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Internet of Things based Electric Vehicle Security and Tracking

Barathvaj P R[1], Gokul A[2], Kaamesh P P[3], Harirajan R[4], Jaswanth S[5], Dr. S. Suja[6]

[1,2,3,4,5] Department of EEE, Coimbatore Institute of Technology, Affiliated by Anna University, Coimbatore, Tamil Nadu, India.
[6]Professor at Department of EEE, Coimbatore Institute of Technology, Affiliated by Anna University, Coimbatore, Tamil Nadu, India.

E-mail: [1]barathvajram@gmail.com, [2]agokul1302@gmail.com, [3]harirajan611@gmai.com, [4]kaamesh213@gmail.com, [5]jesandc@gmail.com, [6]suja@cit.edu.in

Abstract

The aim of this research is to introduce a security system that utilizes IoT and GPS tracking technologies to provide enhanced safety measures. Cayenne and GSM technologies are employed in the proposed system to provide real-time tracking and security features. The system comprises of GPS unit, microcontroller, GSM unit, and Cayenne dashboard. The GPS module is used to obtain the location of the device, while the microcontroller processes the data and sends it to the Cayenne dashboard through the internet. The GSM module is used for real-time communication with the device and to send an alert upon occurrence of any security breaches. The Cayenne dashboard provides an easy-to-use interface for monitoring and controlling the device remotely. The proposed system provides an effective and reliable solution for tracking and securing women and children, especially in potentially dangerous situations. The system can be easily implemented and customized to suit various tracking and security requirements.

Keywords: Vehicles tracking, IoT, Cayenne, GPS, GSM.

1. Introduction

Women and children's safety is a pressing concern in today's society, and the use of technology can play a crucial role in addressing this issue. This research introduces an IoT-based GPS tracking security system that aims to improve the safety of women and children using Cayenne and GSM technologies. The system utilizes a GPS module to trace the

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coordinates of the device and a GSM module for real-time communication. The system is also equipped with a user-friendly interface through the Cayenne dashboard, providing a convenient way to monitor and control the device remotely. The proposed system provides a cost-effective and reliable solution for tracking and securing women and children. With the increasing prevalence of smartphones and affordable GPS modules, the proposed system can be easily implemented and customized to meet specific tracking and security requirements. The aim of this research is to provide a thorough and inclusive analysis of the proposed system, including the design, implementation, and evaluation, with the ultimate goal of improving the safety, security and well-being of women and children.

Overall, the objective is to establish a legally compliant and original IoT-based GPS tracking security system that guarantees the safety and security of women. The system employs GPS technology for accurate tracking and adheres to legal privacy standards by transmitting coordinates as a permissible SMS hyperlink through one-way communication via GSM. The system facilitates the viewing of the user's location on Google Maps by authorized individuals, while ensuring compliance by exclusively displaying the information on the Cayenne website. The user-friendly interface, coupled with real-time updates, further enhances the system's efficacy and legal integrity.

This work aims to achieve the highest level of performance in terms of reliability, efficiency, and effectiveness in ensuring the safety and security of the user through an IoT-based GPS tracking security system. Several factors contribute to the study's exceptional performance:

1. Accurate GPS Tracking: The system utilizes advanced GPS technology to track the user's location with a high degree of precision. By leveraging reliable GPS signals, the system ensures accurate and real-time tracking, providing an optimal level of performance.

2. Efficient One-Way Communication: The use of one-way communication through GSM technology ensures efficient transmission of location coordinates as an SMS hyperlink. This approach minimizes communication delays and optimizes the performance of transmitting critical information to the guardians or parents in a timely manner.

3. Legally Compliant Solution: The system places a strong emphasis on adhering to legal requirements and privacy standards. By ensuring compliance with relevant regulations, the system maintains a high level of performance while respecting the rights and privacy of the individuals involved.

