Metro Seat Counter Using AI

Denial Pegu[1], Saurabh Yadav[2], Anmol Sharma[3]

[1,2,3]B.Tech Student of CSE, SRMIST Delhi-NCR campus

Abstract
Introduction of AFC gates and smart cards have reduced the wait time for passengers during travel. Passengers face overcrowding in selective coaches which provides inconvenience to passengers travelling long distances. We propose a facial recognition framework which can determine which coaches are overcrowded and which coaches are empty with the help of the camera fitted inside each coach. This framework can be integrated with the electronic signboards present on the platform.

Keywords: Metro Train, Passenger Detection, Facial Recognition, Occupancy Detection

1. Introduction

Metro train stations have introduced AFC and RFID technology which has reduced the need of human interaction for ticketing. Passengers can self-check-in into the station with the help of RFID tokens or smartcards through AFC machine. These machines keep count of the daily ridership as well as the duration between check-in and check-out. This helps in assigning fines to passengers who overstayed the duration in the station.
The convenience of these systems has resulted in the increased ridership of metro after every year with the Bangalore metro system reaching a ridership of 200 million for the year of 2022[1].
This increased ridership has resulted in congestion and overcrowding in trains specially during peak rush hours. This rush leads to uneven boarding in different coaches leading to undercrowding in some coaches and overcrowding in some coaches.
This uneven crowding can lead to discomfort, increased pickpockets [2] and as well as safety concerns [3] regarding passengers' life. Passengers are likely to travel on the next train even though it may be overcrowded. So proper distribution of passengers is required amongst the coaches so that the above-mentioned problems can be minimised.
We propose, displaying the occupancy percentage of people traveling in a particular coach on the timing screens, before the arrival of the train which can help the passenger go to the gate for the coach with less crowd. The percentage of vacant space available in each coach can be identified by using a facial recognition framework, which counts the number of people inside each coach [4] and presenting as a percentage showing occupancy.

2. Related Works

Facial recognition is a widely researched field in Computer science due to its real-life applications in biometrics, Information security, access control, law enforcement, smart cards and surveillance system.
Designing and implementation of an embedded system for passenger detection is an emerging track for researchers [7]. Contour feature is used to detect a passenger under the complicated situation. Tao et al [5] propose a clustering-based method for counting passenger in a bus with a single camera. After an in-depth

study of different research papers on passenger detection. Table I shows the summary of existing systems and efficiency of systems.
Infrared and pressure sensors have been conventionally used to count the number of people that are currently present in that area. Xi Zhao et al. [6] presented the use of facial recognition to count the number of people in a closed space using face detectors and Kalman filter.
Vivekanand S Gogi et al. [8] have proposed the use of facial recognition in transportation as a way of ticketing the passengers without the involvement of conductors and smartcards. Their aim was to make traveling more secure and convenient by using facial recognition and matching it with Aadhar database at the entrance and exit, deducting the appropriate amount from their digital wallet at the exit.

3. Proposed System

Every coach in the metro train will be installed with multiple high-resolution cameras in front of each seating bench (Figure I). These cameras will cover the whole coach. Once a person enters the coach, the camera will detect the person inside the coach.
The system is trained to count a person as an object and any other entity as the environment. When a person enters the coach, it will detect the person as an object inside the coach. This will increase the

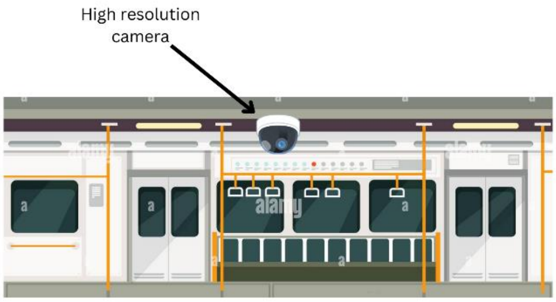

Figure I.

number of occupancy percentage inside the coach. The system also stores the maximum advisable number of people that can be inside the coach.
The system compares the number of objects/people inside each coach with the max limit of the coach. It then comes up with the occupancy percentage for each coach and displays that percentage alongside the coach number on the timing screens put up on each platform of the station.
The system can also be trained to display if a particular coach has reached its capacity and display the overlimit percentage.
The system encourages the passengers waiting on the platform to position themselves in front of the coach with minimum occupancy before the arrival of the train.

A. Algorithm

The algorithm we propose to use in this system is Haar Cascade algorithm [9]. This algorithm is trained using a large number of positive and negative images. It then uses a cascade function to calculate features in windows across the image and classify them as either positive or negative. Positive windows are part of the object, while negative windows are not.
These features are Haar like features and these are extracted by finding the difference between the sum of positive windows and the sum of negative windows.
This algorithm is fast, simple to implement, and can in real-time. It can be used to detect a variety of objects which includes faces, eyes, mouths and many more.

