Road traffic monitoring

Module 4: Video Sequence Analysis

G4
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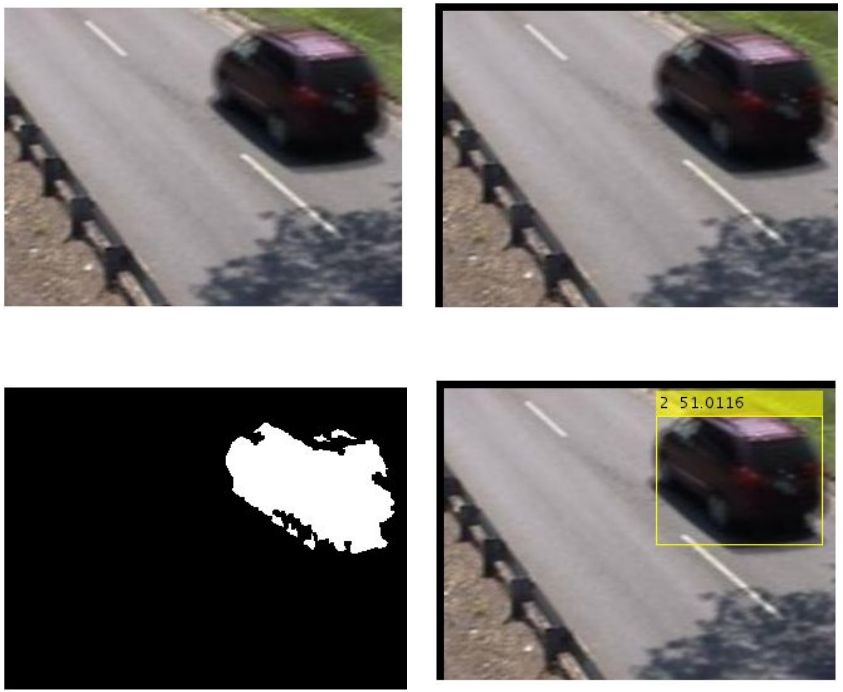
Introduction Pipeline

Goal:
In this project we want to segment the cars from a video. Then we also want to know their speed and count the number of cars in the total video.

These are the steps:

1. Get the optical flow (week 4)
2. Applied video stabilization (week 4)
3. Use background estimation to extract the background (week 2)
4. Reconstruct the scene to get the foreground (week 3)
5. Remove shadow (week 3)
6. Use region tracking to follow the cars in the diferents frames (week 5)
7. Compute the speed (week 5)

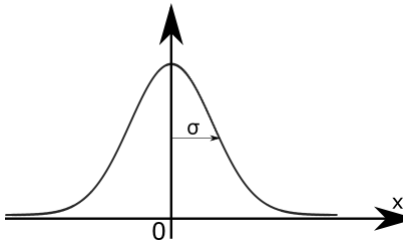


Week 2 Background subtraction

Goal:
Model the background and use it to obtain the foreground

Methods:

- Gaussian modeling: Get the mean and standard deviation from a subset of train.
- Adaptive modeling: Apart from the previous method also update the background with the real detection.
- Stauffer and Grimson: Use a gaussian mixture to split the image.

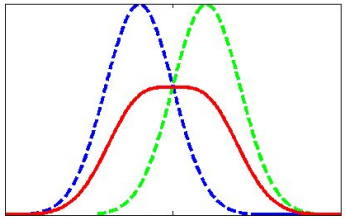


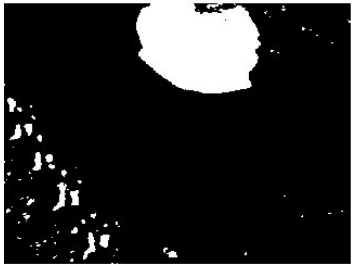
if pixel $i \in$ Background **then**

$$\mu_i = \rho \cdot I_i + (1 - \rho) \cdot \mu_i$$

$$\sigma_i^2 = \rho \cdot (I_i - \mu_i)^2 + (1 - \rho) \cdot \sigma_i^2$$

end if





Week 3 Foreground segmentation

Goal:
To separate the foreground from the background and remove all the noise like the shadows.

Shadow removal: we use the one proposed in the paper “Non-parametric model for background subtraction”[1] applied to the RGB.

Morphology: We use some operators to fill the missing information in the image and try to restore the car and at the same time remove the noise.

original image | detection | shadow | result without shadow

original image | background subtraction | morphology

[1]Elgammal, Ahmed, David Harwood, and Larry Davis. "Non-parametric model for background subtraction." *European conference on computer vision*. Springer Berlin Heidelberg, 2000.

Week 4 Video stabilization

Goal:
To eliminate the shake of the camera from the scene.

Methods:
- Using Optical flow with Block Matching
- Using Point Feature Matching[2].

Block Matching

Point Feature Matching

[2] http://es.mathworks.com/help/vision/examples/video-stabilization-using-point-feature-matching.html

Week 5

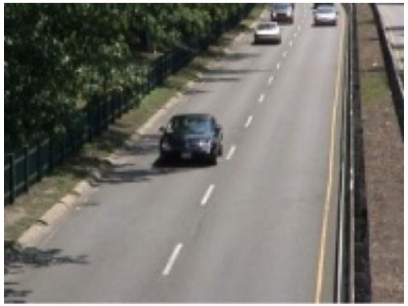
Goal:
Developing a very affordable system to improve road safety

Methods:

- Foreground detection (weeks 2-3) and vehicle tracking (Kalman and particle filters)
- Vehicle detection and counting system
- Speed estimation using simple references
- Testing dataset and our own video

