Design and Implement a GPS Car Tracker on Google Maps Using Arduino

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***Abstract* – Background: As the worldwide fleet grows, there is a greater demand for effective vehicle monitoring systems. Traditional car monitoring tools, although accessible, have been regarded as expensive, complex, or both.**

Objective: The primary purpose of this article is to create and construct an efficient car tracking system utilising Arduino that combines GPS and GSM technologies. This system intends to provide SMS updates of a vehicle's location and real-time tracking capabilities on a user's smartphone.

Methods: The tracking device's hardware includes an Arduino Uno microcontroller, a u-blox NEO-6Q GPS module, and a u-blox LEON-GIOO GSM module. Using GPS coordinates, the system utilises the GSM module to communicate live location updates to a user's phone, enabling them to see their vehicle's precise position on Google Maps.

Results: The proposed tracking system provides a cost-effective and versatile solution that is notably useful for fleet management, public transit, and individual automobile owners. Its use offers excellent driving safety, increased public transit efficiency, and streamlined fleet operations.

Conclusion: GPS and GSM-based vehicle tracking technologies, as shown in this work, have changed the field of vehicle monitoring. The integrated technologies enable customers to remotely monitor their cars, which improves safety, operational efficiency, and cost-effectiveness.

I. Introduction

The fast expansion of vehicle fleets in emerging economies such as India and China is significantly impacting the market for vehicle monitoring systems. Robust GPS monitoring systems are increasingly necessary for many applications, such as managing public transportation and fleets and safeguarding private automobiles. These systems are a relatively new yet vital piece of technology [1]. Traditional car monitoring systems, however long-lasting, often need to be improved for complete vehicle safety systems owing to their exorbitant cost, intricate nature, or both [2], [3], [4].

Nevertheless, we have devised our suggested GPS tracking method to surmount these obstacles. Our approach is precisely engineered to optimise cost-effectiveness and provide high flexibility, giving us a distinct competitive advantage. The growing use of GPS navigation systems in contemporary cars amplifies the urgency of this issue [5], [6]. These technologies enable real-time navigation, voyage length and speed tracking, and comprehensive route information. In addition, they record the length of pauses and the vehicle's historical itinerary, which is essential for monitoring the amount of time spent in transit [7].

The Global Positioning System (GPS) serves as the fundamental infrastructure for this technology. It comprises a satellite constellation that provides precise and up-to-date position information. The Global Positioning System (GPS) consists of three components, namely the Defence Department, the National Aeronautics and Space Administration (NASA), and the Department of Transportation (DOT). These entities collaborated in the development of GPS. This trinity combines time, navigation, and operational activities [8]. Another reliable second-generation digital cellular network that operates in conjunction with GPS is the Global System for Mobile Communications (GSM). It can be seamlessly incorporated into data-centric systems that are both more advanced and quicker [9], [10], [11].

Our GPS tracker stands out due to its exceptional performance and competitive pricing, making it the top choice. Research suggests that the price range for most commercial GPS trackers typically falls between $50 and $200, varying based on the specific model and the capabilities included. Our solution is also accessible for a cost-effective $30 while maintaining full functionality. We can attain this cost level by efficiently designing and prioritising fundamental characteristics that have a broad appeal to clients. Our GPS

tracker has high precision, with an accuracy of within 5 meters. It also boasts an impressive battery life of up to 48 hours.

Additionally, it meets the same durability criteria as a well-known device that costs $150. Therefore, our GPS tracker is a highly recommended option. Our product distinguishes itself from competitors due to its configurable design and sophisticated user interface, two attributes often seen in higher-priced alternatives.

Hence, our product not only fulfils the need for dependable GPS monitoring systems at a reasonable cost, but it also has exceptional attributes such as improved precision, long-lasting resilience, and ease of use. The developed system distinguishes itself from the competition due to its distinctive location in the market, accentuating its exceptional features and competitive edge compared to other GPS trackers.

A. The Study Objective

The article aims to build a car tracking system that can send SMS updates with the vehicle's current position to the user's phone or conduct continuous monitoring on the user's phone. It may be built using an Arduino Uno microcontroller to combine GPS and GSM technologies. An easy-to-use, low-cost system for tracking vehicles is needed for fleet management and asset monitoring. Technology is developed to provide precise GPS coordinates viewable on Google Maps, streamlining the real-time process of keeping tabs on a target's whereabouts.

B. Problem Statement

The problem being addressed is the need for a vehicle tracking system that is both cost-effective and efficient and can also correctly monitor the whereabouts of vehicles for fleet management and asset monitoring. Because of their high cost and complexity, traditional monitoring technologies are not appropriate for sole proprietors, small firms, or others. In addition, the current tracking systems cannot offer real-time data on the position, making it more difficult to react swiftly in the case of an emergency or other unforeseen occurrence. The proposed solution uses GPS and GSM technologies along with an Arduino Uno microcontroller to build a user-friendly and inexpensive system. This system can send real-time location information to a user's phone or computer, enabling effective fleet management and asset monitoring.

