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Smart Bus Passenger Evaluation and E-Ticketing System

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Abstract: *The rapid growth of urban transportation has created a strong need for smarter and more efficient passenger management systems in public buses. Traditional bus operations often face problems such as manual ticketing, overcrowding, inaccurate passenger counting, and delays in communication between operators and passengers. To address these issues, this project proposes a Smart Bus Passenger Evaluation and E-Ticketing System that combines computer vision and digital automation to improve transport management.*

The proposed system uses a camera installed inside the bus to capture live passenger video. The captured video is processed frame by frame using image pre-processing and normalization techniques to improve detection quality. A YOLOv8-based deep learning model is then used to detect and count passengers in real time. The counted passenger data is compared with the available bus capacity, and whenever the seating limit is reached, the system automatically sends a notification to the bus owner or administrator through WhatsApp. In addition to passenger monitoring, the system also provides an electronic ticketing facility. Passenger details entered at the booking counter are digitally processed, and e-tickets are generated instantly and sent directly to the passenger through WhatsApp.

Keywords: Smart Transportation, YOLOv8, Passenger Detection, E-Ticketing System, Real-Time Monitoring, WhatsApp Notification, Public Bus Management, Computer Vision, Deep Learning, Intelligent Transport System

I. INTRODUCTION

Public transportation plays a vital role in supporting urban mobility, but traditional bus systems still rely heavily on manual processes that often lead to inefficiencies such as overcrowding, ticketing errors, and lack of real-time passenger information [1]. These limitations reduce service quality and create inconvenience for both passengers and transport operators. With the increasing demand for smart and reliable transport systems, there is a need to adopt advanced technologies that can automate operations and improve overall efficiency [2].

Recent advancements in Artificial Intelligence (AI), computer vision, and the Internet of Things (IoT) have opened new possibilities for developing intelligent transportation solutions. AI-based models, especially deep learning techniques like YOLO (You Only Look Once), have shown high accuracy in object detection and real-time analysis, making them suitable for passenger detection and counting in dynamic environments [3][4]. These technologies enable automated monitoring systems that can provide accurate and continuous data without human intervention [5].

By using a camera installed inside the bus, the system captures live video, processes it, and applies a YOLOv8 model to detect and count passengers efficiently [6]. The system continuously compares passenger count with the bus capacity and sends instant notifications to the operator when the limit is reached, helping to prevent overcrowding and improve safety [7].

In addition to monitoring, the system incorporates an electronic ticketing mechanism where passenger details are digitally recorded, and e-tickets are generated and delivered through mobile communication platforms such as WhatsApp [8].

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Overall, the integration of AI-driven passenger analysis with automated ticketing provides a smart, scalable, and efficient solution for modern public transportation systems. Such systems also contribute to the development of smart cities by improving resource utilization, enhancing passenger experience, and enabling data-driven decision-making [9][10].

II. PROBLEM STATEMENT

Traditional bus transportation systems often face issues such as manual ticketing, inaccurate passenger counting, overcrowding, and delays in communication. These problems reduce operational efficiency and can affect passenger safety and convenience. In many cases, bus operators do not have real-time information about the number of passengers inside the vehicle, which leads to poor seat management and overloading.To overcome these challenges, there is a need for a smart and automated system that can monitor passengers in real time, manage bus occupancy, and provide a faster and more reliable ticketing process. The proposed system is developed to reduce human effort, minimize errors, and improve the overall efficiency of public transportation.

III . OBJECTIVES

- To develop a real-time passenger detection system for counting the number of passengers inside the bus using camera-based monitoring.
- To prevent overcrowding in buses by comparing passenger count with the available seating capacity.
- To design an automated e-ticketing system that generates and delivers digital tickets efficiently.
- To send instant notifications to the bus operator/owner when the passenger limit reaches full capacity.
- To improve the efficiency, accuracy, and convenience of public transport management by reducing manual work and human errors.

