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RFID Based Prepaid and Entry, Exit System for Metro Station

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ABSTRACT: This project presents an innovative RFID-based entry and exit system for metro stations, offering a contactless and IoT-enhanced alternative to traditional ticketing methods. The system integrates a Node MCU with an RFID scanner, buzzer, and servo motor to automate the process of verifying commuter credentials, checking balances, and managing gate access. Upon scanning their RFID card, commuters' information is validated via a Wi-Fi connection, allowing for real-time balance updates and enabling online recharging. The gate opens only when sufficient balance is detected, with a buzzer providing auditory confirmation of successful transactions. This fully automated system significantly reduces the need for manual intervention, particularly during high-traffic periods, while enhancing security by preventing unauthorized access through user authentication protocols. The project addresses critical issues such as long queues, fare inconsistencies, and system inefficiencies, offering a scalable and streamlined solution to metro fare collection. By optimizing passenger throughput and reducing the operational costs associated with traditional ticketing systems, this project provides a modern and future-proof solution to metro station management.

I. INTRODUCTION

Metro systems around the world face persistent inefficiencies in fare collection, particularly during peak hours, where outdated ticketing methods lead to long queues, slow processing times, and operational bottlenecks. Traditional systems, relying on paper tickets, magnetic stripe cards, or tokens, often result in delays, human errors, and increased maintenance costs. This project proposes an RFID-based entry and exit system that leverages IoT technology to address these challenges by automating fare collection and improving operational efficiency. By integrating RFID cards with a Node MCU microcontroller and Wi-Fi connectivity, the system enables real-time balance verification and remote account management, offering a faster, more convenient, and contactless alternative to physical tickets.

When passengers scan their RFID cards, the system instantly checks their balance online, opens the gate if sufficient funds are available, and deducts the appropriate fare. A web-based recharge feature allows users to top up their accounts remotely, eliminating the need for physical kiosks. This automation not only reduces wait times and manual intervention but also enhances the security and reliability of metro operations. Furthermore, by collecting real-time data on commuter behavior, such as peak usage times and traffic patterns, the system provides valuable insights that can help metro authorities optimize resource allocation and introduce dynamic fare pricing.

In addition to solving the inefficiencies of traditional fare collection methods, this RFID-based system is designed to be scalable and adaptable to various applications beyond metro stations, including bus terminals, airports, parking lots, and amusement parks. The project focuses on creating a cost-effective, future-ready solution that can streamline access control across a range of public transport and commercial sectors. Key performance metrics such as transaction time, balance accuracy, system uptime, security, and user experience will be evaluated to ensure that the system meets the demands of high-traffic environments while offering a modern, efficient alternative to legacy fare collection systems.

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II. LITERATURE SURVEY

The integration of RFID (Radio-Frequency Identification) technology with IoT (Internet of Things) solutions has significantly advanced fare collection and access control in metro systems, addressing inefficiencies such as long wait times, manual errors, and operational delays seen in traditional ticketing methods. RFID-based systems, when coupled with microcontrollers and IoT networks, offer automated fare transactions and optimized passenger flow, reducing congestion and improving throughput, as demonstrated by Yang et al. (2019). These systems, through contactless RFID tags embedded in smart cards, enhance transaction speed, reduce errors and fraud, and have proven effective in reducing manual discrepancies, as shown in Seoul's metro network by Lee et al. (2020). Further innovations, such as integrating RFID with servo motors for automated gate control, streamline operations and minimize human error, according to Zhang et al. (2021). IoT-enabled real-time data collection provides valuable insights into passenger behavior and system performance, allowing for better operational decisions. Additionally, the use of mobile technology for remote fare management has improved user convenience and satisfaction, with Kumar et al. (2024) noting the benefits of features like remote card recharging. However, challenges remain in scalability, security, and infrastructure integration, which are crucial for expanding urban transit networks. This project seeks to develop a scalable, RFID-based entry and exit system that integrates IoT technology, addressing these challenges to enhance efficiency, reliability, and the overall transit experience in modern metro stations.

Existing Systems

Most current metro fare collection systems rely on outdated mechanisms such as paper tickets, magnetic stripe cards, and tokens. Although some have adopted smart cards, these systems still require manual recharging processes, typically done at kiosks or through customer service, especially for issues like lost or damaged cards. Additionally, many existing systems do not offer real-time balance updates, which forces passengers to physically check and recharge their accounts at station kiosks, adding to delays and inconvenience.

Furthermore, metro systems that have adopted RFID technology for entry and exit often do not integrate advanced IoT functionalities. They may not be connected to real-time databases or a centralized platform, meaning passenger balances are not updated instantly after transactions. Many of these systems also require significant infrastructure and operational support, making them expensive and difficult to scale as metro networks expand.

