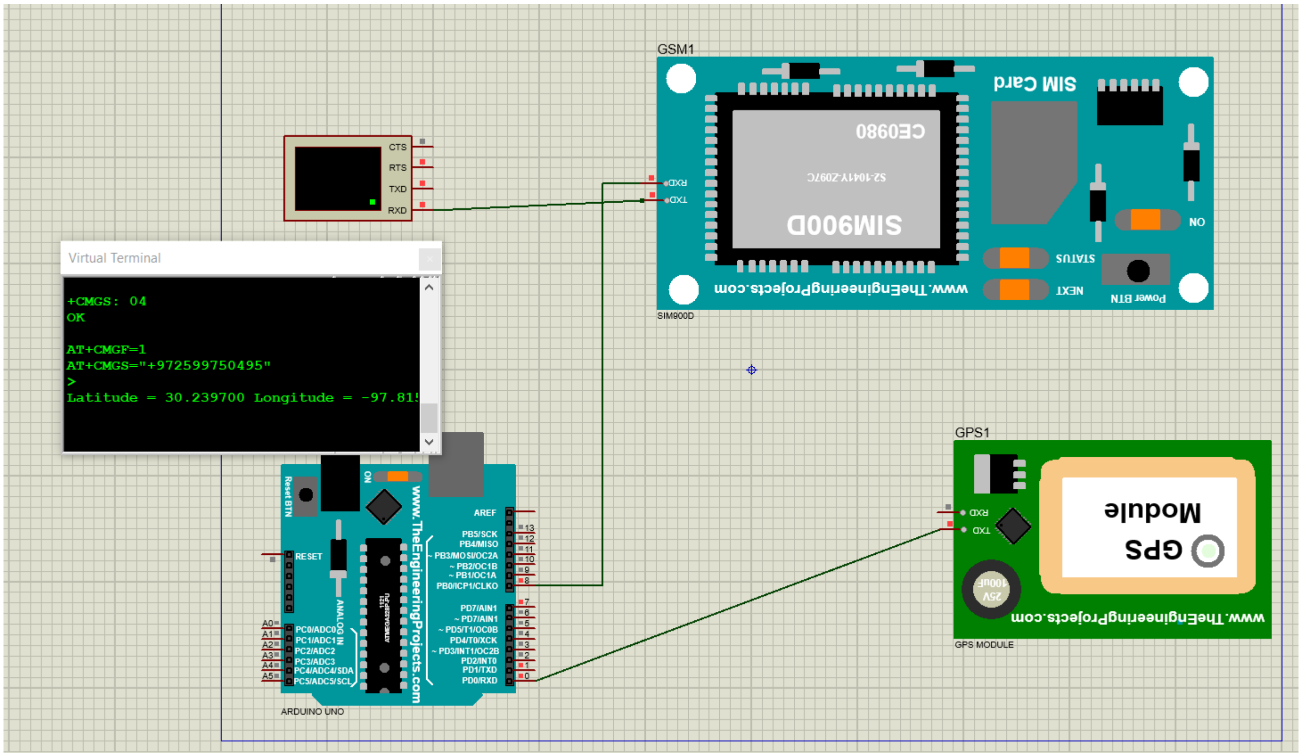


Figure 15: project simulation

**note that the results of semulation is a virtual results (not the correct location)

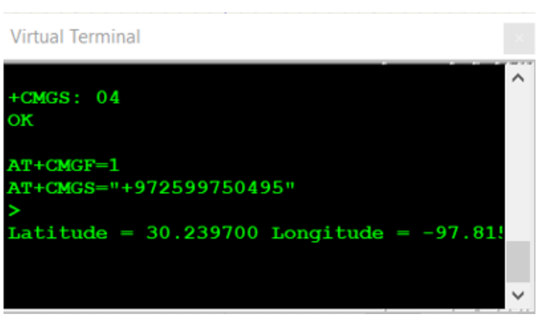


Figure 16: simulation result

Her the code used in semulation :

```
#include <TinyGPS.h>
#include <SoftwareSerial.h>

SoftwareSerial SIM900(7, 8);
TinyGPS gps;
void setup() {
  Serial.begin(9600);
  SIM900.begin(9600);
}
void loop() {
  bool newData = false;
  unsigned long chars;
  unsigned short sentences, failed;
  for (unsigned long start = millis(); millis() - start < 1000;)
  {
    while (Serial.available())
    {
      char c = Serial.read();
      if (gps.encode(c))
        newData = true;
    }
  }
  if (newData)
  {
    float flat, flon;
    unsigned long age;
    gps.f_get_position(&flat, &flon, &age);
    SIM900.print("AT+CMGF=1\r");
    delay(400);
    SIM900.println("AT+CMGS=\"+972599750495\"\r");
    delay(400);
    SIM900.print("Latitude = ");
    SIM900.print(flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
    SIM900.print(" Longitude = ");
    SIM900.print(flon == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flon, 6);
    SIM900.println("\r");
    delay(400);
    SIM900.println((char)26);
    delay(400);
  }
   Serial.println(failed);
}
```

