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AI Based Smart Bus Passenger Counting and Alert System for Bus Capacity

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Abstract: *This paper presents an AI-Based Smart Bus Passenger Counting and Alert System designed to monitor passenger occupancy in public transportation buses. The proposed system utilizes computer vision and deep learning techniques to automatically count passengers entering and exiting the bus through onboard cameras. Real-time passenger data is processed using AI models to determine the current occupancy level and compare it with the maximum bus capacity. When the occupancy exceeds the predefined limit, alert notifications are generated for drivers and transport authorities. The system improves passenger safety, prevents overcrowding, enhances operational efficiency, and provides accurate occupancy statistics for transportation management. Experimental results demonstrate high counting accuracy and reliable real-time performance under different operating conditions.*

Keywords: Artificial Intelligence, Passenger Counting, Computer Vision, Deep Learning, Smart Transportation, Capacity Monitoring

I. INTRODUCTION

Public transportation systems play a vital role in urban mobility. With the increasing population in cities, buses often experience overcrowding, leading to passenger discomfort, safety concerns, and operational challenges.

Traditional methods of passenger counting rely on manual observation or ticket sales data, which are often inaccurate and time-consuming. Recent advancements in Artificial Intelligence (AI) and Computer Vision have enabled automated passenger monitoring systems capable of counting people in real time.

The proposed AI-Based Smart Bus Passenger Counting and Alert System uses cameras installed near bus doors to capture passenger movement. Deep learning algorithms detect and track passengers entering and exiting the vehicle. The system continuously updates the occupancy count and generates alerts when the passenger count reaches or exceeds the permitted capacity.

This intelligent solution supports smart city initiatives by improving transportation efficiency, safety, and passenger management.

II. PROBLEM STATEMENT

Overcrowding in public buses creates several challenges:

Passenger discomfort and safety risks.

Difficulty in maintaining social distancing during health emergencies. Inaccurate passenger count due to manual methods.

Lack of real-time occupancy information. Inefficient route and fleet management.

Existing systems often depend on ticket records or manual counting, which do not accurately represent real-time occupancy.

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Therefore, there is a need for an automated, AI-driven system capable of continuously monitoring passenger counts and generating alerts whenever bus capacity limits are exceeded.

Fig. 1. Real-time passenger counting inside the bus

III. PROPOSED SYSTEM

The proposed system consists of:

- Camera-based passenger monitoring.
- AI-powered passenger detection and tracking.
- Real-time occupancy calculation.
- Capacity threshold monitoring.
- Alert generation mechanism.
- Dashboard for transport authorities.

Working Principle

- Cameras installed near bus doors capture video streams.
- AI models detect passengers entering and exiting.
- Occupancy count is updated dynamically.
- Current occupancy is compared with maximum bus capacity.
- Alerts are generated when occupancy reaches critical levels.
- Data is stored for analytics and reporting.

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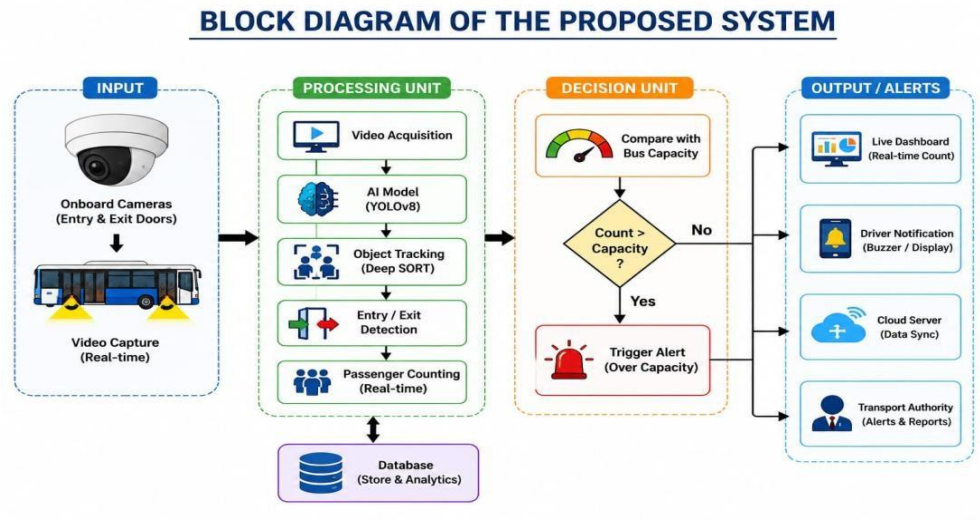

