

Intelligent Bus Identification and Announcement System

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ABSTRACT

In the current bus transport system, passengers often face challenges in identifying the correct bus, which leads to inconvenience and potential safety concerns. Visually impaired individuals, in particular, rely heavily on others or memorized routes, which are not always dependable. The proposed project, titled "IoT and RFID Bus Announcement System," addresses these issues by providing real-time bus arrival information, especially aiding visually impaired users through voice announcements. The system utilizes RFID technology to detect approaching buses, an ESP32 microcontroller for processing, and an IoT-based mobile application for real-time monitoring. By integrating RFID with IoT, the system ensures passengers receive timely and accurate updates about buses, making public transport more accessible and user-friendly. It employs RFID cards and readers to identify buses and delivers output through three modes: an LCD display for visual cues, a speaker for voice alerts, and a mobile app for IoT-based notifications. This enables blind passengers to receive spoken bus details, helping them identify the correct bus independently without relying on others. Designed for use in public transportation systems, smart city infrastructure, and assistive technologies, the project offers several key benefits. These include enhanced accessibility, improved safety, and reliable real-time information. Additionally, it fosters independence and confidence among visually impaired travelers, contributing to a more efficient and inclusive transportation system.

Keywords: RFID Technology, ESP32 Microcontroller, GPS, Voice, LED.

1. INTRODUCTION

Public transportation is essential for daily travel, but most of the people face challenges in identifying buses and routes. The IoT and RFID Bus Announcement System is designed to assist them in recognizing buses efficiently. This system uses RFID (Radio Frequency Identification) technology, where each bus is assigned a unique RFID card.

LCD Display – Shows the bus details for general users.

Voice Announcement – Speaks out the bus details for visually impaired passengers. IoT Connectivity – Sends bus information to a mobile app for further accessibility.

The system operates using a Regulated Power Supply (RPS) of 230V AC to 5V DC, making it suitable for integration with public transport infrastructure. The Arduino IDE is used to program the microcontroller for processing and managing inputs and outputs. This project aims to improve accessibility, safety, and independence for visually impaired passengers, enhancing their public transport experience.

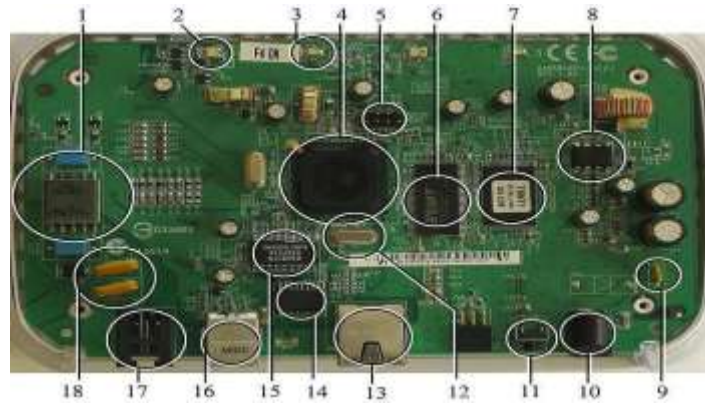


Fig. 1: A modern example of embedded system

Public transportation is one of the most essential aspects of daily life, providing mobility to millions of people worldwide. However, for people who are facing trouble of finding the correct bus and also visually impaired individuals, using public transport, especially buses, presents several challenges. Identifying the correct bus, knowing when it has arrived, and ensuring a safe and smooth journey become difficult without assistance. Most bus stops do not provide audio announcements or real-time notifications, making it difficult for passengers and also for the blind people to travel confidently. GPS-based mobile applications provide general directions, but they do not help in recognizing a specific bus at a crowded bus stop. This creates a critical need for a more reliable and automated solution that assists blind individuals in recognizing and boarding their buses independently. To address this issue, this project introduces an IoT and RFID-based Bus Announcement System designed for public. The system uses Radio Frequency Identification (RFID) technology, Internet of Things (IoT), voice assistance, and LCD displays to provide real-time bus arrival notifications.