4. Seamless Integration with Google Maps: The system's ability to send coordinates as a hyperlink, which can be opened directly in Google Maps, enhances performance by providing a familiar and user-friendly interface. This integration allows guardians or parents to effortlessly visualize the user's location, leading to efficient monitoring and decision-making.

5. Dedicated Cayenne Website: The system's exclusive display of location information on the Cayenne website further enhances performance by providing a secure and centralized platform for accessing and monitoring the user's whereabouts. This dedicated website ensures optimized performance and convenience for authorized individuals.

6. User-Friendly Interface: The system prioritizes usability and ease of interaction for all users, including the woman, guardians, and parents. A well-designed and intuitive user interface improves the overall performance of the system, enabling seamless navigation, monitoring, and understanding of the information presented.

7. Real-Time Updates: The system continuously updates the location information in real-time, ensuring that the monitored data remains accurate and up-to-date. This feature enhances the system's performance by providing timely and reliable information for monitoring and taking appropriate actions.

By combining these performance-driven factors, the IoT-based GPS tracking security system offers an exceptional level of performance. It not only enables accurate and real-time tracking but also ensures efficient communication, legal compliance, seamless integration with popular platforms like Google Maps, and a user-friendly interface. These qualities collectively contribute to the system's high performance, making it a reliable and effective solution for ensuring the safety and security of the user.

1.1 Literature Review

Several studies have proposed IoT-based GPS tracking systems for women's safety. These systems aim to provide real-time location tracking and communication features to ensure women's safety and well-being. One such system utilized GPS and GSM technologies to enable women to alert their guardians or authorities during an emergency. The system also includes a panic button that, when pressed, sends an alert to the preconfigured phone numbers with the current location. Another system proposed using IoT-based wearable devices to provide location tracking and monitoring features for women. The device incorporates sensors that detect unusual behaviour and movements, and alert the emergency contacts or authorities. It

also includes features like geo-fencing, which notifies the contacts when the wearer enters or leaves a specific location. A third system proposed using a smart IoT-based necklace as a safety gadget for women. The necklace incorporates a GPS module, which sends real-time location updates to a smartphone app. It also includes a panic button that, when pressed, sends an alert to the emergency contacts with the current location. These IoT-based systems have the potential to enhance women's safety and provide a sense of security, particularly in unsafe or vulnerable environments. In addition, certain systems have integrated audio and video recording features that can serve as evidence in the event of an unfavourable occurrence. The use of these technologies and the IoT has led to more affordable and attainable safety solutions for women. Nevertheless, it is essential to safeguard the privacy and security of the user's information while ensuring that the system operates efficiently and effectively in practical situations [1]-[7].

The works described in references [8]-[10] proposed vehicle tracking security systems that utilize GPS and GSM technologies. The devices were capable of tracking the location of vehicles whether they are stationary or in motion. The systems provided real-time updates of the vehicle's geographic coordinates, which can be displayed on a cell phone using Google Maps. The practical implementation of these systems have demonstrated their effective performance for tracking vehicles from any point in time and any geographic location.

The authors of reference [11] suggested a technique to improve the veracity of GPS by utilizing satellite signals to transmit longitude and latitude coordinates, enabling the reception of critical data. The system incorporates a micro-controller, enabling two-way communication between the client and the geo-locator. A SIM card is required for both systems, and the interaction of GSM network interface is parallel to that of traditional wireless technology. However, communication is disrupted in the event of a loss of internet connection, which requires reconnection. The system is divided into two parts: a mobile unit and a controlling station, and data is transmitted through multiple transmission lines.

As described in reference [12], it is possible to transfer remote signals over the GSM network. This involves two main components: the remote observation station and the surveillance hub. The surveillance hub incorporates a computer and a GSM communication module, with Virtual Basic software used for the remote observation station and the surveillance hub. The system is optimized such that the interaction between the remote observation station and the surveillance hub could be managed effectively.

