Affordable Vehicle Tracking System

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Abstract:

In this research, a low-cost automobile safety and tracking system that transmits real-time latitude and longitude coordinates to a pre-designated smartphone is proposed. It integrates Global Positioning System and Global System for Mobile Communications technologies with a microprocessor in order to function as the primary computing device for the transmission of data, analysis, and gathering.

The fundamental module of this system efficiently communicates location-related information to a designated smartphone after receiving satellite signals for precise geographic positioning. Since its components are cost-effective, its pricing offers sophisticated tracking features without breaking the bank.

It enables dependable, inexpensive automobile asset surveillance, which makes it suitable for both individuals and small enterprises. Tracking in real-time makes it achievable to respond quickly to theft or unauthorized use. The system's straightforward layout makes system implementation and administration simpler for individuals with only limited technical know-how.

This system delivers a simplified, affordable solution for real-time automotive tracking using the aforementioned technologies, enhancing asset safety and accessibility. It accomplishes this by bridging the gap between modern monitoring technology and budgetary restrictions.

Keywords: Global Positioning System (GPS), Global System for Mobile Communication (GSM), General Packet Radio Service (GPRS).

1. Introduction.

The design and implementation of a vehicle tracking system based on GPS and GSM technology is covered in this paper. This system is an embedded solution that uses a GPS receiver to continuously track the location of a moving vehicle and a GSM modem to send the location data to a distant location. The paper includes an overview of the system's hardware and software components, such as the GSM modem, GPS receiver, and microcontroller, as well as the communication protocol that's employed within them. The methods for testing and assessing the system's performance, including the dependability of the GSM communication link and the precision of the GPS data, is also covered in the paper [1].

The suggested approaches provide an efficient and inexpensive method to track a car's location using GPS and GSM technology. The system utilizes an Arduino UNO and a smartphone to manage the GSM module and GPS receiver, allowing SMS updates of the vehicle's location every minute. The user can continuously track the progress of the car and predict the arrival time and distance to a certain destination via an LCD and Google Maps that displays the positions. All things considered, this car monitoring system provides a dependable and practical real-time tracking solution [4].

The GPS module periodically captures the geographic coordinates of the automobile, while the GSM module uses a wireless communication network to send this data, along with other vehicle data, to a distant server or database. In order to determine the vehicle's position on Earth, the GPS module makes use of an ensemble of satellites in orbit. The position of the car is determined by the GPS receiver within the vehicle by receiving signals from a minimum of four GPS satellites [2].

The GSM module, on the other hand, connects remotely to the remote server or database over a cellular network. Through messages sent via SMS or other communication protocols, the module communicates the GPS data to the server along with other data such as vehicle speed, direction, and status. This enables the user to access the vehicle's current location information from any location in the globe with an internet connection [2][3].

The benefits of this present system include accurate location and immediate tracking, increased security measures. Better fleet management: Fleet managers can cut fuel expenses, design better routes, and optimize fleet operations with the use of vehicle tracking technologies. Lower maintenance expenses: By keeping an eye on the state of the car and spotting problems early, vehicle tracking systems can help keep maintenance expenses down [5].

However, the limitations of the current systems tend to be: Cost - Vehicle tracking systems based on GPS and GSM can be costly to set up and maintain, particularly for smaller companies or private users. Power consumption: Over time, the constant power supply needed for GPS and GSM-based devices may deplete the vehicle's battery. Privacy concerns: Some people might be worried about the privacy consequences of having their car's location traced and observed continuously. Data management and storage: It can be challenging to handle and store the massive volumes of data generated by GPS and GSM-based devices. Both people and companies with significant fleets of automobiles may find this to be an issue [5].

Three important components are examined while considering potential improvements to the current system. First, it is predicted that the possibility of integrating with various sensors, such as temperature meters, fuel level indicators, or speed sensors, will provide additional information for improved fleet management and vehicle maintenance. Second, integrating AI technology might provide the system the ability to learn from collected data, which would enable real-time traffic insights, predictive maintenance, and optimal routing. Last but not least, integrating blockchain technology presents itself as a viable option for safe, unchangeable data storage, improving system dependability and data integrity in general.