2. LITERATURE SURVEY

Hussain, A., & Ahmed, M. [1] presents a system integrating RFID technology with GPS for real-time bus tracking and automatic stop announcements. The RFID tags placed at bus stops are read by RFID readers on the buses, allowing for accurate tracking of bus locations. GPS provides live data on the bus's precise location. The system automatically announces upcoming bus stops, improving efficiency and passenger experience. This reduces human error and ensures timely notifications for passengers, especially those unfamiliar with routes. The system also offers live updates on mobile apps or digital displays, reducing waiting times. For transportation authorities, it enables better fleet management by providing real-time monitoring of bus locations and improving operational efficiency.

Rahman, M. M., & Saha, S. [2] presents a prototype for an Automated Bus Stop Announcement System using RFID technology. The system utilizes RFID tags installed at bus stops, which are detected by an RFID reader on the bus. As the bus approaches a stop, the RFID reader identifies the tag and triggers an automatic announcement of the stop's name, providing real-time information to passengers. This system eliminates the need for manual intervention by the driver or conductor. The system also reduces the potential for human error and enhances passenger convenience by ensuring timely and consistent announcements. The integration of RFID with automatic systems streamlines bus operations and offers an innovative solution to improve public transportation management. Additionally, this system can be easily scaled to various bus fleets, making it a practical solution for transportation authorities.

Khan, S., & Shahid, S. [3] They introduced an RFID-based intelligent bus management system to manage bus routes and provide real-time passenger information. The system improves operational

efficiency by automating bus tracking, up-to-date data. By utilizing RFID for tracking buses and collecting passenger data, the system allows transportation authorities to better manage fleet operations. The proposed system enhances route optimization, reduces delays, and provides live updates to passengers, improving their overall experience.

Zhang, Y., & Liu, Q. [4] they introduced a hybrid system that integrates RFID with real-time bus data for accurate passenger announcements. The system ensures that passengers receive up-to-date travel information about bus arrivals and stops. RFID tags on bus stops communicate with the bus reader, automating announcements. The integration of real-time data minimizes delays, improving service accuracy. The system also helps with route changes and dynamic scheduling. This real-time data combination enhances communication between buses and passengers. Overall, the system streamlines operations and improves the commuter experience.

Alavi, M., & Raza, K. [5] In their case study, the authors explored the implementation of an RFID-based announcement system in a city's bus network. They assessed operational performance and cost-effectiveness of the system in a real-world setting. The system improved bus stop automation and provided real-time updates to passengers. They evaluated the integration of RFID with existing infrastructure, highlighting the challenges of cost and installation. The study showed improved passenger experience due to reliable announcements. It also showcased the system's ability to reduce human errors. The case study emphasized practical benefits and scalability.

Iqbal, S., & Ali, R. [6] his paper reviewed RFID applications for real-time bus tracking and passenger information systems. It explored both the benefits of RFID, such as improved route management, and the challenges of system integration. Issues like signal interference, cost, and tag accuracy were discussed in detail. The paper highlighted how RFID improves operational efficiency and automates bus tracking and stop announcements. The review also addressed barriers to widespread implementation, such as urban infrastructure limitations.

Patel, S. & Mehta, A. [7] Patel and Mehta focused on the user experience of RFID-powered bus systems, evaluating their efficiency and impact on passenger satisfaction. Their study showed that RFID systems reduce delays and provide more accurate communication about bus arrivals. By automating bus stop announcements, RFID technology reduces human error and enhances service reliability. The paper emphasized the importance of real-time updates for passengers, ensuring they receive timely and relevant information. RFID-powered systems also streamline fare collection and reduce operational costs. The authors concluded that RFID-based automation significantly improves commuter satisfaction and efficiency. Their study advocates for the widespread adoption of RFID in public transport.

Chandra, P. & Verma, R. [8] Chandra and Verma proposed a novel approach to improve the accuracy and reliability of RFID-based bus stop announcements. They focused on minimizing tag interference, which is a common issue that affects the system's performance. Their approach ensures that RFID tags provide accurate data for automated announcements, even in challenging environments. By optimizing the RFID system, they increased the efficiency and consistency of stop announcements. The system ensures timely and accurate communication to passengers, reducing waiting times and improving service. Their work also enhances the reliability of the bus stop automation process. The paper demonstrates how to address common RFID system challenges.