Datasets

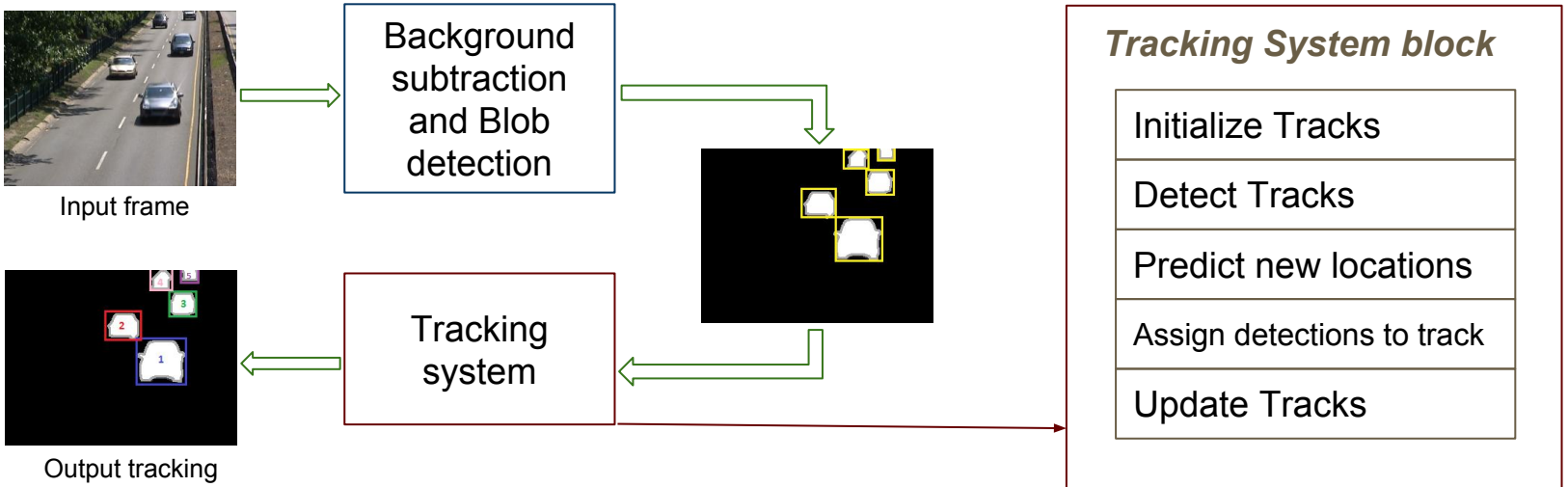
- HIGHWAY:
  - Development: 1050-1350
  - Demo: Rest



- TRAFFIC
  - Development: 950-1050
  - Demo: Rest

Week 5

- Foreground detection (weeks 2-3) and vehicle tracking following the MathWorks tutorial for object tracking[3]

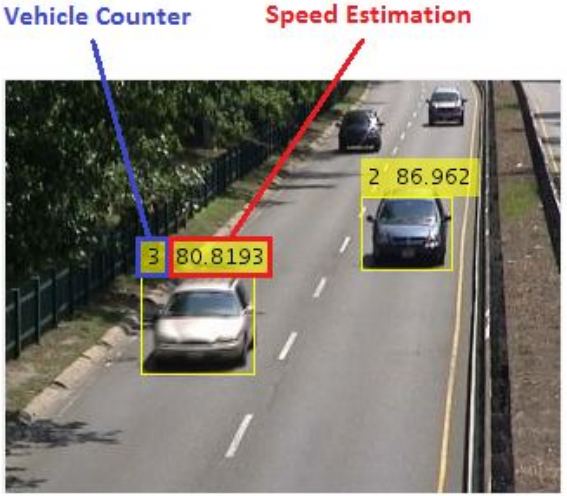


Block diagram of the modules

[3] https://es.mathworks.com/help/vision/examples/motion-based-multiple-object-tracking.html

Week 5

- Vehicle counter
  - Using the tracking system and a cost function Assign Detections to Tracks
  - ID control with one counter to avoid the track to be lost and another to eliminate it.
- Speed Estimation (Using model of Team 2/2016[4])
  - Using homography transformation to change to an aerial view of 4 points of the image
  - Using references as line size or car speed to make an approximation of the final speed for all the vehicles tracked.
    - Traffic: Using 4.5m the line size in order to calculate to speed of the vehicle.
    - Highway and our video: Guessing the speed of a vehicle in train and use it as a reference for the rest.



[4] https://github.com/mcv-m4-video/class2016/raw/gh-pages/papers/team2.pdf

Week 5

Tracking using Kalman filters

- Ideal to solve linear dynamic model as our case.
- configureKalmanFilter(**'ConstantVelocity'**, **centroid**, **InitialEstimateError**(200, 50), **MotionNoise**(100, 25), **MeasurementNoise**(100));

Tracking using Particle filters

- Sequential Monte Carlo Method, for nonlinear system.
- particleFilter = **robotics.ParticleFilter**
- initialize(50000, centroid(1:2), eye(2));

Highway / Traffic

Week 5

Test with our own video at UAB:

- Noise in the mask:
  - Produced by the camera shake even when we try to compensate.
  - Shadow removal, difficult to adjust the threshold.
- Tracking problems
  - Blobs of the cars sometimes segmented due to aggressive shadow removal.
- **Need improves**

Test using Kalman filter

Conclusions

- We learnt differents techniques in order to calculate a background subtraction: **best model adaptative.**
- Also, techniques in order to improve foreground detection and essential in order to perform the tracking: **Morphology and Shadow removal.**
- We saw how a video shaking destroy our performance and the necessity to apply **video stabilization techniques**.
- We made a real test of video surveillance in order to **track cars**, count them and estimate their speed where all this techniques was needed.
- Finally, we can say that our works need improvements in some parts like shadow removal

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QUESTIONS?

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