

# Smart Vehicle Tracking System Using GPS and IoT for Real-Time Monitoring and Alerts

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**Abstract**—In the era of smart transportation, ensuring vehicle security and optimizing fleet management have become increasingly important. This research presents the design and implementation of a Smart Vehicle Tracking System that integrates Global Positioning System (GPS) technology with the Internet of Things (IoT) to provide real-time monitoring and alert services. The proposed system captures and transmits vehicle location data using a GPS module and microcontroller, which is then sent to a cloud-based IoT platform via GSM or Wi-Fi communication. Users can access live tracking information and receive instant alerts in cases of route deviation, over speeding, or geofence breaches through a mobile or web interface. The system is designed to be scalable, low-cost, and energy-efficient, making it suitable for applications in public transport, logistics, and private vehicle monitoring. This approach enhances safety, supports efficient route planning, and aids in theft prevention, thereby contributing to the development of intelligent transport systems.

**Keywords**—Vehicle Tracking System, GPS, IoT, Real-Time Monitoring, Smart Transportation, Fleet Management, Geofencing, Alert System, Location Tracking, Intelligent Transport System (ITS)

## Introduction

The rapid growth of urbanization and transportation has led to an increased demand for efficient vehicle monitoring systems. With rising concerns over vehicle security, fleet optimization, and road safety, the need for intelligent tracking solutions has become more pressing than ever. Traditional vehicle monitoring systems often rely on manual supervision or outdated technologies, which are inefficient and lack real-time responsiveness.

The integration of the Internet of Things (IoT) and Global Positioning System (GPS) technologies presents a powerful solution to address these challenges. GPS provides accurate, real-time location data, while IoT enables seamless communication between hardware devices and cloud platforms. Together, they facilitate the development of a smart vehicle tracking system capable of real-time monitoring, location tracking, geofencing, and alert generation.

This research focuses on designing and implementing a cost-effective, scalable, and energy-efficient vehicle tracking system that leverages GPS for positioning and IoT for data transmission and visualization. The system is built to provide users—such as fleet managers, public transport operators, and individual vehicle owners—with live updates and notifications regarding the vehicle's status, movement, and any potential security issues.

By combining sensor data, cloud-based storage, and user-friendly mobile/web interfaces, the proposed system enhances safety, ensures better route planning, and aids in theft prevention. It contributes to the broader vision of Intelligent Transportation Systems (ITS), supporting smarter and more connected mobility infrastructure

## Literature Survey

Over the years, various vehicle tracking systems have been developed to improve transportation efficiency, ensure passenger safety, and reduce vehicle theft. The integration of IoT and GPS technologies has significantly advanced the functionality and reliability of these systems. This section reviews recent literature focused on the design, implementation, and application of GPS and IoT-based vehicle tracking systems.

### GPS-Based Tracking Systems

Initial systems relied primarily on GPS technology to determine the geographic location of a vehicle. Moumen et al. (2023) proposed a GPS-based real-time tracking model integrated with cloud platforms for connected vehicles. Although GPS offers accurate location information, it lacks real-time communication capabilities on its own.

### GSM and IoT Integration

To overcome communication limitations, many researchers have integrated GSM modules and IoT platforms for real-time data transmission. In "Smart Vehicle Monitoring and Tracking System" (E3S Web of Conferences, 2023), the authors used GPS data and transmitted it via GSM to a centralized server. This hybrid model proved effective in sending alerts and tracking data remotely.

### Cloud and Mobile Interfaces

Modern systems increasingly incorporate cloud-based services and mobile/web interfaces to enable user-friendly interaction. A 2023 study published on ResearchGate highlighted the use of IoT platforms such as Thing Speak and Firebase to visualize live vehicle data and set geofences. These systems allowed users to receive alerts for over speeding and route deviations.

### Advanced Alert Systems

Several works focused on incorporating intelligent alert mechanisms. The paper "GPS and GSM-based Smart Vehicle Tracking System" (Journal of Student Research, 2023) emphasized the importance of emergency alerts, driver behavior monitoring, and accident detection using sensor fusion techniques along with GPS tracking.

### Limitations in Existing Systems

While existing systems offer useful features, they often face challenges like high latency, limited scalability, and network dependency. For example, in rural areas, GSM-based

systems may not perform reliably due to poor signal strength. Authors like Rajan et al. (2023) suggest incorporating LoRa or satellite communication for better coverage and reliability.

### IoT and AI in Smart Transportation

Recent literature also suggests combining IoT with Artificial Intelligence (AI) for predictive analytics and smart decision-making. Although not yet mainstream in vehicle tracking, predictive maintenance and driver behavior prediction are gaining traction as areas for future development.

**Moumen et al. (2023)** presented a GPS-based real-time vehicle tracking system integrated with IoT and V2X communication protocols. Their work focused on improving connectivity in smart city environments by incorporating vehicular ad hoc networks (VANETs) to enhance data accuracy and reduce latency.