IV. LITERATURE SURVEY

[1] Huei-Yung Lin et al. (2024), in the paper "A Passenger Detection and Action Recognition System for Public Transport Vehicles," proposed a vision-based passenger monitoring system for public transport. The study focused on detecting and recognizing passenger presence and movement inside vehicles using image processing and deep learning techniques. The proposed system improved passenger safety and monitoring by analyzing real-time bus environments. It demonstrated the usefulness of AI-based surveillance for intelligent transport applications.

[2] Ricard Borges et al. (2025), in the paper "A Reusable Public Transport Electronic Ticket System with Fast Validation," introduced an advanced electronic ticketing system designed for public transportation. The system allowed fast ticket validation and supported seamless passenger travel with improved ticket management. The proposed approach reduced the dependence on paper tickets and enhanced the speed and reliability of fare collection. It showed how digital ticketing can improve convenience and efficiency in public transit systems.

[3] Oleksii Tiutiunyk et al. (2024), in the paper "Creation of a High-Precision, Single-Board Computer-Based Intelligent Passenger Counting System," developed a smart passenger counting system using computer vision and embedded computing devices. The system used detection and tracking methods to count passengers entering and leaving public transport vehicles. The research highlighted the importance of accurate passenger data for fare control and operational planning. The model achieved good performance in real-time passenger monitoring scenarios.

[4] Xiangyang Zhang et al. (2026), in the paper "A Study on Bus Passenger Boarding and Alighting Detection and Recognition Based on Video Images and YOLO Algorithm," proposed a video-based passenger recognition system for analyzing boarding and alighting behavior in buses. The study used the YOLO algorithm for real-time object detection and improved the collection of passenger movement data. The proposed system helped in understanding travel patterns and supporting intelligent bus operation management. It also contributed to smart transportation planning through accurate visual monitoring.

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[5] Saddam Hussain Khan et al. (2020), in the paper "Passenger Detection and Counting for Public Transport System," presented a computer vision-based passenger counting framework for public transport. The system was designed to track and count passengers accurately under different indoor and outdoor transport conditions. The study emphasized the role of automated passenger counting in improving transport planning, reducing errors, and enhancing service efficiency. The proposed method provided a reliable base for modern bus monitoring systems.

[6] Sakshi Sambhaji Deshmukh et al. (2025), in the paper "AI Based Smart Bus Passenger Counting and Alert System for Bus Capacity," proposed an AI-powered passenger counting and alert mechanism to reduce overcrowding in buses. The system continuously monitored passenger load and generated alerts when bus capacity limits were approached or exceeded. The proposed model improved safety and operational control in public transport. It also showed the practical importance of combining AI with real-time transport monitoring.

Comparison Table

Author & Year	Technology Used	Key Feature	Limitation
Huei-Yung Lin et al. (2024)	Deep Learning, Computer Vision	Passenger detection and action recognition in vehicles	Limited to monitoring, no ticketing feature
Ricard Borges et al. (2025)	Electronic Ticketing System, Digital Validation	Fast and reusable e-ticket validation	Does not include passenger counting
Oleksii Tiutiunyk et al. (2024)	Single-Board Computer, Computer Vision	High-precision passenger counting	Hardware-dependent and limited scalability
Xiangyang Zhang et al. (2026)	YOLO Algorithm, Video Image Processing	Boarding and alighting passenger recognition	Performance may reduce in crowded conditions
Saddam Hussain Khan et al. (2020)	Image Processing, Passenger Counting Model	Automated passenger counting	Accuracy affected by lighting and occlusion
Sakshi S. Deshmukh et al. (2025)	AI-Based Monitoring, Alert System	Bus capacity alert generation	No integrated e-ticketing support