Proposed System

Our project aims to overcome the limitations of existing systems by developing a cost-effective, real-time, and scalable RFID-based entry and exit solution for metro stations. The proposed system will use RFID technology integrated with IoT capabilities, specifically Wi-Fi connectivity and cloud-based data management, to provide seamless real-time updates of passenger balances. This eliminates the need for physical kiosks and manual processes, allowing passengers to remotely recharge their balances through an online platform. Additionally, the system will reduce operational costs and enhance scalability, making it suitable for expanding metro networks while maintaining efficiency and reliability.

III. METHODOLOGY

The RFID-based prepaid entry and exit system automates access control and fare deduction processes for metro stations or similar environments. It integrates RFID technology with a web platform, allowing users to recharge and manage their balances online. The system is divided into two main subsystems: the Recharge System and the Entry/Exit System, both managed by an ESP32 microcontroller and connected through NodeMCU to a web-based platform.

1. Recharge System

The Recharge System allows users to add funds to their RFID cards through a web platform. The following steps describe the recharge process:

1. RFID Card Scanning

- The user presents their RFID card to the Recharge RFID Reader, which reads the card's unique ID.
- The RFID Reader transmits the scanned data (card ID) to the ESP32 via the NodeMCU for further processing.

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1.2 Web-Based Balance Recharge

- The user accesses the web platform, connected via Wi-Fi, where they input the amount they wish to recharge.
- The ESP32 receives this information and updates the user's balance in the database based on the unique RFID card ID.
- All transactions are synchronized between the ESP32 and the web platform, ensuring real-time balance updates.

1.3 Real-Time Feedback via Web Platform

- Upon a successful recharge, the updated balance is immediately reflected on the web platform, eliminating the need for a physical display at the recharge station.
- If there is a failure (e.g., network issues or incorrect input), the web platform notifies the user in real-time.

2. Entry/Exit System

The Entry/Exit System manages the access control for gates, ensuring that users can only pass through if they have sufficient balance. The system deducts the correct fare from their balance as they enter or exit.

2.1 RFID Card Scanning

- The user presents their RFID card to the Entry/Exit RFID Reader at the gate.
- The RFID Reader sends the card ID to the ESP32, which checks the balance in the system database through the web platform.

2.2 Balance Verification and Deduction

- The ESP32 verifies the current balance of the cardholder by querying the web platform database.
- If the balance is sufficient, the ESP32 deducts the fare. The deducted balance is immediately updated on the web platform.
- If the balance is insufficient, the system denies access, and the user is notified via the web platform.

2.3 Gate Control and Monitoring

- Upon successful balance verification, the ESP32 sends a signal to the servo motor, which opens the gate, allowing the user to pass.
- If access is denied, the gate remains closed, and LED indicators (green for successful entry, red for denied access) provide visual feedback.

2.4 IR Sensors for Entry/Exit Monitoring

- Infrared (IR) sensors detect the user's movement through the gate. Once the user passes, the IR sensor informs the ESP32 to close the gate, ensuring controlled and timed access.

2.5 Web-Based Notifications

- The entire process, including fare deduction and gate access, is logged on the web platform. The user can view their updated balance and transaction history online, ensuring transparency.

3. Central Communication and Web Integration

The ESP32, along with NodeMCU, handles all communication between the RFID readers, sensors, and web platform via Wi-Fi. This allows for seamless real-time data flow and system synchronization.

3.1 Wi-Fi Connectivity

- The NodeMCU establishes a Wi-Fi connection between the hardware (ESP32, RFID readers, etc.) and the web platform.
- All user data, such as card balances, recharge history, and fare deductions, is stored and retrieved from the web platform's database through Wi-Fi communication.

3.2 Web Platform Role

- The web platform serves as the central interface for users to recharge balances, view transaction history, and monitor their account status.
- It also acts as a management tool for administrators to track user activity, system errors, and perform maintenance when necessary.

4. System Data Flow

1. Card Scanning: The user scans their RFID card at the recharge station or entry/exit point.
2. Data Transmission: The RFID readers send card data to the ESP32, which communicates with the web platform over Wi-Fi via NodeMCU.

