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Automatic Fare Collection System for Railway Transportation

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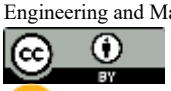

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Abstract— The Automatic Fare Collection System (AFCS) for Railway Transportation is a smart and efficient ticketing solution designed to automate the fare collection process in railway networks. Traditional ticketing methods often lead to long queues, manual errors, ticket fraud, and increased operational costs. The proposed system utilizes technologies such as RFID smart cards, QR codes, and cloud-based databases to provide a fast, secure, and contactless fare payment mechanism. Passengers can access railway services by simply scanning their smart card or QR code at entry and exit gates, where the fare is automatically calculated and deducted based on the distance traveled.

The system maintains passenger records, transaction history, and account balances in a centralized database, enabling real-time monitoring and management. It also reduces human intervention, improves operational efficiency, enhances passenger convenience, and minimizes revenue leakage. The integration of IoT and cloud technologies ensures scalability, reliability, and secure data handling. The proposed AFCS contributes to the development of intelligent transportation systems by providing a seamless, user-friendly, and cost-effective solution for modern railway fare management.

Keywords— **Automatic Fare Collection System, Railway Transportation, RFID, Smart Card, QR Code, IoT, Cloud Computing, Contactless Payment, Intelligent Transportation System.**

I. INTRODUCTION

Railway transportation is one of the most widely used and cost-effective modes of public transport. With the increasing number of passengers, managing ticketing operations efficiently has become a major challenge for railway authorities. Traditional ticketing systems rely heavily on manual processes, which often result in long queues, increased waiting times, ticket fraud, human errors, and higher operational costs. These limitations affect passenger convenience and reduce the overall efficiency of railway services.

To overcome these challenges, modern transportation systems are adopting Automatic Fare Collection Systems (AFCS). An AFCS is an intelligent ticketing solution that automates the process of fare calculation, ticket validation, and payment collection. By utilizing technologies such as Radio Frequency Identification (RFID), Quick Response (QR) codes, Internet of Things (IoT), and cloud computing, passengers can access railway services through contactless transactions without the need for paper tickets.

The proposed Automatic Fare Collection System for Railway Transportation provides a secure, reliable, and user-friendly platform for managing passenger fares. The system automatically records passenger entry and exit information, calculates the travel fare based on distance or predefined rules, and deducts the amount from the passenger's account. The collected data is stored in a centralized cloud database, enabling real-time monitoring, transaction management, and reporting.

II. LITERATURE SURVEY

A large amount of research has been conducted in the field of Automatic Fare Collection Systems (AFCS) to improve the efficiency, security, and convenience of public transportation services. Various technologies such as RFID, NFC, QR codes, smart cards, IoT, and cloud computing have been employed to automate ticketing and fare management processes.

Several researchers have proposed RFID-based ticketing systems to eliminate the need for paper tickets. In these systems, passengers use RFID-enabled smart cards to enter and exit stations. The fare is automatically calculated and deducted from the user's account. These systems reduce waiting time, minimize human intervention, and improve transaction speed. However, some RFID systems face challenges related to card security and unauthorized access.

Smart card technology has been widely adopted in metro and railway networks worldwide. Researchers have demonstrated that smart cards provide a reliable and contactless method of fare payment. The system stores passenger information and travel history, allowing quick fare processing and reducing operational costs. Despite their advantages, smart card systems require dedicated infrastructure and periodic card maintenance.

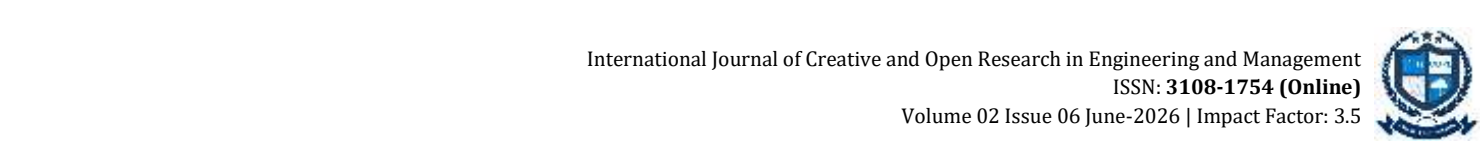
Recent studies have explored the use of QR codes for electronic ticketing. In this approach, passengers receive a digital ticket containing a unique QR code that is scanned at railway stations. QR code-based systems are cost-effective, easy to implement, and compatible with smartphones. However, issues such as internet dependency and code duplication require additional security measures..

The integration of IoT and cloud computing has enhanced the capabilities of fare collection systems. IoT devices enable real-time monitoring of passenger movements and ticket validations, while cloud platforms provide centralized data storage and management. Researchers have shown that cloud-based solutions improve scalability, accessibility, and data security. These systems also support analytics for transportation planning and decision-making.

Several studies have proposed integrated transportation management systems that combine automatic fare collection, passenger tracking, and route management. These systems improve operational efficiency and provide better services to passengers. Advanced technologies such as mobile applications, digital payments, and real-time notifications further enhance user experience.

III. PROPOSED METHODOLOGY

The proposed Automatic Fare Collection System (AFCS) is designed to provide a fast, secure, and automated ticketing solution for railway transportation. The system uses RFID smart cards or QR code-based



digital tickets for passenger identification and automatic fare deduction. A centralized cloud database stores passenger information, account balances, and transaction records for efficient management Passenger Registration → RFID/QR Code Generation → Entry Gate Authentication → Journey Travel → Exit Gate Authentication → Automatic Fare Calculation → Fare Deduction → Database Update → Report Generation

The proposed methodology ensures efficient fare management, enhanced security, and improved passenger experience, making it suitable for modern railway transportation systems.