2. Proposed Methods.

2.1.1. Block Diagram

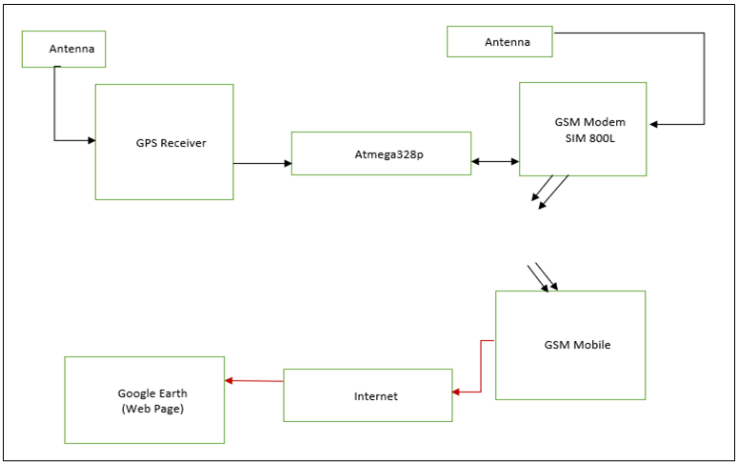

Figure 1: Block Diagram

2.1.2. Technical Approach

1. Research included a review of several vehicle monitoring systems on the market as well as an investigation of the underlying technologies of each, including thorough examinations of GPS and GSM technology to understand its capabilities and constraints.
2. Based on the research findings, a GPS receiver, an ATMega microcontroller, and a GSM modem were used to construct a system. The right parts were chosen after the necessary hardware and software requirements were established.

3. Proteus Simulation Software was used to simulate the system, and AVR Studio 7 IDE was used for system development. The ATMega microcontroller was programmed using embedded C code, while SMS messaging operations on the GSM modem were programmed using SIM800L GSM Modem AT Commands.
4. The technology was tested to ensure that it could track the vehicle's location precisely and report it quickly when needed. Furthermore, in order to verify the functionality of remote system control, the SMS command capability was tried.
5. Refinement methods were started after testing in order to improve the accuracy, dependability, and user-friendliness of the system based on the results that were received. When it was thought necessary, changes were made to the hardware and programming.

