

Video Analytics in Smart Transportation for the AIC'18 Challenge

Introduction

Motivation:

- Ubiquitous street cameras generate enormous amount of data.
- AI technologies are readily applicable to help analyze real-world videos.
- Automatic traffic data analysis can improve congestion control, safety, accident recovery, and transportation infrastructure planning.



Summary:

- In Track 1 challenge, we demonstrated automatic traffic flow analysis using vehicle detection and tracking with robust speed estimation.
- In Track 2 challenge, we developed a reliable anomaly detection pipeline that can recognize abnormal stalled vehicles with precise location and time.
- In Track 3 challenge, we presented early results of vehicle re-identification by combining vehicle detection/tracking with the deep triplet-loss features that can match vehicles across 4 sites from long hours of videos.

AICity'18 Challenge

Datasets

- 35+ hours of street intersection and highway data from CA and Iowa
- Track 1: 4 CA locations, 27 minutes of videos
- Track 2: 20+ Iowa locations, 25 hours of all-weather, day/night videos
- Track 3: 4 CA locations, 15 hours of videos



Evaluation

- Track 1: $S1 = DR * (1 - NRMSE \text{ of speed})$
- Track 2: $S2 = F1 * (1 - NRMSE \text{ of stall time})$
- Track 3: $S3 = 0.5 * (\text{Target Detection Rate} + \text{Localization Precision})$

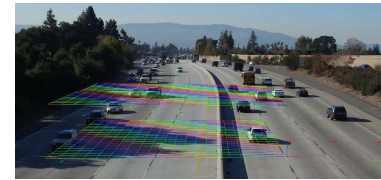
Vehicle Detection

- Faster R-CNN inception ResNet v2 atrous model from Google Object Detection API.
- Trained on COCO dataset, fine-tuned on UA-DETRAC dataset.
- New results using Mask-RCNN.



Track 1. Traffic Flow Speed Analysis

Camera Calibration

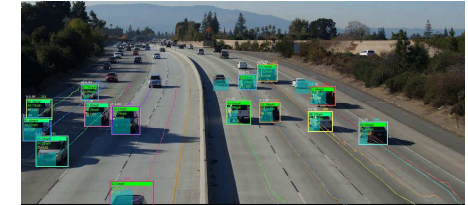


Camera PMat
Ground plane projection

Online Tracking

Ground plane tracking using confidence-aware Kalman filtering

Vehicle Tracks with Speed Estimation



Offline speed denoising & post-processing

Track 2. Anomaly Detection

(1) Flow Density Estimation

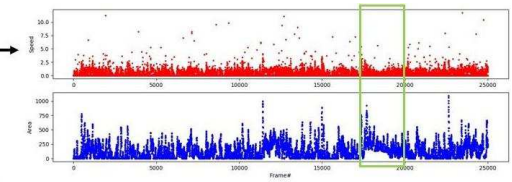
Background subtraction + averaging



(3) Patch-based Feature Extraction



Speed: optical flow low in a time window for anomaly
Foreground: # pixels high in a time window for anomaly



(2) ROI Extraction



(4) Thresholding & Cleaning for Anomaly Output



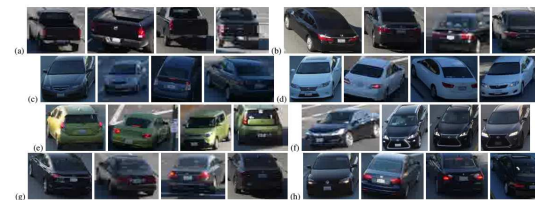
Track 3. Multi-Camera Vehicle Re-identification

Assumption

- Vehicles of interest must appear at all 4 sites at least once.

Pipeline

- Vehicle detection & tracking (by applying Track 1 method).
- Extract deep triplet loss features for re-identification.
- Pairwise matching across videos and sites and keep top 200 matching pairs.
- Extend the matching pairs across three sites, keep 300 triplets of matches.
- Extend the matching pairs across all four sites, fine select top 100 quadruplets as output.



Conclusions

- Track1. Real-time online traffic speed monitoring.
- Track2. Abnormal stalled vehicle detection and alert. Results rank #3 in the AIC'18 challenge.
- Track3. Large-scale, multi-camera vehicle detection, tracking, and re-identification. Result ranks #4 in the AIC'18 challenge.
- Future work** include continue refinement of the methods on live, real-world use cases.