3.6The code used in the hardware

```
#include <SoftwareSerial.h>
#include <AltSoftSerial.h>
#include <TinyGPS++.h>
const String PHONE = "+972599592916";
#define ignition_switch 4
#define ignition_sensor A0

//GSM Module RX pin to Arduino 11
//GSM Module TX pin to Arduino 10
#define rxPin 11
#define txPin 10
SoftwareSerial sim800(rxPin, txPin);

//GPS Module RX pin to Arduino 9
//GPS Module TX pin to Arduino 8
AltSoftSerial neogps;

TinyGPSPlus gps;

String sms_status, sender_number, received_date, msg;
boolean ignition_status = false;
boolean tracking_status = false;
boolean reply_status = true;
boolean anti_theft = false;

unsigned long previousMillis = 0;
long interval = 60000;

void setup() {

  pinMode(ignition_switch, OUTPUT);
   digitalWrite(ignition_switch, 0);
  pinMode(ignition_sensor, INPUT);
  delay(3000);
  Serial.begin(115200);

  sim800.begin(9600);
  neogps.begin(9600);
  sms_status = "";
  sender_number = "";
```

```
  received_date = "";
  msg = "";

  sim800.print("AT\r");
  delay(100);
  sim800.print("ATE1\r");
  delay(100);
  sim800.print("AT+CPIN?\r");
  delay(100);
  while (sim800.available() < 1) {

  };
  Serial.println(sim800.readString());

  sim800.print("AT+CMGF=1\r");
  delay(50);
  while (sim800.available() < 1) {
    delay(10);
  };
  Serial.println(sim800.readString());

  sim800.print("AT+CNMI=2,2,0,0,0\r");
  delay(50);
  while (sim800.available() < 1) {
    delay(10);
  };
  Serial.println(sim800.readString());
}

void loop() {

  ignition_status = getIgnitionStatus();

  if (tracking_status == true && ignition_status == true) {
    unsigned long currentMillis = millis();
    if (currentMillis - previousMillis > interval) {
      previousMillis = currentMillis;

    }
  }
```

```
  if (ignition_status == true) {
    unsigned long currentMillis = millis();
    if (currentMillis - previousMillis > interval || previousMillis == 0) {
      previousMillis = currentMillis;
      sendSms("Someone Trying to start your bike");
      sendSmsGPS("Location");
    }
  }

  if (anti_theft == true && ignition_status == true) {
    digitalWrite(ignition_switch, HIGH);
  }

  while (sim800.available()) {
    parseData(sim800.readString());
  }

  while (Serial.available()) {
    sim800.println(Serial.readString());
  }

}

void parseData(String buff) {
  Serial.println(buff);

  unsigned int len, index;
  index = buff.indexOf("\r");
  buff.remove(0, index + 2);
  buff.trim();
  if (buff != "OK") {
    index = buff.indexOf(":");
    String cmd = buff.substring(0, index);
    cmd.trim();

    buff.remove(0, index + 2);

    if (cmd == "+CMT") {
      extractSms(buff);
      if (sender_number == PHONE) {
        Serial.println("yesss");
        doAction();

      }
```

```
    }
  }
  else {
    //The result of AT Command is "OK"
  }
}
void extractSms(String buff) {
  unsigned int index;
  Serial.print("buff>");
  Serial.println(buff);

  index = buff.indexOf(",");
  sender_number = buff.substring(1, index - 1);
  sender_number.trim();
  buff.remove(0, index + 5);

  received_date = buff.substring(0, buff.indexOf(","));
  buff.remove(0, 19);

  sms_status = buff.substring(0, buff.indexOf("\""));
  buff.remove(0, buff.indexOf("\r"));
  buff.trim();

  index = buff.indexOf("\n\r");
  buff = buff.substring(0, index);
  buff.trim();
  msg = buff;
  buff = "";
  msg.toLowerCase();

  Serial.println(".........");
  Serial.println("sms_status>" + sms_status);
  Serial.println("sender_number>" + sender_number);
  Serial.println("received_date>" + received_date);
  Serial.println("msg>" + msg);
  Serial.println(".........");
}

void doAction() {
  if (msg == "bike on") {
    digitalWrite(ignition_switch, HIGH);
    Serial.println("Bike has ON");
    if (reply_status == true) {
      sendSms("Bike has ON");
```

```
    }
  } else if (msg == "bike off") {
    digitalWrite(ignition_switch, LOW);
    Serial.println("Bike has OFF");
    if (reply_status == true) {
      sendSms("Bike has OFF");
    }
  } else if (msg == "get location") {
    Serial.println(">>>get location<<<");
    sendSmsGPS("Location");
  } else if (msg == "anti theft on") {
    anti_theft = true;
    if (reply_status == true) {
      sendSms("Someone Trying to start your bike");
      sendSms("Bike Has OFF");
    }
  } else if (msg == "anti theft off") {
    anti_theft = false;
    if (reply_status == true) {
      sendSms("Anti-Theft has OFF");
    }

    else if (msg == "reply on") {
      reply_status = true;
      sendSms("Reply has ON");
    }

    else if (msg == "reply off") {
      reply_status = false;
    }
  } else if (msg == "tracking on") {
    tracking_status = true;
    if (reply_status == true) {
      sendSms("Live Tracking has ON");
    }
  }
  else if (msg == "tracking off") {
    tracking_status = false;
    if (reply_status == true) {
      sendSms("Live Tracking has OFF");
    }
  } else if (msg == "tracking status") {
    if (tracking_status == false) {
      sendSms("Live Tracking has OFF");
```

```
    } else {
      sendSms("Live Tracking has ON");
    }
  }
  sms_status = "";
  sender_number = "";
  received_date = "";
  msg = "";
}
void deleteSms() {
  sendATcommand("AT+CMGD=1,4", "OK", 2000);
  Serial.println("All SMS are deleted.");
}
void sendSmsGPS(String text) {
  // Can take up to 60 seconds
  boolean newData = false;
  for (unsigned long start = millis(); millis() - start < 2000;) {
    while (neogps.available()) {
      if (gps.encode(neogps.read())) {
        newData = true;
      }
    }
  }
  if (newData)
  {
    float flat, flon;
    unsigned long age;
    Serial.print("Latitude= ");
    Serial.print(gps.location.lat(), 6);
    Serial.print(" Longitude= ");
    Serial.println(gps.location.lng(), 6);
    newData = false;
    delay(300);
    sim800.print("AT+CMGF=1\r");
    delay(1000);
    sim800.print("AT+CMGS=\"" + PHONE + "\"\r");
    delay(1000);
    sim800.print("http://maps.google.com/maps?q=loc:");
    sim800.print(gps.location.lat(), 6);
    sim800.print(",");
    sim800.print(gps.location.lng(), 6);
    delay(100);
    sim800.write(0x1A);
    delay(1000);
```

```
  }
}
void sendSms(String text) {
  sim800.print("AT+CMGF=1\r");
  delay(1000);
  sim800.print("AT+CMGS=\"" + PHONE + "\"\r");
  delay(1000);
  sim800.print(text);
  delay(100);
  sim800.write(0x1A);
  delay(1000);
  Serial.println("SMS Sent Successfully.");
}
int8_t sendATcommand(char* ATcommand, char* expected_answer, unsigned int
timeout) {

  uint8_t x = 0, answer = 0;
  char response[100];
  unsigned long previous;

  memset(response, '\0', 100);

  delay(100);

  while (sim800.available() > 0) sim800.read();

  if (ATcommand[0] != '\0') {
    sim800.println(ATcommand);
  }
   x = 0;
  previous = millis();
  do {
    if (sim800.available() != 0) {
      response[x] = sim800.read();
      x++;
      if (strstr(response, expected_answer) != NULL) {
        answer = 1;
      }
    }
  } while ((answer == 0) && ((millis() - previous) < timeout));

  return answer;
}
```

```
boolean getIgnitionStatus() {
  float val = 0;
  for (int i = 1; i <= 10; i++) {
    val = val + analogRead(ignition_sensor);
  }
  val = val / 10;
  //Serial.println(val);
  if (val > 90) {
    //Serial.println(val);

    //delay(5000);
    return true;
  } else if (val < 50) {
    return false;
  }
}
void setIgnition() {
  ignition_status = getIgnitionStatus;
  if (ignition_status == false) {
    sim800.print("AT");
    sendATcommand("AT+CSCLK=0", "OK", 1000);
  } else if (ignition_status == true) {
    sendATcommand("AT+CSCLK=2", "OK", 1000);
  }
}
```

3.6 AT command:

AT+CMGF=1

AT+CMGF=1

By making use of the AT+CMGF=1 command with GSM modules one can manage the SMS text mode.
All texts that are transmitted or received through a GSM module in plain and simple form are handled using AT+CMGF=1. This mode enables us to use regular text format for sending and receiving SMS messages.
If you send an AT+CMGF=1 command to the GSM module then it will be set up to communicate via SMS using text mode. This is in contrast to the PDU (Protocol Data Unit) mode, which is another mode used for handling SMS messages but requires a specific binary format.

