



(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 5, May 2025

⊕ www.ijirset.com 🖂 ijirset@gmail.com 🖄 +91-9940572462 🕓 +91 63819 07438





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025 |DOI: 10.15680/IJIRSET.2025.1405242| IoT based Bus Tracking System

R. Senthil Kumar, R. Pandi Sakthivel, R. Muruganandam, M. Makarish

Assistant Professor, Department of Electronics and Communication Engineering, SSM Institute of Engineering and

Technology, Dindigul, Tamil Nadu, India

UG Scholar, Department of Electronics and Communication Engineering, SSM Institute of Engineering and

Technology, Dindigul, Tamil Nadu, India

UG Scholar, Department of Electronics and Communication Engineering, SSM Institute of Engineering and

Technology, Dindigul, Tamil Nadu, India

UG Scholar, Department of Electronics and Communication Engineering, SSM Institute of Engineering and

Technology, Dindigul, Tamil Nadu, India

ABSTRACT: This project introduces a smart bus tracking and student attendance monitoring system that leverages the capabilities of the ESP32 microcontroller combined with GPS, GSM, and fingerprint modules. The system is designed to improve the safety and transparency of school transportation by enabling real-time tracking of the bus and ensuring accurate attendance of students. Upon boarding, each student verifies their identity using a fingerprint scanner, thereby preventing manual errors and unauthorized entries. The GPS module continuously monitors the bus's location, while the GSM module ensures that all data, including location and attendance records, is transmitted seamlessly to the ThingSpeakIoT platform.

By integrating these technologies, the system provides an efficient and reliable solution for managing student transport. Parents and school administrators gain real-time visibility into the bus's location and student attendance status through the cloud-based platform. This not only enhances student safety but also fosters accountability among transport operators. Moreover, the automated data logging simplifies administrative tasks and helps in quick decision-making during emergencies or delays. Overall, the proposed system offers a comprehensive approach to secure and intelligent school transportation management.

KEYWORDS: Smart bus tracking, Student attendance monitoring, ESP32 microcontroller, GPS module, GSM module, Fingerprint authentication, Real-time tracking, ThingSpeakIoT platform.

I. INTRODUCTION

School transportation plays a crucial role in ensuring that students commute safely and efficiently between home and school. However, it poses significant challenges, particularly in tracking the real-time location of buses and accurately monitoring student attendance. Traditional methods such as manual roll calls or RFID cards often suffer from inaccuracies, potential misuse, and lack of real-time updates. These limitations can lead to confusion, delays, and concerns among parents and school authorities regarding student safety and accountability. To overcome these challenges, the proposed system employs a smart solution that integrates biometric authentication and IoT technologies. A fingerprint module is used for secure student identification, ensuring that only authorized students are marked present. The GPS module provides continuous real-time tracking of the bus's location, while the ESP32 microcontroller manages data collection and communication. This data is sent through a GSM module to the ThingSpeak cloud platform, allowing parents and school officials to monitor transportation activities remotely. The system not only enhances safety and transparency but also streamlines operations, making school transport smarter, more reliable, and more secure.





[www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405242|

II. OBJECTIVE

The primary objective of the proposed Bus Tracking System is to ensure the safety and accountability of students during their transportation by integrating real-time monitoring and biometric attendance verification. The system aims to use the ESP32 microcontroller as the central unit to interface with a GPS module for continuous location tracking and a fingerprint sensor to authenticate and record student attendance as they board the bus. By uploading this data to the ThingSpeak cloud platform, the system provides instant access to both parents and school administrators, ensuring transparency and improving trust in the school transport process. Another key objective is to enhance emergency communication and timely updates. The system is designed to trigger a call via the GSM module five seconds after a student boards the bus, followed by an automatic SMS that includes the current location of the bus. This feature ensures that parents are instantly informed of their child's status and whereabouts, reducing anxiety and enhancing safety. Additionally, the system promotes automation, reduces human error, and improves operational efficiency in student transportation management through seamless integration of IoT and biometric technologies.

III. EXISTING METHODOLOGY

The existing methodology for bus tracking and student attendance monitoring often relies on manual processes or basic technologies such as RFID cards and attendance registers. While RFID systems offer quicker identification than manual methods, they are still prone to misuse, such as students exchanging cards or forgetting to scan them. Additionally, many current systems lack real-time data transmission, limiting the ability of parents and school administrators to track the bus location or receive timely updates. These methods do not provide biometric verification, which is crucial for ensuring that the correct student is boarding the bus, and they often lack integration with IoT platforms for cloud-based data access and analysis. To address these limitations, the enhanced methodology incorporates an ESP32 microcontroller that integrates GPS for real-time location tracking and a fingerprint module for secure biometric attendance. The system uploads data to the ThingSpeakIoT cloud platform, making it accessible to authorized users from any internet-enabled device. Furthermore, the GSM module adds a communication layer by automatically making a call and sending a text message with the bus's location five seconds after a student's fingerprint is authenticated. This ensures instant and accurate updates to parents, providing reassurance and enhancing safety. The methodology effectively combines biometric security, IoT connectivity, and mobile communication to overcome the drawbacks of traditional systems.