3. Results & Discussion

3.1. Results

3.1.1. Simulation Result

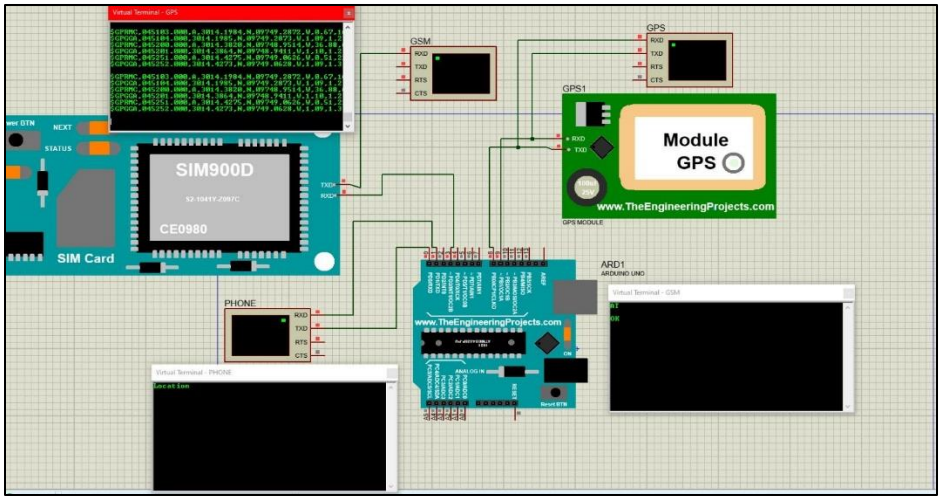

Figure 2: Simulation Result

3.1.2. Implementation on Breadboard

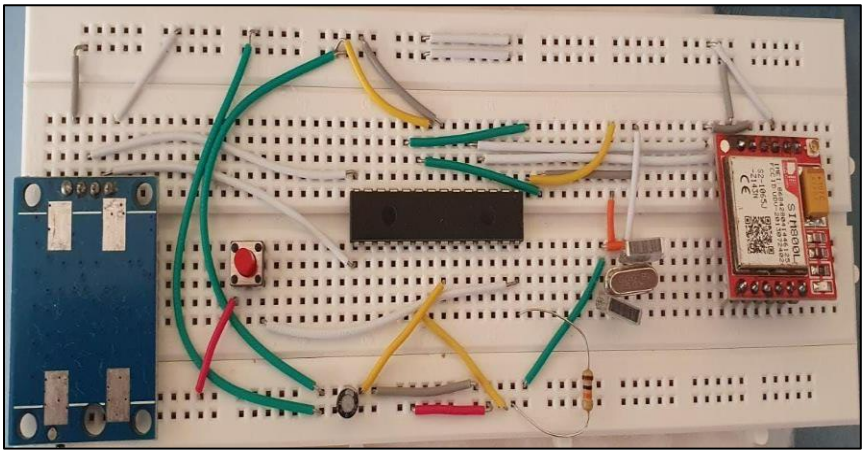

Figure 3: Breadboard Implementation

3.1.3. PCB Design

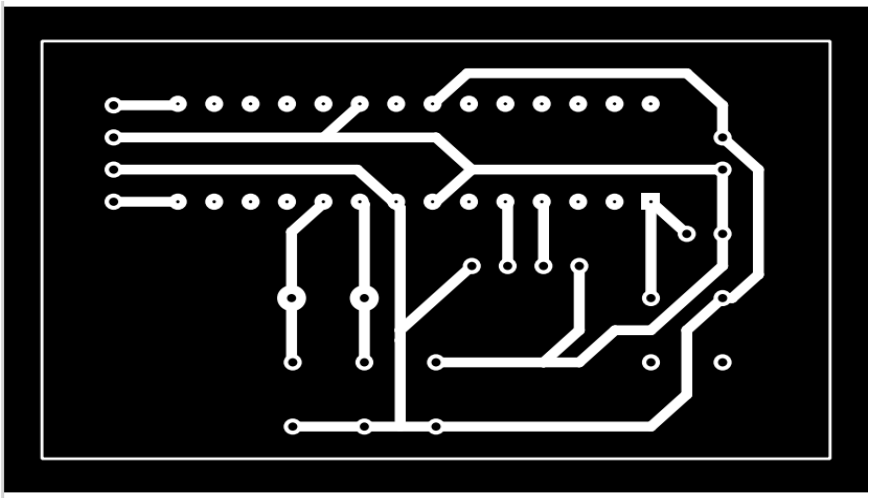

Figure 4: PCB Design

3.1.4. Working prototype

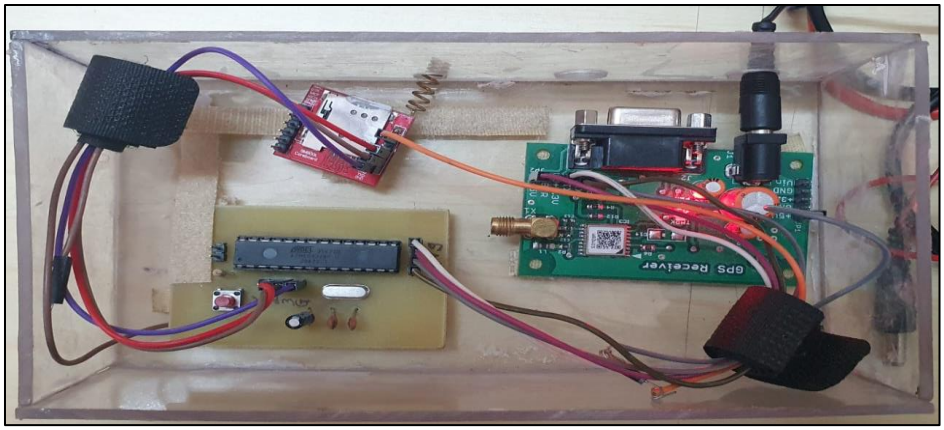

Figure 5: Prototype

3.1.5. Observed outputs

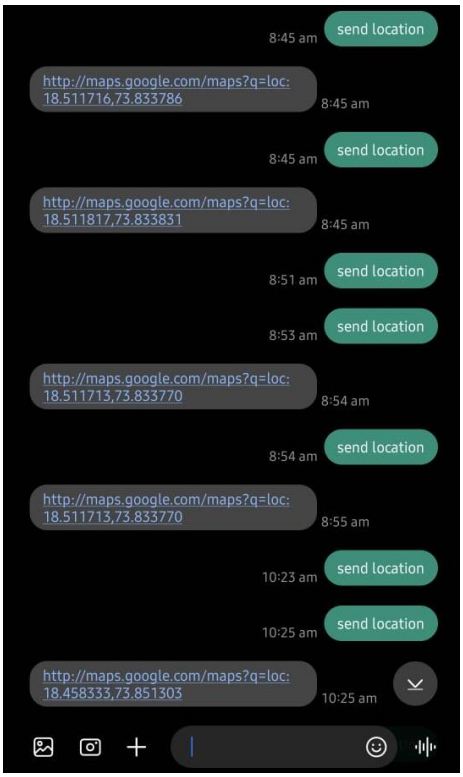

Figure 6: Requested Message

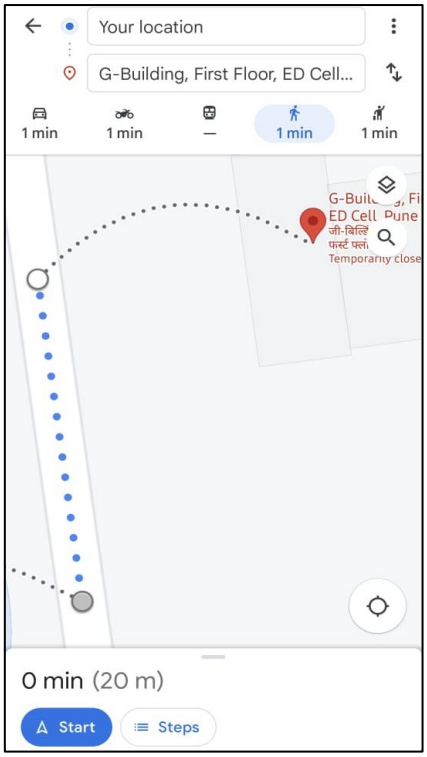

Figure 7: Received Location

3.2. Tables

Table 1: Simulation Observation.

Sr. No.	Test	Observation
1.	Co-ordinates	The GPS modem will continuously give the data i.e. the latitude and longitude indicating the position of the vehicle
2.	GSM Modem	It sends the position (Latitude and Longitude) of the vehicle from a remote place.
3.	Input to the system	Sending a message to the GSM receiver. Ex:- "Send Location"
4.	System Response	Google map link is sent on mobile by SIM800L
5.	System Stability	The system remains stable and responsive even with variations in input voltage, indicating that it is robust andreliable.

Table 2: Testing, Debugging Observations.

Test	Expected Outcome	Actual Outcome	Action Taken	Results
Microcontroller operation	Armega328 performs programmed functions correctly, sending and receiving signals.	The microcontroller does not respond to input or sends incorrect signals.	Verfied programming code, tested microcontroller.	Programming error found and corrected. Microcontroller now responds correctly to inputs.
GPS operation.	Continuous sending of co-ordinates	Continuous sending of co-ordinates between 20m to 500m with accuracy.	Proper exposure of the antenna to the sky and testing it in open-air conditions.	Consistent accuracy upto 20m.
System stability	The system remains stable and responsive even with variations in input signal.	System crashes or behaves unpredictably under certain conditions.	Tested system under different at remote places.	Quick response at the receiver side by sending a Google map link.

3.3. Discussion

- The work's main findings and ramifications for a low-cost vehicle tracking system can be summed up in this statement. The demonstrated tracking method is a viable and effective way to track cars, in accordance with the project's findings. A broad spectrum of users, including individuals and small businesses, are able to utilize the system as it can provide precise GPS coordinates at a low cost. The system's affordability is achieved via the use of off-the-shelf components and a layout that minimizes the need for expensive hardware. This makes the system a more economical resolution for tracking vehicles in contrast to alternative solutions.