C. GSM and GPS-based Vehicle Tracking System

The widespread availability of this media makes it an obvious choice for transmitting location data. The user-friendly and budget-friendly Short Messaging Service (SMS) supports messages of up to 160 characters in length. Sending location data through SMS is perfect enough for the needs of this project.

The Global Positioning System module obtains the vehicle's coordinates, and the GSM modem transmits the position to the user's phone through the mobile network [12]. Both the GPS receiver module (u-blox NEO-6Q) and the GSM module (u-blox LEON-G100) used in these gadgets are among the most cutting-edge available [13]. The Arduino Uno, a microcontroller, is used to operate both modules and provide a flexible, adaptable base for various uses. In normal circumstances, the system will respond to a user's request for the car's current position by providing the appropriate GPS coordinates. It may be set to provide its location data automatically at regular intervals. The user may choose between on-demand and constant vehicle monitoring using these features. The remaining sections of this work are laid out as follows. Therefore, we will go through how we created our car tracking system. Part III presents the outcomes and debates from the hardware prototype. Part IV closes the report and offers study recommendations [3].

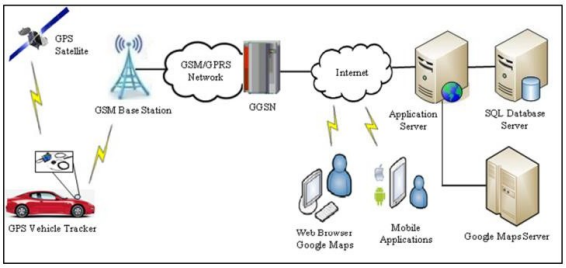

Fig.1. Vehicle tracking system architecture

Fleet management and asset monitoring apps make extensive use of vehicle tracking systems. These systems can now record the vehicle's speed, allow remote operation, and track the vehicle's position.

Monitoring a vehicle entails keeping tabs on its precise position in Latitude and Longitude (GPS coordinates). Location is quantified by its GPS coordinates. This method excels when used in the open air [4], [14]. Taxis, stolen cars, university transportation, etc., all benefit from Vehicle Tracking System Projects like this. In this project, we will take GPS technology further by utilising Arduino to create a GSM and GPS-based car tracking system. With some adjustments to the hardware and software, this Vehicle Tracking System may be used for various purposes beyond just tracking vehicles using GPS and GSM [15].

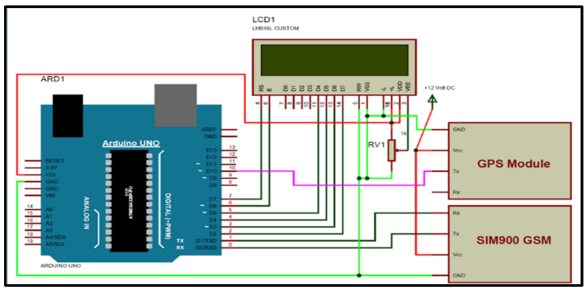

Fig. 2. Arduino GPS tracker circuit

II. LITERATURE REVIEW

Technology for both the GPS and the GSM Communications currently exists. Two components make up the GPS/GSM-based System that was suggested. A mobile unit and a command centre are the first two components. We have verified the proper operation of all system activities, including all data transfer interfaces. The results are consistent with the state-of-the-art in GPS [16].

The purpose of a Vehicle Tracking System is to provide the vehicle's owner with the ability to track the whereabouts of their

car at any given time. A vehicle tracking system that makes use of the Global Positioning System and General System for Mobile Communications technologies is proposed in this study. Including GPS and GSM, this embedded device may monitor and be controlled from inside any vehicle. This configuration will keep track of a moving vehicle in real-time and provide updates as requested [3], [17], [18].

It is planned to employ a Face Detection System to identify the driver's face and then compare it to a database of known faces. If the vehicle's owner is asleep during a carjacking, The Face Detection System may gather photographs via a small web camera installed in the vehicle [12], [19]. The Face Detection System will compare the collected photographs to the previously recorded examples. Messages-to-Screen (MMS) alert the owner if the graphics do not match. The owners will get photos of the thief sent to their phones and be able to track the vehicle's whereabouts via GPS. Also, the owner may get updates on the car's position and speed by text message. The owner can track the stolen car and view photos of the perpetrator. To conclude, it is clear that this technology has practical applications [11], [2].

By adopting the preexisting modules, this embedded system-based technology ensures the safety and security of the vehicle's interior. The device detects the presence of potentially harmful gases like carbon monoxide (CO), liquid petroleum gas (LPG), and ethanol (ethanol) and sounds an alarm if those concentrations reach unsafe thresholds. The GSM will use the recipient's phone number to send a text message to a verified contact. The IR sensor is utilised to detect a stationary barrier in the path of the vehicle, and if one is found, the vehicle comes to a complete stop. In short, this method will help avoid barriers [20].