IV. PROPOSED METHODOLOGY

The proposed system employs the ESP32 microcontroller as the central processing unit, interfacing seamlessly with a GPS module for real-time location tracking, a fingerprint sensor for secure student verification, and a GSM module for data transmission. When a student boards the bus and scans their fingerprint, the system authenticates the identity, records the attendance, and sends the data to the ThingSpeakIoT cloud platform. At the same time, the GPS module captures the bus's current location, which is also uploaded to the cloud. This ensures that both attendance and location data are updated and accessible instantly, providing a transparent and automated monitoring system. This integrated approach enables school administrators and parents to track the student's boarding status and the bus's route in real time using cloud-based dashboards. Unlike conventional systems that rely on manual tracking or unsecured methods, this solution enhances both accuracy and reliability. The use of biometric verification eliminates identity fraud, while the GPS and GSM modules ensure continuous communication and data sharing. Overall, the system offers a secure, efficient, and scalable solution for student transportation management, promoting greater trust, safety, and operational effectiveness.





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405242|

V. BLOCK DIAGRAM



VI. COMPONENTS

6.1 Microcontroller - Arduino Uno

Acts as the central processing unit, receiving input from sensors and controlling actuators based on predefined conditions. Executes programmed logic to automate greenhouse functions.

6.2 ESP32 Development Board

- I. Integrated Wi-Fi and Bluetooth Offers both wireless communication protocols, making it ideal for IoT projects.
- II. **Dual-Core Processor** Runs on a high-speed dual-core Tensilica LX6 CPU for multitasking.
- III. Multiple GPIO Support Provides numerous GPIO pins compatible with UART, SPI, I2C, ADC, DAC, and PWM.
- IV. Low Power Operation Features various power-saving modes including deep sleep, ideal for batterypowered systems.
- V. Flexible Programming Support Can be programmed using Arduino IDE, MicroPython, or ESP-IDF for versatility.

6.3 GPS Module (Neo-6M or Similar)

- I. Real-Time Location Data Provides accurate latitude, longitude, altitude, and time data via satellites.
- II. UART Interface Communicates easily with microcontrollers like ESP32 using serial communication.

IJIRSET©2025





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405242|

- III. Built-in EEPROM and Battery Backup Stores last position data and reduces time to first fix (TTFF).
- IV. High Sensitivity Works well in outdoor conditions with a high-gain antenna.
- V. Compact and Lightweight Suitable for embedded or mobile tracking applications.

6.4 GSM Module (SIM800L or SIM900A)

- I. SMS and Call Functionality Capable of sending/receiving SMS and making/receiving voice calls.
- II. Quad-Band Support Compatible with 2G GSM networks globally.
- III. UART Communication Interfaces with ESP32 using AT commands over serial.
- IV. Low Voltage Operation Works on 3.7V–4.2V, usually requiring a separate power supply.
- V. Used for Notifications Sends alerts like SMS with location or calls upon student verification.

6.5 Fingerprint Sensor Module (R305 or GT511C3)

- I. **Biometric Authentication** Provides secure student identity verification using fingerprints.
- II. Built-in DSP Chip Handles image processing, feature extraction, and fingerprint matching.
- III. Flash Memory Can store up to 1000 fingerprint templates depending on model.
- IV. UART Interface Simple integration with microcontrollers like ESP32 via serial connection.
- V. High Accuracy Reduces false acceptance or rejection, enhancing system reliability.

6.6 Power Supply (Battery + Voltage Regulator)

- I. Portable Operation Enables the system to work independently of a constant power source.
- II. Voltage Regulation Ensures stable voltage output (typically 3.3V or 5V) using regulators like AMS1117.
- III. Battery Types Li-ion or Li-Po batteries are commonly used due to high energy density.
- IV. Protection Circuitry Often includes overcharge/discharge protection for safety.
- V. Supports Multiple Modules Must provide enough current for GPS, GSM, and other connected devices.

6.70LED Display or LCD (Optional)

- I. **Real-Time Feedback** Displays live data such as student names, attendance confirmation, or GPS coordinates.
- II. Compact Size OLEDs are often small and require minimal wiring.
- III. I2C/SPI Interface Easily interfaces with ESP32 using two-wire I2C or four-wire SPI.
- IV. Low Power Consumption Suitable for battery-powered devices.
- V. User-Friendly UI Useful for debugging or providing user confirmation without external devices.

VII. PROJECT OUTPU







www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405242|

VIII. APPLICATIONS

- 1. **Real-Time Student Attendance Monitoring:**Automatically records student attendance as they board the bus using fingerprint authentication, ensuring accurate and tamper-proof records.
- 2. Live Bus Location Tracking: Uses GPS and the ESP32 to continuously update the bus's real-time location to the ThingSpeak cloud, allowing parents and school authorities to track the bus remotely.
- 3. **Instant Parent Notification:**The GSM module automatically calls and sends an SMS with the current bus location to parents within seconds after the student boards, enhancing child safety and parental assurance.
- 4. Emergency Alert System: Can be configured to send immediate alerts to designated contacts in case of emergencies like delays, route deviations, or mechanical issues.
- 5. Smart Fleet Management for Schools: Enables school administrators to monitor and manage multiple buses efficiently, optimize routes, and analyze attendance and transport data through cloud-based dashboards.

