



Bus Tracking and Student Monitoring System Using Esp8266

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To Cite this Article

Sai Srinivas Vellela, M. Vishnupriya, Ch. Sivaji, A. Manikanta & A. Gowtham Sai (2026). Bus Tracking and Student Monitoring System Using Esp8266. International Journal for Modern Trends in Science and Technology, 12(SI01), 1130-1136. <https://doi.org/10.5281/zenodo.19718603>

Article Info

Received: 12 March 2026; Revised: 07 April 2026; Accepted: 10 April 2026.

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KEYWORDS

Bus Tracking System, Student Safety, RFID, ESP8266, Internet of Things (IoT), Real-Time Monitoring

ABSTRACT

The need for efficient and reliable transportation monitoring systems has increased significantly in educational institutions to ensure student safety and proper bus management. Traditional bus tracking systems rely on manual attendance and lack real-time updates, which can lead to inaccuracies, delays and reduced transparency in monitoring student movement. These limitations make it difficult for parents and administrators to track whether students have boarded or exited the bus on time. To overcome these challenges, this paper presents a Bus Tracking and Student Entry-Exit Monitoring System Using ESP8266 with RFID and IoT-Based Dashboard, which provides real-time tracking and automated data management [1]. The proposed system utilizes an RFID reader to scan unique RFID cards assigned to buses and students. When a card is scanned, the ESP8266 microcontroller processes the data and determines whether the user is entering or exiting the bus. The system maintains the status of each bus and student dynamically, ensuring accurate tracking of movement. Additionally, a buzzer is used to provide immediate feedback upon scanning, and a servo motor mechanism is implemented to simulate gate control for entry and exit operations [2]. The ESP8266 module, with built-in Wi-Fi capability, transmits the collected data to a web-based dashboard through an IP address using HTTP communication. The dashboard displays real-time information such as bus arrival and departure, student entry and exit status, and timestamps synchronized using Network Time Protocol (NTP). This enables administrators and parents to monitor transportation activities remotely with improved accuracy and transparency.

I. INTRODUCTION

In recent years, the need for efficient and secure transportation systems has increased significantly, especially in educational institutions where student

safety is a primary concern. Traditional bus monitoring systems rely on manual attendance or verbal confirmation, which are often unreliable and prone to human error. These methods lack real-time tracking and

do not provide accurate information about whether a student has boarded or exited the bus. As a result, it becomes difficult for school authorities and parents to ensure the safety and proper movement of students during transportation [1].

With the advancement of embedded systems and Internet of Things (IoT) technologies, smart transportation solutions have emerged to address these limitations. IoT enables real-time data communication between devices, allowing continuous monitoring and instant updates. RFID (Radio Frequency Identification) technology plays a crucial role in automated identification systems, as it provides a fast and reliable method for recognizing users through unique card IDs. When integrated with microcontrollers such as ESP8266, RFID-based systems can efficiently track entry and exit activities without manual intervention [2].

This paper presents a Bus Tracking and Student Entry-Exit Monitoring System Using ESP8266 with RFID and IoT-Based Dashboard, which aims to automate the process of tracking bus movements and student attendance. The system uses RFID cards assigned to buses and students, and an RFID reader scans these cards during entry and exit. The ESP8266 processes the scanned data and determines the status of each user, such as "ENTER" or "EXIT." The system also records timestamps using Network Time Protocol (NTP), ensuring accurate and synchronized data logging.

The proposed system offers a smart, automated, and reliable solution for transportation management. It reduces manual effort, improves accuracy, and enhances student safety by providing real-time monitoring and data transparency. The system is cost-effective and can be easily implemented in schools and organizations, with the potential for future enhancements such as GPS tracking and mobile application integration for more advanced monitoring capabilities [1][2].