Kai-Tai Song and Chih-Chieh Yang developed a real-time, graphical system for monitoring vehicle safety [21]. This study describes a unique, feature-rich method for tracking vehicles, which can automatically recognise and follow many preceding moving objects like automobiles and motorbikes. Using FOE and view analysis together, the system can distinguish between the objects' characteristics and the moving backdrop's features, thereby providing a real-time collision warning. It has been shown that the suggested visual tracking system works in the actual world. The findings may be used for collision warnings in metropolitan areas at night and during the day at speeds of about 60 kilometers per hour.

The gear and software for a GSM- and SMS-based remote monitoring system are already in place. Using the GSM network to send signals from a distance is mentioned in this study. The central monitoring facility and the outpost will play a role in this. Initially, a computer and the GSM connection module form the heart of the monitoring center. Virtual Basic was used to build the central software monitoring facility and the off-site monitoring station. This demonstration has shown that the system can regulate data transfer between the control room and the outpost [8].

The suggested solution is based on existing cloud computing infrastructure. Sensors track data like speed and fuel level to improve safety and efficiency behind the wheel. A GSM-enabled gadget is used to upload everything to a remote server. An optional GPS antenna may be installed in any car. An alcohol sensor in the car may help keep drunk drivers off the road. So, the suggested technique has the potential to drastically cut down on highway accidents [22].

III. Methodology

D. Technical Specifications and Features

1) Antenna Placement and Visibility

The GPS tracker integrates an antenna into its design to ensure continuous satellite communication and visibility. We spent a substantial amount of time contemplating the optimal placement for the antenna in our GPS tracker. The device's integrated antenna guarantees a streamlined and practical design. It is crucial to integrate and establish a visible connection with GPS satellites. The efficiency of the integrated antenna is equivalent to that of external antennas. Its compact and streamlined design enhances its versatility, making it suitable for many applications, such as vehicle monitoring.

The antenna's purposeful location minimises impediments, improving its ability to retain an undisturbed view of GPS satellites. Incorporating this function into the design is crucial for accurate monitoring, particularly under demanding conditions. To provide precise and uninterrupted location data in real-time tracking systems, the study conducted by Rajkumar et al. [23] and Chadil et al. [12] highlights the significance of antenna positioning.

2) Offline Mode

Our GPS tracker has an offline mode, allowing it to function in areas with unreliable GSM coverage. In this configuration, the device internally records your location and may transmit it either when GSM service is restored or via a physical connection, such as a USB cable. This feature ensures data integrity in locations with unreliable service, as discussed by Maurya et al. [23] and Pham et al. [8], in line with advancements in vehicle tracking technology.

3) Compatibility with NEO-F10N Module

The system can use many satellite systems such as GPS, BeiDou, Galileo, and QZSS due to its compatibility with the NEO-F10N module. The interoperability of these systems ensures enhanced tracking performance throughout different regions worldwide, aligning with the findings of Huang et al. [23] about the effectiveness of multi-system satellite navigation.

4) Data Protection Mechanisms

Our GPS tracker employs robust data protection and encryption measures to ensure the confidentiality and privacy of location data. These measures are crucial for addressing privacy concerns related to GPS tracking data.

In transit encryption or over-the-air encryption, data employs sophisticated algorithms to secure data movement between trackers, servers, or devices. It is a deterrent against the interception of data and unlawful entry into wireless networks.

Our encryption methods use AES (Advanced et al.) with 256-bit keys, a widely accepted industry standard.

Data transit between devices is secured using SSL/TLS. This enhances the level of encryption and ensures the security of device data.

Static information On-device data encryption for protection: Robust algorithms encrypt data stored on the device. If the device is compromised, the data remains unattainable without the encryption keys.

The device implements stringent access constraints. Authentication serves as a safeguard against unwanted data access. Only authorized users are permitted to access or retrieve data following secure authentication.

The tracker undergoes periodic firmware and software updates to address security issues. Regular updates ensure that the device's security protocols remain up to date.

The tracker is capable of detecting any attempts of tampering. The device will notify the user or system administrator if it detects unauthorised hardware or software access.

The system meticulously documents all instances of access and data exchanges. This improves the investigation of security breaches and detects any abnormal activities.

Our device adheres to global data protection regulations, including the General Data Protection Regulation (GDPR). The trust and legality of users are contingent upon adherence to this compliance.

Data is anonymized to safeguard user privacy wherever it is deemed suitable. This process eliminates or encodes personally identifiable information from datasets.

Ultimately, our GPS tracker ensures data safeguarding throughout its transmission and storage. These measures ensure user privacy protection and adherence to global data security standards via the secure management, storage, and transmission of sensitive location data.

