International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 04 | April - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

Public Transport Crowd Estimation via Bus Stop Images Using AI

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Abstract -: Urban areas are rapidly expanding, increasing pressure on public transportation systems. Bus stops often become overcrowded, causing inconvenience, safety risks, and service delays. Traditional methods of monitoring passenger density, such as manual counting and ticket-based estimation, are often slow and inaccurate, and lack real-time insights.This research proposes an Artificial Intelligence-based crowd estimation system using images captured from cameras installed at bus stops. The system applies computer vision and deep learning techniques to automatically detect and count passengers. Models such as Convolutional Neural Networks (CNNs) and object detection algorithms like YOLO or Faster R-CNN are used to identify individuals under varying conditions such as lighting, occlusion, and weather.The system continuously monitors passenger density and provides real-time data to transportation authorities. This helps identify peak hours, optimize bus schedules, reduce congestion, and improve passenger safety, contributing to more efficient public transport management.

1.INTRODUCTION

Public transportation plays an important role in supporting daily travel for millions of people in urban environments. However, increasing population density in cities has created several challenges for transportation authorities, particularly in managing passenger flow at bus stops.

In many cities, bus stops become overcrowded during peak hours. Overcrowding leads to longer waiting times, discomfort for passengers, and sometimes unsafe situations. Monitoring passenger density manually is difficult and often inaccurate. Human observation methods require significant effort and cannot provide real-time data that can help authorities make quick decisions.

Recent developments in Artificial Intelligence (AI) and computer vision have made it possible to automatically analyze images and videos for crowd detection. AI-based systems can detect and count individuals in images with high accuracy. This technology allows transportation systems to monitor crowd density continuously and efficiently.

The proposed project focuses on estimating crowd density at bus stops using image analysis. Cameras capture images of waiting passengers, and deep learning algorithms analyze the images to detect individuals and estimate the total number of people present. This information can then be used to improve bus scheduling, reduce congestion, and enhance passenger safety.

2.SYSTEM DESCRIPTION

The proposed system consists of several components that work together to monitor passenger density at bus stops.

1.Camera System

Cameras are installed at bus stops to capture images or short video frames of passengers waiting for buses.

2.Image Processing Unit

The captured images are processed to improve quality. Preprocessing techniques such as resizing, noise reduction, and normalization are applied.

3.AI-Based Detection Module

Deep learning algorithms such as YOLO or Faster R-CNN analyze the processed images to detect and count people in the scene.

4.Data Analysis System

The detected crowd data is stored and analyzed to understand patterns such as peak hours and passenger flow trends.

5.Visualization Dashboard

The processed information is displayed on a dashboard or web application that allows transport authorities to monitor crowd levels in real time

3. WORKING METHODOLOGY

The system works through a sequence of steps to estimate crowd density at bus stops.

A. Image Preprocessing:
Captured images are enhanced using image processing techniques. This may include resizing, brightness adjustment, noise removal, and normalization.

B. Human Detection:
The processed images are analyzed using deep learning models such as YOLO or Faster R-CNN. These algorithms detect individuals in the image.

C. Crowd Counting:
After detecting people in the image, the system counts the number of individuals present. CNN-based density estimation methods help improve accuracy when the crowd is dense.

D. Data Analysis:
The system stores the estimated crowd counts and analyzes them over time to identify peak hours and passenger flowpatterns

E .Output Visualization:
The results are displayed on a dashboard or web application. Authorities can monitor the crowd level and receive alerts when overcrowding occurs

4. TECHNOLOGIES USED

A. Artificial Intelligence (AI):
AI enables the system to analyze visual data automatically and identify patterns related to crowd density.

B. Computer Vision:
Computer vision techniques allow the system to interpret images captured by cameras and extract useful information.

C. Convolutional Neural Networks (CNN):
CNN models are used for image recognition tasks. They help identify people in images and estimate crowd density.

D.YOLO / Faster R-CNN:
These object detection algorithms are capable of detecting multiple individuals in a single frame with high accuracy.

E. Image Processing Tools:
Libraries such as OpenCV are used to preprocess images before deep learning analysis.

F .Web Technologies:
Technologies such as HTML, CSS, JavaScript, and Python frameworks are used to create the dashboard interface.

5.SYSTEM ARCHITECTURE AND MODLES

The proposed system consists of four main modules.

- Image Acquisition Module – Captures images from cameras installed at bus stops.
- Preprocessing Module – Enhances captured images for accurate analysis.
- Crowd Detection Module – Detects and counts individuals using deep learning models.
- Visualization Module – Displays crowd density information on a dashboard.

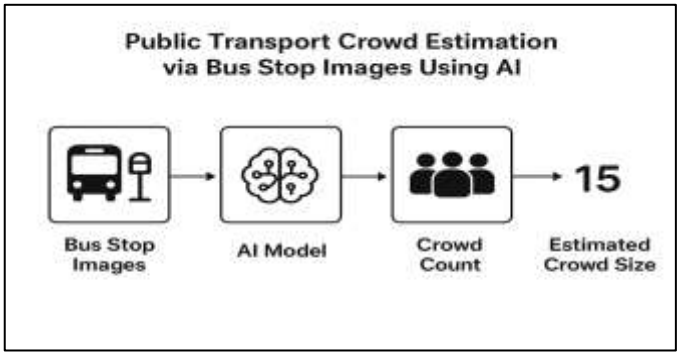

Fig1. Block Diagram

6.ADVANTAGES OVER TRADITIONAL METHODS

The proposed system provides several benefits compared to manual monitoring techniques.

- Provides real-time crowd monitoring
- Reduces dependency on manual observation
- Improves bus schedule planning
- Enhances passenger safety

- Helps manage peak-hour congestion
- Supports data-driven transportation management

7.LIMITATIONS

The proposed system also has some limitations.

- Requires high computational power
- Accuracy drops in very dense crowds
- Affected by weather and lighting conditions
- Needs large datasets for training

8.FUTURE ENHANCEMENTS

The system can be improved in the future by implementing several additional features.

- Integration with smart city transport systems for better coordination
- Mobile apps to provide real-time passenger information
- Edge computing to enable faster data processing
- Real-time bus arrival prediction for improved planning
- Advanced AI models to enhance accuracy in dense crowds

The Public Transport Crowd Estimation System, utilizing bus stop image analysis, provides an intelligent and efficient solution for monitoring passenger density in urban transportation networks. By leveraging advanced Artificial Intelligence (AI) and computer vision techniques, the system can automatically detect and count individuals from images captured at bus stops, ensuring accurate and reliable crowd estimation.

This capability supports effective decision-making for transport authorities, enabling better resource allocation, improved passenger flow management, and enhanced overall service quality. Furthermore, the system contributes to a more organized and responsive public transportation infrastructure.

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