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TRANSPORTATION INFO MANAGEMENT SYSTEM AND SMART BUS ATTENDANCE SYSTEM USING RFID & GOOGLE FIREBASE

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ABSTRACT

This paper presents the development of a Smart Bus Attendance and Transportation Management System using RFID technology and Google Firebase that streamlines student transportation management in educational institutions. Traditional manual attendance systems are prone to errors and inefficiencies; our proposed solution offers real-time attendance logging, automated E-Pass generation, and centralized data access for students and administrators. Each student carries an RFID tag scanned at boarding and exiting, with the data instantly stored and updated in Firebase. The integration of bar-code scanning enhances identity verification, while the dashboard allows route analysis, performance monitoring, and secure data retrieval. Designed with scalability and usability in mind, the system supports both mobile and web access, ensuring better communication, reduced administrative workload, and increased transport security. This solution represents a modern, cost-effective approach to automate student transportation, enabling data-driven decisions and improving overall operational efficiency.

Keywords: RFID Technology, Google Firebase, Real-Time Monitoring, ESP32 Micro-controller, Cloud-Based Attendance System.

INTRODUCTION

With the growing student population in educational institutions, managing transportation efficiently has become a critical challenge. Traditional methods like paper-based attendance and static transport schedules are prone to human error, inefficiency, and lack of real-time data. These limitations often result in delays, miscommunication, and inaccurate records, compromising student safety and operational effectiveness.

This project introduces an **automated, real-time transport management system** that leverages **RFID technology** and **Google Firebase** to address these issues. Each student is issued an RFID card, which is scanned when boarding or exiting a bus. The data is immediately uploaded to the cloud, enabling real-time access by administrators and parents, thus enhancing transparency and safety.

A centralized web dashboard allows administrators to monitor student attendance in real-time, with features like route and stop information, instant alerts regarding changes or delays, and automated E-Pass generation. By replacing physical passes with digital ones, the system reduces paperwork and administrative load.

Firebase's cloud-based database ensures high data accuracy, security, and scalability. This solution aims to modernize educational transport services by eliminating manual intervention, improving student security, and enabling data-driven decisions for route optimization and scheduling.

METHODOLOGY

This section describes the step-by-step methodology adopted for the development of the **Transportation Information Management System and Smart Bus Attendance System**. The system integrates RFID-based hardware with a web-based application and Firebase cloud services to provide real-time attendance tracking and data management.

A. Frontend Development

The front-end of the system was developed using React.js to build a responsive and dynamic user interface for administrators. Tailwind CSS was used for styling, enabling a clean and modern UI design. The admin dashboard allows users to view student information, attendance records, and access logs in real-time.

B. Backend and Cloud Integration

Google Firebase Real-time Database was used as the back-end for storing student details and attendance records. The Firebase API enabled seamless real-time data synchronization between the ESP32 micro-controller (hardware) and the front-end web application. Firebase also ensures secure, scalable cloud storage and fast data retrieval.

C. RFID-Based Attendance System

The hardware implementation included an RC522 RFID reader module interfaced with an ESP32 microcontroller. Each student is assigned a unique RFID card (UID). When scanned, the ESP32 reads the UID and matches it against pre-registered student data. Upon successful validation, attendance data is pushed to Firebase via Wi-Fi.

The system uses the **SPI communication protocol** for RFID-to-ESP32 interfacing and **Wi-Fi libraries** for network connectivity. The entire process is programmed using the **Arduino IDE**, with libraries such as MFRC522.h, WiFi.h, and FirebaseESP32.h.

D. Admin Dashboard and Data Management

The React-based admin panel fetches and displays real-time data from Firebase. It offers features such as:

- Viewing daily attendance logs
- Filtering by student or date
- Adding or deleting student profiles
- Monitoring live scan records.

E. Testing and Integration

Each module—front-end, back-end, and hardware—was initially tested in isolation to ensure functionality. Integration testing followed to verify seamless communication between hardware, Firebase, and the React frontend. The system was validated through multiple test scenarios, such as scanning valid/invalid RFID cards, testing network delays, and observing data synchronization

SYSTEM ARCHITECTURE AND IMPLEMENTATION

The proposed system follows a client-server architecture integrating both hardware and web components. It consists of three major modules: RFID-based attendance hardware, Firebase real-time database, and a web-based dashboard.

The **hardware module** includes an **ESP32 micro-controller** connected to an **RFID reader**. When a student taps their RFID card, the ESP32 reads the card's UID and sends it to Firebase using Wi-Fi. This enables real-time attendance marking without manual intervention.