3. PROPOSED SYSTEM

IoT and RFID-based Bus Announcement System, designed to assist individuals in navigating public transport independently. The system utilizes an ESP32 microcontroller, which integrates various

components such as RFID, GPS, IoT, LCD display, and a voice module to provide real-time bus stop announcements through voice messages. At the core of the system is the ESP32 microcontroller, a powerful and energy-efficient unit with built-in Wi-Fi and Bluetooth capabilities. It acts as the central processing unit that receives input from various sensors and modules, processes the data, and triggers appropriate output responses. To ensure a stable and consistent power supply, the system uses a Regulated Power Supply (RPS), which converts the standard 230V AC into 5V DC, a suitable voltage for the ESP32 and its connected modules.

The system takes two primary inputs: RFID (Radio Frequency Identification) and GPS (Global Positioning System). The RFID module plays a crucial role in detecting bus stops by reading pre-installed RFID tags at designated locations. Each tag has a unique identification number corresponding to a specific bus stop. When the bus approaches a stop, the RFID reader scans the tag and sends the relevant data to the ESP32 microcontroller. This helps in identifying the exact location of the bus without manual intervention. In addition to RFID, the GPS module continuously tracks the bus's location by obtaining latitude and longitude coordinates. This ensures that even if an RFID tag fails to be detected, the GPS data can verify the stop's location and provide accurate updates.

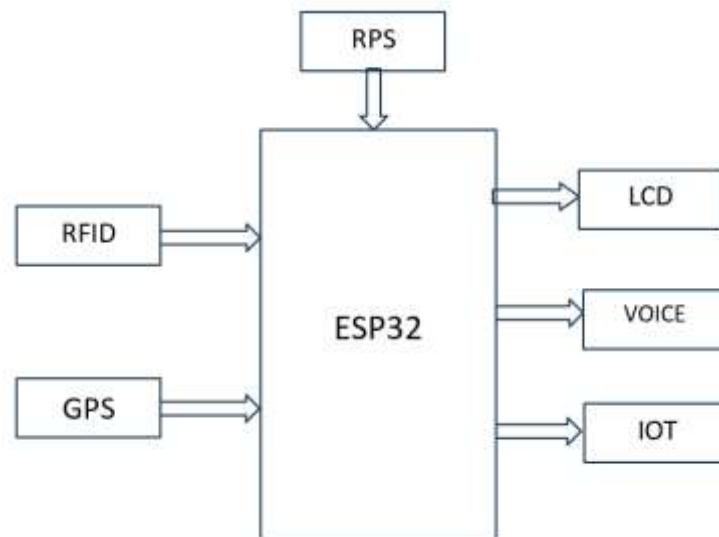


Fig. 2: BLOCK DIAGRAM

The given block diagram represents the architecture of an IoT and RFID Bus Announcement System based on the ESP32 microcontroller. This system is designed to help passengers, especially visually impaired individuals, by providing real-time bus arrival information through multiple output modes such as LCD display, voice announcement, and IoT-based mobile updates.