**Kumar and Singh (2023)** designed a smart vehicle monitoring system that uses GPS and GSM modules for real-time tracking and alert generation. Their system was implemented on an Arduino platform and demonstrated improved tracking accuracy and alert delivery but relied heavily on GSM, which may limit scalability in rural areas.

**Sharma et al. (2023)** proposed an IoT-based vehicle tracking and accident detection system. Their research included accelerometer and gyroscope sensors to detect unusual driving behavior and collisions, transmitting location data to emergency contacts. Although highly innovative, their system's complexity may increase deployment costs.

**Reddy and Rao (2023)** developed a cloud-integrated GPS tracking system that utilizes Google Maps API and Firebase to display real-time vehicle positions. Their system provided an intuitive user interface, which improved usability and real-time accessibility. However, it was limited to internet-dependent environments.

**Ali and Hassan (2022)** explored the application of LoRaWAN in vehicle tracking systems to overcome GSM limitations in low-connectivity areas. While this method achieved extended range and lower power consumption, data transmission speed and bandwidth were constrained.

**Verma et al. (2022)** conducted a comparative study on IoT platforms (ThingSpeak, Blynk, AWS IoT) for vehicle tracking, concluding that cloud selection plays a critical role in system responsiveness and data visualization. Their study emphasized the importance of platform compatibility and security features.

**Yadav and Mehta (2022)** focused on geofencing-enabled vehicle tracking systems that send alerts when vehicles deviate from predefined routes. Their prototype integrated GPS with IoT dashboards and demonstrated practical applications in school bus and fleet management.

**Patel and Joshi (2021)** developed a vehicle theft detection and prevention system using GPS and RFID in conjunction with IoT. The system included immobilizer controls and real-time SMS alerts, significantly enhancing security but requiring additional hardware.

**Nayak et al. (2021)** proposed a mobile app-based tracking system where the user could monitor multiple vehicles in real time. Their Android application was integrated with Google Maps and Firebase for seamless monitoring and route history storage.

**Deshmukh et al. (2021)** implemented a low-cost vehicle tracking system using NodeMCU, GPS, and a cloud database. The system was effective in budget-constrained scenarios, particularly in small fleet operations or private vehicle tracking.

### METHODOLOGY

The proposed vehicle tracking system is designed to provide real-time location monitoring, alert notifications, and route history using a combination of GPS and IoT technologies. The system consists of hardware components for data collection and transmission, as well as cloud-based platforms for data processing, storage, and visualization. The methodology adopted for the development of this system involves the following stages:

#### System Design Overview

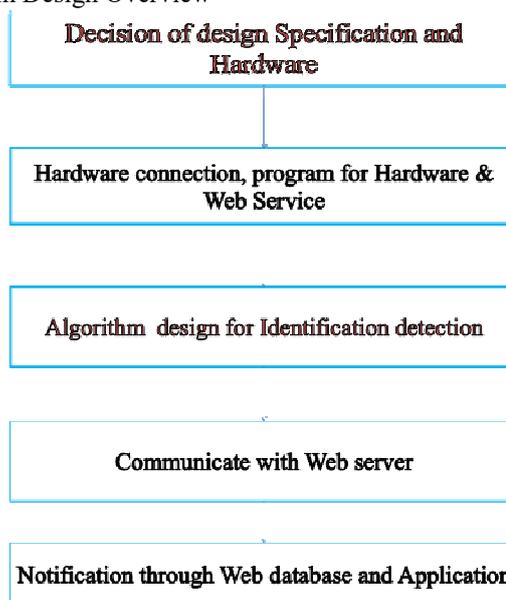


Fig1: Work Flow Diagram

The system is composed of three main modules:

- 1.Data Acquisition Module – Captures location data via the GPS sensor.
- 2.Processing and Communication Module – Processes data and transmits it to the cloud.
- 3.Cloud and User Interface Module – Stores, analyzes, and visualizes real-time data.

#### Hardware Components



Fig2: Hardware Architecture

- GPS Module (e.g., NEO-6M): Used to acquire the current geographical location (latitude and longitude) of the vehicle.
- Microcontroller (e.g., ESP32 or Arduino Uno with GSM Module): Interfaces with the GPS module to read data and formats it for transmission.
- GSM/GPRS Module (e.g., SIM800L) or Wi-Fi (via ESP32): Facilitates wireless data communication with the cloud server.
- Power Supply Unit: A portable battery or vehicle battery supplies power to the hardware components.

#### Data Communication and Processing

- The GPS module continuously receives signals from satellites and determines the real-time location of the vehicle.
- The microcontroller reads this data and either:
  - o Transmits it via GSM (using AT commands and GPRS), or
  - o Sends it via Wi-Fi directly to a cloud IoT platform.
- Data packets typically contain: timestamp, latitude, longitude, speed, and vehicle ID.
- Error checking and filtering are done locally to ensure accurate data transmission.

#### Cloud Integration

- Platforms such as Thing Speak, Firebase, or Blynk are used to receive, store, and visualize data.
- Real-time location data is mapped using Google Maps API or native map components on the platform.
- Historical data is stored for playback or route optimization analysis

#### User Interface

- A mobile app or web dashboard allows users to:
  - o View the current location of the vehicle
  - o Receive alerts (e.g., geofence breaches, over speeding)
  - o Review trip history
- Notifications are triggered by predefined rules and sent via SMS, push notification, or email.