5) Data Processing Capabilities

The data processing capabilities of our powerful GPS tracker enable precise monitoring and recording of critical indicators. The device accurately records present and past speed data with an accuracy of ±0.5 km/h. The device's acceleration sensor has a sensitivity of ±0.02 g, allowing it to detect even small oscillations in motion. Thorough motion analysis is essential for monitoring driver behaviour in fleet management, making sensitivity a critical factor.

Supplementary sensors may be easily included in the tracker. This device is well-suited for monitoring products in diverse environments because of its temperature sensor, which can detect temperatures ranging from -40°C to +85°C with an accuracy of ±0.5°C. This aim may be achieved by using a sensor that measures relative humidity (RH) within a range of 0 to 100% with an accuracy of ±2% RH. Maintaining certain climatic conditions is crucial when transporting perishable products or delicate electronics.

The tracker's extensive features and essential GPS capability make it well-suited for a range of jobs, providing clients with comprehensive information on the location and status of their assets.

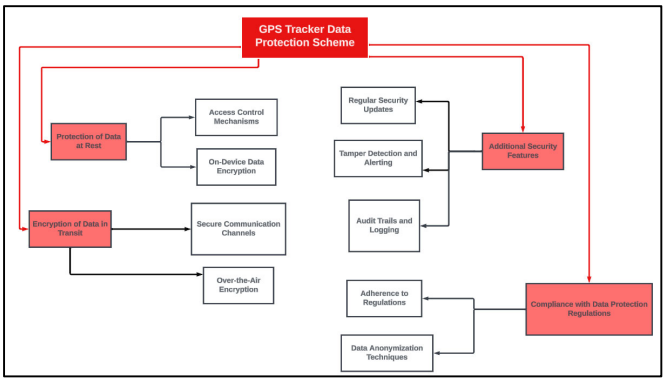

Fig. 3. Data Protection Scheme for GPS Trackers

6) Power Source

A power supply with a unique design ensures maximum reliability and uninterrupted operation for the GPS tracker. The device may be powered in two ways: either by its integrated rechargeable lithium-ion battery or by an external power source, such as the vehicle's electrical system. The internal battery has an impressive capacity of 2000 mAh, enabling it to operate independently for a maximum of 48 hours, depending upon use patterns. By establishing a connection between the tracker and the electrical system of a vehicle, regardless of whether it operates on a 12V or 24V system, the tracker can recharge its internal battery and operate continuously. This dual system is crucial for uninterrupted monitoring and effectively minimises the probability of power interruptions.

The charging circuit ensures durability and easy upkeep via its safety and efficiency features, such as overcharge and overcurrent prevention. The tracker's power adaptability makes it an ideal option in scenarios where a consistent electrical supply, such as long-distance transportation, is not always feasible.

E. System Design or Development

A microcontroller and GPS + GPRS module are used to create a tracking and monitoring system for automobiles, which is the article's investigation technique. The system may monitor and record Data like location, velocity, engine temperature, and fuel level. The microcontroller receives location data from the GPS module and transmits it to the server using GSM/GPRS technology with the help of a Sim808 module and an Arduino controller [24].

A database is created on a web server to hold the information, and a website showcases the car's details. Also, the information is linked to Google Maps so that the car's location may be shown on the map. The system's hardware components include an Arduino Uno microcontroller, a u-blox NEO-6Q GPS receiver module, and a u-blox LEON-GIOO GSM module [4], [25].

The system undergoes testing and evaluation to guarantee its reliability and efficiency in tracking and monitoring vehicles [26]. The technique is based on creating a trustworthy and effective vehicle tracking and monitoring system using hardware and software components. The article describes how law enforcement, public transportation, and fleet management agencies may reap the rewards of installing vehicle tracking systems.

The suggested solution makes it easier for car owners to monitor their cars and protect their safety by providing users with remote automobile locations through the cellular network. By keeping tabs on where buses and trains are at all times, public transportation systems may save money and improve the quality of service they provide to riders. Fleet management systems may also use this technology to improve productivity, reduce costs, and optimise fuel economy [27], [28]

The article's technique entails creating an automobile monitoring and tracking system that gives consumers access to their vehicles' whereabouts through the Internet via a cellular network. The system employs Global Positioning System (GPS) and General System Mobile Radio Service (GSM/GPRS) technologies to monitor and log information about the car, including its location, velocity, internal temperature, and fuel level. The system undergoes testing and evaluation to guarantee its reliability and efficiency in tracking and monitoring vehicles.

The article makes an essential contribution to the development of vehicle tracking technology by highlighting the advantages of monitoring systems in various domains.

The hardware necessary to program an Arduino UNO microcontroller board is detailed in this article. The board is a programmable open-source microcontroller board that is inexpensive, versatile, and simple.

The board can only be used when connected to a computer with a USB port through a USB connection. For free download, use the Arduino IDE software to program the board.

Six analogue input pins and fourteen digital I/O pins are on the board, with six dedicated to pulse width modulation (PWM). A reset button, USB port, DC jack, and power indicator light are also on board.

