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Metro GO: An AI-Based Ticketless Metro Entry System Using Face Recognition

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A B S T R A C T

Metro GO is a smart metro entry system designed to enable ticketless travel through face recognition technology. Traditional metro systems rely on physical tokens, QR codes, or mobile apps, which can cause delays, require user interaction, and are not entirely contactless. Metro GO eliminates these issues by allowing users to register with their facial image and later access metro services through real-time face verification at the station. Once the face is successfully matched, the system logs the journey and generates a PDF ticket with the travel details. The project is developed using Python, OpenCV, the face_recognition library, and Tkinter for the user interface. ReportLab is used to generate the ticket in PDF format, and user data is stored in CSV files. Metro GO offers a faster,touch-free, and AI-based solution for urban metro access, aligning with the needs of future smart city infrastructure.

Keywords: Face Recognition, Metro Ticketing, Python, OpenCV, Tkinter, PDF Ticket, AI-based System ,Smart Transport.

1. Introduction

Metro systems play a vital role in urban transportation, but current ticketing methods—like tokens, smart cards, and QR codes—often cause delays, long queues, and operational issues. Physical handling of tickets leads to problems such as loss or damage and increases dependency on machines or staff. These methods also generate environmental waste and maintenance costs for metro authorities.

To overcome these limitations, we developed Metro GO, an AI-based, face recognition metro entry system that provides a completely hands-free experience. Users register their facial data once and can access metro services through real-time facial authentication, eliminating the need for any physical or digital ticket. On successful recognition, a PDF ticket is generated and sent via email. The system enhances speed, security, and hygiene in public transport, making it ideal for future-ready urban infrastructure.

2. Literature Review

Facial recognition has become an important technology in security and automation systems. In [1], methods like Eigenfaces, Neural Networks, and Gabor filters are examined for surveillance and access control. While these methods demonstrate good accuracy, challenges like pose variation, lighting, and facial aging still impact real-time performance in uncontrolled settings. These issues are particularly important in busy public places like metro stations.

Real-time facial recognition for automating attendance is discussed in [2]. This showcases its ability to verify identity without manual input. Such systems effectively prevent proxy attendance and human error, but they are often limited to controlled environments like classrooms or offices. Using similar approaches in public transport systems could improve entry verification, although issues like scalability and fare handling have not been fully explored.

A fingerprint-based biometric ticketing system is suggested in [3]. It provides secure travel validation using cloud storage and encryption. While effective in ensuring security, fingerprint systems require physical contact, making them less suitable in post-pandemic and high-volume situations. In contrast, [4] presents an AI-powered facial recognition system for metro entry that automates the gate access process and reduces manual operations. These systems improve user flow and decrease environmental impact, but they often lack integrated platforms that connect identity verification with ticketing.

Despite progress in biometric and AI systems, there is still a need for a fully contactless, real-time, and scalable facial recognition-based metro ticketing solution. This project is intended to fill that gap by proposing METRO-GO, a seamless and secure facial recognition system designed to improve metro access, shorten wait times, and ensure safe, automated fare collection.

