CS4243 TEAM JARD

Separation of Foreground & Background of Surveillance Video

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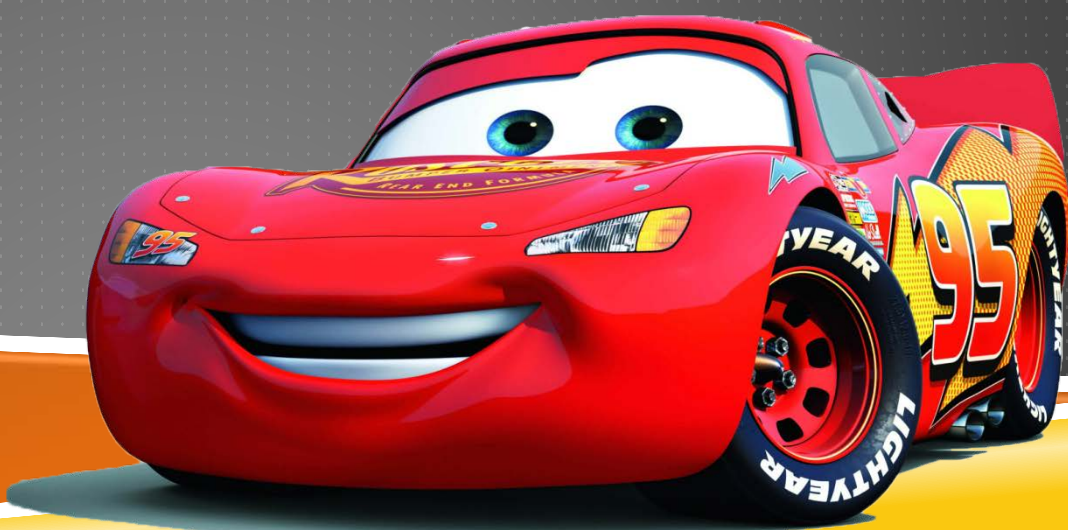
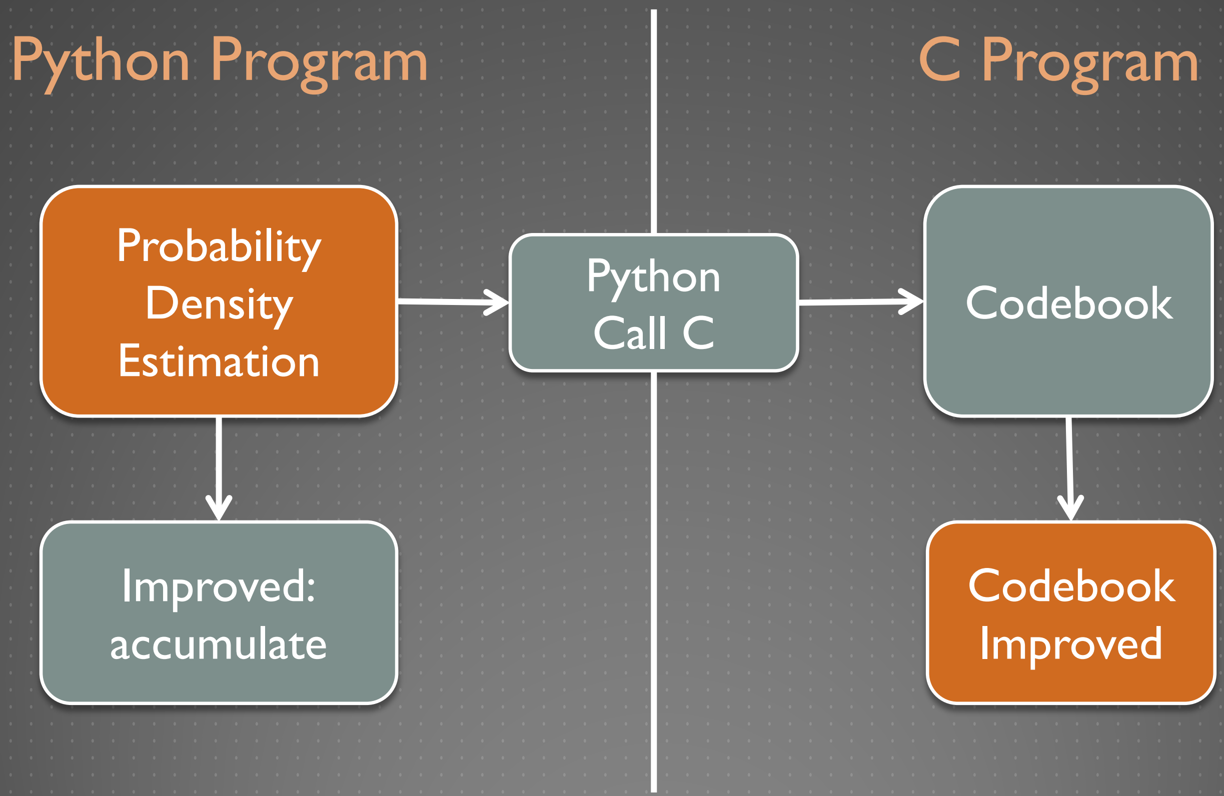