The authors of reference [13] highlighted the need for secure access to the devices. However, as these devices are used for diverse applications, it is important to ensure that they are secured from unauthorized access. To address this issue, the authors proposed a password-based security feature that restricts access to only authorized individuals. The structure of the system, including the integrated components, as well as the testing and evaluation of its performance were detailed. The results of the study demonstrated the effectiveness of the password protection system in preventing unauthorized access to the microcontroller-based device, thereby enhancing its security.

The research [14] detailed the integrated components of the system, which includes a GPS module, GSM module, and a microcontroller. The proposed system allows Automobile owners to trace their vehicles in real-time, thereby enhancing vehicle security and reducing the likelihood of theft. The study presented the results of testing and evaluating the performance of the system, which demonstrated its effectiveness in accurately tracking the location of vehicles. Overall, the work provided valuable insight into the design and implementation of an IoT-based vehicle tracking security system.

The proposed system in [15] was engineered to be cost-effective, easy to install, and operate. The work provided a detailed description of the integrated components used in the system, including the ESP8266 Wi-Fi module, GPS module, Arduino microcontroller, Android application, and remote server. The system architecture and communication protocols used for data transmission were also discussed in detail. The authors concluded that the proposed system is capable of various applications such as fleet management, logistics, and transportation.

This research work is structured into three distinct sections. Section 2 pertains to the system modelling, while section 3 presents the results and analysis. The final section, denoted as Section 4, provides the conclusion of the research.

2. System Model

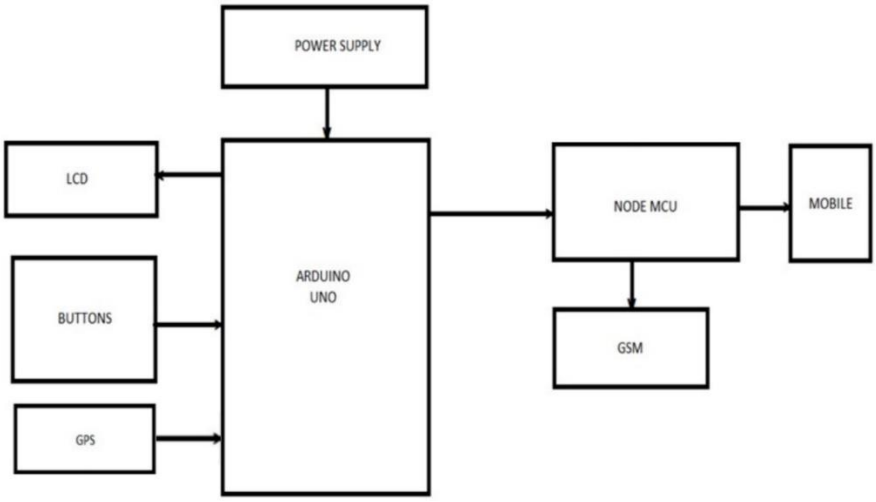

Figure 1. Block Diagram of IoT based GPS Tracking Security System

The IoT-based GPS tracking security system for women's safety is designed to provide efficient and reliable tracking capabilities. The system model can be described as follows:

1. Hardware Components

- Arduino: Serves as the central control unit responsible for data processing and communication.

- NodeMCU: Facilitates wireless connectivity and enables GSM communication.

- GPS Module: Acquires precise location coordinates of the user.

- GSM Module: Allows communication via SMS.

- 16x2 LCD: Provides a local display interface for system status and relevant information.

- Keypad: Enables password entry and verification.

2. User Initialization

- The user powers on the system to initialize it.

- The 16x2 LCD prompts the user to enter a password using the keypad for authentication.

3. Password Verification

- The entered password is compared with a predefined password stored in the system's memory.

- If the entered password matches the stored password, the system proceeds to the tracking mode.

- In the case of a mismatch, access to the tracking feature is denied.

4. GPS Tracking and Data Processing

- The GPS module continuously retrieves the current location coordinates of the user.