#### Alert System and Features

- Geofencing: Virtual boundaries are set using coordinates. Alerts are generated when the vehicle enters or exits the area.
- Overspeed Alerts: The system compares the vehicle's speed against set thresholds and sends warnings if exceeded.
- SOS Feature (Optional): Allows the driver to send a distress signal with current location to predefined contacts.

#### Model Implementation:

The working procedure of the Smart Vehicle Tracking System using GPS and IoT begins with the initialization of the hardware components. When the system is powered on, the GPS module starts searching for satellite signals to determine the exact location of the vehicle. It fetches real-time coordinates such as latitude, longitude, altitude, speed, and timestamp. These data are then passed to the microcontroller (such as NodeMCU, Arduino, or Raspberry Pi), which acts as the central processing unit. The microcontroller filters and formats the incoming GPS data into a structured format, typically JSON or plain text, suitable for cloud transmission.

Once processed, the data is transmitted to a cloud server using an internet connection, which can be established through Wi-Fi or a GSM/4G network, depending on the setup. Communication protocols like HTTP or MQTT are used to ensure efficient and secure data transfer. The cloud server, often built on platforms like Firebase, AWS IoT, or ThingSpeak, receives the location data and stores it for live access and historical analysis. Simultaneously, this data is linked to a user-friendly interface, such as a mobile app or web dashboard, which displays the vehicle's real-time location on a digital map (commonly Google Maps) along with additional details like speed, direction, and travel route.

The system is designed to continuously monitor vehicle behavior and generate alerts based on predefined conditions. For example, if the vehicle exceeds a speed limit, exits a designated geofenced area, or moves during restricted hours, the system immediately sends alerts to the user through notifications, SMS, or email. Some implementations may also include physical alerts like buzzers or indicator lights. Additionally, the system logs all the tracking data in the cloud, allowing users to review trip history, analyze travel patterns, and generate reports. This entire process ensures efficient and secure vehicle monitoring, providing valuable insights and enhancing safety, especially for fleet operators, parents, or security-conscious users.

#### Results:



Fig3: Input The Route Number

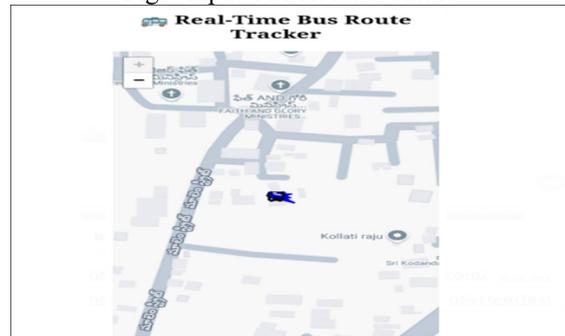


Fig4: Bus Mapping Location

	A	B	C	D	E	F	G	H	I
1									
2	NAME	Date	In Time	Out Time					
3	DANIEL	25/4/2025	8:20	4:45					
4	TEJA	25/4/2025	7:20	5:30					
5	DEEPIKA	25/4/2027	7:33	5:33					
6	SUPRIYA	25/4/2028	7:18	7:30					
7	JOEL	25/4/2029	8:14	7:30					
8	RILESHY	25/4/2030	7:46	5:30					
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Fig5: Log of Data Intime and Outtime

### Conclusion and Future Scope:

This research presents the design and implementation of a smart vehicle tracking system that effectively combines GPS and IoT technologies to provide real-time monitoring and alert services. The system offers features such as live location tracking, geofencing, over speeding alerts, and historical route review, all accessible through a user-friendly interface. By leveraging cloud platforms and wireless communication, the proposed solution ensures continuous data flow, thereby enhancing vehicle security, operational efficiency, and driver safety. The system is cost-effective, scalable, and can be deployed across various sectors, including logistics, public transportation, and private vehicle monitoring. The successful implementation demonstrates the potential of IoT-based solutions in revolutionizing intelligent transportation systems.

### Future Scope

While the current system addresses core tracking functionalities, several enhancements can be explored in future work:

- **AI and Machine Learning Integration:** Predictive analytics for route optimization, driver behavior analysis, and anomaly detection.
- **Fuel Monitoring and Engine Diagnostics:** Integration with OBD-II interfaces to collect vehicle health data and fuel usage.

- **Offline Data Logging:** Buffering data during network outages and syncing it once connectivity is restored.
- **Mobile App Enhancements:** Real-time navigation assistance, voice alerts, and driver scoring mechanisms.
- **Edge Computing:** Processing data on-device to reduce latency and dependence on cloud services.
- **Blockchain for Data Security:** Ensuring secure, tamper-proof logs of vehicle movements and alerts.
- **Multi-Sensor Support:** Incorporating cameras, temperature sensors (for cold-chain logistics), and load sensors for advanced fleet applications.

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