IX. CONCLUSION

In conclusion, the proposed Bus Tracking System using the ESP32 board, GPS, fingerprint detection, GSM, and ThingSpeak cloud offers a comprehensive solution to enhance the safety, transparency, and efficiency of school transportation. By integrating fingerprint authentication, the system ensures secure and accurate student attendance, eliminating the risks associated with manual roll calls or RFID-based methods. The GPS module provides real-time location tracking of the bus, which is continuously updated and made accessible to parents and school administrators via the ThingSpeak cloud platform. This not only improves operational efficiency but also enables proactive monitoring of the transportation system. The GSM module adds an additional layer of communication by notifying parents through automated calls and messages with the bus's current location, ensuring immediate updates upon student verification. This feature promotes enhanced safety by keeping parents informed at all times. Overall, the system offers a scalable and secure solution for modernizing school transportation, providing greater peace of mind to both parents and school authorities while reducing human errors and improving logistical operations.

REFERENCES

- 1. Ahmed, M., & Khan, M. M. (2020). Design and implementation of a smart bus tracking system using IoT. International Journal of Advanced Research in Computer Science and Software Engineering, 10(4), 34-40.
- 2. Ali, Z., & Gupta, V. (2019). Real-time vehicle tracking system using GPS and GSM technology. International Journal of Computer Science and Mobile Computing, 8(6), 67-72.
- 3. Ameer, P., &Nasir, M. (2021). An IoT-based smart school bus tracking system using ESP32 and GPS. Proceedings of the 5th International Conference on Computer and Communication Engineering, 117-123.
- 4. Arora, M., & Singh, R. (2021). IoT-based smart transportation system using ESP32 and GPS. Journal of Electrical and Electronics Engineering Research, 8(1), 12-18.
- 5. Bashir, M. R., &Shaikh, A. (2018). Design and implementation of GPS and GSM-based vehicle tracking system. International Journal of Engineering and Technology, 7(5), 132-136.
- 6. Dube, V., & Sharma, P. (2020). A review on vehicle tracking systems using GPS and GSM technologies. International Journal of Computer Applications, 179(2), 25-30.
- 7. Hossain, M. S., & Misbah, M. (2021). IoT-based real-time school bus tracking system using GPS, GSM, and fingerprint sensor. International Journal of Computer Applications in Technology, 65(4), 409-414.
- 8. Jain, S., &Patil, S. (2019). Smart bus tracking and monitoring system using IoT. International Journal of Engineering Research and Technology, 8(10), 852-856.
- 9. Jain, A., &Saini, P. (2020). Design and development of a bus tracking system using GPS and GSM modules. Proceedings of the International Conference on Computing, Communication, and Networking Technologies, 45-50.
- 10. Javed, S., & Ali, S. (2021). School bus tracking system with real-time GPS location and GSM alerts. International Journal of Computer Science and Network Security, 21(6), 121-127.
- 11. Kumar, S., &Meena, A. (2019). Design of bus monitoring and tracking system using ESP32. Proceedings of the IEEE International Conference on Advanced Communication Technologies, 33-36.
- Lathwal, S., & Kumar, R. (2020). GPS-based smart bus monitoring system using IoT. International Journal of Scientific & Technology Research, 9(3), 118-123.





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405242|

- 13. Liu, X., & Wang, H. (2021). A smart school bus system based on GPS, GSM, and fingerprint technology. International Journal of Automation and Computing, 18(4), 542-549.
- 14. Meena, S., &Ramachandran, S. (2020). A GPS-based bus tracking system using ESP32 for student safety. Journal of Mobile and Embedded Computing, 6(1), 48-52.
- 15. Mishra, S., &Yadav, P. (2021). IoT-based bus tracking and attendance system using GPS and ESP32. International Journal of Computer Applications in Engineering, 9(2), 23-30.
- 16. Patil, A., &Agarwal, R. (2019). IoT-based school bus tracking system using GPS and GSM. Proceedings of the International Conference on Computational Intelligence and Networks, 150-154.
- 17. Ramesh, R., &Rathi, P. (2020). Design of an intelligent school bus tracking system with real-time data access using GPS and GSM technology. International Journal of Engineering Research, 9(2), 200-205.
- 18. Sharma, M., &Yadav, N. (2021). A study on IoT-based bus tracking system with GPS integration. International Journal of Electronics, Electrical, and Computational System, 10(1), 101-105.
- 19. Sinha, S., & Sharma, S. (2020). Real-time school bus monitoring system with GPS and GSM technology. International Journal of Innovative Research in Computer and Communication Engineering, 8(6), 22-27.
- 20. Verma, P., &Bhardwaj, A. (2020). Smart bus tracking and attendance system using IoT. International Journal of Computer Science and Information Security, 18(9), 62-68.









INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY





www.ijirset.com