Due to its capability of working in real time it can be handle the constant incoming and outgoing passengers in the coach. It provides a fast and reliable capacity measure to the passengers.

B. Testing and training

For testing and training the model, we used a pre-existing face database by the MUCT (Milborrow / University of Cape Town) [10]. The model was subjected to 3755 images of human faces with 76 manual landmarks. The database contained images of people from different ethnicity, age group and under different lighting conditions. It got 3635 hits of the actual faces (Figure II). The accuracy of the model in recognizing the faces in the images was over 96 percent (Table II).

4. Conclusion and Future Work

Facial recognition for counting occupancy can help commuters have less stressful journey as whole. The commuters can focus on reaching their destination in place of worrying about travelling making their journey more comfortable. This system will reduce overcrowding of coaches, this will result in lower frequency of pickpockets, higher safety as people may get injured while rushing into highly packed coaches, and more security for identifying individuals resulting in the commuters to expend less energy during travelling. Resulting in improved productivity for people commuting for work and comfort for people traveling for pleasure.

This system can also be integrated with city bus system. With the help of this system passengers can avoid congested bus stops and go to bus stops with less passenger traffic.

Reference	Paradigm	Passenger Detection			Percentage	Description
		Actual	Detects	Missed		
[25]	HOG Algorithm	113	109	4	96	Design an algorithm and software for passenger flow detection with real-time embedded equipment
		114	104	10	91	
[26]	Hough Transform &Fuzzy	123	110	13	88	Applied image processing techniques for real-time detection of passengers. The produced technique applied in DSP based embedded system
		27	23	4	82	
		50	47	3	93	
		33	31	2	93	
		233	211	22	89	

Table I COMPARISON OF EXISTING SYSTEMS

Actual faces	Hits	Misses	False Detects	Multi-hit	Accuracy
3755	3635	55	63	5	96.8

Table II Haar Cascade Algorithm Accuracy

```
Cascade:frontalface_default.xml
Datafile:muct.csv
|--------------------------------------------------|
|   Hits   |  Misses   | False Detects   | Multi-hit  |
|  3635    |   55      |   63            |    5       |
|--------------------------------------------------|
```

Figure II

References

1. Avnish Kumar Yadav, Chamandeep Kaur, “Revamping Urban Mobility: Metro AFC and RFID Analysis”, SciWaveBulletin, Vol. 1, No. 3, 50-56, 2023.
2. Sameera. P, Ms. G. Maheshwari, “A Survey on Detecting Pickpocket Suspects from Large-Scale Public Transit Records-Recent Approaches”, IOSR Journal of Engineering (IOSRJEN), ISSN (e): 2250-3021, ISSN (p): 2278-8719, Vol. 09, Issue 10, October. 2019, Series -IV, PP 01-05.
3. Mrs. Roopa Rao,” Passenger Perception of Safety on Mumbai Local Train Platform”, Veethika, Vol. 2, No.2, Apr-Jun, 2016.
4. Khawar Islam, Uzma Afzal, “Framework for Passenger Seat Availability Using Face Detection in Passenger Bus”, Cornell University (2020), DOI: 10.48550/arXiv.2007.05906
5. T. Yang, Yanning Zhang, Dapei Shao, “Clustering Method for Counting Passengers Getting in A Bus with Single Camera”, Optical Engineering, vol. 49, no. 3, 3 2010.
6. Xi Zhao, Emmanuel Dellandréa, Liming Chen, “A People Counting System Based on Face Detection and Tracking in a Video”, Sixth IEEE International Conference on Advanced Video
7. and Signal Based Surveillance, AVSS 2009, 2-4 September 2009, Genova, Italy
8. Tian, Q., Wang, L., Wei, Y., Pang, X., Wang, Q., & Fei, W. (2016, July). Research of Embedded Real-Time Passenger Flow Detection Equipment. In International Conference on Green Intelligent Transportation System and Safety (pp. 961-972). Springer, Singapore.
9. Vivekanand S Gogi, Samyukta R, Nishchitha M, Bhaskar Mg,” Bus Transportation using Face Recognition System”, International Conference on Trends in Industrial & Value Engineering Business & Social Innovation, ICIVBS – 2018, Bangalore.
10. F.M. Javed Mehedi Shamrat, Anup Majumder, Probal Roy Antu, Saykot Kumar Barmon, Itisha Nowrin, Rumesh Ranjan, “Human Face Recognition Applying Haar Cascade Classifier”, International Conference on Pervasive Computing and Social Networking Volume:317, DOI: 10.1007/978-981-16-5640-8_12
11. S. Milborrow, J. Morkel, F. Nicolls, “The MUCT Landmarked Face Database”, Pattern Recognition Association of South Africa, 2010.