IV. WORKING OF SYSTEM

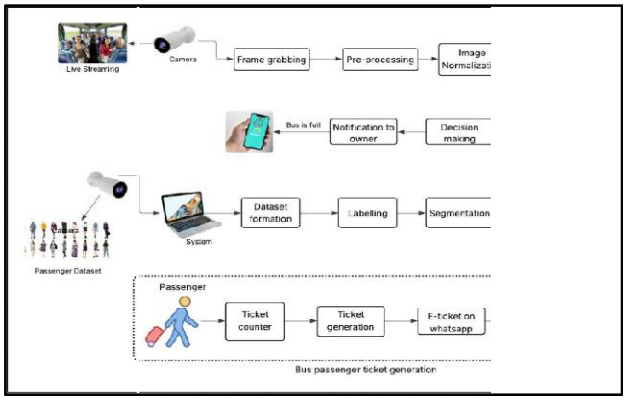

Fig 1: Design of the system

The Smart Bus Passenger Evaluation and E-Ticketing System works by combining real-time passenger monitoring with digital ticket generation. Based on the block diagram, the complete operation of the system is divided into two major parts: Passenger Detection and Capacity Monitoring and E-Ticket Generation.

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1. Live Streaming and Video Capture

A camera installed inside the bus continuously captures live video streaming of passengers. This live footage serves as the input for the monitoring system and helps in observing passenger movement and occupancy in real time.

2. Frame Grabbing

The live video is then converted into multiple image frames through a frame grabbing process. Each frame is extracted separately so that it can be analyzed by the system more effectively.

3. Pre-Processing

After frame extraction, the images are sent for pre-processing. In this stage, noise is reduced, unwanted disturbances are removed, and the image quality is improved. This helps in making the detection process more accurate.

4. Image Normalization

The pre-processed images are further passed through image normalization, where brightness, contrast, and image size are standardized. This step ensures that all frames are in a consistent format before being given to the detection model.

5. Passenger Detection Using YOLOv8

The normalized images are then analyzed using the YOLOv8 algorithm, which detects and counts the number of passengers present inside the bus. YOLOv8 is used because of its speed and accuracy in object detection tasks.

6. Dataset Formation and Training

To improve the performance of the detection model, a passenger dataset is created using images collected from the camera. These images are then passed through labelling and segmentation processes, where passenger objects are identified and marked properly. The labeled dataset is used to train the YOLOv8 model, resulting in better passenger detection accuracy.

7. Decision Making

The output from the trained model is given to the decision-making unit, which compares the current passenger count with the total seating capacity of the bus. This helps in identifying whether the bus is underloaded, partially occupied, or fully occupied.

8. Notification to Owner

If the passenger count reaches the maximum bus capacity, the system automatically triggers a notification to the owner or administrator. A message such as “Bus is Full” is sent through WhatsApp, enabling the operator to take immediate action and avoid overcrowding.

9. Passenger Ticket Booking

In the second part of the system, a passenger approaches the ticket counter to book a seat. The passenger details are entered into the system digitally.

10. Ticket Generation

After verifying seat availability, the system automatically performs ticket generation. A digital ticket containing journey details is created in electronic form.

11. E-Ticket Delivery on WhatsApp

Finally, the generated ticket is sent directly to the passenger through WhatsApp as an e-ticket. This makes the ticketing process faster, paperless, and more convenient for passengers.

V. SYSTEM DESIGN

1. Overview of the System

The Smart Bus Passenger Evaluation and E-Ticketing System is designed to automate passenger monitoring and ticketing using computer vision and digital communication technologies. The system integrates hardware components like cameras and processing units with software modules such as image processing, deep learning (YOLOv8), and messaging services.

The working begins with a camera installed inside the bus that captures live video of passengers. This video is processed into frames and enhanced using pre-processing and normalization techniques.

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Camera Module

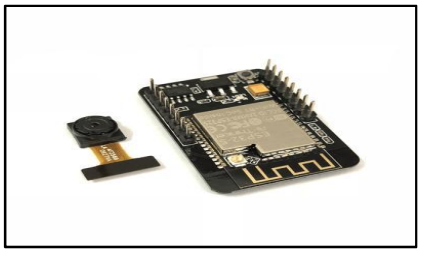

Fig.2.Camera Module

Description:
Captures real-time video of passengers inside the bus. It acts as the primary input device for the system and continuously monitors passenger movement and occupancy..