The board operates at 5V and accepts an input voltage of 6V to 20V, with the sweet spot being 7V to 12V. A voltage regulator is included in the board to regulate the power supply.

The board's outputs include the ability to operate relays, Lights, servos, and motors, and it can communicate with other Arduino boards, Arduino shields, and Raspberry Pi boards. The board is capable of reading analogue sensor data and digitizing it. The board has serial peripheral interface (SPI) pins and transmit/receive (TX/RX) pins [4], [25].

An Arduino UNO board may be used with any computer that has a USB port, a USB cable, and the Arduino IDE program. AVR microprocessor, analogue and digital I/O pins, reset button, USB interface, DC power connector, power LED, SPI, and TX/RX pins are all on the board. The power supply must have an input voltage between 6V and 20V, with the optimal range being 7V to 12V; this is specified on the board.

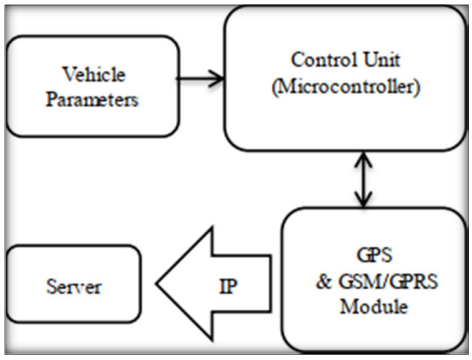

Fig. 4. Proposed system for vehicle tracking/monitoring

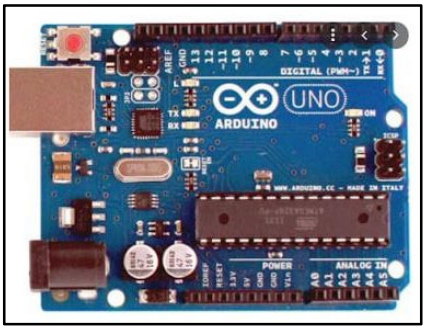

Fig. 5. Arduino Uno

TABLE I. ASSESSING THE PERFORMANCE OF THE ARDUINO UNO BOARD UNDER VARYING INPUT VOLTAGES

Specification	Description
Microcontroller	Arduino Uno: Utilised for overall system control, integrating GPS and GSM modules.
GPS Module	u-blox NEO-6Q: Advanced GPS receiver ensuring accurate and reliable geolocation data.
GSM Module	u-blox LEON-G100: Provides GSM connectivity for transmitting location data and receiving commands.
Antenna Type	Integrated Antenna: Optimised for consistent satellite communication and visibility.
Operating Voltage	5V (Arduino Uno Standard)
Input Voltage Range	6V to 20V (Ideal range for the Arduino Uno to ensure stable operation)
Battery Capacity	2000 mAh: Internal rechargeable lithium-ion battery, offering up to 48 hours of operation.
External Power Compatibility	12V/24V vehicle electrical system compatibility for continuous operation and battery charging.
Data Protection	AES 256-bit encryption and SSL/TLS for secure data transmission and storage.
Environmental Durability	Designed to withstand vibration, humidity, and temperature variations.
Data Processing	Capable of calculating speed and acceleration; potential for additional sensor integration.
Connectivity Ports	USB for programming and data transfer, DC power jack for external power supply.
Digital I/O Pins	14 digital pins are available for additional sensor and component connectivity.
Analog Input Pins	6 pins for integrating and reading data from analogue sensors.
Dimensions	Compact design tailored for ease of installation in vehicles.
Additional Features	It supports real-time tracking via Google Maps, SMS updates for vehicle location, and a face detection system.

The SIM ST-901 is a GPS tracker device that tracks the real-time location of vehicles, teenagers, and loved ones. It may be used everywhere thanks to its built-in GPS tracker and compatibility with four different GSM frequencies (850, 900, 1800, and 1900 MHz). The device supports real-time tracking and provides the real-time address via Google link. It has a 150mAh built-in battery, supports Geo Fence Alarm, and can send alarm notifications for low battery power and when the main power is turned off.

Additionally, the device is waterproof to protect it from water damage and has an ACC feature to detect the vehicle's ignition status [1], [3].

A Safety Feature of the SIM ST-901 GPS Tracker Device follow:

- GPS Vehicles locator: The device has a built-in GPS locator to track the vehicle's real-time location.
- GSM 4-frequency support: The device supports 4-frequency GSM 850/900/1800/1900 MHz, allowing it to work worldwide.
- Real-time tracking: The device supports real-time tracking and provides the real-time address via Google link.
- Built-in battery: The device has a 150mAh built-in battery that allows it to operate even when the main power is off.
- Geo-Fence Alarm: The device supports Geo-Fence Alarm to alert the user when the vehicle crosses a pre-defined geographical boundary.
- Main Power Off Alarm: The device can notify when the main power is turned off, but the built-in battery is still active.
- Single Location: The device can provide a single location when requested.
- Over Speed Alarm: The device can notify if the vehicle exceeds a pre-set speed limit.
- Low Power Alarm: The device can send an alarm notification when the battery is low.
- Waterproof: The device is waterproof to protect it from water damage.
- ACC Ignition Detection: The device has an ACC feature to detect the vehicle's ignition status.