3. Methodology

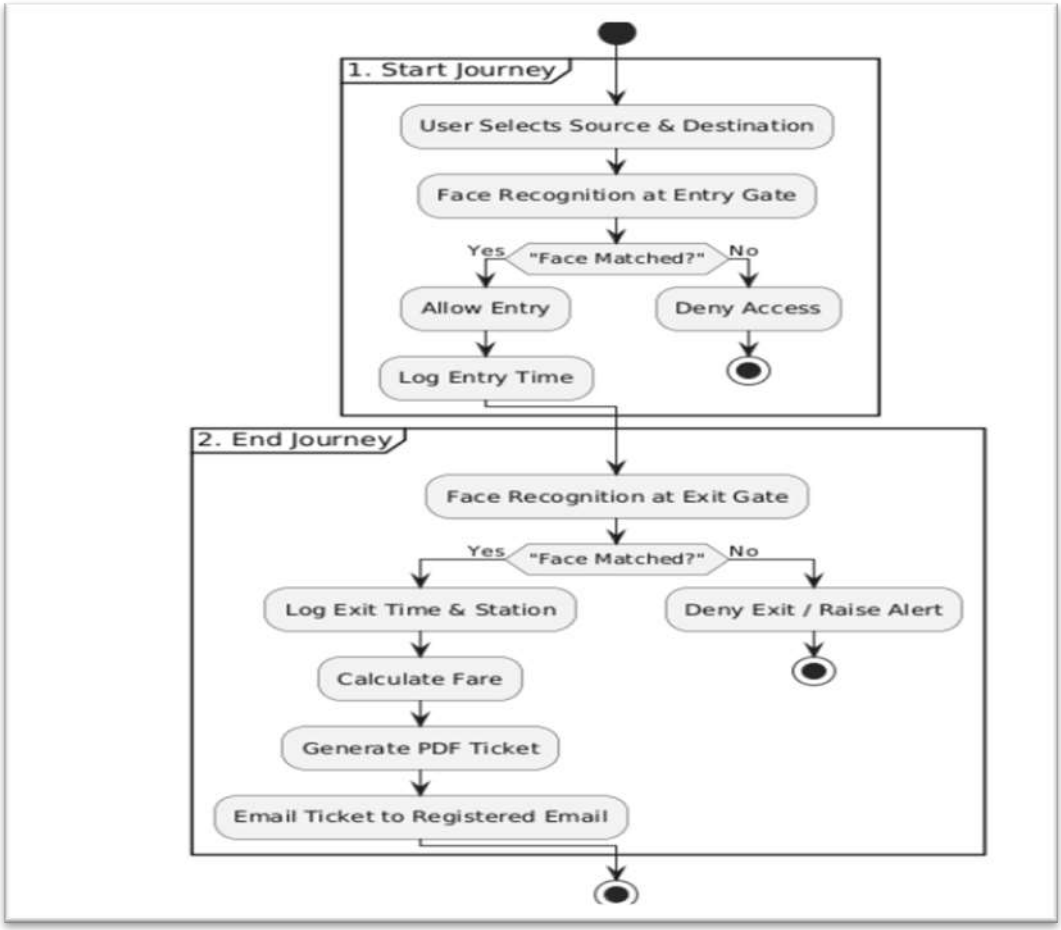

Fig. 1. METRO-GO System Methodology

The proposed system, METRO-GO, utilizes facial recognition technology to automate and streamline metro ticketing. The methodology consists of two major phases: Start Journey and End Journey, as illustrated in Fig. 1.

In the Start Journey phase, the user selects the source and destination stations via a mobile or kiosk interface. Upon arrival at the entry gate, a facial recognition system captures and verifies the user's identity against the stored database. If the face is successfully matched, entry is granted and the entry time is logged; otherwise, access is denied.

The End Journey phase begins at the exit gate, where facial recognition is again performed. If the user's face is matched with the entry record, the system logs the exit time and station, calculates the fare based on journey details, and generates a PDF ticket. This ticket is then sent to the user's registered email. In cases of mismatched facial recognition at the exit gate, access is denied and an alert is triggered for security intervention.

This approach guarantees a contactless, secure, and efficient ticketing process, removing reliance on tokens or smart cards or manual fare verification.