The system automatically records passenger travel information and calculates the fare based on the source and destination stations. The calculated fare is deducted from the passenger's account balance, and the transaction is stored in the database.

Figure 1: System Architecture of Proposed System

List of Modules and Functionality

The proposed Automatic Fare Collection System (AFCS) for Railway Transportation consists of several integrated modules that work together to automate ticketing and fare management operations. The system begins with the **Passenger Registration Module**, where users create an account by providing personal information such as name, mobile number, and email address. After successful registration, each passenger is assigned an RFID smart card or a QR code ticket that serves as a unique travel identifier

The **User Application Module** provides passengers with a convenient platform to access railway services. Through a mobile or web application, users can view their account balance, recharge their wallet, check travel history, and receive notifications related to transactions and journeys. This module enhances user convenience by enabling digital management of travel-related activities.

The **RFID/QR Authentication Module** is responsible for verifying passenger credentials at railway stations. When a passenger scans an RFID card or QR code at the entry or exit gate, the system validates the information and grants access only to authorized users. This module ensures secure and contactless authentication while reducing the possibility of ticket fraud.

The **Entry Gate Management Module** records the passenger's source station and entry time when the RFID card or QR code is scanned. The system verifies the account status and stores journey details in the centralized database. Similarly, the **Exit Gate Management Module** records the destination station and exit time, which are required for fare calculation and transaction processing.

Extraction Module: The Extraction Module's goal is determining and extracting the relevant information pertaining to the specific field from the user query and the conversation history.

The **Fare Calculation Module** plays a crucial role in the system by automatically calculating the travel fare based on predefined rules such as distance traveled, station zones, or fare slabs. Once the journey is completed, the module determines the appropriate fare and forwards it to the wallet management system for deduction..

The **Wallet and Balance Management Module** maintains the passenger's account balance and processes automatic fare deductions. It also supports online recharge facilities through various payment methods, ensuring that passengers can easily add funds to their accounts whenever necessary. The updated balance is immediately reflected in the user's account.

A centralized **Cloud Database Module** stores all system data, including passenger profiles, transaction records, travel history, station information, and fare details. The cloud-based architecture enables secure storage, real-time access, and efficient management of information while ensuring scalability and reliability.

The **Payment Gateway Module** facilitates secure online transactions for wallet recharges and fare-related payments. It supports multiple payment options such as UPI, debit cards, credit cards, and net banking. The module verifies payment transactions and updates user balances accordingly.

The **Admin Dashboard Module** allows railway authorities to manage system operations efficiently. Administrators can monitor passenger activities, manage stations, track fare collections, oversee transactions, and generate reports. This module provides complete control over the system and supports decision-making processes.

The **Report and Analytics Module** generates detailed reports related to passenger traffic, revenue collection, transaction history, and system performance. These analytical insights help railway management evaluate operational efficiency and plan future improvements.

IV. RESULTS AND DISCUSSION

The experimental design for the implementation of the deep learning components was completed in the Google Colab environment, with an NVIDIA Tesla T4 GPU with 16 GB of VRAM. Normal Colab setup gives about 12–13 GB of system RAM, while the high-RAM session gives about 25–27 GB. which is especially useful for storing large amounts of text data. In addition, 100–120 GB temporary disk space was assigned for the effective storage management of datasets and model checkpoints. The environment was set up with CUDA versions 11.x/12.x, and Python 3.10+ support, which enabled the most recent deep learning technologies to facilitate efficient and stable training of models.

The proposed Automatic Fare Collection System for Railway Transportation was designed and evaluated to automate ticketing operations and improve fare management efficiency. The system successfully performed passenger registration, RFID/QR code authentication, journey tracking, automatic fare calculation, and fare deduction processes. All transaction records were securely stored in the centralized cloud database and could be accessed by both passengers and administrators.

The implementation demonstrated that passengers could enter and exit railway stations quickly without purchasing paper tickets or waiting in long queues. The RFID and QR code authentication mechanisms provided fast and accurate passenger identification, reducing manual intervention and improving station throughput. The automated fare calculation module correctly determined fares based on travel distance and predefined fare rules, ensuring transparent and accurate billing.

The cloud-based architecture enabled real-time data synchronization between stations, user applications, and the administration dashboard. Administrators were able to monitor passenger activities, track revenue collection, and generate reports efficiently. The payment gateway integration also allowed passengers to recharge their accounts securely through various online payment methods.

V. CONCLUSIONS

The Automatic Fare Collection System for Railway Transportation provides an efficient, secure, and user-friendly solution for modern railway ticketing and fare management. By integrating RFID smart cards, QR code technology, cloud computing, and digital payment systems, the proposed system automates passenger authentication, fare calculation, and payment processing. This eliminates the need for traditional paper-based ticketing and significantly reduces waiting time at railway stations..

The system improves operational efficiency by minimizing manual intervention, reducing ticket fraud, and ensuring accurate fare collection. The centralized cloud database enables real-time monitoring, secure storage of passenger and transaction data, and efficient administration of railway operations. In addition, the

user application offers convenient services such as balance checking, online recharge, and travel history management.

The results demonstrate that the proposed system enhances passenger convenience, improves revenue management, and supports the development of smart railway infrastructure. Therefore, the Automatic Fare Collection System can serve as a reliable and scalable solution for future railway transportation networks. Further enhancements such as Artificial Intelligence, facial recognition, and advanced data analytics can be incorporated to improve system performance and provide additional intelligent services.

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