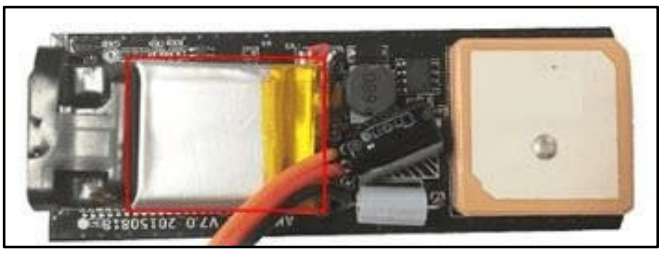

Fig. 6. SIM ST-901

The Arduino Integrated Development Environment (IDE) is a software tool used to write and compile code for the Arduino microcontroller. It is the official software for programming Arduino boards and is available for free on the Arduino website. The IDE has a code editor, a message window, a terminal for message input, a toolbar with frequently used buttons, and many menus to access extra features [29]. The IDE can connect to Arduino hardware, allowing for program upload and communication with the board. The Arduino IDE is widely used by hobbyists, students, and professionals alike due to its user-friendly interface and extensive online documentation and support.

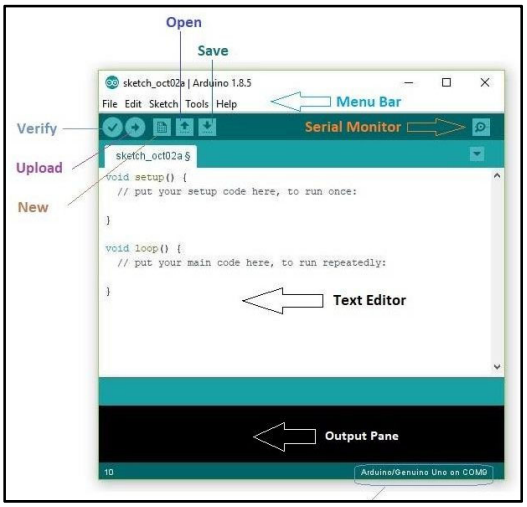

Fig. 7. Arduino IDE

The NEO-6Q, developed by Swiss firm U-Blox, is a practical GPS receiver module. It is a 24-pin surface-mount device (SMD) that is just 12.2 mm by 16.0 mm by 2.4 mm in size. The TTFF of the NEO-6Q's 50 channels is less than 1 second for hot starts and more than 26 seconds for warm and cold beginnings [23]. The gadget operates on 2.7 to 3.6 V and 50 mA of current. The NEO-6Q GPS receiver is compatible with the I2C standard and the Universal Asynchronous Receiver Transceiver (UART) and Display Data Channel (DDC) interfaces. Figure 7 shows the pinout and connection information for the NEO-6Q GPS receiver. Connecting the VCC RF and RSD (Reserved) pins is necessary for operation.

The NEO-6Q is a highly effective and versatile GPS receiver module suitable for anything from DIY to industrial systems [16].

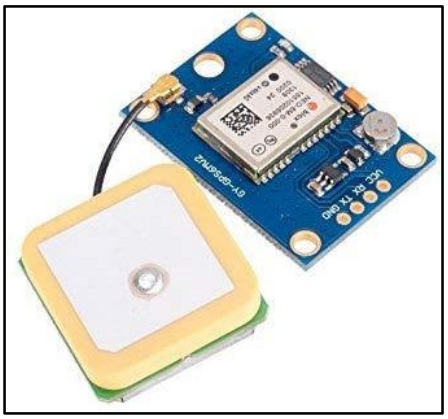

Fig. 8. NEO-6Q GPS pin assignment

The SinoTrackPro App provides a convenient and user-friendly way to track a car's or person's location in real-time. The app allows for detailed tracking information to be displayed on Google Maps and provides alerts to users.

The subscription for the app is made through the tracking site (www.sinotrack.com) and can be accessed through a web browser, allowing for easy monitoring of the device. The user can input the GPS device number, username, and password to access all the features available on the site [22].

Fig. 9. SinoTrackPro App

First, you must choose (sinoTracking) through the window.

