TEXAS TECH UNIVERSITY SYSTEM™

Smart Waiting Room System

Enhancing Efficiency through AI and Computer Vision

Adaptive Learning System

Final Project Proposal

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1. Introduction

- Purpose: To accurately track the number of people in a waiting room and estimate wait times using advanced AI technologies.

- Need: Improve management, reduce perceived wait times, and enhance visitor experience.

Outline:

- Problem Statement
- Proposed Solution
- Technologies Used
- System Workflow
- Benefits and Potential

2. Problem Statement

Current Challenges:

- Inefficiencies in traditional waiting room management.
- Unpredictable and often inaccurate wait times.
- Increased dissatisfaction among visitors.

Impact:

- Poor experience affects service perception.
- Stressful environment for both staff and visitors.

3. Proposed Solution

System Overview:

- Use of object detection and tracking to monitor the number of people.
- Application of the Kalman Filter to estimate dynamic wait times.

Components:

- Real-time human detection.
- Advanced tracking for accurate count.
- Time estimation model based on current data.

4. Technologies Employed

Object Detection:

- YOLOv8: Latest in the series of You Only Look Once models, known for its speed and accuracy in object recognition.

Object Tracking:

- ByteTracker: State-of-the-art tracking algorithm that effectively handles identity switches and occlusions.

Image Processing:

- OpenCV: Utilized for image enhancements and setting up virtual boundaries in the waiting area.

Data Filtering:

- FilterPy: A Python library implementing the Kalman Filter for smoothing and predicting wait times.

5. System Architecture

Camera Setup:

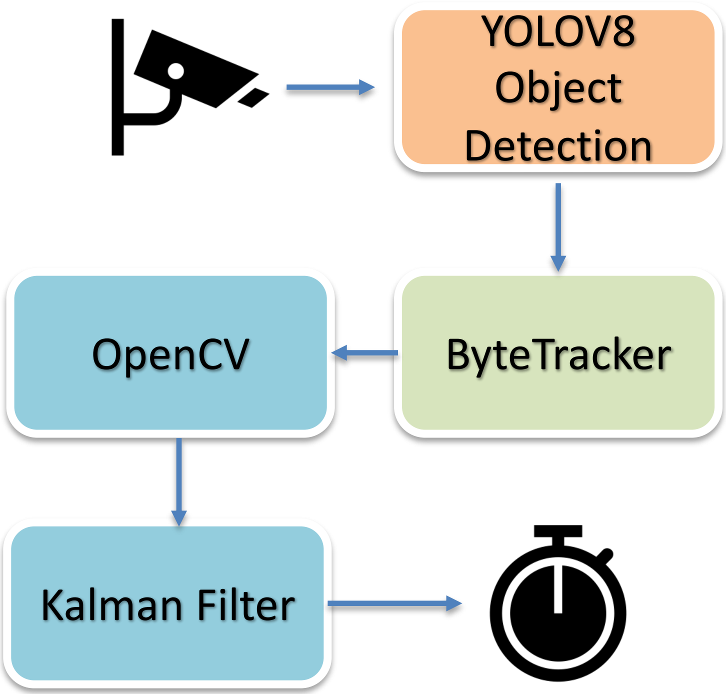
- Strategically placed to cover the entire waiting area.

Data Flow:

- Real-time video input to the YOLOv8 model for detection.
- Detected outputs handed over to ByteTracker.
- Tracking information fed into the Kalman Filter for predictions.

Output:

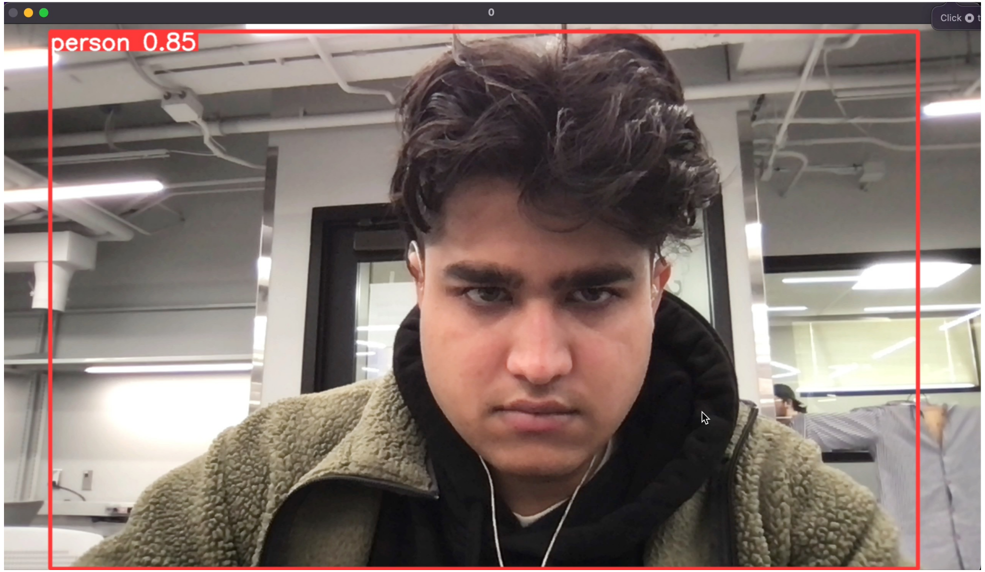
- Current wait time predictions displayed on monitors in real-time.



6. YOLOv8 & ByteTracker Integration

YOLOv8:

- Implements deep learning algorithm (CNNs) for feature extraction and object classification.
- High Speed and accuracy, suitable for real-time processing
- https://youtu.be/vG4xJKmtQE0



ByteTracker:

- Takes output from the YOLOV8 and performs tracking
- Handling occlusions and maintaining consistency in identity tracking.

7. Kalman Filter Implementation

Theory: a powerful algorithm used to estimate the state of a linear dynamic system from a series of noisy measurement.

$$\dot{x}=Fx+Gu+w$$

- Predict: the filter predicts the future state of the waiting room e.g., expected no. of people, wait time… based on the current state and the known process dynamic e.g., average time taken by current people.
- Update: As new data arrives from the object detection and tracking system (e.g., a person leaves the waiting room), the filter updates its predictions. It incorporates the new measurement, adjusting the estimated wait time by considering both the predicted state and the new information, to reduce the uncertainty.

Application:

- Customizing the FilterPy library to the specific needs of wait time prediction.
- Continuous update mechanism based on new and exiting individuals.

8. Benefits & Potential

Immediate Benefits:

- Accurate real-time wait time estimates.
- Enhanced visitor satisfaction and resource management.

Future Applications:

- Scalability to other settings like hospitals, banks, etc.
- Integration with app notifications or digital kiosks.

9. Conclusion & Questions

Key Points:

- Fixing the inefficiency in traditional waiting rooms.
- YOLOV8, ByteTracker, OpenCV, & Kalman Filter.
- Improve real time wait time results, & Human statisfaction.

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