By setting the SMS text mode using AT+CMGF=1 we can facilitate the process of working with SMS functionality in Arduino or other microcontroller-based projects by enabling usage of simple text commands to send and receive messages. The following demonstrates how to use the AT+CMGF=1 command:

1. The serial communication interface can be used to send AT+CMGF=1 and configure the GSM module for text messaging.
2. The response from the GSM module indicating successful execution of a command will be OK.

   AT commands like AT+CMGS and others are available to you once you have successfully set up the SMS text mode, and these commands can be used to send and receive messages. Remember to ensure that your GSM module supports the AT+CMGF command and that we have properly initialized the module and established a serial communication connection before issuing this command.

- **"AT+CMGC="**

1. Use the AT+CMGC= command followed by enclosing recipient's phone number in double quotation marks to send an SMS. To illustrate: AT+CMGC=972599750495.
2. After displaying a > prompt the GSM module will be able to receive message content.
3. It is possible to send the content of the SMS message after that, and the message could consist of either plain text or a mix of both plain text and special characters. Using the ASCII control character Ctrl+Z (ASCII code 26), indicate that you have reached the end of your message

4. After sending the message content, the GSM module will respond with a message reference number or an "OK" response if the message was sent successfully.

an example of how you can use the AT+CMGC command to send an SMS message:

1. Send the command 'AT+CMGC="972599750495"' to the GSM
2. The module will respond with >
3. Send the content of the SMS message, for example: A message to check functionality.
4. Sending the ASCII control character Ctrl+Z (ASCII code 26) is necessary to terminate the message.
5. . The response from the module on successful delivery of messages can be either an OK status confirmation or a specific reference code.

Chapter 4: Results and Analysis

4.1 the hardware system:

The system that was created is a solution to the problem of vehicle theft Vehicle theft presents a multifaceted problem encompassing financial losses for owners, increased insurance rates, and broader societal impacts, including heightened crime rates and safety concerns. The link between stolen vehicles and other criminal activities amplifies the challenge, requiring law enforcement to contend with a range of offenses. Rapid technological advances in electronic key cloning and relay attacks add sophistication to theft methods, while the existence of chop shops and illegal markets facilitates the disposal of stolen vehicles and their parts. Inadequate security measures on some vehicles, coupled with owners' lapses in precautions, contribute to the vulnerability of certain models. The international trafficking of stolen vehicles further complicates recovery efforts, as they can be easily transported across borders. Addressing this issue necessitates a comprehensive approach, involving preventive measures, public awareness campaigns, community policing, and the integration of technology such as GPS tracking devices and security systems. Public cooperation and vigilance remain crucial in curbing the incidence of vehicle theft.

The incorporation of a control system, for a DC motor into the framework of an Arduino Uno, GPS GSM module and an ignition sensor signifies an approach to managing vehicles. This system allows users to have control over the DC motor by sending SMS commands. The simplicity and ease of use of this mechanism is demonstrated by instructions like "turn vehicle on" which activates the DC motor. This feature not provides users with the convenience of starting or stopping the motor but also plays a crucial role in enhancing vehicle security. System responsiveness is particularly highlighted in situations where there is a theft attempt as any unauthorized activity triggers a response. If the system is on and if someone is trying to steal your vehicle that promptly sends an SMS notification to a pre-defined mobile number informing the vehicle owner with a message similar to "someone is trying to steal your vehicle." By integrating this control system for DC motors into the broader framework, for managing vehicles it not only enhances user control and convenience but also establishes a strong layer of security by promptly addressing and notifying owners about any unauthorized access or tampering with their vehicles.

The SMS-based control mechanism allows for remote commands, enabling users to start or stop the DC motor in each vehicle. Although this may not constitute advanced fleet management, it does offer a basic level of control over multiple vehicles in a fleet through SMS instructions.

After connecting the hardware, programming it, and supplying it with power

The GPS module lights up intermittently when the system is in an open range. This means that data is being received from satellites.

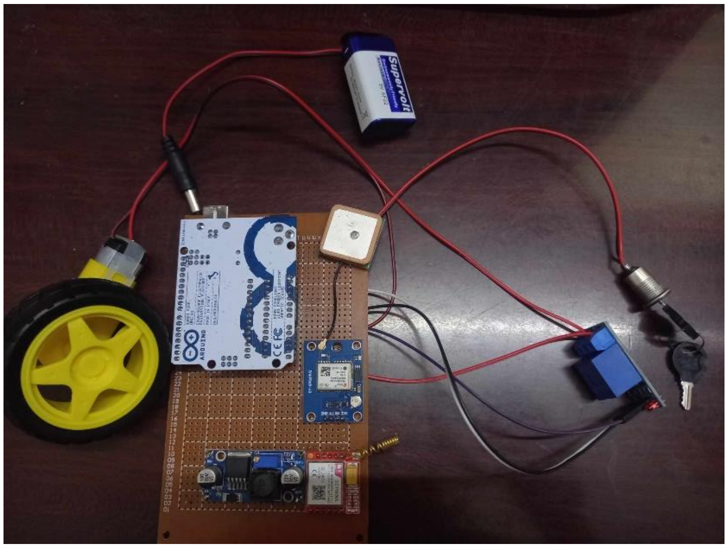


Figure 17: the hardware

The GSM module also lights up intermittently, and this is evidence that it is working. In addition, the GSM was checked by calling the SIM number found in the GSM, and this is what was obtained in the serial monitor.

This means that the system is working 100%.

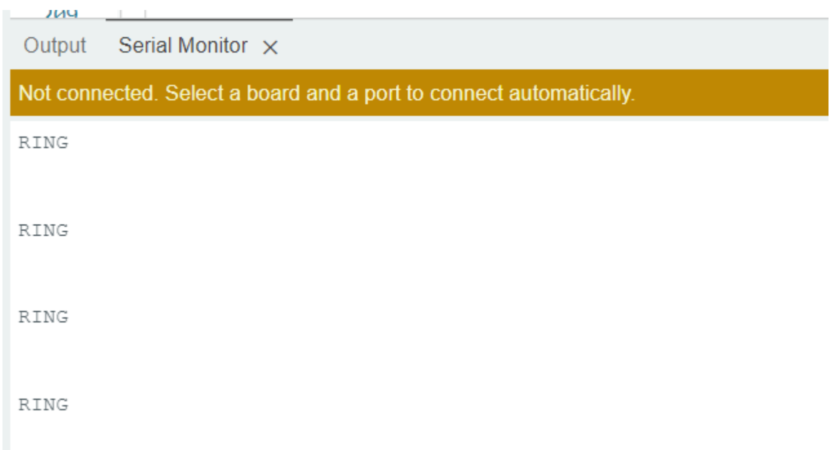


Figure 18: testing the GSM

4.2 the three functions that the system works on:

first of all the system should be on by sending SMS to the GSM number (system on)