II. REVIEW LITERATURE SURVEY

Recent advancements in transportation monitoring systems have focused on automation and real-time tracking using embedded systems and Internet of Things (IoT) technologies. Traditional bus monitoring systems rely on manual attendance and supervision, which are

prone to human errors and lack real-time updates. These limitations make it difficult to track student movement accurately and ensure safety during transportation, especially in school environments [1].

To address these issues, several researchers have proposed RFID-based tracking systems. RFID technology is widely used for automatic identification and data capture, where each user is assigned a unique card. When scanned, the system records entry and exit details efficiently. These systems provide improved accuracy; however, some implementations lack real-time communication capabilities, limiting remote monitoring [2].

In recent years, IoT-based transportation systems have gained significant attention. These systems integrate microcontrollers with wireless communication modules such as Wi-Fi or GSM to transmit real-time data to cloud platforms or web dashboards. Some studies have implemented GPS-based bus tracking systems that provide live location updates. While these systems enhance tracking capabilities, they increase system complexity and cost [3].

Alternatively, ESP8266-based systems have been proposed as a cost-effective solution for real-time monitoring. The ESP8266 microcontroller has built-in Wi-Fi capability, enabling seamless communication between hardware and web-based applications. When combined with RFID technology, it allows real-time tracking of student entry and exit along with data synchronization to dashboards using IP-based communication.

Furthermore, web-based dashboards and IoT platforms enable administrators and parents to monitor student movement remotely. These systems provide real-time updates, timestamps, and data logs, improving transparency and safety.

Based on the reviewed literature, it is evident that integrating RFID technology, ESP8266 microcontroller, and IoT-based dashboards provides a low-cost, efficient, and reliable solution for smart bus tracking and student monitoring systems. The proposed system builds upon these approaches to deliver an optimized solution for real-time transportation monitoring [1][2][3][4].

III. RESEARCH METHODOLOGY

The proposed system is designed to monitor bus movement and student entry-exit status using RFID cards, ESP8266 microcontroller, LCD display, buzzer, servo motor, and IoT communication. The methodology focuses on identification, data processing, and real-time data transmission.

A. System Design

The system consists of an RFID reader, ESP8266 microcontroller, LCD display, buzzer, servo motor, and Wi-Fi communication module. The ESP8266 acts as the central processing unit.

B. Data Acquisition

RFID cards assigned to students and buses are scanned using the RFID reader. Each card contains a unique identification number.

C. Data Processing

The ESP8266 processes the scanned card data and determines whether the user is entering or exiting based on system logic.

D. Display Unit

An I2C LCD module displays real-time information such as student and bus status, providing local monitoring.

E. Alert Mechanism

The system uses Wi-Fi communication to send data to a web-based dashboard through an IP address. A buzzer provides immediate feedback, and a servo motor controls gate operation.

IV. PROPOSED METHODOLOGY

The proposed system presents a smart and automated approach for bus tracking and student monitoring using ESP8266 and IoT technologies. The system continuously monitors student entry and exit activities and provides real-time updates.

In this methodology, RFID cards are assigned to students and buses. When a card is scanned, the RFID reader sends the data to the ESP8266 microcontroller. The controller processes the data and identifies whether the user is entering or exiting.

The ESP8266 acts as the central processing unit, updating the status of each student and bus. The system records timestamps using NTP (Network Time Protocol) to ensure accurate time synchronization.

An I2C LCD module displays real-time status locally, while a buzzer provides confirmation of successful scanning. The servo motor simulates gate control by opening and closing during entry and exit.

Additionally, the system transmits data to a web-based dashboard using HTTP communication via Wi-Fi. The dashboard, accessible through an IP address, allows remote monitoring of student movement and bus activity.

The system operates continuously without manual intervention, making it suitable for modern smart transportation systems.

WORKING PRINCIPLE

The working principle of the proposed system is based on RFID-based identification and real-time IoT communication. The system continuously monitors the scanning of RFID cards.

