AUTOMATIC BUS FARE COLLECTION SYSTEM WITH LOACTION TRACKING AND SAFETY ALERTS

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Keywords:

Automated ticketing, Smart transport, Fare deduction, GPS tracking, Bus route optimization, Passenger safety, Environmental sustainability,

Introduction:

Public transportation systems typically rely on conductors using paper tickets or handheld electronic devices to manage fare collection. While functional, these methods often lack efficiency and can be inaccessible to those who are visually impaired. Navigating the ticketing process, understanding routes, and requesting assistance without visual cues can be highly challenging, limiting their ability to travel independently.

To overcome these barriers, this project proposes a smart, accessible ticketing system designed to enhance the public transport experience for all users, with special consideration for the visually impaired. The system is powered by a Raspberry Pi Pico, and incorporates RFID technology to enable contactless ticketing and easy passenger identification. In addition, GPS is used for real-time location tracking, while a GSM module provides SMS-based updates and emergency notifications, ensuring that essential information reaches passengers and caregivers promptly

Objectives:

- Automate fare collection to improve efficiency, reduce boarding time, and minimize manual effort.
- Enhance passenger experience with cashless payments, real-time updates, and increased security.
- Enable data-driven decisions by analysing passenger travel patterns.
- Promote sustainability by eliminating paper tickets and supporting eco-friendly transport practices.
- Use GPS for live vehicle tracking, optimizing routes, ensuring safety, and providing passengers with accurate arrival times and location updates.

Methodology:

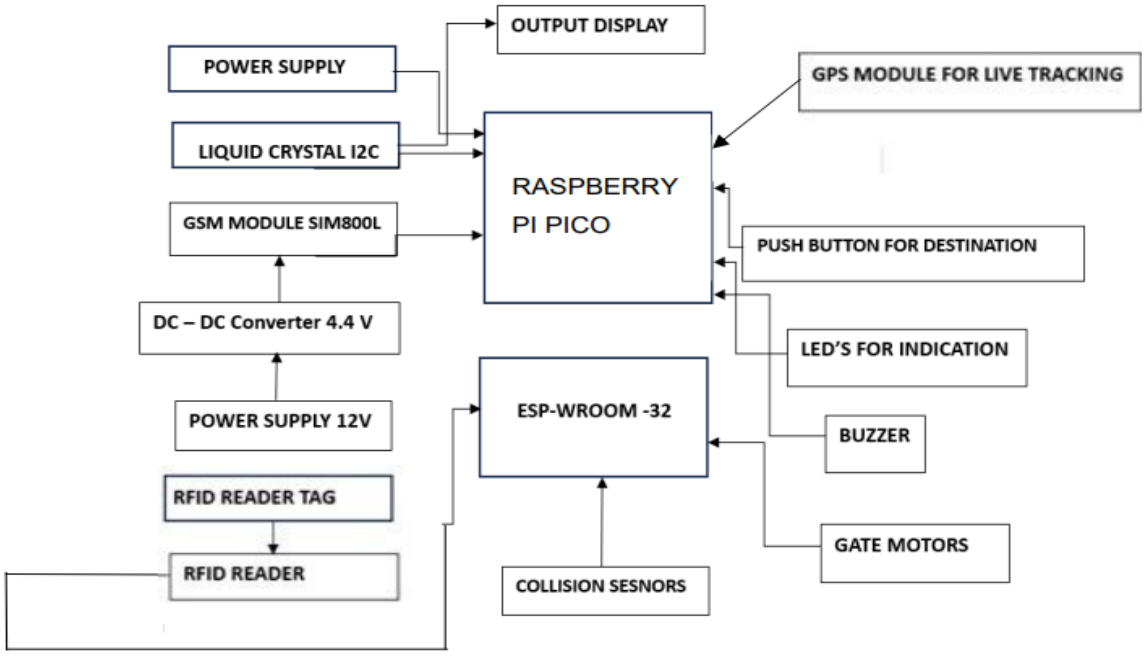


Fig Block diagram of Automated bus fare collection system

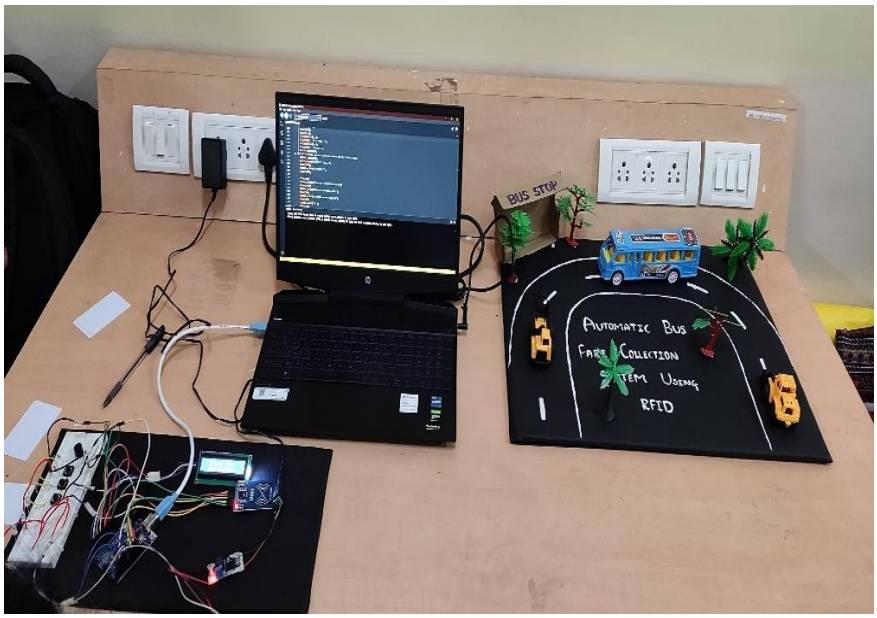
The automatic bus fare collection system with location tracking and safety alerts, powered by Raspberry Pi, integrates RFID/NFC technologies for seamless fare payments, GPS for real-time vehicle tracking, and safety mechanisms for enhanced security. Passengers use RFID cards or mobile apps to automatically pay fares, which

are deducted based on the distance or predefined zones, with the transaction details displayed on an LCD screen. The GPS module provides live location updates, allowing passengers and operators to track the bus's route and estimated arrival times. Safety alerts are triggered by panic buttons or sensors installed on the bus, sending emergency notifications via SMS or email to authorities and passengers. The Raspberry Pi serves as the central processing unit, managing communication between the hardware components, fare calculations, location tracking, and safety alerts, ensuring efficient operation and improved passenger experience. This system not only streamlines fare collection but also enhances security and provides real-time updates, contributing to a more efficient, safer, and eco-friendly public transportation solution.

Result and Conclusion:

Result

The developed system streamlines fare collection in public transport by leveraging RFID technology, GPS tracking, and integrated safety features such as panic buttons and sensors. Powered by Raspberry Pi, the system ensures smooth coordination between hardware components, enabling real-time bus monitoring, automated fare deduction, and instant status updates. This enhances overall transit efficiency and passenger convenience.