1- if you send an **SMS** (get location) to the system from the vehicle owner number then you will get the location as SMS

```
+CMT: "+972599592916","","23/12/28,13:56:39+08"
get location

buff>"+972599592916","","23/12/28,13:56:39+08"
get location
.........
sms_status>8
sender_number>+972599592916
received_date>23/12/28
msg>get location
```

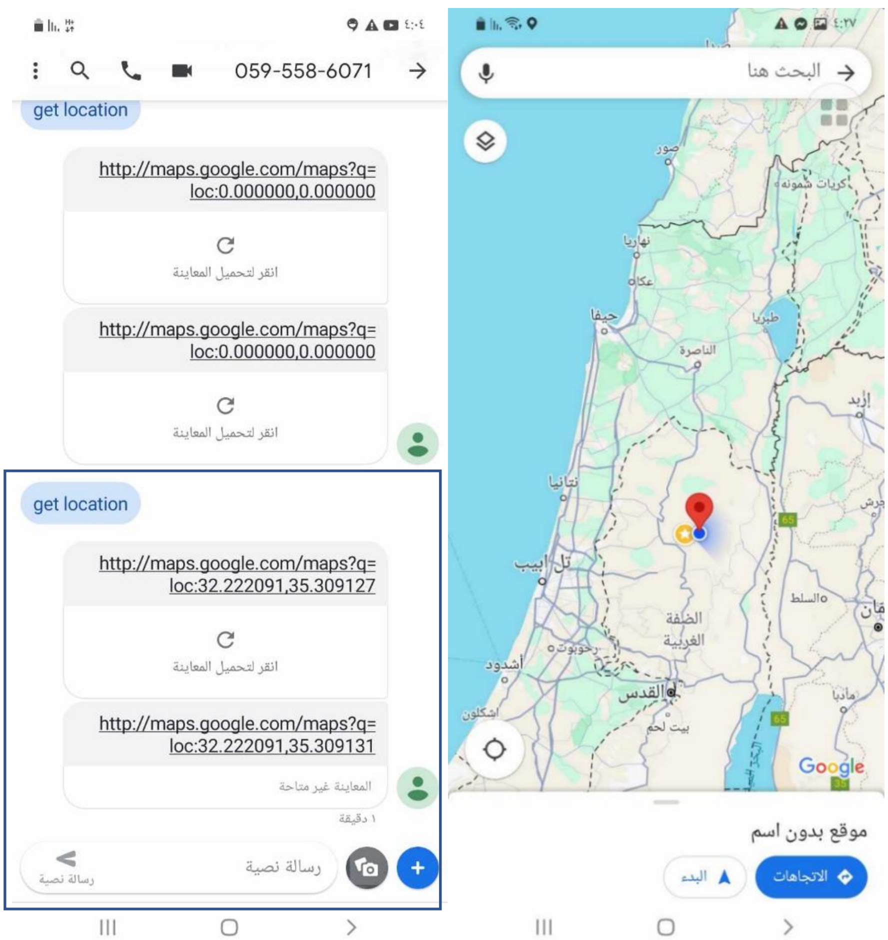


Figure 19: the first functions that the system works on and the results of location

Note that the system is an outdoor system and when we are inside it will gave the location : 0.000000,0.00000 like the above.

2- you can control the vehicle motors by sending a short message that says (bike on, bike off) and the system will understand if you will want to make your vehicle on or off, This system enables users to exercise precise control over the DC motor through the transmission of SMS commands. The simplicity and accessibility of this mechanism are exemplified by a straightforward command like "bicke on," triggering the activation of the DC motor. This capability not only offers users the convenience of remotely initiating or deactivating the motor but also serves as a pivotal feature in enhancing vehicle security.

Ignition Switch

The ignition switch is a physical switch that controls the vehicle's ignition system.

It can be turned on or off remotely through SMS commands, providing control over the vehicle's engine.

