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Automatic Traffic Monitoring and Management for Pedestrian and Cyclist Safety Using Deep Learning and Artificial Intelligence

Project 1808
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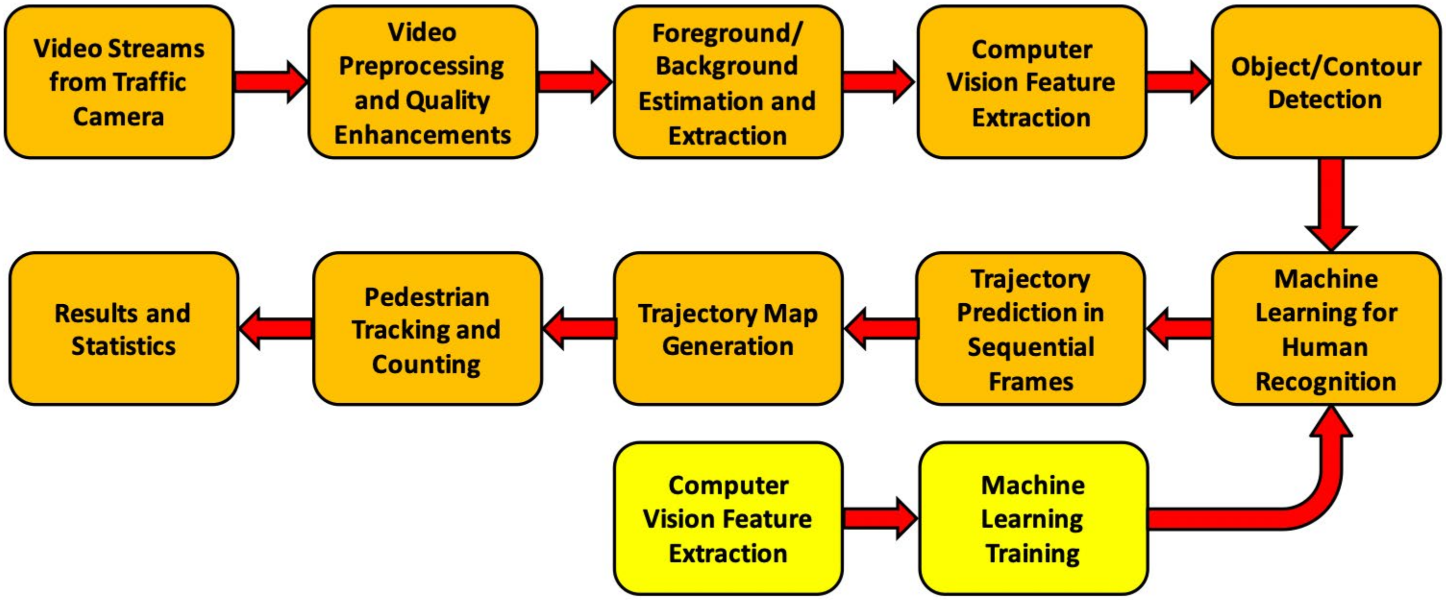

Figure 1. End-to-End Architecture

According to the US Department of Transportation, the number of traffic fatalities in the state of California was 3,623 in 2016, which is more than 9.2 deaths per 100,000 population (USDOT 2016). The city of Los Angeles alone has one of the highest rates of traffic death among large U.S. cities. The most vulnerable elements in traffic accidents are pedestrians and cyclists. Nonetheless, there is no efficient automated system for monitoring the movement of pedestrians and bicyclists across the state of California and in major urban areas.

In this project, the researchers designed and developed an effective system to automatically monitor, track, and count pedestrians and bicyclists based on computer vision and machine learning algorithms. The developed system includes algorithms for detecting the pedestrians and bicyclists, as well as algorithms for tracking and counting the pedestrians. It is important to notice that in this project, we are not planning to install new cameras or add new components or sensors to the traffic operation infrastructure. The system can use the videos captured by existing traffic cameras operated by Caltrans.

Study Methods

In this project, we developed an end-to-end system including a series of image/ video processing algorithms, computer vision algorithms, Machine Learning algorithms, and optimal state estimator algorithms that receive videos and monitor, recognize, track, and count pedestrians and cyclists in the video (Figure 1 shows the high-level system architecture).

The first step in our end-to-end traffic vision system is the raw video preprocessing, which includes a series of algorithms for quality enhancement, and brightness and contrast adjustment. After data preprocessing, the next step is to extract and select the best set of computer vision features that can be used in machine learning algorithms for object detection. In this projects, we have developed and used deep learning models, particularly the Convolutional Neural Networks (ConvNet), R-CNN (Regions with CNN features) and YOLO (You Only Look Once) algorithms (Ren et al. 2015, Redmon et al. 2016, Zarchan and Musoff 2000).

After detecting a target object (e.g., a pedestrian or bicyclist) in several sequential frames, we use Optimal State Estimator to estimate the Trajectory of each object. Since several objects may exist in each frame at a time (e.g., several pedestrians walking together in the same direction or different directions), it is essential to estimate the trajectory of each object individually. To this end, we use the Kalman Filter (Zarchan and Musoff 2000) as an optimal state estimator to predict the next location of the object and estimate the trajectory of the object over time. Every time we detect a pedestrian whose location does not match any of the previously predicted locations (i.e., the pedestrian is not located on any of the existing estimated trajectories), we consider that person as a new pedestrian and, consequently, add to the pedestrian counter. This will allow us to monitor and count each pedestrian everywhere in the video, and avoid double counting them in sequential frames.

This project introduced an effective system to automatically monitor and count pedestrians and cyclists. It can help increase safety through better traffic management and planning.

Findings

We evaluated our methods and the developed system on 12 hours of real videos captured by actual traffic cameras. Despite the low quality of some of the videos, the results demonstrated the high accuracy and effectiveness of the developed system in automatically detecting and counting pedestrians and bicyclists. This approach particularly enables us to recognize and monitor busy intersections that are prone to traffic accidents, and allows us to control and manage traffic in those intersections to protect our pedestrians and bicyclists.

About the Author

Dr. Mohammad Pourhomayoun is an Assistant Professor of Computer Science at California State University Los Angeles (CSULA). He is the founder and director of Artificial Intelligence & Data Science Research Lab at CSULA. Dr. Pourhomayoun's research interests focus on Data Science, Artificial Intelligence (AI), and Machine Learning for social good.

To Learn More

For more details about the study, download the full report at transweb.sjsu.edu/research/1808

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