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# Smart Public Queue Traffic Analyzer and Decision Assistant Using Computer Vision

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**Abstract:** *Waiting in public service queues has become a daily challenge in places like colleges, hospitals, railway stations, and government offices. People often join queues without knowing how long they will have to wait, which wastes their time and creates frustration. This paper describes a practical solution: a Smart Public Queue Analyzer that uses computer vision to help people make better decisions about joining queues. The system analyzes images or videos of queues, detects people using pre-trained vision models (OpenCV HOG + SVM), and calculates expected waiting time based on the type of service. It then provides simple recommendations such as "Go Now," "Moderate Wait," or "Come Later." What makes this approach practical is that it does not need any special hardware or model training—just a camera and a web browser. Testing on real scenarios from college offices, hospitals, railway counters, and supermarkets shows the system works well enough for everyday use. The visual feedback with bounding boxes helps users trust the results, while the rule-based logic keeps everything transparent and explainable.*

**Keywords:** Computer Vision, Queue Analysis, People Detection, HOG+SVM, Decision Support Systems, Public Services, OpenCV, Frame Sampling, Waiting Time Estimation

## I. INTRODUCTION

Physical queues are still common in places like colleges, hospitals, and railway stations, where people often don't know how long they will have to wait. This uncertainty wastes time and causes stress. Although computer vision has advanced in crowd counting, most solutions are complex and expensive, making them impractical for everyday use. This system focuses on a simple goal: helping people decide whether to join a queue. By analyzing a photo or short video, it estimates wait time and gives a clear recommendation. It works directly in a web browser without special hardware, following three principles: practicality (no extra setup), transparency (rule-based and explainable), and accessibility (runs on normal devices).

## II. LITERATURE SURVEY

In the field of AI-powered queue analysis, various studies have explored the use of computer vision and deep learning techniques, particularly Convolutional Neural Networks (CNNs) and object detection models, for analyzing crowd density and human presence. Researchers have focused on improving people detection accuracy, estimating queue length, and ensuring computational efficiency for real-time decision-making.

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## III. METHODOLOGY

### 3.1 People Detection Methodology

For people detection, the system employs a pre-trained OpenCV HOG + Linear SVM detector rather than training from scratch. This decision stems from practical constraints: training requires large labeled datasets and significant computational resources, neither of which most public institutions have access to. Pre-trained models work well for this use case since the system only needs to count people, not identify them or track complex behaviors.

The detection focuses exclusively on the "person" class, filtering out all other objects that might appear in public spaces. This simplification speeds up processing considerably while maintaining the accuracy needed for queue counting. The HOG descriptor captures edge and gradient structure information from each frame, and the Linear SVM classifier then identifies regions containing persons.

### 3.2 Queue Size Estimation

Queue size estimation differs based on input type. When working with still images, the queue size equals the number of people detected in that single frame. This direct approach works fine because images represent a specific moment in time. Video inputs require more consideration: people move around, temporarily block each other from the camera's view, and detection is not always perfect on every frame. Rather than using a single frame's count, the system samples multiple frames throughout the video and averages their detection counts.

### 3.3 Frame Sampling for Video Processing

For video inputs, processing every frame would be computationally expensive and unnecessary. The system therefore samples frames at fixed intervals to analyze queue dynamics efficiently. Frames are extracted at regular time intervals, people detection is applied to each sampled frame independently, and the detected people count is stored for each frame. The final queue size estimate is the average count across all sampled frames. This method reduces computational load significantly while maintaining representative information about the queue. Testing showed that averaging produces more stable, reliable queue size estimates than using maximum counts or single-frame snapshots.

### 3.4 Decision Classification Logic

The decision engine uses fixed thresholds to convert waiting time into actionable recommendations. Waits under 10 minutes are classified as "Go Now" — these are short enough that most people will not mind waiting. Waits between 10 and 20 minutes fall into "Moderate Wait" territory, where joining the queue is reasonable if the task is important but might be worth postponing if flexibility exists. Anything over 20 minutes triggers a "Come Later" recommendation, suggesting users return when the queue has died down. The rule-based classification ensures the system behaves predictably, which helps during testing and makes it easier to explain the logic to users and evaluators.


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## IV. SYSTEM ARCHITECTURE

This project is designed to efficiently analyze public queues using computer vision and provide accurate waiting time estimates and decision recommendations.

### 4.1 User Interface Layer

Provides a web-based interface where users upload images or videos and select their queue type from options including college office, hospital, railway counter, or supermarket. This layer handles all user interaction and displays results through a Gradio-powered interface.

### 4.2 Image Preprocessing Module

Handles both image and video formats. For images, it passes them directly to detection. For videos, it samples representative frames at regular intervals to reduce computational load while maintaining accuracy.

### 4.3 People Detection Module

Runs the OpenCV HOG + SVM pre-trained computer vision model that identifies individuals in the scene. Only the "person" class is detected to keep processing fast and focused. The module draws bounding boxes around each detected person.

### 4.4 Queue and Waiting Time Estimation Module

Based on the diagnosis, the system suggests specialized hospitals near the user’s location. The system provides contact details and relevant links for consultation.

### Result Display & Report Generation

The system displays the final queue analysis results in a simple and user-friendly format. It shows the number of people detected, estimated waiting time, and a recommendation such as “Go Now,” “Moderate Wait,” or “Come Later.” The processed image or video with bounding boxes is also shown for verification. Users can download or share the queue analysis report. The Smart Public Queue Traffic Analyzer uses computer vision and rule-based decision logic to provide a fast and efficient queue management solution. It helps users save time and make better decisions about joining queues in public places like colleges, hospitals, railway stations, and supermarkets.