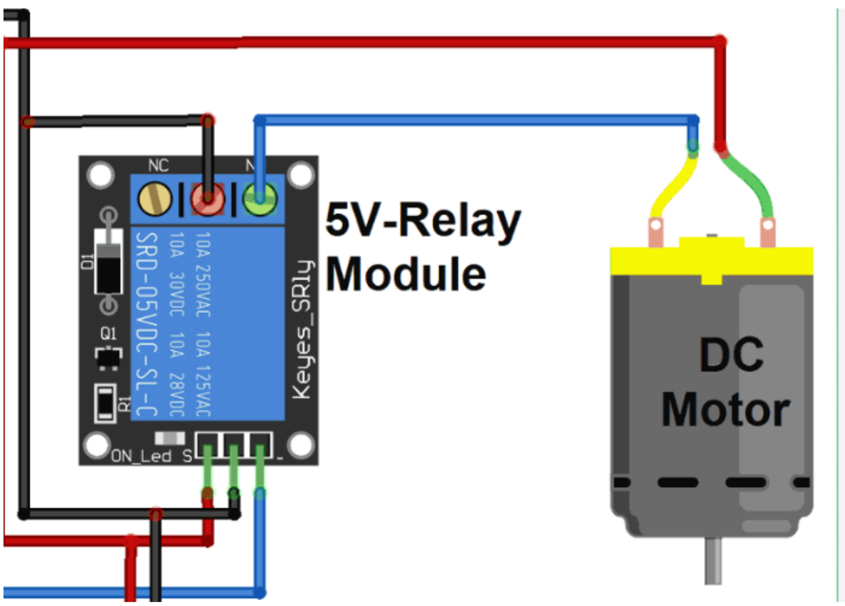


Figure 20: connecting between dc motor and relay

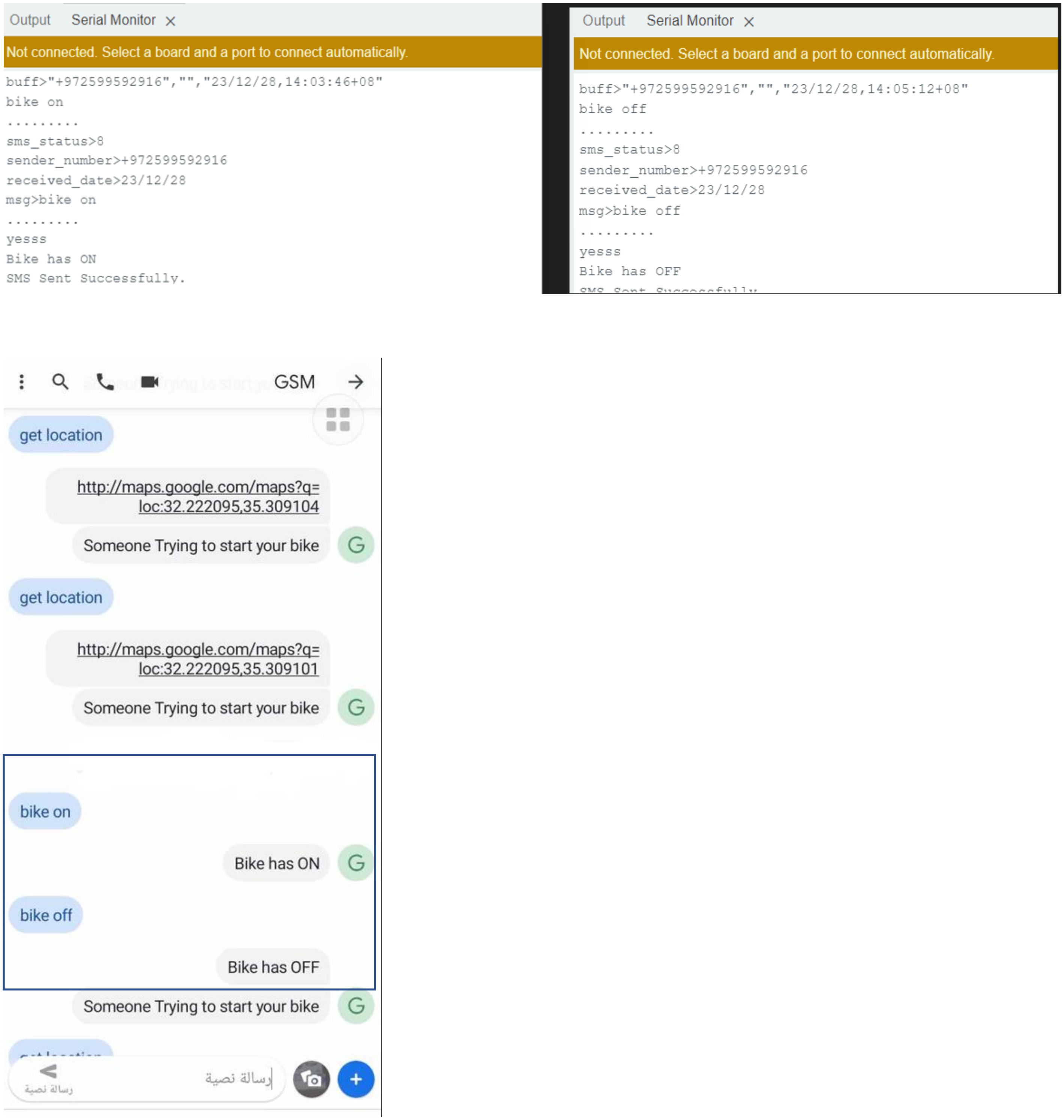


Figure 21: the second functions that the system works on

3- if someone is trying to open your vehicle the system will quickly send a sms to tell you that (someone Trying to start your bike)

Ignition Sensor

The ignition sensor is an analog sensor connected to the Arduino board.

It measures the voltage or resistance associated with the vehicle's ignition status.

The sensor helps detect whether the ignition is on or off, enabling the system to monitor the vehicle's status.

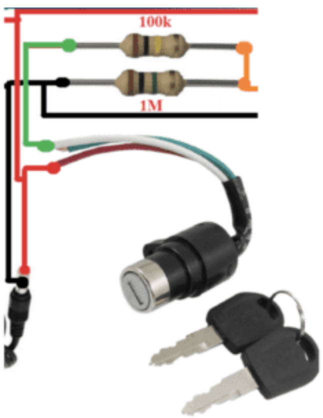


Figure 22: Ignition Sensor connection

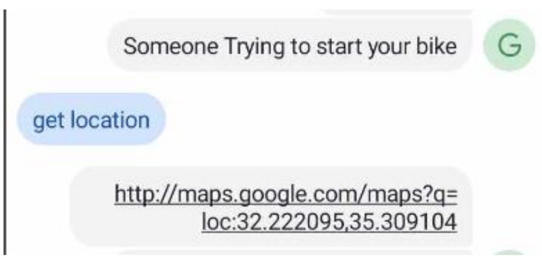
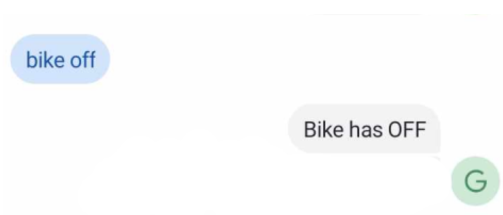


Figure 23: the third functions that the system works on

Then we can make the vehicle motor off



4.3 Writing Latitude and Longitude:

Basic Latitude and Longitude:

Latitude and Longitude are represented by two numbers. These numbers can be expressed in degrees, minutes and seconds (, with N, S, E, W) or in degrees.

Latitude indicates the position of a point in relation to the equator (North or South) while longitude indicates the position of a point in relation to the Prime Meridian (East or West).

Each degree is divided into 60 minutes. Each minute is further divided into 60 seconds. For instance 40°45'11"N can be read as "40 degrees, 45 minutes and 11 seconds North."

As an example, New York City coordinates in degrees, minutes & seconds are 40°45'11"N and 73°58'59"W—. Simply expressed as degrees; 40.753056 for latitude and 73.983056 for longitude.

To identify lines of latitude; these lines run from East to West starting with the equator at the reference line of 0°. Each line is labeled with its degree value followed by "N" for North or "S" for South. Lines located north of the equator will have an "N" label while those located south will have an "S" label. The degree value increases as you move away, from the equator towards either pole.

For instance, New York City is situated in the vicinity of the 40°N latitude line indicating that it is positioned 40 degrees of the equator. Similarly, Sydney, Australia can be found near the 34°S latitude line signifying its location as 34 degrees of the equator. Latitude lines extend from 0° to 180° in both Southern directions. Since 0° (the equator) lies between the two hemispheres, both 0°N and 0°S represent the geographical reference.

180°N is the geographic North Pole, while 180°S is the geographic South Pole. Since these are different locations, 180°N and 180°S are not the same.

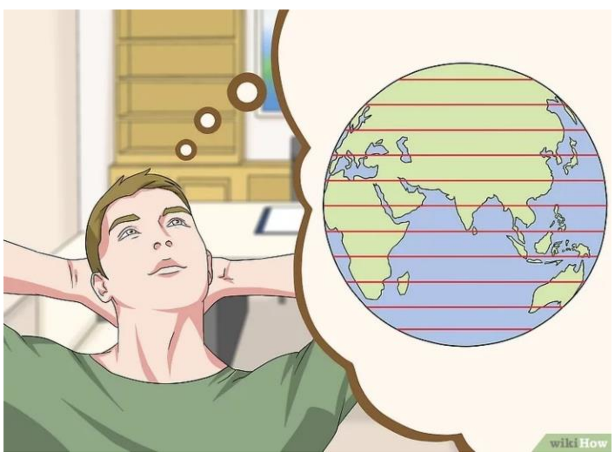


Figure 24: Latitude on the map

lines of longitude. These lines stretch from north to south. Begin with the 0° line, which's close to London U.K. Each line is labeled with degrees, followed by either an "E" for east or a "W" for west. If a line is to the east of 0° it will have an "E" label while lines to the west will have a "W" label. The number of degrees increases as you move away from 0° in either direction.