3.1 System Architecture

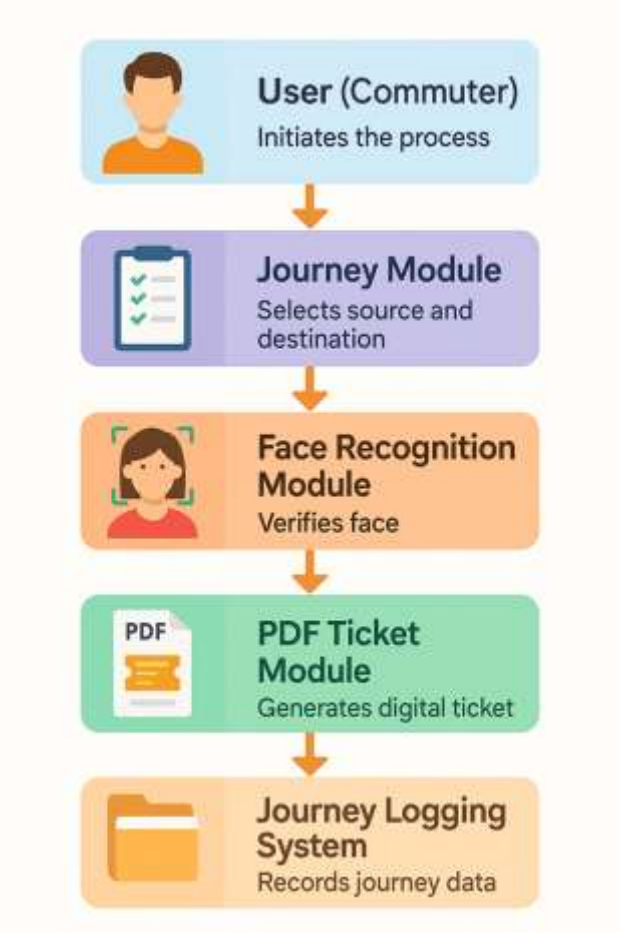

Fig. 2. METRO-GO System Architecture

Metro GO has been developed with a user-friendly, modular flow that ensures a smooth and secure metro ride using face recognition technology. The process consists of five main modules, each handling a specific part of the workflow. The system is lightweight, based on a graphical user interface, and suitable for real-time metro access.

1. User (Commuter)

The commuter begins interaction with the system by using the system's graphical interface. They are the main user who chooses stations and goes through facial authentication.

2. Journey Module

The user selects their starting and ending metro stations from dropdown menus in the GUI. This choice sets up the journey for that session and readies the system for verification and ticket creation.

3. Face Recognition Module

After the user confirms their journey details, the system activates the webcam to take a live image. Using the `face_recognition` library, the system compares this image with stored facial data. If it finds a match, it moves forward to generate a ticket; if not, access is denied.

4. PDF Ticket Module

Upon successful facial authentication, the system creates a digital ticket in PDF format. The ticket includes details like name, source, destination, and timestamp. This module uses the ReportLab library for formatting and output.

5. Journey Logging System

The last step logs the journey data into a CSV or Excel file. The log includes the commuter's name, email (if available), travel details, and timestamp. This helps maintain travel records and support traceability.

This setup allows for secure, contactless travel, removing the need for physical tickets, smart cards, or QR scanning. Each module works independently but in order to provide a smooth and efficient experience.