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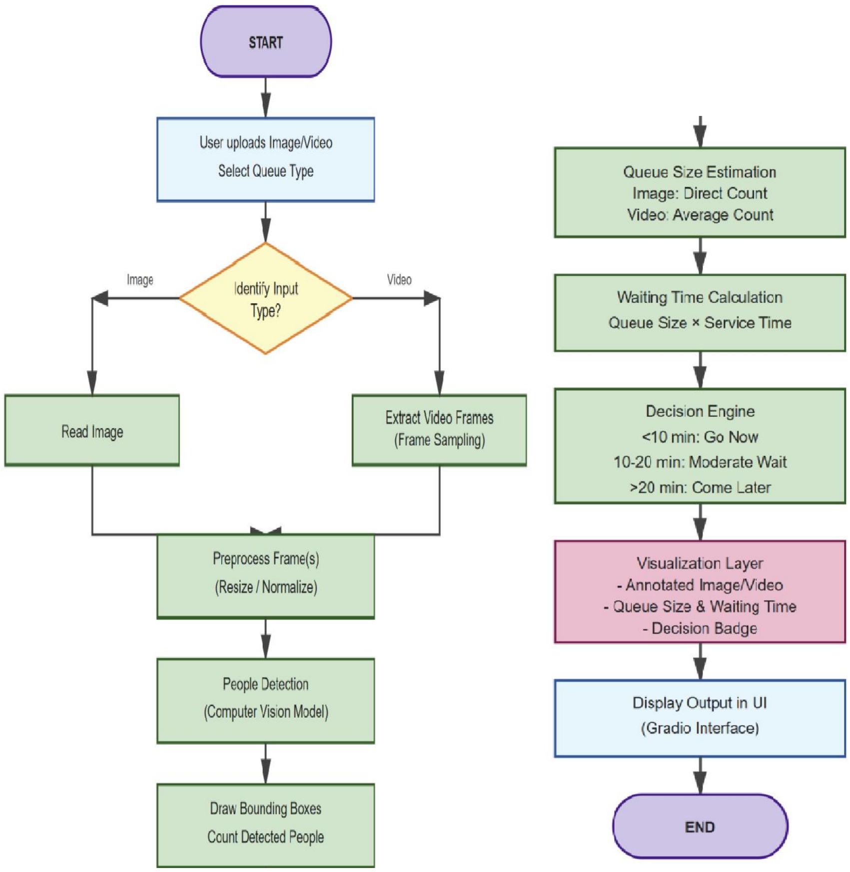
### 4.5 Flow Chart




## V. RESULTS AND DISCUSSION

### 5.1 Output

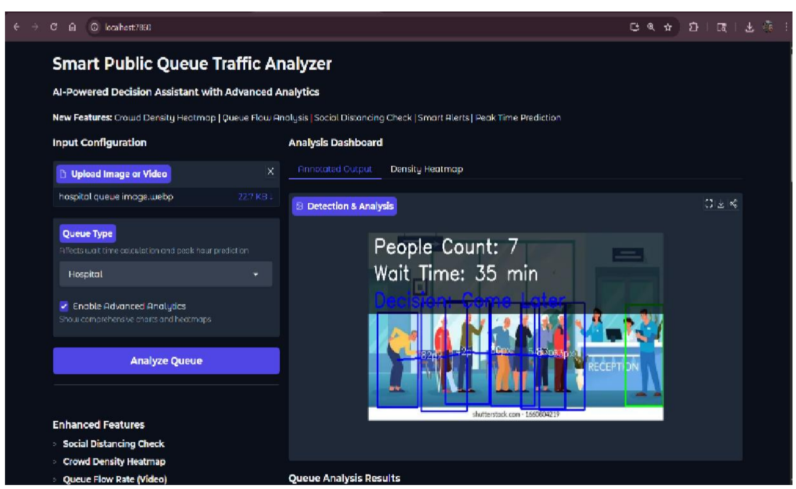



Figure 5.1


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Figure 5.2

### 5.2 DETECTION ACCURACY

The accuracy of the Smart Public Queue Traffic Analyzer depends on the performance of the people detection model and input quality. Using the OpenCV HOG + SVM approach, the system achieves reliable detection accuracy in normal conditions such as clear lighting and moderate crowd density. The model performs well for real-time queue counting with satisfactory precision. Accuracy is improved by frame averaging for video inputs, which reduces noise caused by movement and occlusion. Overall, the system provides consistent and practical results suitable for real-world queue analysis.

### 5.3 CHALLENGES AND SOLUTIONS

The system faces challenges such as reduced accuracy in dense crowds, occlusion of people, poor lighting conditions, and variation in camera angles. Additionally, fixed service time assumptions may affect waiting time estimation accuracy. To address these issues, frame sampling and averaging techniques are used to improve detection stability. Proper camera positioning and lighting conditions enhance detection performance. The use of lightweight models ensures fast processing without high computational requirements. Future improvements like advanced models (e.g., YOLOv8) can further enhance accuracy. These solutions make the system efficient, practical, and user-friendly for real-world deployment.

## VI. CONCLUSION

This project presented a Smart Public Queue Analyzer that helps users make better decisions about joining public service queues by analyzing images or videos using computer vision and estimating waiting time through simple rule-based logic. The system provides clear recommendations such as “Go Now,” “Moderate Wait,” or “Come Later,” helping users save time and reduce unnecessary waiting. The system is practical, low-cost, and easy to deploy since it does not require special hardware or complex infrastructure. Overall, the project demonstrates that a simple computer vision–based solution can effectively improve queue management and user decision-making in public service environments.

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