For instance, let's take New York City as an example. It is located near the line marked at 74°W. This means that New York City is positioned 74 degrees to the west of the prime meridian.

Similarly, Sydney in Australia can be found close to the line marked at 150°E. This indicates that Sydney is situated 150 degrees east of the prime meridian.

The prime meridian itself is marked at 0° longitude. Serves as a reference point between the western hemispheres. So, when we say 0°E or 0°W they essentially mean the thing.

On the other hand, there is another line running through the middle of the Pacific Ocean, known as the opposite line, or simply at 180° longitude.

Just like 0 degrees both 180 degrees east and 180 degrees west signify the thing because the 180-degree line lies in between the Western and Eastern hemispheres.

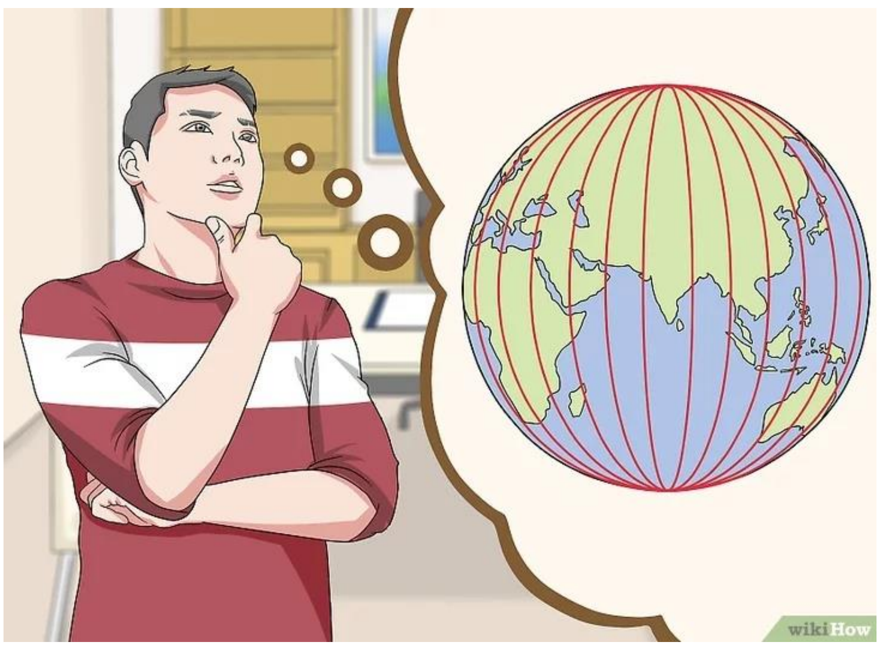


Figure 25: longitude on the map

Using Decimal Degrees

Use Google Maps to find the latitude and longitude of a specific location. Choose a specific city or location, then tap or right-click to view the latitude and longitude. Your coordinates will be displayed in decimal minutes, without N, S, E, or W.

For example, your coordinates could be 15.23456 and 30.67890.

Figure 26: decimal coordinates

Determine if numbers are positive or negative by utilizing an approach relying on directional terms like North, South, East and West. In this method, positive values are assigned to numbers for lines of latitude situated above the equator while negative values are given to lines located below the equator. Similarly, for lines of longitude positive values represent those eastwards from the Prime Meridian whereas negative values indicate those westwards, from the Prime Meridian.

For example, the line of latitude 15.23456 is north of the equator, while the line -15.23456 is south of the equator. The line of longitude written as 30.67890 is east of the Prime Meridian, while the line -30.67890 is west of the Prime Meridian.

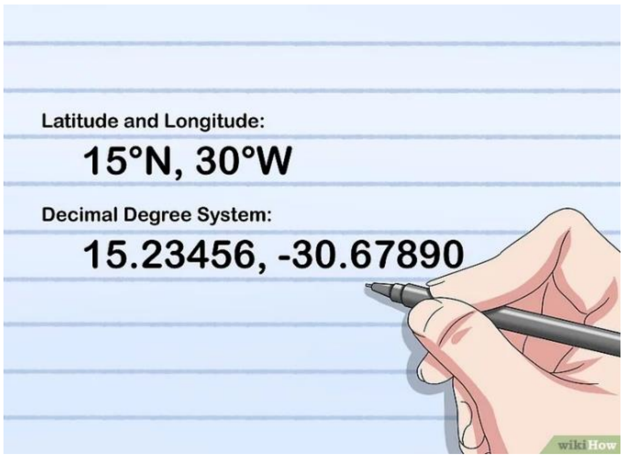


Figure 27: write decimal coordinates

4.4 data analysis

This data was obtained through the system and compared to the data of the real location from which the system was operated. The data is 100% identical. This proves the validity of the system and the accuracy of its data. The longitude lines are shown in the data in addition to the latitude and time lines from which the location data was obtained and of course whenever the system is moved the coordinates changed. The GPS system changes the value of the longitude and latitude due to the change in distance, and since the GPS system at least picks up the signal from at least 3 satellites, this is the main reason for the system's accuracy.

time	latitude	longitude
5/12/2023 .4:01:00 PM	32.222046	35.309105
5/12/2023 .4:01:00 PM	32.222046	35.309105
5/12/2023 .4:01:00 PM	32.222046	35.309105
5/12/2023 .4:01:00 PM	32.222046	35.309105
5/12/2023 .4:01:00 PM	32.222046	35.309105
5/12/2023 .4:02:00 PM	32.222045	35.309105
5/12/2023 .4:02:00 PM	32.222044	35.309119
5/12/2023 .4:03:00 PM	32.222052	35.309123
5/12/2023 .4:04:00 PM	32.222052	35.309127
5/12/2023 .4:04:00 PM	32.222059	35.309129
5/12/2023 .4:05:00 PM	32.222066	35.309129
5/12/2023 .4:05:00 PM	32.222069	35.309131
5/12/2023 .4:06:00 PM	32.222173	35.309232
5/12/2023 .4:06:00 PM	32.222175	35.309232
5/12/2023 .4:06:00 PM	32.223182	35.301335

Figure 28: sample of data set used in the analysis

Time Patterns;

The time column shows a series of data points that were captured at times.

The data points were recorded every minute in part of the dataset (e.g., 4;01;00 PM, 4;02;00 PM). Then, at irregular intervals later on.

Coordinate Changes;

The latitude and longitude columns indicate the users location. Most of the data points in the part of the dataset have the coordinates (32.222046° latitude, 35.309105° longitude) suggesting that the user stayed in one place during that time. Later in the dataset, there are variations in coordinates suggesting a change in the users location.