- The Arduino processes the acquired coordinates, ensuring accuracy and reliability.

5. SMS Hyperlink Generation

- The processed coordinates are transformed into an SMS hyperlink format.

- The SMS hyperlink includes the location coordinates and is ready for transmission.

6. One-Way Communication through GSM

- The GSM module facilitates one-way communication for sending the SMS.

- The system transmits the SMS containing the hyperlink, which is sent to a predefined phone number.

7. Guardian Monitoring

- The guardian or parents receive the SMS on their mobile devices.

- By clicking on the SMS hyperlink, Google Maps opens on their devices.

- Google Maps displays the real-time location of the user, allowing guardians to monitor the position effectively.

8. Cayenne Website Integration

- The system integrates with the Cayenne website platform.

- It establishes a secure connection with the Cayenne API and periodically sends location coordinates.

- The Cayenne website offers a user-friendly interface where guardians can conveniently access and monitor the woman's location.

The system model ensures that only authorized users can access the tracking feature through password verification. The GPS module provides accurate location coordinates, which are transmitted as an SMS hyperlink via the GSM module. Guardians or parents can monitor the woman's real-time location by clicking on the SMS hyperlink, opening Google Maps with the coordinates displayed. The integration with the Cayenne website enhances monitoring capabilities, while the 16x2 LCD provides a local display for real-time system information. The transmission of signals from the GSM module to the GPS receiver is crucial in this system. To accomplish this, an Arduino UNO is utilized to manage the vehicle tracking system. The GSM module serves as a transmitter while the identifies the user's location coordinates. These coordinates are then transmitted to the user, and to the Cayenne IoT platform through the ESP8266. Additionally, a 16x2 LCD shows the detected coordinates and status messages.

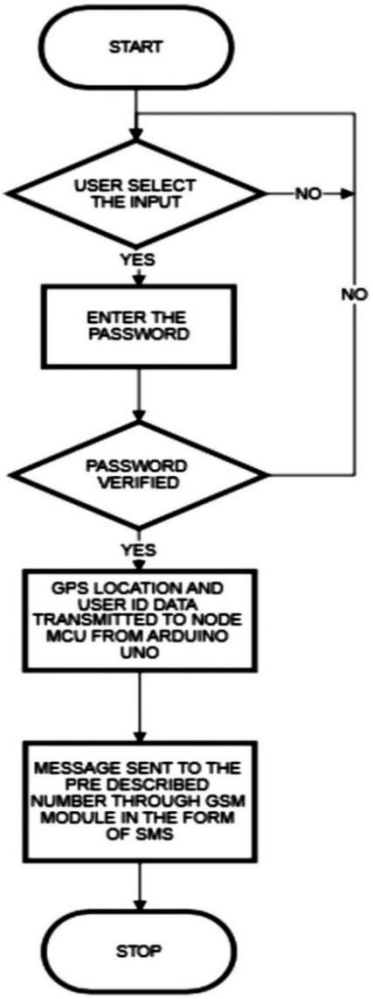

Figure 2. Flow Chart of IoT based GPS Tracking Security System

The flowchart shown in Figure 2 outlines a basic password verification process in which the user is prompted to enter their password. The program compares the entered password with the stored password and then sends the location using GSM. The entered password is compared with a predefined password stored in the system's memory. If the entered password matches the stored password, the system proceeds to the tracking mode, allowing access to the tracking feature. However, in the case of a mismatch between the entered password and the stored password, the system denies access to the tracking feature. This password verification mechanism serves as an additional layer of security to ensure that only authorized users can activate the tracking mode and monitor the user's location. By comparing the entered password with the predefined password, the system confirms the user's identity and grants access to the tracking functionality. This helps prevent unauthorized individuals from tracking the user's location and ensures that only trusted guardians or parents can monitor her safety.