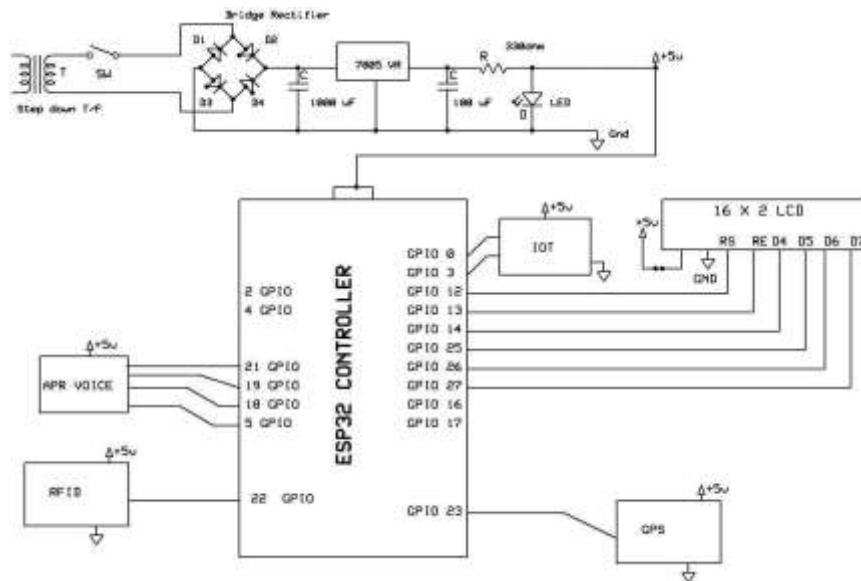


Fig. 3: SCHEMATIC DIAGRAM

The schematic diagram represents the IoT and RFID-based Bus Announcement System using an ESP32 microcontroller. The system is designed to detect buses using RFID, track their location with GPS, and provide real-time bus information through LCD display, voice announcements, and an IoT module.

ADVANTAGES

This innovative system offers significant advantages, particularly in improving accessibility for visually impaired individuals. By incorporating automated voice announcements, it enables blind passengers to navigate public transport independently without needing assistance, ensuring they can recognize their stops with ease. One of the key features of the system is real-time bus stop announcements, made possible through a combination of RFID-based location detection and GPS tracking. This dual approach ensures accurate, timely updates and reduces the risk of passengers missing their stops. The system also employs a multi-mode notification strategy, offering voice announcements via speakers for the visually impaired, LCD display notifications for passengers who prefer reading text, and IoT-based mobile alerts through a smartphone app. This inclusivity ensures the system caters to diverse passenger needs.

Moreover, the integration of RFID and GPS enhances the system's accuracy. RFID tags provide precise stop detection, while GPS acts as a backup to confirm the bus's location if RFID fails. The automated nature of the system significantly reduces human dependency by eliminating the need for manual stop announcements, thereby minimizing errors and ensuring consistent, timely information delivery. It is also designed to be cost-effective and scalable. The use of the ESP32 microcontroller, known for its affordability and energy efficiency, along with inexpensive RFID tags, makes the system suitable for widespread deployment across large transport networks.

4. RESULTS AND DISCUSSION

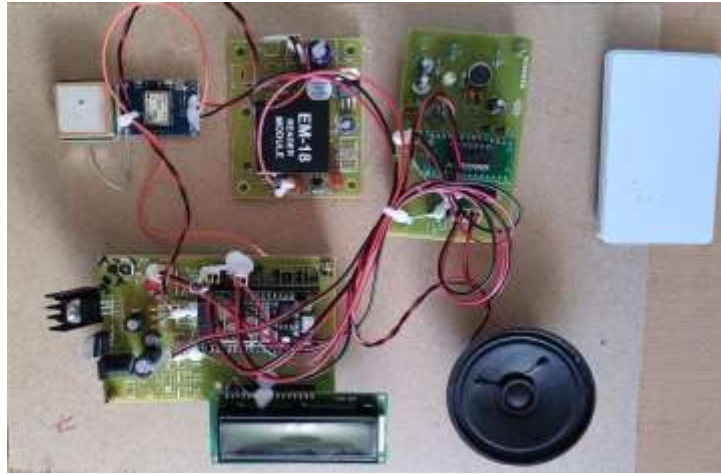


Fig. 4: This is the final view of the project

Fig 4 shows the final assembled view of the IoT and RFID-Based Bus Announcement System. It includes key components such as the ESP32 microcontroller, RFID reader, LCD display, speaker, and power supply, all integrated on a compact board. The setup demonstrates how real-time bus detection and multi-mode announcements are delivered. This final model is ready for implementation in a real-world transport environment.



Fig. 5: This image shows an RFID-based bus announcement system in the 16x2 LCD display.

Fig. 5 illustrates the RFID-based bus announcement system displaying bus information on a 16x2 LCD screen. When the RFID reader detects a tagged bus, the corresponding bus details are shown on the display in real time. This feature assists passengers, especially those who can read text, by providing clear and immediate visual updates about the arriving bus.