Potential Anomalies:

There are instances where the coordinates remain constant for time points (e.g. rows with identical coordinates at 4;01;00 PM). There is a shift in latitude and longitude values in the middle of the dataset (at 4;06;00 PM) due to a change, in location.

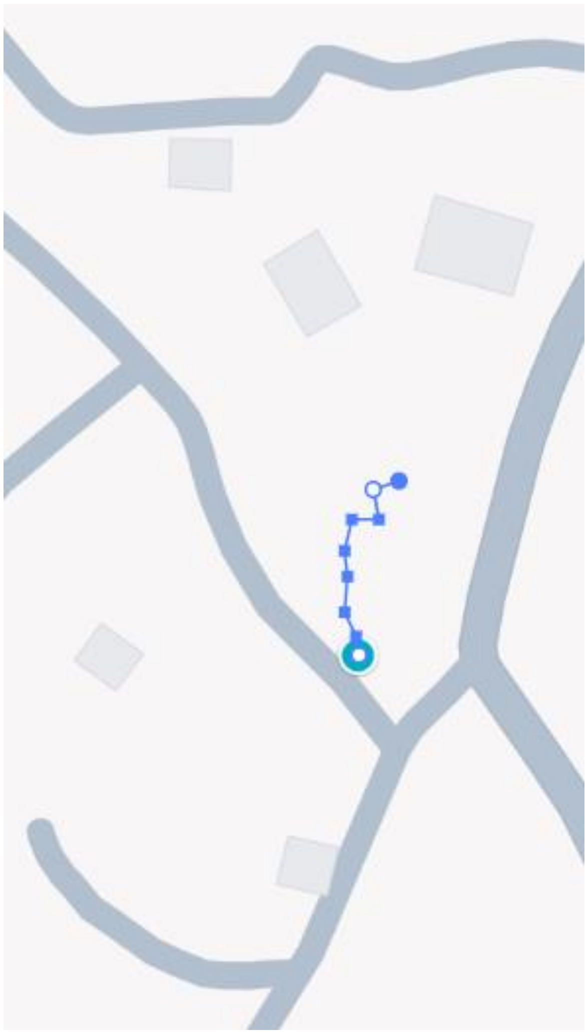


Figure 29: Track according to coordinates

Chapter 5: Discussion

5.1 Have the problem been resolved or not

The GPS GSM system that has been developed using an Arduino Uno, an ignition sensor and a DC motor is an example of tackling the issue of vehicle theft. The system effectively addresses the problem by providing location information of the vehicle through SMS commands. Additionally, it allows for control by sending SMS instructions, such as "turn on vehicle" which activates the DC motor. Overall this practical and cost effective solution greatly enhances vehicle security. The inclusion of an ignition sensor adds another layer of protection, by triggering an SMS whenever there are attempts to steal the vehicle, thus serving as a powerful deterrent, against theft. This aligns with the primary objective of mitigating vehicle theft, as the system empowers users with a direct means of monitoring, controlling, and securing their vehicles.

However it's important to recognize limitations. Although the system works well for individual vehicle use, it may face challenges when scaling up for fleets due to its reliance on SMS commands. Furthermore, the potential delay in SMS communication could affect how quickly the system responds, in situations. Additionally, when considering fleet management as a whole, the system may not offer a solution that includes features like optimizing routes, scheduling maintenance and advanced analytics.

When comparing these findings with existing knowledge in the field, the developed system aligns with the increasing trend of do-it-yourself solutions for vehicle security. By utilizing technologies like GPS and GSM along with the Arduino Uno platform, this system presents a practical approach, to reducing vehicle theft for individual users.

In conclusion, the project effectively contributes to resolving the problem of vehicle theft by providing a viable and accessible solution. While it may not encompass the complexities of fleet management, the system fulfills its primary purpose of enhancing security for individual vehicle owners. The practicality and user-friendliness of the system make it a valuable addition to the evolving landscape of DIY vehicle security solutions.

5.2 implications of the system on the Society

The logical consequences of implementing the GPS GSM system for vehicle security have reaching implications for society. This system offers an easily accessible solution to combat the risk of car theft, which in turn positively impacts societal concerns surrounding property security and public safety. With this do-it-yourself security solution individual vehicle owners can experience a sense of peace and control, over their assets.

The system's ability to send alert SMS notifications in case of unauthorized ignition attempts not only serves the immediate interest of the vehicle owner but also contributes to a safer community by acting as a deterrent to potential thieves. In the broader societal context, the adoption of such DIY security measures may collectively contribute to reducing the prevalence of vehicle theft, fostering a more secure and resilient community.

5.3 further studies or applications

While commercial products often offer features, this project aims to make vehicle security technologies more accessible to everyone, paving the way for future innovations. To further enhance GPS GSM vehicle tracking and security systems, it's worth exploring the development of both end and back end components for a web based interface. This will allow users to have an interactive experience by incorporating features such as real time map visualization. It's important to prioritize creating a design that ensures accessibility across devices while maintaining user friendliness. on the back end focuses on building a system for storing and retrieving data efficiently, including information like vehicle locations, alerts and user profiles. Implementing websockets for real time updates is crucial as it enables notifications and live tracking of vehicles. Additionally, ensure security measures are in place by incorporating encryption protocols and secure communication channels to protect user data and maintain system integrity. Lastly, by integrating APIs you can open up possibilities for collaborations with platforms while enhancing scalability and flexibility.

For user experience, it is recommended to incorporate features such as geofencing, customizable preferences and reporting capabilities. These additions will provide users with a comprehensive system that goes beyond GPS GSM functionality. This holistic approach does not improve the effectiveness of vehicle tracking and security. It also ensures a sophisticated and user friendly solution that leverages the latest technology.

Looking ahead, further studies and applications involving AI could significantly enhance the system. Implementing machine learning algorithms for behavioral analysis, predictive maintenance, and anomaly detection can refine security measures and operational efficiency. Integrating facial recognition, voice-activated commands, and smart route optimization through AI could elevate user experience and security features. Additionally, exploring collaborations with emergency services and developing adaptive security policies using AI could address emerging challenges in the field. These suggestions not only extend the functionality of the current system but also pave the way for more sophisticated and intelligent applications in the domain of vehicle tracking and security.

Integrating Biometric Authentication:

We are looking into incorporating biometric authentication methods like fingerprint and retina scans to enhance user verification and ensure access to vehicle controls.

Using Machine Learning for Predictive Maintenance:

We are implementing machine learning algorithms to analyze sensor data and predict maintenance needs. This will help users address issues before they escalate and contribute to long term vehicle health.

Exploring Blockchain for Enhanced Security:

We are investigating the application of technology to secure data transmission and storage. This will ensure the integrity and authenticity of the information exchanged between the vehicle and the user.

Developing a Comprehensive Vehicle Health Monitoring System:

Our goal is to develop a comprehensive vehicle health monitoring system that goes beyond security. This will provide real-time data on engine performance, fluid levels and other critical parameters to enhance vehicle maintenance.