Table 1. Hardware Components and their Uses

Hardware Component	**Description**
Arduino	Microcontroller board for data processing and control
NodeMCU	ESP8266-based development board for wireless connectivity
GPS Module	Receives and provides accurate location coordinates
GSM Module	Enables communication via SMS
16x2 LCD	Local display for system status and information
Keypad	Input device for password entry and verification

Table 2. Software Components and their Uses

Software Component	Description
Arduino IDE	Integrated development environment for programming Arduino
NodeMCU Firmware	Firmware for NodeMCU development board
GSM Library	Library for GSM communication with the GSM module
GPS Library	Library for retrieving and processing GPS coordinates
Google Maps API	API for integrating with Google Maps
Cayenne API	API for integrating with the Cayenne website platform

3. Results and Analysis

The designed model is depicted in Figure 3 and involves the use of an IoT-based GPS tracking approach using Arduino. The GPS unit collects the vehicle's location information, which is then transmitted to Cayenne through ESP8266.

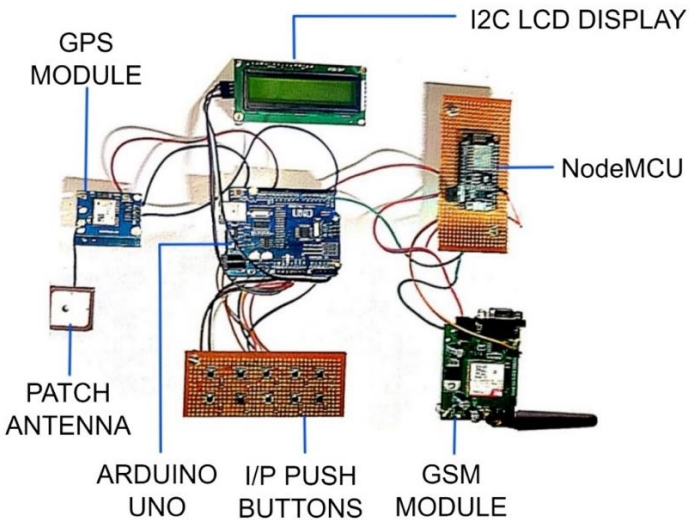

Figure 3. Hardware Model of IoT based GPS Tracking Security System

Before sending location data to Cayenne, the Arduino software performs a preliminary step of reading latitude and longitude values from the GPS module. These values are then

displayed in the Terminal emulator of the software. This ensures that the correct values are being collected and transmitted. The displayed values in the Terminal emulator are updated in real-time, meaning that any changes to the vehicle's location will be immediately reflected, as the GPS module sends updated values. Once the accuracy of the values is verified through the Terminal emulator, the same values are then uploaded to the Cayenne platform. This process ensures that the location data being sent to Cayenne is reliable and up-to-date. The output is depicted in figure 4.

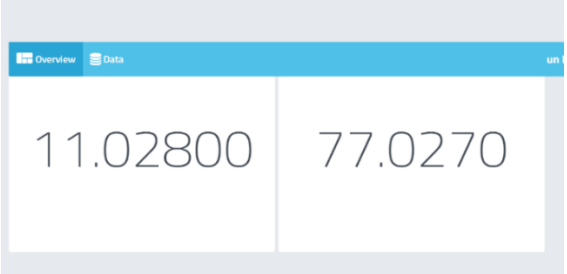

Figure 4. Location Coordinates Displayed in Terminal Emulator - Cayenne Platform

Figure 5 depicts the password verification process. The result of the password verification process determines whether the user is authorized to access the tracking feature or not. A successful verification ensures that only trusted individuals can monitor the woman's safety. On the other hand, a failed verification denies access to the tracking functionality, preventing unauthorized individuals from tracking the woman's location. This helps maintain the system's security and ensures that only authorized guardians or parents can monitor and ensure the woman's well-being.