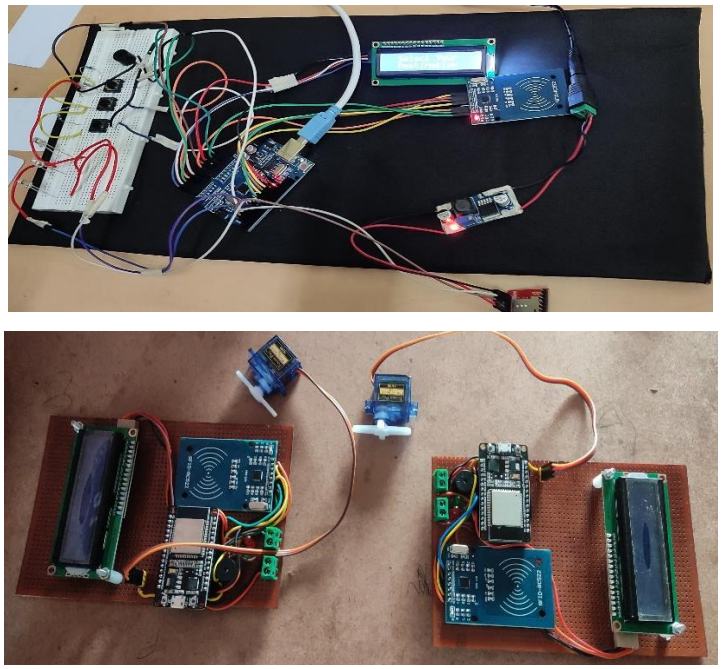


Fig Images of execution of project

Conclusion

This automated fare collection solution represents a significant advancement in smart public transportation. By integrating RFID-based ticketing, GPS-based tracking, and onboard safety mechanisms, it offers a secure, efficient, and eco-conscious mode of travel. The system supports operational improvements while contributing to a safer and more sustainable commuting experience.

Project Outcome & Industry Relevance:

The bus automation project holds significant practical implications by integrating modern technologies such as RFID/NFC, GPS, and IoT to create a smarter and more efficient public transportation system. Through automated fare collection, it ensures seamless and contactless ticketing, reducing dependency on manual processes and minimizing human errors. The inclusion of real-time GPS tracking empowers both passengers and operators with live location updates, enhancing travel planning, safety, and operational transparency. By applying embedded systems principles using Raspberry Pi, sensors, and serial communication, the project provides a hands-on platform for students and professionals to understand the real-world functionality of intelligent systems. In industry, such systems are already being adopted by

metropolitan transit authorities and can be further expanded to integrate with broader urban mobility networks, enhancing the efficiency, accessibility, and sustainability of public transportation.

Working Model vs. Simulation/Study:

The project is centred around the development of a fully functional physical working model, not a simulation or theoretical concept. Utilizing real-time embedded systems and IoT hardware, including Raspberry Pi, RFID/NFC readers, GPS and GSM modules, the model demonstrates complete system behaviour in a live environment

Key operations such as automated fare deduction, GPS-based live location tracking, emergency alert triggering via GSM, and LCD-based user feedback were physically implemented and tested. This hands-on prototype validates system feasibility and performance in real-world conditions. The practical deployment of sensors, communication interfaces, and real-time data handling showcases a comprehensive integration of hardware and software, confirming the system's readiness for industry-level application beyond academic simulation.

Project Outcomes and Learnings:

Project Outcomes:

- Successfully implemented an integrated fare collection and passenger safety system using Raspberry Pi, combining RFID/NFC, GPS, and GSM modules.
- Achieved real-time fare deduction based on distance and verified live location tracking with dynamic SMS alerts for emergencies.
- Established a secure, contactless, and paperless ticketing mechanism to minimize fraud and enhance user experience.
- Enabled backend data collection for fare trends, passenger movement patterns, and system diagnostics.
- Created a user interface using LCD display and keypad to enhance interaction between passengers and the embedded system.

Project Learnings:

- Gained hands-on expertise in integrating and programming peripheral modules (RFID, GPS, GSM) with Raspberry Pi via Python and GPIO control.
- Learned to handle real-time communication protocols and asynchronous data processing from hardware devices.
- Developed critical problem-solving and debugging skills in both hardware interfacing and software logic.
- Explored the challenges of implementing secure and scalable IoT systems for real-world transportation use cases.
- Built awareness of industry standards for public safety, smart mobility, and intelligent transport infrastructure.

Future Scope:

The future scope of this project includes:

1. The future of the Automatic Bus Fare Collection System will incorporate advanced technologies to enhance efficiency and passenger experience.
2. Biometric authentication, such as facial recognition, can replace RFID cards for secure and seamless boarding.
3. AI-powered demand analysis will help optimize bus routes and schedules, reducing congestion and wait times.
4. Renewable energy integration, such as solar-powered ticketing systems, will promote sustainability.
5. Enhanced real-time communication between buses and traffic control systems will improve traffic flow and reduce delays.
6. These innovations will lead to a smarter, more secure, and eco-friendly public transportation system.