### **Methodology for People Tracking**

### **1. Data Collection and Preprocessing**

* **Video Input:** Surveillance videos are collected and stored in a Google Drive folder, each approximately 20 seconds long.
* **Preprocessing:** The videos are preprocessed using OpenCV to standardize frame rates and resolutions. The preprocessing also includes background subtraction to enhance foreground detection.

#### **2. People Detection**

* **YOLOv5 Model:** The YOLOv5u model (yolov5su.pt) is employed to detect people in the video frames. The model is chosen for its balance between speed and accuracy.
* **Bounding Box Extraction:** The detected individuals are enclosed within bounding boxes, which are used to track their movements across frames.

#### **3. Person Re-Identification**

* **Feature Extraction:** ResNet50 is utilized to extract unique feature vectors for each detected person. These features represent the individual's appearance and are invariant to changes in lighting and viewpoint.
* **Self-Supervised Learning for Unsupervised Re-Identification:** A self-supervised learning framework is implemented to perform unsupervised re-identification. This method refines the feature embeddings, making them more discriminative across different video segments.
* **Unique ID Assignment:** Each person detected across multiple frames and videos is assigned a unique identifier. The system ensures consistent identification even when the individual reappears in different videos.

#### **4. Trajectory Tracking and Analysis**

* **Path Tracking:** The paths of individuals are tracked frame by frame. This is achieved by linking the bounding boxes of the same individual across consecutive frames using the extracted feature vectors.
* **Path Annotations with Contextual Information:**
  + **Context-Aware Path Annotations:** In addition to basic trajectory tracking, the system annotates paths with contextual information. This includes interactions between individuals, proximity to specific locations (e.g., entrances, exits, high-traffic zones), and the duration spent in these areas.
  + **Heatmap Generation:** A heatmap is generated to visualize areas with high density of activity, providing insights into movement patterns within the monitored area.

#### **5. Output Generation**

* **Path Summaries:** For each individual, a detailed summary of their movement is generated, including entry/exit times, paths taken, time spent in different areas, and any interactions with other individuals.
* **Analytical Insights:** The system provides analytics on high-traffic areas, common paths, and regions where people tend to congregate, offering actionable insights for surveillance and security purposes.

#### **6. System Evaluation and Improvement**

* **Performance Metrics:** The system’s performance is evaluated based on metrics like detection accuracy, re-identification precision, and tracking consistency.
* **Iterative Refinement:** The models and methods are iteratively refined based on evaluation results to enhance the system's overall effectiveness.

Highlighted areas were considered as a novelty for this component.