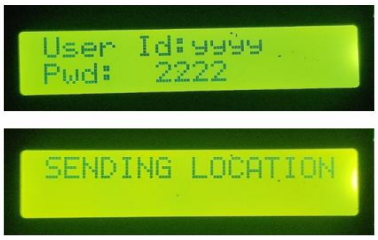

Figure 5. Password Verification Process

Figure 6 displays the SMS hyperlink sent through the GSM module and location tracking in Google map. The result of the SMS hyperlink sharing through GSM and location tracking in Google Maps is an effective and reliable means of keeping guardians or parents

informed about the woman's whereabouts. The system successfully delivers the SMS containing the hyperlink, enabling the guardian or parent to access the woman's location on Google Maps with a single click. The continuous tracking and accurate location display provide real-time updates, ensuring that the guardian can monitor the woman's movements accurately. This real-time monitoring capability enhances the safety and security of the woman, as any potential risks or emergencies can be addressed promptly.

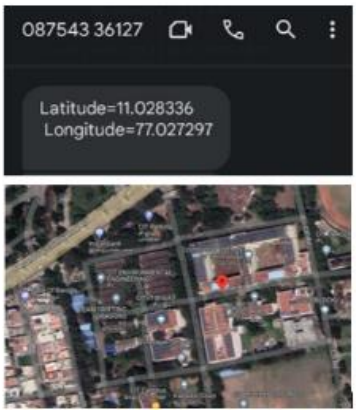

Figure 6. SMS Hyperlink Sharing through GSM and Location Tracking in Google Map

4. Conclusion

This research presents an innovative design and successful testing of an IoT-based GPS tracking security system. The system is engineered to provide real-time tracking information for efficient and reliable tracking purposes. The proposed system includes an Arduino module, GPS/GSM unit, and a smartphone to detect the coordinates of the vehicle. The system aims to address the increasing safety concerns, especially for women and children, by providing an IoT-based GPS tracking security system. Moreover, the IoT-based GPS tracking security system can be an effective solution for ensuring the safety of women and children, by utilizing the Cayenne platform and GSM technology. The system is easy to implement, cost-effective, and reliable for tracking the location of the device in real-time and alerting the designated guardians or authorities in case of emergencies or abnormal situations. The proposed system's performance in different environments has been evaluated, and it is found that the system's precision and accuracy were affected by the location of the device and the number of satellites available. Therefore, further investigations are recommended to optimize the system's accuracy, especially in moving vehicles, which can help enhance its overall performance in different environments.

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Author's Biography

Barathvaj P R is currently pursuing his final year BE-Electrical and Electronics Engineering at Coimbatore Institute of Technology, Coimbatore, Tamil Nadu. His research area of interest includes IOT and Data Communication Networks.

Gokul A is currently pursuing his final year BE-Electrical and Electronics Engineering at Coimbatore Institute of Technology, Coimbatore, Tamil Nadu. His research area of interest includes Power Electronics and Embedded systems.

Harirajan R is pursuing his final year BE-Electrical and Electronics Engineering at Coimbatore Institute of Technology, Coimbatore, Tamil Nadu. His research area of interest includes Power Electronics and Digital Electronics.

Kaamesh P P is pursuing his final year BE-Electrical and Electronics Engineering at Coimbatore Institute of Technology, Coimbatore, Tamil Nadu. His research area of interest includes Machines and Control Systems.

Jaswanth S is pursuing his final year BE-Electrical and Electronics Engineering at Coimbatore Institute of Technology, Coimbatore, Tamil Nadu. His research area of interest includes Machines and Control Systems.

Dr.S.Suja joined as a Lecturer in the Year 2000 in Coimbatore Institute of Technology. She was upgraded as a Senior Lecturer in the year 2005, registered Ph.D in the year 2005, submitted the thesis in the year 2009, and awarded Ph.D in the Year 2010. Her International Journal Publications are 7 (With Impact Factor) Publications Available in the Science Direct, Elsevier Publications and John Wiley Publications.