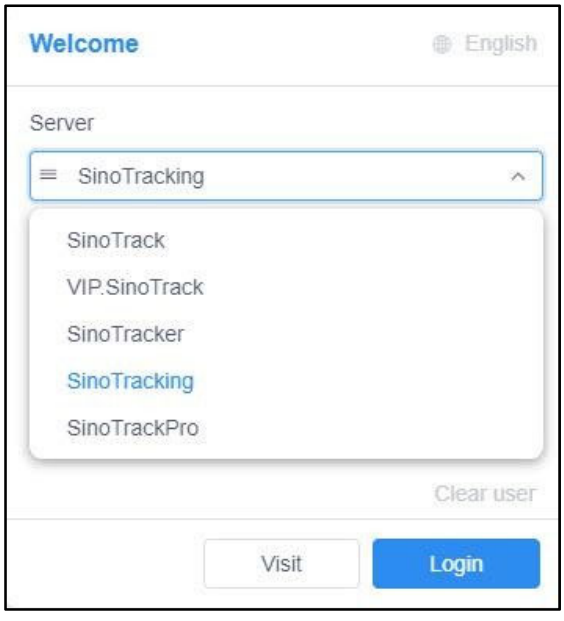

Fig. 10. SinoTracking

Then, enter the information shown in the image into the site.

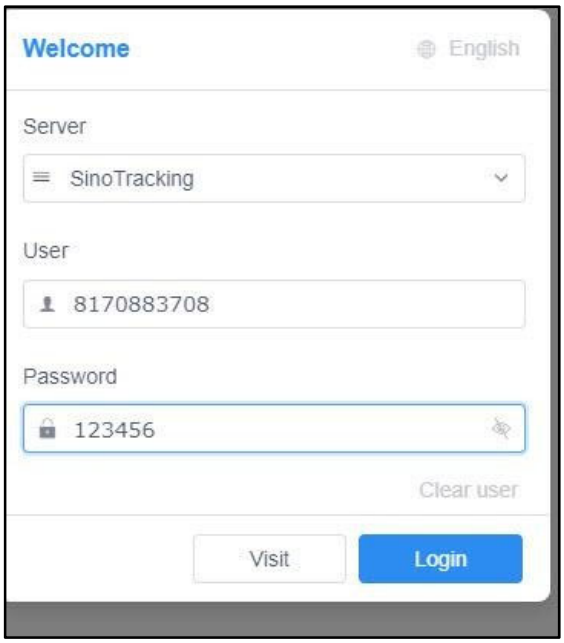

Fig. 11. Full Information

IV. Results

The result (shown in Fig.11) features a box-shaped device with a screen and various internal components. The SIM card slot is visible from the outside of the device for easy placement. When power is connected to the device, a small red light illuminates to indicate that it is powered on. A violet light is next to the red light that blinks approximately every second to indicate a successful connection with the network. The design ensures that the device is both functional and aesthetically pleasing.

Fig. 12. Project Design

Based on the findings, we created a prototype for this article. The system shown in the paper is easy to use. It is simple to install in dark spaces, such as the garage. Efficiency system to prevent a vehicle's collision with an object when parked. High-performance infrared sensors find and gauge objects, and the distance in the displayed distance is exact. The LCD panel assists the driver in minimising manual judgments. Distance is distance. During parking, the parking assist system helps direct

and assist the driver to stop the car safely without collisions or damage, even in a dark place like a garage.

This article details a flexible, customizable, and accurate actual vehicle tracking system that utilises GPS and GPRS of the GSM network and may be used worldwide. The usage of GPRS and GPS allows for constant and instantaneous tracking. The location is shown on a Google map through the Google Maps API. The Global Positioning System (GPS) acts as the system's eyes and ears. At the same time, the GSM module (operated by AT commands) handles the processing and transmission of data through the GSM network. Whenever the GPS gets new data, it stores it in its database and displays the updated position in Google Maps. The proposed system can monitor a vehicle's position in space and relay data such as its speed over ground (OTG), date, satellite location, and route. The technology produces high-quality outputs on par with those of commercial machinery. Many services may be integrated into this system in the not-too-distant future via sensors and actuators.

TABLE II. COMPARISON OF GPS DEVICES: RESULTS OF TRACKING SYSTEM PROPOSED

Software/Hardware Component	Description	Features/Specifications
Arduino Uno Microcontroller	Core component for system control	Utilizes ATmega328, offers 14 digital I/O pins, 6 analog input pins, USB connection, 6-20V input voltage range
u-blox NEO-6Q GPS Module	GPS receiver for location tracking	High sensitivity, 50-channel GPS receiver, supports up to -161 dBm navigation sensitivity
u-blox LEON-G100 GSM Module	GSM module for communication	The quad-band GSM/GPRS module supports SMS and data transmission over GSM networks.
Integrated Antenna	Antenna system for GPS and GSM modules	Optimised for clear satellite and network communication, ensuring consistent connectivity
Lithium-Ion Battery (2000 mAh)	Internal power source	Provides up to 48 hours of operation, is rechargeable, and ensures tracker functionality in the absence of external power
External Power Source Compatibility	Allows connection to vehicle power system	Supports 12V/24V input, enables continuous operation and battery charging
Data Encryption and Security	Data protection mechanisms	Features AES 256-bit encryption and SSL/TLS for secure data transmission and storage
Environmental Durability Design	Built to withstand harsh conditions	Resilient against vibration, humidity, and temperature variations, suitable for automotive applications
Real-time Tracking via Google Maps	Location tracking and visualisation	Enables users to view the real-time location of vehicles on Google Maps
SMS Updates for Vehicle Location	Communication feature	Sends SMS updates with the vehicle's current location to the user's phone
Face Detection System Integration	Enhanced security feature	Utilises face recognition for additional security alerts in case of unauthorised access.