Integrating with Smart City Infrastructure;

We are exploring opportunities for integration with smart city infrastructure. This will allow vehicles to communicate with traffic management systems, parking facilities and other urban services for improved mobility and efficiency.

Utilizing Multi Sensor Fusion for Enhanced Security;

By integrating sensors such as cameras and radar, we aim to explore sensor fusion techniques that provide a comprehensive understanding of the vehicle's surroundings. This contributes to security and safety measures.

Ensuring Cybersecurity:

Thoroughly researching cybersecurity risks, to GPS GSM systems and creating security measures, such as encryption protocols and intrusion detection systems to protect against cyberattacks.

Improvements in Human Machine Interaction (HMI);

explore the possibilities of HMI technologies like augmented reality displays and gesture based controls. These enhancements will make the user interface more intuitive and user friendly, enhancing the experience.

Collaboration with Insurance Companies:

We should consider forming partnerships with insurance companies to integrate our system into their programs. This collaboration could potentially offer discounts to users who utilize security and tracking systems.

Enhancing the Global Navigation Satellite System (GNSS):

It's important to research and implement enhancements for our GNSS module. By supporting constellations like GPS, GLONASS and Galileo we can improve accuracy and reliability in challenging urban or remote environments.

Smart Charging and Energy Efficiency:

Our development efforts should focus on optimizing energy consumption. Features like charging capabilities and energy efficiency protocols will ensure that the system remains operational for periods without draining the vehicle's power source.

Adaptive Learning for User Preferences:

We can enhance the system by implementing learning algorithms. This will enable it to understand user preferences and behaviors, allowing for responses and recommendations over time.

These proposed areas of further study aim to enhance GPS GSM based vehicle tracking systems in terms of functionality, security and user experience. They open up possibilities for innovation in this field.

5.4 results and discussion

The implementation of the GPS and GSM-based vehicle tracking and security system yielded promising outcomes, showcasing its effectiveness location retrieval, remote control functionalities, and security measures. The system successfully demonstrated accurate and prompt location updates, allowing users to obtain information about their vehicle's whereabouts. This was achieved through the integration of GPS technology, providing precise geographical coordinates, and GSM communication for seamless transmission of location data to the user's mobile device.

The responsiveness of the system to SMS commands was evident during practical tests. Commands such as "vehicle on" were executed promptly, activating the DC motor as intended. This feature enhances user control over their vehicle remotely, demonstrating the practicality and convenience of the implemented solution.

The security features, notably the ignition sensor and alert system, proved to be effective deterrents against unauthorized access and potential theft. The system successfully detected and responded to unauthorized ignition attempts by sending immediate alert SMS messages to the designated mobile number. This functionality aligns with the core objective of enhancing vehicle security, providing users with timely notifications in case of suspicious activities.

However, it is important to note certain limitations observed during the testing phase. Potential latency issues in SMS communication were identified, impacting the system's responsiveness in certain scenarios. Additionally, scalability challenges were noted, particularly in managing larger fleets of vehicles, where the simplicity of SMS commands might pose constraints.

In summary, the results highlight the successful implementation of a functional GPS and GSM-based vehicle tracking and security system. The system effectively delivers real-time location updates, remote control capabilities, and robust security features, contributing to its overall reliability and practicality.

Chapter 6: Conclusions and Recommendation

6.1-Conclusions:

the implementation of GPS and GSM-based vehicle tracking and security systems has yielded significant outcomes, substantiated by clear evidence of successful location tracking, remote control functionalities, and robust security features. GPS technology ensures accurate and timely location updates Upon request from the vehicle owner. The seamless integration with GSM technology allowed for prompt execution of remote commands, exemplified by the responsive activation of the DC motor through SMS instructions like "vehicle on", The inclusion of an ignition sensor adds another layer of protection, by triggering an SMS including a warning whenever there are attempts to steal the vehicle, thus serving as a powerful deterrent, against theft. This aligns with the primary objective of mitigating vehicle theft, as the system empowers users with a direct means of monitoring, controlling, and securing their vehicles. Security measures, the ignition sensor and alert system, effectively deterred unauthorized access, enhancing overall vehicle security.

The role of vehicle tracking systems in fleet monitoring and stolen car recovery is vital. By implementing semi-offline systems, there are significant advantages in simplicity, effectiveness, and cost-efficiency. Semi-offline systems enable the receipt of location data from satellites while only transmitting this information upon request to conserve energy by not continuously consuming data or draining batteries.

Communication channels such as GPRS, 3G or SMS allow for timely delivery of location information as required. These simplistically designed user-friendly semi-offline systems provide easy installation with minimal technical expertise requirements, which makes them accessible by individuals and businesses alike for obtaining strategic asset management support service updates by simply utilizing uncomplicated commands or messages.

The semi-offline system has proven effective due to its capacity to offer precise and current location data. These systems ensure steadfast tracking by directly transmitting information and relying on satellite signals. In incidents of car theft or unauthorized use, the system is able to promptly establish the vehicle’s whereabouts, thus enabling immediate action towards recovery or necessary measures. Their cost-effectiveness is what makes semi-offline systems an attractive choice. Unlike competing tracking solutions that necessitate constant data transmission, these systems minimize operational expenses. The cost of messages with SMS is very low, which is particularly beneficial when transmitting data and reducing expenses. Communication between the tracking device and user remains reliable through maintenance.

6.2 Recommendations:

6.2 Recommendations:

To enhance the system’s performance in a cost manner, we suggest the following recommendations:

1. Improve SMS Communication: Look for ways to optimize SMS communication to reduce delay and make remote commands more responsive. This could involve collaborating with mobile network providers to ensure timely data transmission.

2. Enhance Scalability: Explore solutions that can accommodate vehicle fleets without compromising responsiveness. This might require refining the system architecture to handle increased data volume.

3. Refine User Interface: Develop a user web interface, alongside SMS-based commands providing users with a platform to monitor and control their vehicles. This improvement can contribute to a more interactive user experience.

Learnings:

Throughout this project we have gained insights into integrating GPS and GSM technologies for vehicle tracking and security purposes. The successful outcomes highlight the potential of user-friendly solutions in addressing real world challenges.

Future Work and Directions;

Moving forward, it is essential to focus on testing, refinement and optimization in order to address identified limitations as well as emerging challenges. Additionally, exploring security measures like authentication and incorporating machine learning for predictive capabilities can further enhance the system’s effectiveness.

There are still some challenges that need to be addressed in the system. One of the challenges is finding ways to deal with cybersecurity threats. Additionally, it would be beneficial to explore communication channels that go beyond SMS to ensure reliability. Ongoing research and innovation in these areas will play a role in the improvement of the system.

Overall, the project has provided a robust foundation for GPS and GSM-based vehicle tracking and security. The outlined recommendations offer practical ways to enhance performance, and the insights gained pave the way for future advancements in this dynamic field

Hardware demo:

https://www.youtube.com/watch?v=FWXbjAMdGOg&t=9s

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