YOLOv8 Detection Model

Fig.3.YOLOv8 Model

Description:
A deep learning model used to detect and count passengers in real time. It provides high accuracy and fast processing for object detection tasks.

Dataset & Training Module

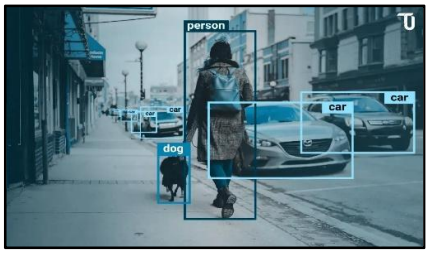

Fig.4 Dataset & Training Model

Description:
Used to create and label passenger datasets. These labeled images are used to train the YOLOv8 model for improving detection accuracy under different conditions..

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Notification System (WhatsApp API)

Fig.5. Notification System

Description:
Sends real-time alerts to the bus owner or operator when the bus reaches full capacity. It ensures quick communication and better control over passenger management.

Ticketing System

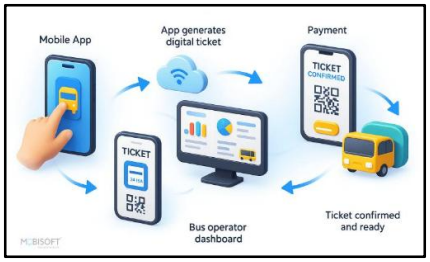

Fig.6.Ticketing System

Description:
Handles passenger data entry, ticket generation, and seat management. It automates the ticketing process and reduces manual work.

VI. RESULTS

The Smart Bus Passenger Evaluation and E-Ticketing System was implemented and tested to evaluate its performance in passenger monitoring and digital ticket generation. The system successfully captured live video from the camera installed inside the bus and processed the video frames efficiently. By using the YOLOv8 model, the system was able to detect and count passengers in real time with good accuracy under normal lighting and moderate crowd conditions. This made it possible to continuously monitor the number of passengers present inside the bus without the need for manual supervision.

During testing, the passenger count generated by the system was compared with the actual seating capacity of the bus. When the bus reached its maximum passenger limit, the system correctly identified the condition and triggered a notification to the bus owner or administrator through WhatsApp. This feature proved useful in preventing overcrowding and improving the safety and management of bus operations. The notification process was quick and reliable, showing the effectiveness of integrating real-time monitoring with digital communication.

The e-ticketing section of the system also produced satisfactory results. Passenger details entered at the ticket counter were processed smoothly, and the system generated digital tickets without delay. These tickets were successfully delivered to passengers via WhatsApp, making the process simple, paperless, and convenient. This reduced manual effort and improved the speed of ticket issuance when compared to traditional ticketing methods.

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VII. CONCLUSION

The Smart Bus Passenger Evaluation and E-Ticketing System provides an efficient and practical solution for improving public transportation management by combining real-time passenger monitoring with digital ticketing. The system successfully uses camera-based surveillance and the YOLOv8 deep learning model to detect and count passengers accurately, helping to prevent overcrowding and improve passenger safety. In addition, the automated e-ticket generation and WhatsApp-based ticket delivery make the ticketing process faster, paperless, and more convenient for passengers and operators. Overall, the proposed system reduces manual effort, minimizes errors, and supports smarter and more reliable bus transport operations.

VIII. FUTURE SCOPE

The future scope of this project lies in enhancing the system with more advanced smart transportation features such as GPS-based live bus tracking, mobile application integration, online seat booking, digital payment support, and route optimization. The system can also be improved by incorporating facial recognition, IoT sensors, cloud-based storage, and predictive analytics for better passenger management and transport planning. With further development, the proposed model can be extended to support smart city infrastructure, making public transportation more intelligent, secure, and user-friendly.

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