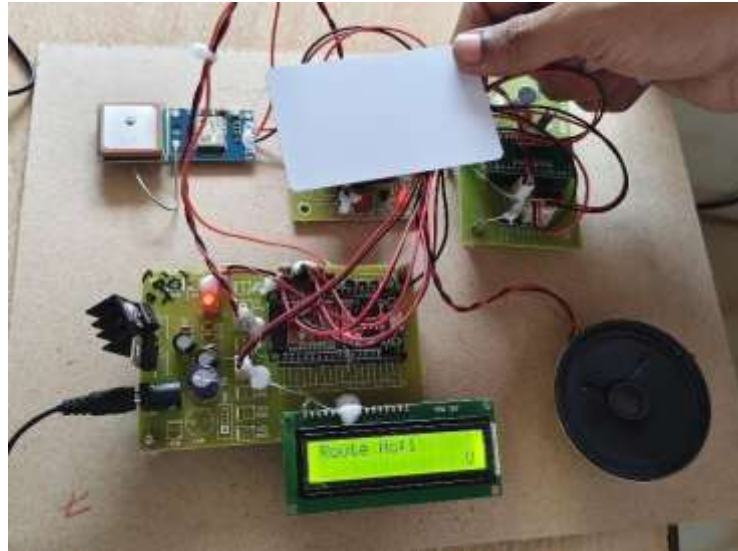


Fig. 6: RFID card scanning through EM-18 reader

Fig. 6 shows the process of scanning an RFID card using the EM-18 reader. When the RFID card is brought near the reader, it detects the unique ID encoded on the card. This identification triggers the system to recognize the corresponding bus and initiate the announcement and display functions.

Sl. No	Route	Location	Date	Time
1	Route_No_1	Location	Location	2025-03-21 10:01:34
2	Route_No_1	Location	Location	2025-03-21 10:04:43
3	Route_No_1	Location	Location	2025-03-21 10:05:13
4	Invalid	Location	Location	2025-03-19 14:19:28
5	Route_No_2	Location	Location	2025-03-19 14:19:42
6	Route_No_3	Location	Location	2025-03-19 14:19:26
7	Route_No_4	Location	Location	2025-03-19 14:19:18
8	Route_No_1	Location	Location	2025-03-19 14:19:52
9	Route_No_2	Location	Location	2025-03-19 14:19:44
10	Route_No_4	Location	Location	2025-03-19 14:19:30
11	Route_No_5	Location	Location	2025-03-19 14:18:22
12	Route_No_1	Location	Location	2025-03-19 14:19:02
13	Route_No_3	Location	Location	2025-03-19 14:18:14
14	Route_No_3	Location	Location	2025-03-19 14:17:46
15	Route_No_1	Location	Location	2025-03-19 14:17:11
16	Route_No_4	Location	Location	2025-03-19 14:06:51
17	Route_No_2	Location	Location	2025-03-19 14:06:25
18	Invalid	Location	Location	2025-03-19 14:06:09
19	Route_No_1	Location	Location	2025-03-19 15:39:29
20	Route_No_4	Location	Location	2025-03-19 15:39:11

Fig. 7: The bus location or the route no. are uploaded in the server by using GPS tracker through IoT module

Fig. 7 depicts the uploading of the bus location or route number to the server using a GPS tracker integrated with an IoT module. The GPS continuously tracks the real-time position of the bus, while the IoT module transmits this data to the server. This enables passengers to access live updates about bus locations and route information through a connected mobile application or web interface.

5. CONCLUSION

The IoT and RFID based Bus Announcement System effectively enhances public transportation by addressing the challenges passengers face in identifying the correct bus. By integrating RFID

technology, an ESP-32 microcontroller, and an IoT-based mobile application, the system provides real-time bus arrival updates through voice announcements and an LCD display. This ensures accessibility for both regular commuters and visually impaired individuals, reducing dependence on others and increasing travel confidence. With its ability to detect buses using RFID cards and readers, the system improves safety and efficiency in public transportation. The combination of IoT and assistive technology makes it a valuable addition to smart city infrastructure, offering a more inclusive and intelligent commuting experience. By providing real-time bus information through multiple outputs, this project significantly enhances accessibility, making public transport more convenient and reliable for all passengers.

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