The **Firebase** cloud back-end stores attendance data and manages student information securely. It ensures real-time synchronization between the hardware and the web interface.

Fig 1:RFID based hardware setup with ESP32

The **frontend** is developed using **HTML, CSS, and JavaScript**, providing a clean and responsive interface for administrators to view attendance, student profiles, and generate E-Passes. The **backend logic** and data retrieval are handled through **Firebase SDKs**, ensuring seamless data access and updates.This architecture ensures automation, scalability, and real-time data access across the system.

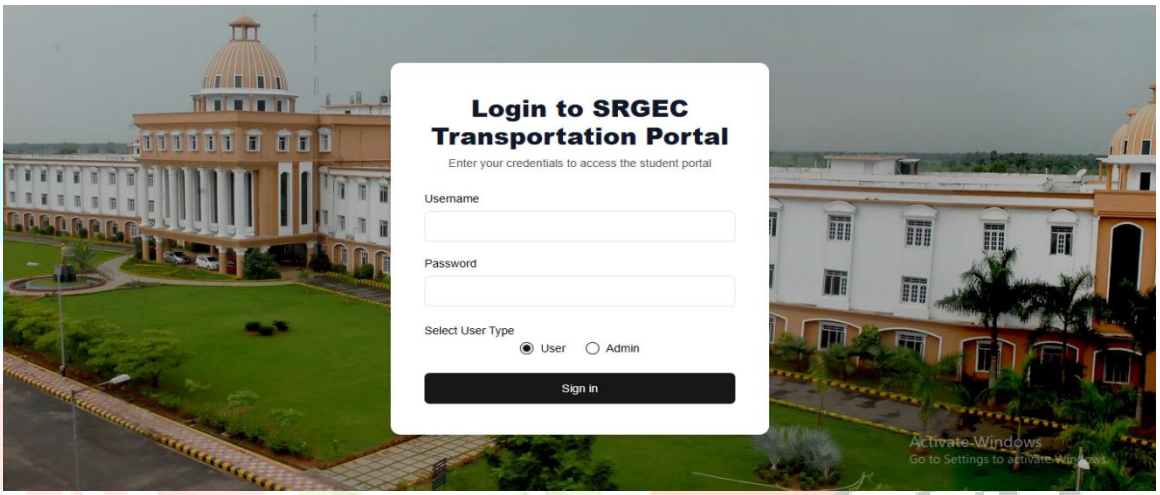


Fig 2: Login Page

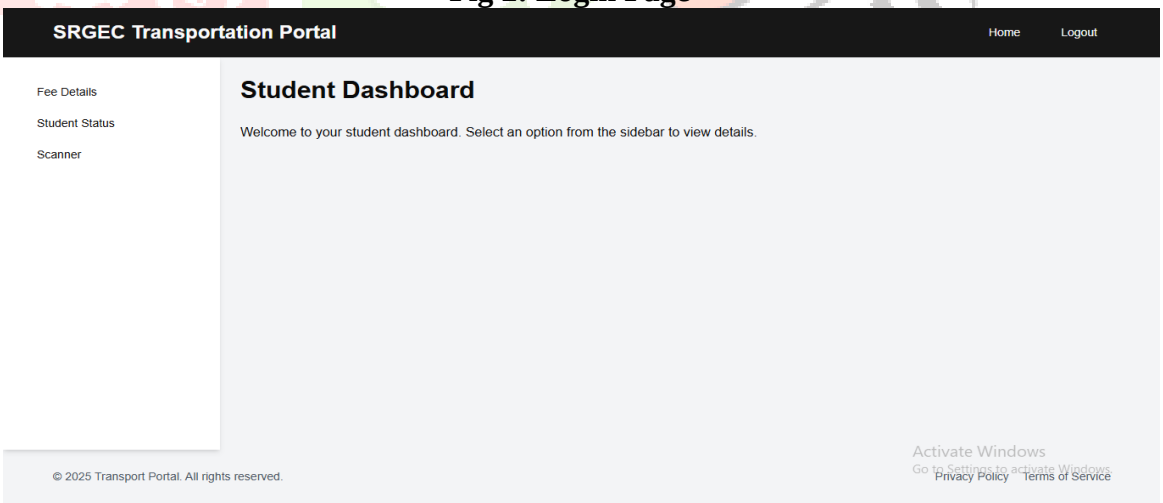


Fig 3: Student Dashboard

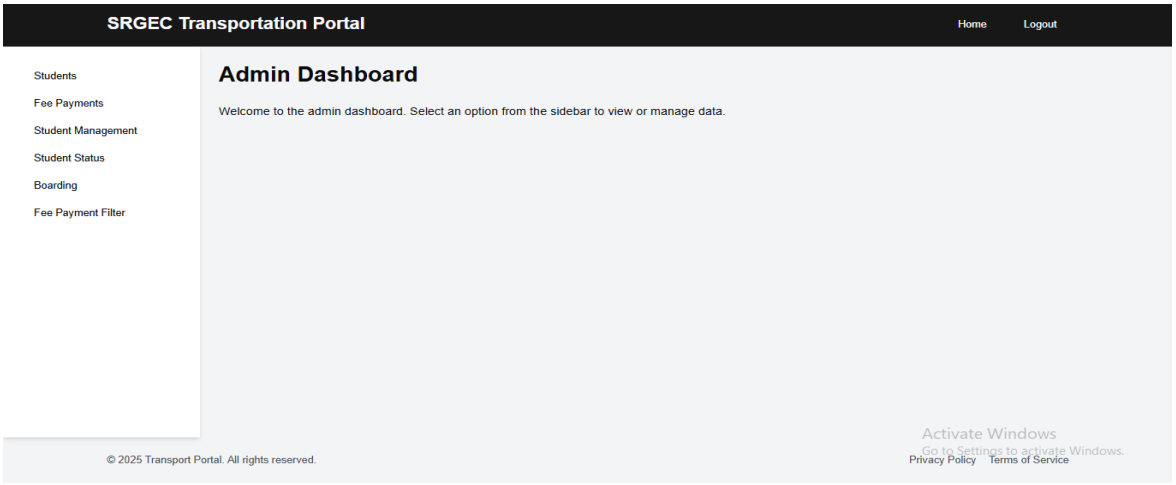
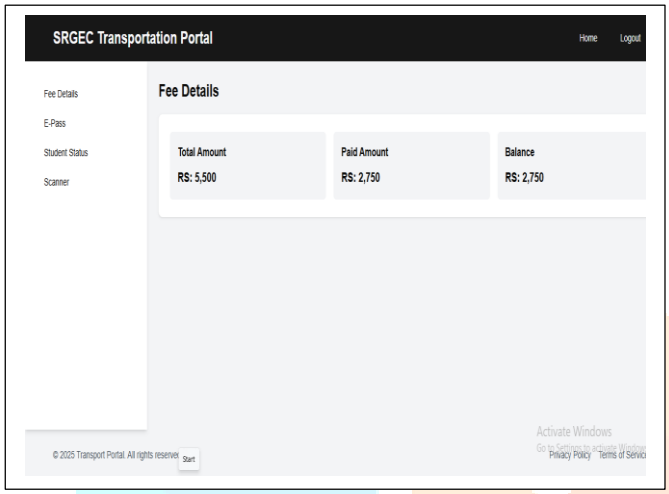