Project Objectives

1. To separate a moving foreground from the static background
2. Ultimate difficulty – Real time mode, long duration

Methods overview



Method 1: Python

1. Average mean and covariance of each pixel

$$n - dimensional\ Gaussian$$

$$G(x) = \frac{1}{\sqrt{(2\pi)^n |\sum|}} \exp\left(-\frac{1}{2} (x-\mu)^T \sum{}^T (x-\mu) \right)$$

2. Probability Density Estimation

Method 1: Python

Issues

1. Long processing time
2. Ghosting effect on background
3. Offline mode

Method 2: Python Improved

1. Update the mean and covariance matrix

2. Make it faster

3. Condition to stop finding the clean plate

Method 2: Python

1. Update the mean and covariance matrix

Cumulative calculation:

(1) $\mu_n = \mathrm{E}(X)$

(2) $\Sigma_n = \mathrm{E}\left[(X - \mathrm{E}[X])\,(X - \mathrm{E}[X])^{\top}\right]$

(3) $\mu_{n+1} = f(\mu_n) = \frac{1}{N+1}\,(\mu_n * N + x_{n+1})$

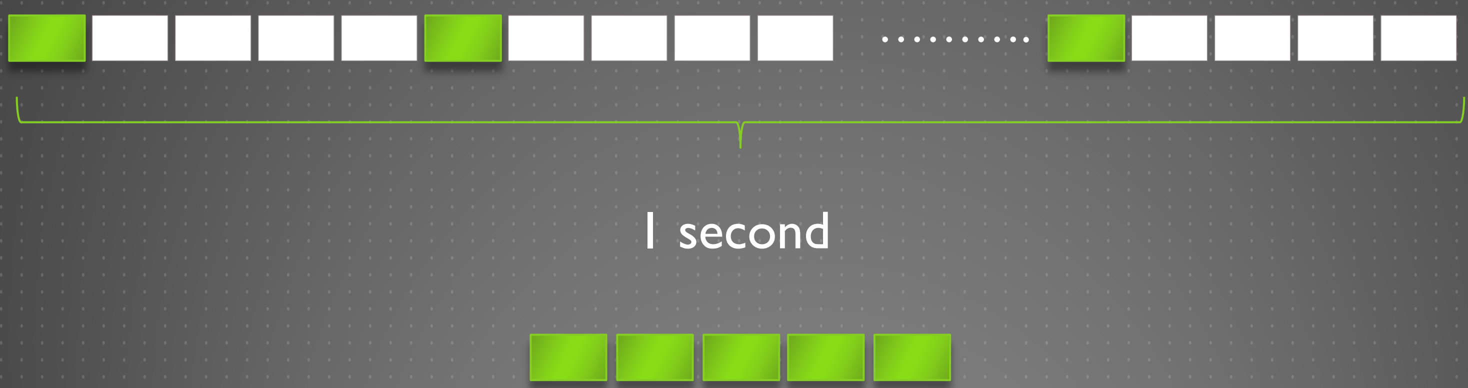
(4) $\Sigma_n = \mathrm{E}(XX^{\top}) - \mu_n\mu_n^{\top}$

(5) $\Sigma_{n+1} = \frac{1}{N+1}\left((\Sigma_n + \mu_n\mu_n^{\top}) * N + x_{n+1}x_{n+1}^{\top}\right) - \mu_{n+1}\mu_{n+1}^{\top}$

Method 2: Python

2. Make it faster

Drop frames to make it online

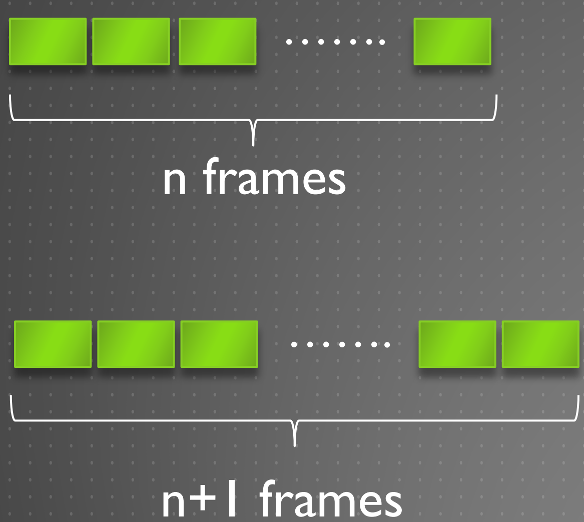


Processed: 5 frames

Method 2: Python

3. Condition to stop finding the clean plate

Is mean stable?