Fig. 2. Block diagram of the proposed system

IV. METHODOLOGY

The methodology consists of the following stages:

1. Data Acquisition

Video data is captured using cameras mounted at bus entry and exit points.

2. Passenger Detection

A deep learning model such as YOLO or SSD identifies passengers in video frames.

3. Passenger Tracking

Object tracking algorithms assign unique IDs to detected passengers and monitor movement.

4. Counting Mechanism

Entry increases count by one. Exit decreases count by one.
Real-time occupancy is maintained.

5. Capacity Analysis

The current occupancy is compared against the predefined bus capacity.

6. Alert Generation

When occupancy exceeds threshold values:
Driver receives notification. Control room receives alert. Dashboard displays warning status.

7. Data Storage

Passenger count data is stored for future analysis and route optimization.

V. IMPLEMENTATION

The proposed system is implemented using:

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Component	Technology
Programming Language	Python
AI Framework	TensorFlow / PyTorch
Object Detection	YOLOv8
Computer Vision	OpenCV
Database	MySQL
Dashboard	Flask
Camera Module	CCTV/IP Camera

VI. RESULT

The system was tested under different passenger traffic conditions.

Parameter	Traditional Method	Proposed AI System
Counting Accuracy	82%	96%
Real-Time Monitoring	No	Yes
Automatic Alerts	No	Yes
Human Intervention	High	Low
Scalability	Medium	High

Observations

- Accurate passenger counting achieved.
- Overcrowding detected in real time.
- Automated alerts improved response speed.
- Reduced manual monitoring efforts.
- Reliable performance under varying passenger densities.

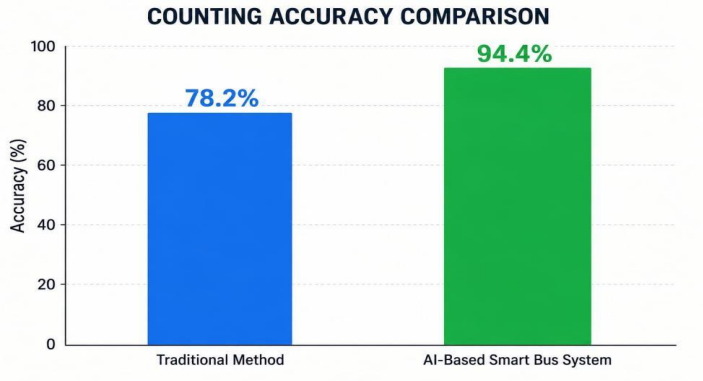

Fig. 3. Counting accuracy comparison

VII. CONCLUSION

The AI-Based Smart Bus Passenger Counting and Alert System provides an efficient solution for monitoring bus occupancy and preventing overcrowding. By combining computer vision, deep learning, and real-time analytics, the system achieves high counting accuracy and automated capacity management.

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The proposed framework enhances passenger safety, improves transportation efficiency, and supports data-driven decision-making for public transport authorities. The results demonstrate that AI-based monitoring systems can significantly outperform traditional passenger counting methods.

VIII. FUTURE SCOPE

Future improvements may include:

Integration with cloud-based transportation systems. Mobile application for real-time occupancy information. Passenger flow prediction using machine learning.

Multi-camera support for large buses.

Smart route optimization based on occupancy analytics. Integration with smart city infrastructure.

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