Fig 4: Admin Dashboard



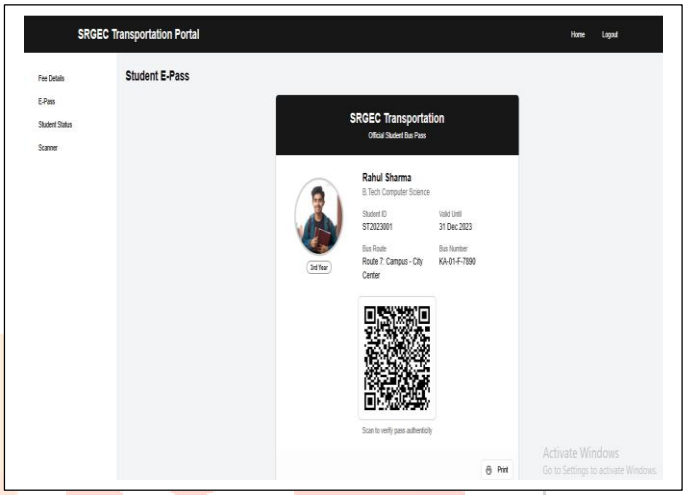


Fig 5-6: Student fee status & E-Pass view

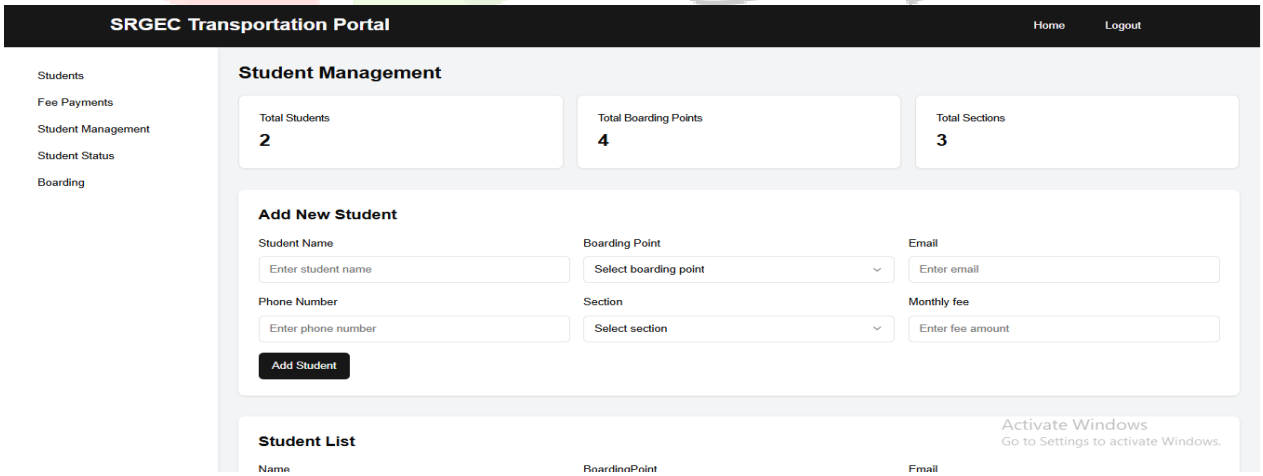


Fig 7: Admin login students page

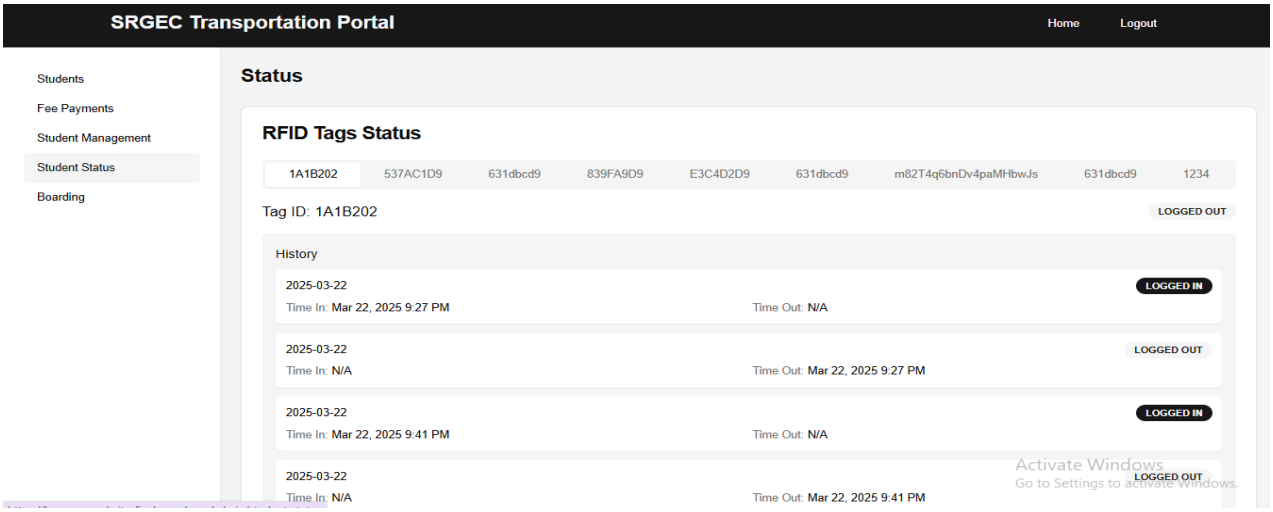


Fig 8: Admin dashboard showing student check-in logs

CONCLUSION

This system effectively modernizes student transport management by integrating RFID technology with Google Firebase to automate and digitize attendance processes. It eliminates manual errors, enhances data accuracy, and reduces administrative workload through real-time synchronization of attendance records and cloud-based data storage. The web interface allows administrators to manage student profiles, update schedules, and generate digital E-Passes with ease, ensuring both security and efficiency. Role-based access control and encryption techniques safeguard sensitive data, while testing confirmed the system's high reliability and scalability. By streamlining operations and ensuring accurate attendance logging, this solution provides a robust, scalable, and secure framework for improving student transportation systems in educational institutions.

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