μ_n

μ_{n+1}

$$\frac{|\mu_{n+1} - \mu_n|}{\mu_n} < 0.005\%$$

Method 2: Python

Result

Input Video

Background

Foreground

Method 3: Codebook in C

Why Codebook?

- Allows for lighting changes
- Real time mode

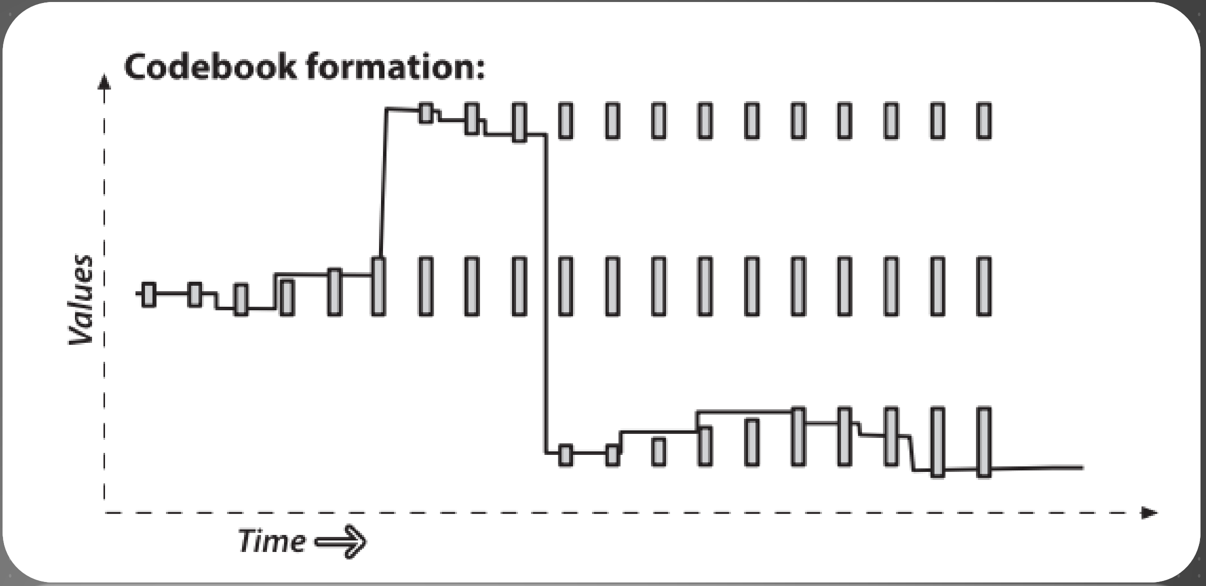
Why YUV?

- Variation in background along brightness axis
- YUV is a color space whose axis is aligned with brightness

Method 3: Codebook in C

How does Codebook work?