4. Output Screens:

Fig 3.User Interface

Fig 4.Selecting Source and Destination

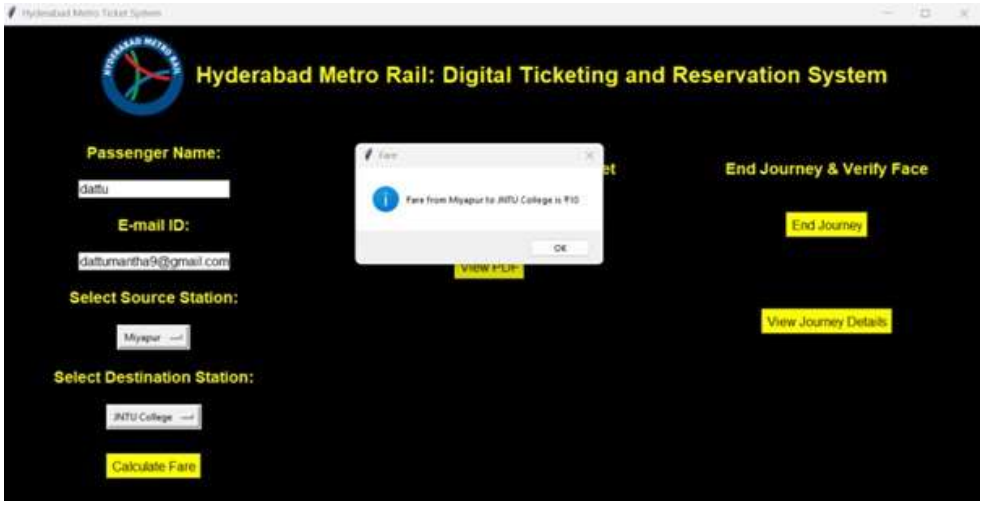

Fig 5. Fare calculation

Fig 6.Anomaly Detection

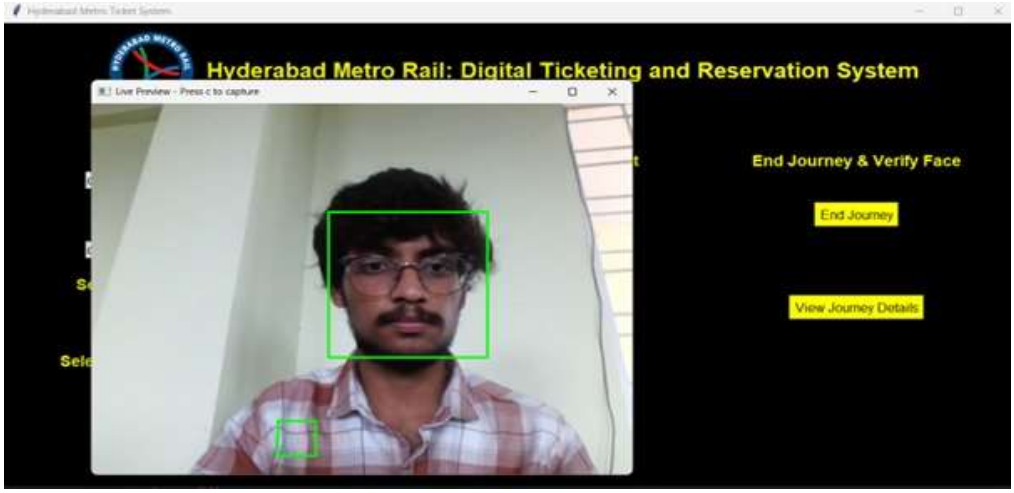

Fig 7.Register your face

Fig 8.Generated Ticket Preview

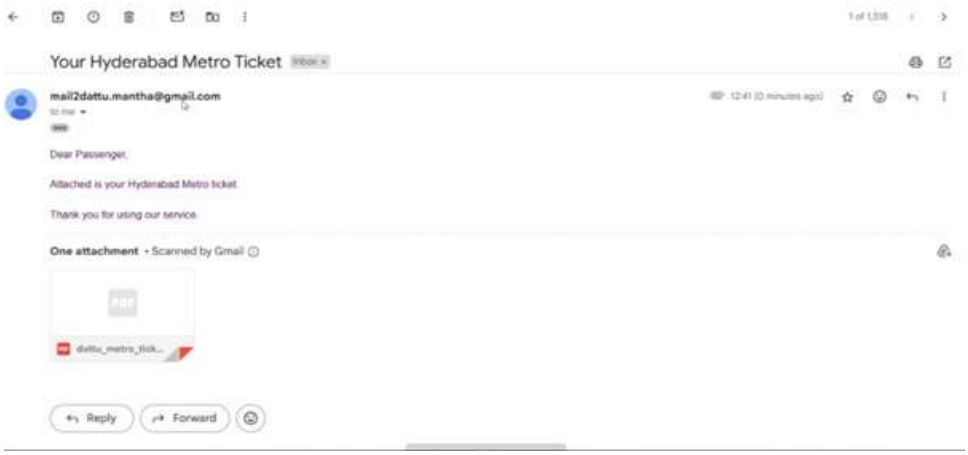

Fig 9.Ticket Email Confirmation

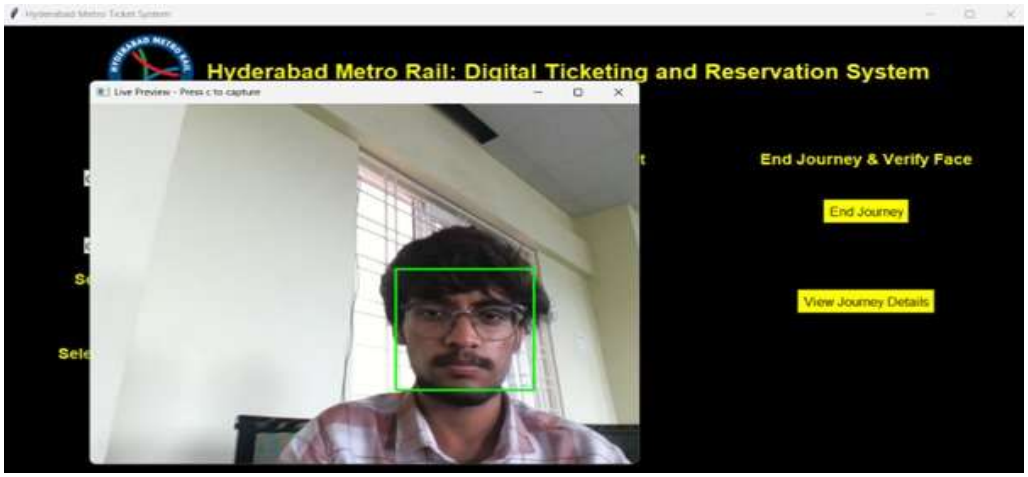

Fig 10.Ending the journey by verifying the face

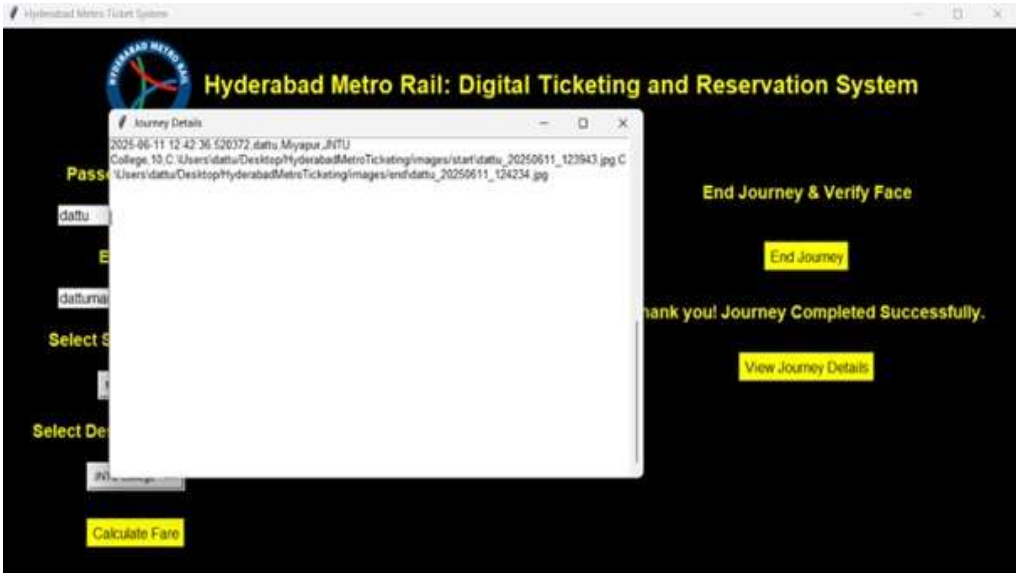

Fig 11. Passenger journey details

5. Work Flow:

The Metro GO system uses a clear process that combines face recognition and a graphical interface for a contactless metro ticketing experience. The full workflow is outlined below:

Step 1: Launch the Application

The user opens the Metro GO desktop application, which shows a graphical user interface (GUI) created with Tkinter.

Step 2: Journey Selection

The user picks the source and destination metro stations from the dropdown menus in the GUI.

Step 3: Live Face Capture

When the user clicks "Start Journey," the webcam turns on to take a live picture of their face.

Step 4: Face Verification

The system checks the captured face against the pre-registered faces in a CSV file using the `face_recognition` library.

- If the face matches, the system continues to ticket generation.

- If it does not match, access is denied, and an error message appears.

Step 5: PDF Ticket Generation

The system generates a digital ticket in PDF format with the ReportLab library. The ticket includes the user's name, chosen source and destination stations, date, and time of journey.

Step 6: Journey Logging

The system saves the journey details in a CSV/Excel file (`journey_log.csv` or `.xlsx`) for future reference or review. Logged data includes the user name, email, stations, and time.

Step 7: End of Process