Initially, when a student or bus card is scanned, the RFID reader captures the unique ID and sends it to the ESP8266 microcontroller. The controller processes this data and determines whether it is an entry or exit event based on the current status.

Once processed, the system updates the status of the user and displays it on the LCD module. A buzzer is activated to indicate a successful scan, and the servo motor opens the gate for entry or exit.

Simultaneously, the system sends the data, including user type, name, status, and timestamp, to a web-based dashboard using Wi-Fi communication. The dashboard displays real-time updates, allowing remote monitoring.

This process is repeated continuously, ensuring accurate tracking and real-time updates. Thus, the system provides an efficient and automated solution for bus tracking and student monitoring.

BLOCK DIAGRAM

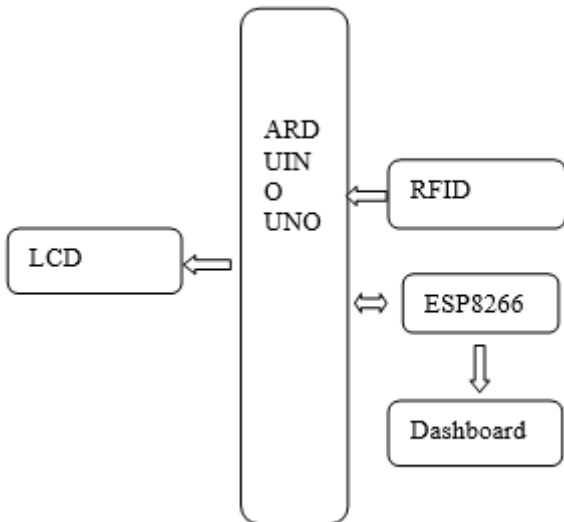


Fig. 4.1. Block Diagram

V. RESULTS AND OUTCOMES

The proposed bus tracking and student monitoring system was successfully designed and implemented using ESP8266, RFID reader, LCD display, buzzer, servo motor, and Wi-Fi communication. The system was tested under different scenarios to evaluate its performance and reliability.

Fig. 1. The RFID reader accurately detected card scans, and the ESP8266 processed the data efficiently. The LCD display provided clear real-time status updates for both buses and students..

The system successfully transmitted data to the web dashboard through an IP address, enabling real-time monitoring. The buzzer and servo motor functioned effectively, providing user interaction and gate control.

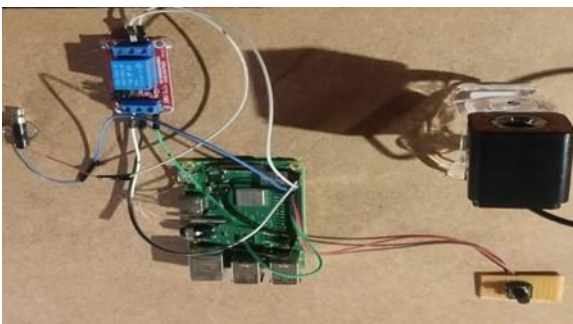


Fig. 5.1. Output 1



Fig. 5.2. Output 2

The overall performance of the system was stable, reliable, and efficient. It reduced manual effort, improved accuracy, and enhanced student safety. The results demonstrate that the system is effective for real-time transportation monitoring.

VI. CONCLUSION

The proposed Bus Tracking and Student Monitoring System using ESP8266 was successfully implemented and tested. The system effectively tracked student entry and exit and provided real-time updates through an IoT-based dashboard.

The ESP8266 microcontroller processed RFID data efficiently, and the LCD display provided clear local monitoring. The IoT functionality enabled remote access to transportation data, improving transparency and safety.

The system demonstrated reliable performance and reduced manual errors in attendance tracking. It is cost-effective and suitable for school transportation systems.

In conclusion, the proposed system offers a simple, efficient, and scalable solution for modern transportation challenges. It highlights the importance of integrating IoT and embedded systems in smart monitoring applications and can be further enhanced with GPS tracking and mobile app integration.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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