- The study additionally emphasizes how the proposed tracking system will impact vehicle safety and security in significant manners. The systems can lessen the possibility of auto theft and raise the likelihood of retrieval in the instance that it happens through providing exact geographic information. Moreover, the system has the capacity to track the automobile's driving style, which can improve security and reduce the potential of accidents.

- The analysis did concede, though, that additional research and development may be necessary to optimize the system for different automobile makes as well as operational environments. To ensure the precision and dependability of the entire system, it has to be evaluated in diverse geographical locations and climatic conditions. It may be necessary to alter the system to fit various automotive types and their particular requirements.

- Overall, the study's conclusions indicate that the proposed affordable automobile tracking system has an extensive amount of potential as an inexpensive and reliable vehicle tracking solution, with significant implications for the security and safety of automobiles.

4. Conclusion

GSM and GPS technologies have been utilized for the development and design of a relatively economical real-time automobile tracking system. Via an app, the system in question provides continuous automobile monitoring. Recognizing the growing demand for automotive security, a thorough analysis and study was carried out on the present condition of current tracking technologies. After identifying a few drawbacks, a model that would enhance the level of accuracy and value for money of vehicle surveillance systems was put forth. Upon the prototype's assembly and testing, accurate latitude and longitude coordinates for the motor vehicle can be consistently detected, with an accuracy of up to 20 meters.

Features:-

1. Real-time Tracking.
2. Geofencing.
3. Affordable and portable.

5. Future Scope

1. Prototype can more cost-effective by adding advanced features like an anti-theft system into the ignition and handy by reducing the volume occupied by the device.

2. Blockchain technology can be used to store the tracking information on the decentralized system to maintain privacy and immutability from 3rd parties.

3. It can be a self-powering device and a one-time investment for a customer also reduces maintenance costs for the user.

4. Speed Alert for vehicles.

6. Acknowledgement

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