The user gets confirmation that their journey has been logged and can now go through the metro gate.

6. Conclusion and Future scope:

The Metro-Go project introduces a biometric-based metro ticketing system using facial recognition to eliminate the drawbacks of traditional ticketing systems such as paper tickets, tokens, QR codes, and smart cards. It achieves:

* A seamless, ticketless experience using real-time face recognition at metro entry and exit points.

* Automated fare calculation and ticket generation without manual intervention.

* Enhanced commuter convenience, operational efficiency, and security.

* Support for contactless travel, which is especially valuable in post-pandemic public transport scenarios.

* Reduction in fraud, environmental impact, and human effort..

* End-to-end integration of modules like image capture, recognition, fare calculation, ticket generation, and email dispatch into a cohesive, modular system.

Future Scope:

1. Advanced Face Detection:

Replace Haar Cascades with deep learning models like FaceNet or MediaPipe for higher accuracy under varied lighting and crowd conditions.

2. Cloud Storage:

Store all face records, travel logs, and tickets in the cloud for easy access and secure backups.

3. Mobile App Integration:

*Allow users to:

* View travel history

* Receive ticket notifications

* Report scan errors

* Check fare details

4. Hardware Integration:

Connect the software to automated gates for a fully contactless experience, opening gates only on successful facial authentication.

5. Admin Dashboard:

* Enable metro staff to monitor:

* Passenger logs

* Fare reports

* Entry/exit statistics

This conclusion and future scope strongly advocate for Metro-Go as a scalable, user-friendly, and future-ready smart metro ticketing

7.Acknowledgement:

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