Vivekanand Education Society's Institute of Technology

Department of Computer Engineering

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Project Synopsis Template (2024-25) - Sem V

RailRelax: Enhancing Train Travel Comfort

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Abstract:
The daily discomfort and uncertainty faced by passengers seeking seats in crammed trains, particularly during peak hours, necessitate a solution to enhance travel comfort and optimize train capacity. The project aims to develop a real-time occupancy monitoring system for train compartments using advanced image-processing technology. By capturing and analyzing video inputs from multiple cameras installed in each compartment, the system accurately counts standing and seated passengers. The system reports real-time occupancy data to passengers and train operators, facilitating better passenger distribution before train arrival at stations. The multi-camera setup, including overhead, angled, and platform-level positioning, ensures comprehensive coverage and high accuracy. This innovative approach promises to improve the public transport experience, providing a more comfortable and efficient journey for passengers.

Introduction:-
Many passengers have to endure a lot of pain and discomfort daily in crammed trains looking for a seat to be seated. Most of them stand up due to uncertainty about whether some seats are available or not, adding strain to an already tiring journey. In particular, train compartments are full during peak hours, and it's tough for a person looking for an open seat.

We are working on a project in which, by using image-processing technology, we wish to ease this very issue. This technology aims to ensure the best travel experience for passengers by letting them know in real-time which seats are available in all train compartments. It will count the total number of passengers and spot free space to help the passengers find seats for themselves and have a comfortable, happy journey. This ingenuity also ensures more comfort for passengers, thereby helping in optimizing the use of train capacity to ultimately provide a better public transport system.

Problem Statement:-

Design and implement a real-time system to monitor and report the occupancy status of train compartments. The system processes video inputs from multiple cameras installed in each compartment, accurately counting the number of standing and seated passengers. The goal is to deliver reliable occupancy data to passengers and train operators before the train enters the station, facilitating better passenger distribution and enhancing travel comfort.

Proposed Solution:-

Video Capture and Preprocessing:

- The video camera captures continuous footage of people at the train doors.
- Preprocessing steps like frame extraction, resizing, and normalization are performed to prepare the video for analysis.

Background Subtraction:

- This technique helps in identifying moving objects (people) by comparing each frame with a background model.
- Common methods include Gaussian Mixture Models (GMM) or more advanced deep learning-based background subtraction techniques.

Object Detection:

- A deep learning model, such as a Convolutional Neural Network (CNN), is used to detect people in each frame.
- Popular models include YOLO (You Only Look Once), SSD (Single Shot MultiBox Detector), or Faster R-CNN.

Object Tracking:

- After detecting people, the next step is to track them across frames.
- Algorithms like SORT (Simple Online and Realtime Tracking) or DeepSORT can be used.
- These algorithms associate detected objects in consecutive frames based on their positions and appearances.

Counting People:

- The system identifies and counts people as they cross predefined entry and exit lines.
- The entry and exit lines are virtual lines drawn at the train door.
- When a person crosses an entry line, the count of people getting on the train increases, and similarly, crossing the exit line increases the count of people getting off.

Data Aggregation and Reporting:

- The counting data is aggregated over a specified period (e.g., per minute, per hour) to generate useful statistics.
- This data can be used to understand passenger flow, peak times, and for planning and resource allocation.

For capturing the number of people the camera's would have to be positioned in the following ways:

Overhead Positioning:

- Cameras are mounted on the ceiling directly above the train doors.
- This position provides a clear view of people entering and exiting without obstructions.
- It minimizes occlusions (where one person blocks the view of another) and provides a top-down perspective, making it easier to detect individuals and their movements.

Angled Positioning:

- Cameras are placed at an angle, mounted on the sidewalls near the doors.
- This allows for capturing a broader view of the platform and the train door area.
- It can help in scenarios where overhead mounting is not possible or when additional context of the surrounding area is needed.

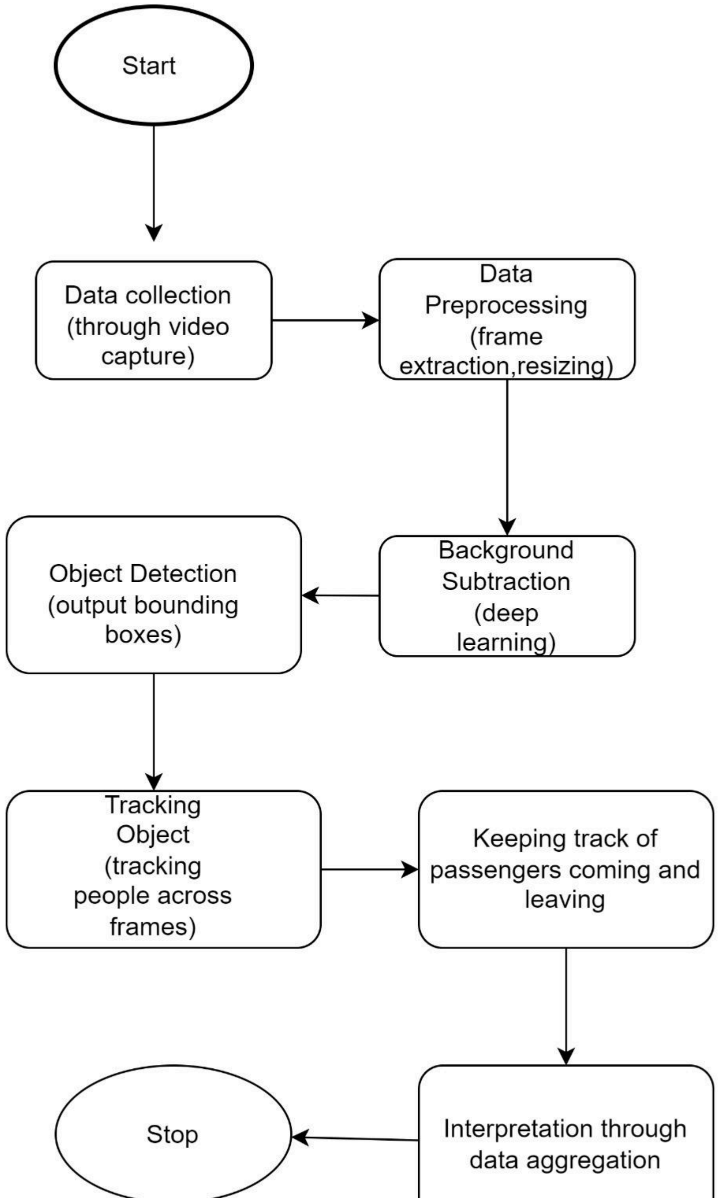
Platform-Level Positioning:

- Cameras are installed at platform level, facing the train doors.
- These cameras capture the front or side views of people, providing additional perspectives that can be useful for detection and tracking.
- However, this position is more prone to occlusions and may require multiple cameras to cover all doors adequately.

Multi-Camera Setup:

- A combination of overhead, angled, and platform-level cameras can be used to ensure comprehensive coverage.
- Multi-camera setups help in reducing blind spots and improving accuracy through redundancy.

Methodology / Block Diagram



Hardware , Software and tools Requirements

Hardware Requirements:

a. Cameras:
- High-resolution video cameras (preferably with night vision capabilities) for overhead, angled, and platform-level positioning.

b. Processing Units:
- High-performance GPUs (e.g., NVIDIA GeForce RTX series) for real-time video processing and deep learning model execution.

- Dedicated servers or edge devices for running the object detection and tracking algorithms.

c. Storage:
- High-capacity storage solutions to store video footage and processed data.

d. Network Equipment:
- High-speed network infrastructure (routers, switches) to handle the large amount of data transfer from cameras to processing units.

Software Requirements:

a. Operating System:
- Linux-based operating systems (e.g., Ubuntu) for servers and processing units.

b. Deep Learning Frameworks:
- TensorFlow or PyTorch for implementing and training the object detection and tracking models.

c. Computer Vision Libraries:
- OpenCV for video processing and background subtraction.

d. Database:
- SQL or NoSQL databases (e.g., MySQL, MongoDB) for storing processed data and statistics.

Tools Requirements:

a. Development Tools:
- Python as the primary programming language for developing the system.
- Jupyter Notebooks for experimentation and model development.

b. Integrated Development Environment (IDE):
- PyCharm or Visual Studio Code for code development and debugging.

c. Version Control:
- Git for version control and collaboration.

d. Containerization:
- Docker for containerizing the application components to ensure consistency across different environments.

e. Cloud Services:
- AWS, Azure, or Google Cloud Platform for scalable storage, processing power, and database services.

Proposed Evaluation Measures:

1. Accuracy:
   - **Detection Accuracy:** Measure the percentage of passengers correctly identified by the system compared to manual counts.
   - **Tracking Accuracy:** Evaluate how well the system tracks individual passengers across frames without losing them or creating duplicates.

2. Precision and Recall:
   - Precision: The ratio of true positive detections to the total number of detections made. It measures the system's ability to avoid false positives.
   - Recall: The ratio of true positive detections to the actual number of passengers. It measures the system's ability to detect all relevant instances.

3. Latency:
   - Measure the time taken from capturing the video to reporting the occupancy status. Lower latency ensures real-time data delivery to passengers and operators.

4. Scalability:
   - Evaluate the system's performance when scaled to multiple train compartments and increased number of passengers.
   - The system should maintain accuracy and low latency as the number of cameras and passengers increases.

5. Reliability:
   - Uptime: Measure the system's uptime and ensure it operates continuously without failures.
   - Error Rate: Track the number of errors or failures over a specific period. The system should have a low error rate to be deemed reliable.

6. Cost effectiveness:
   - Compare the costs of implementing and maintaining the system against the benefits gained in terms of improved passenger distribution and comfort.
   - The system should provide a positive return on investment.

7. Integration:
    - Evaluate how well the system integrates with existing train and station infrastructure, including compatibility with current monitoring systems and ease of installation

Conclusion:
In summary, the real-time train occupancy monitoring system offers a transformative approach to improving public transportation through advanced technology.

1. Enhanced Public Transportation:
- The real-time train occupancy monitoring system represents a significant improvement in public transportation through the use of modern image-processing and deep learning technologies.

2. Addressing Overcrowding:
- The system effectively addresses the issue of overcrowded trains during peak hours by accurately detecting, tracking, and counting passengers.

3. Comprehensive Methodology:
- The project employs a thorough methodology including video capture, preprocessing, background subtraction, object detection, and tracking, ensuring effective passenger monitoring.

4. Detailed Evaluation Measures:
- The project outlines clear evaluation measures, such as accuracy, latency, scalability, and robustness, to assess the system's performance and reliability.

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