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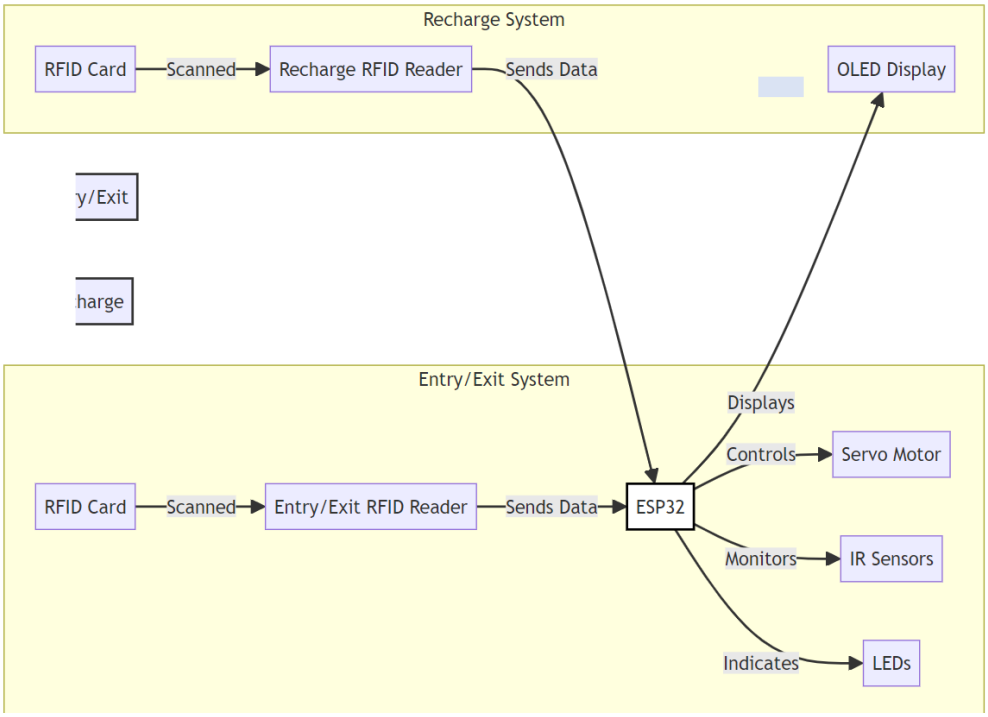
3. Processing: The web platform updates and checks balances, sends fare deduction confirmation, or denies access if needed.
4. User Feedback: Real-time updates are shown on the web platform, and gate status is indicated via LEDs and servo motor control at the gates.
5. Completion: Upon successful entry/exit, IR sensors close the gate, and the system resets for the next user.

5. Conclusion

The RFID-based prepaid entry and exit system efficiently manages access control and fare collection using RFID technology and a web platform for real-time updates. By connecting the system through Wi-Fi, it offers users remote access to recharge and monitor their balances while automating the gate operation at metro stations. This design eliminates the need for physical displays by leveraging the web platform for user interaction, allowing the system to scale and provide a smooth, automated experience.

6. Block diagram



IV. RESULTS AND DISCUSSION

The RFID-based prepaid entry and exit system successfully streamlines access control and balance management by integrating RFID technology with a web-based interface. Using an RFID reader and an ESP8266 microcontroller, the system authenticates users and checks their balance in real time before granting access based on predefined conditions. This automation minimizes manual intervention, enhances security, and ensures that only authorized users with sufficient balances can enter. The incorporation of a web interface allows users to check and recharge their balances through mobile devices or PCs, making account management more accessible. The user-friendly HTML pages, served by the ESP8266, guide users through login, balance checks, and recharges, creating a seamless experience for both users and administrators.

Technically, the system demonstrates effective integration of components like the MFRC522 RFID module, servo motor, and LEDs, all controlled through code written in the Arduino IDE. The servo motor operates precisely,

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controlling the gate based on the system's verification results, while LEDs and a buzzer provide immediate feedback during RFID scans, enhancing user interaction. Overall, the project showcases how IoT and web technologies can be combined to address challenges in access control, offering a practical and scalable solution that improves both security and convenience in a variety of applications.