The table thoroughly summarizes the fundamental elements and characteristics of the GPS tracking system created in the article. The text highlights the system's use of sophisticated technology and new solutions, demonstrating its excellence and efficacy in vehicle tracking applications.

V. DISCUSSION

The article presents a comprehensive guide to creating a GPS car-tracking system utilising Arduino and Google Maps. This article aims to provide readers with the necessary knowledge and step-by-step instructions to develop a real-time car tracking system using easily accessible components. The article combines information from multiple sources, including academic publications, conferences, and online resources [1], [3], [7], [27]. The article ensures a robust and well-informed approach to its topic by utilising this wide array of references.

The article commences by introducing the purpose and significance of GPS-based car tracking systems. Such systems have become increasingly valuable for various applications, including vehicle security, fleet management, and location monitoring [3]. The integration of Arduino as the primary microcontroller for the project is discussed, emphasising its widespread popularity and ease of use for hobbyists and professionals alike [8].

The authors detail the essential components for constructing the GPS car tracker, such as the GPS module, Arduino board, external GPS antenna, GSM module, and a power source [2], [10], [20]. These components are explained with clarity and precision, ensuring readers understand the system's hardware setup comprehensively.

The implementation of the GPS car tracker is described in a step-by-step manner, enabling readers to follow along and replicate the project themselves. The article covers various aspects, including GPS data acquisition, communication with the GSM module for data transmission, and the use of Google Maps for visualisation [1], [12], [17]. Combining these elements results in a real-time tracking system with efficient and accurate location updates.

The paper addresses potential challenges and solutions during the implementation process. Common issues such as signal interference, power management, and data transmission reliability are discussed, and mitigation strategies are proposed based on the author's findings [18], [19].

The authors discuss future possibilities and enhancements for the GPS car tracker system. Suggestions for integrating additional features like remote control capabilities, vehicle diagnostics, and analytics are presented [7], [14]. By considering potential advancements, the article encourages readers to explore further development possibilities beyond the basic implementation.

The effectiveness and accuracy of the GPS car tracker system are highlighted through practical demonstrations and test scenarios [7], [12]. The article presents results and performance evaluations that validate the system's real-time tracking capabilities, making it a valuable resource for readers interested in assessing its reliability before implementation.

The paper mentions various related technologies and applications in GPS tracking and IoT [2], [24], [27], [28]. This breadth of information allows readers to contextualize the project within the broader landscape of emerging technologies and innovations.

The article offers a comprehensive and well-researched guide to building a real-time car tracking system. By drawing on a diverse set of references, the article ensures credibility and accuracy in its approach. The step-by-step implementation instructions, performance evaluations, and future possibilities make it a valuable resource for hobbyists, students, and professionals seeking to develop their GPS car-tracking systems.

VI. Conclusions

This article's conclusion describes a real-time vehicle tracking and monitoring system that uses GPS and GPRS technology. A SIM908 Module with GPS, GPRS, and GSM services is used in the proposed system, which is designed and implemented using an embedded board with Arduino Intel Galileo. In the event of a vehicle theft, the system provides location information, including latitude, longitude, altitude, date, satellites, speed OTG, and course, enabling quick and easy recovery of the stolen vehicle. The data gathered by the gadget within the car is relayed to the vehicle's owner through SMS.

To verify the location accuracy of the proposed system, it was tested on two commercial GPS devices. The findings are promising and similar to those of industrial machinery. This system is simple to set up and use and may be used in many different applications worldwide. The position is displayed on a Google map using the Google Map API, which enables continuous and real-time tracking by combining GPRS and GPS.

The proposed system, which may be expanded to include several services by connecting sensors or actuators, is also discussed in this study, along with its potential future development. The system is adaptable and suited for various industries since it can be modified to fit the requirements of various applications.

Another great feature that may be used to guide and aid the driver in stopping the car securely without any crashes or damage, even in dimly lit areas like a garage, is the parking assist system detailed in this paper. The high-performance infrared sensors provide accurate distance measuring, and the LCD helps the driver make fewer manual decisions.

The recommended real-time vehicle monitoring and tracking system uses GPS and GPRS technologies to provide continuous and real-time tracking. It is very effective and efficient. The system is simple to set up and operate, and it can be customised to match the requirements of various applications. The system is highly adaptable and ideal for various industries thanks to the inclusion of sensors or actuators, which will allow various services to be added in the future. The parking assist system is an excellent feature for drivers because it helps avoid accidents or damage while parking. This technology can transform how we track and monitor automobiles, making their management and protection more straightforward and effective.

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