Software implementation

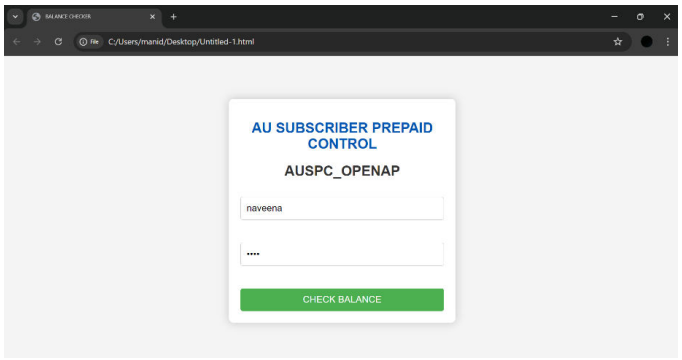


Fig 5.0.1 USER LOGIN

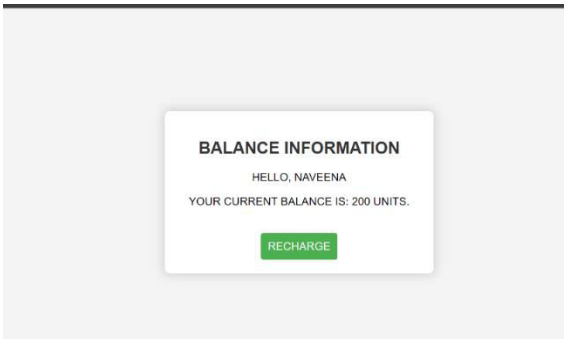
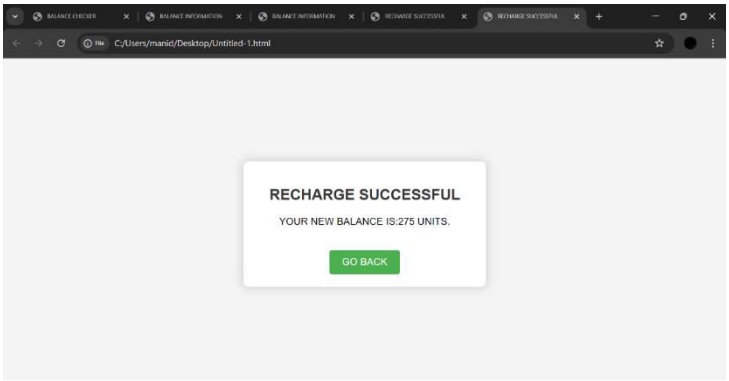


Fig 5.0.2 BALANCE INFORMATION

Fig 5.0.3 RECHARGE PORTAL



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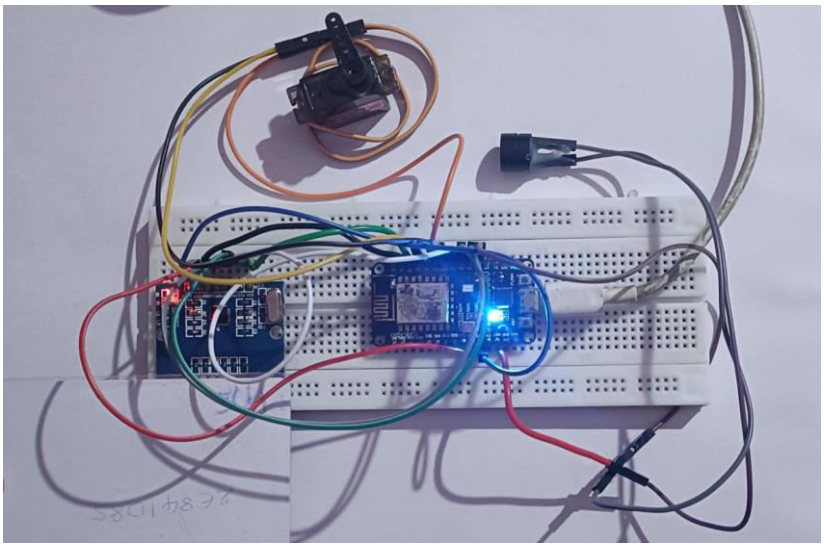
Hardware implementation

Fig 5.0.4 Working Model



REFERENCES

Text Books:
1. RFID Handbook: Fundamentals and Applications in Contactless Smart Cards, Radio Frequency Identification, and Near-Field Communication – Klaus Finkenzeller
2. The Internet of Things: Key Applications and Protocols – Olivier Hersent, David Boswarthick, Omar Elloumi
3. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things – David Hanes, Gonzalo Salgueiro
4. Microcontroller-Based Projects: Embedded Systems and Applications – Dogan Ibrahim
5. Learning the ESP8266: IoT with NodeMCU and Arduino IDE – Kolban

Journals:
1. Yang, L., & Wang, J. (2019). RFID-enabled smart metro systems: Enhancing access control and fare management. *IEEE Transactions on Intelligent Transportation Systems*.
2. Lee, J., Kim, S., & Park, H. (2020). Enhancing urban transit efficiency with IoT and RFID technology. *Journal of Transportation and Smart Mobility*.
3. Zhang, Y., Li, K., & Xu, M. (2021). Automation in metro systems: Integrating RFID with IoT for smart entry/exit. *Journal of Automation and Control Engineering*.
4. Kumar, R., & Singh, M. (2024). Mobile integration in RFID-based fare systems: Impact on user experience. *International Journal of IoT Applications*.

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