1. Update codebook
2. Clear stale pixels
3. Segment based on learned codebook



Method 3: Codebook in C

Result

Input Video

Foreground

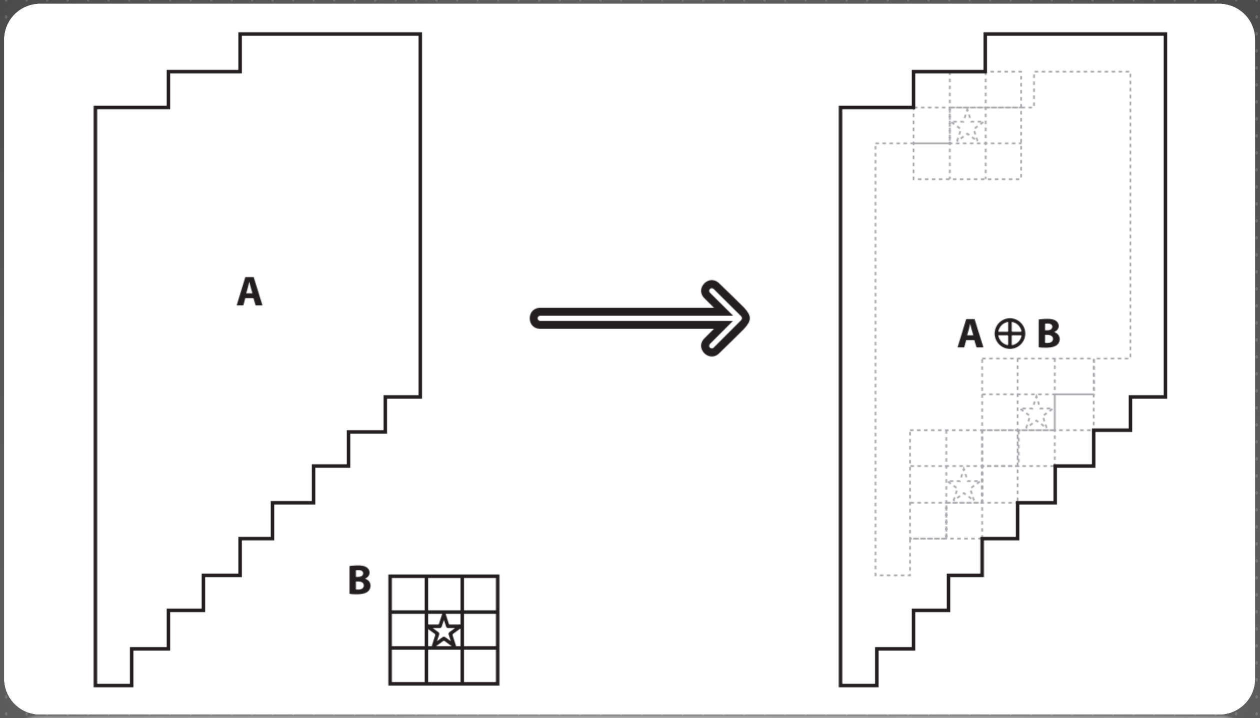
Method 4: Improved Codebook

Curing of false negatives

1. Gaussian filtering
2. Differencing
3. Dilate & Erode
4. Threshold

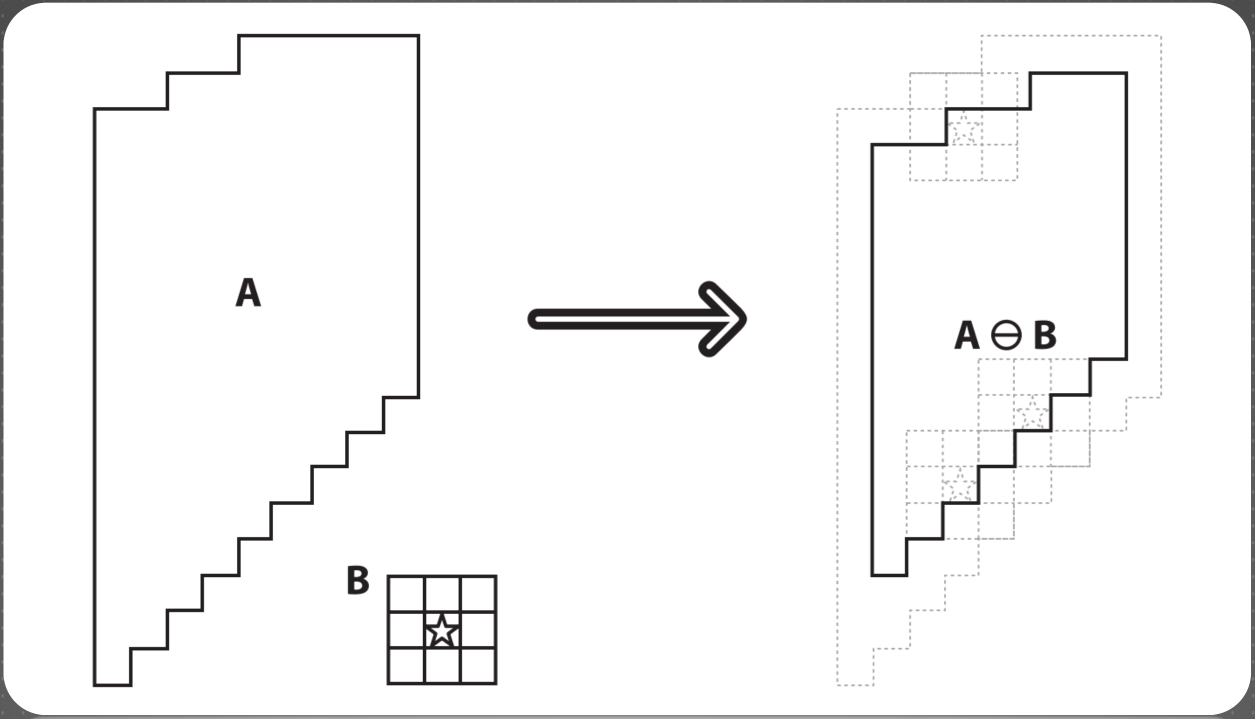
Method 4: Improved Codebook

Dilate



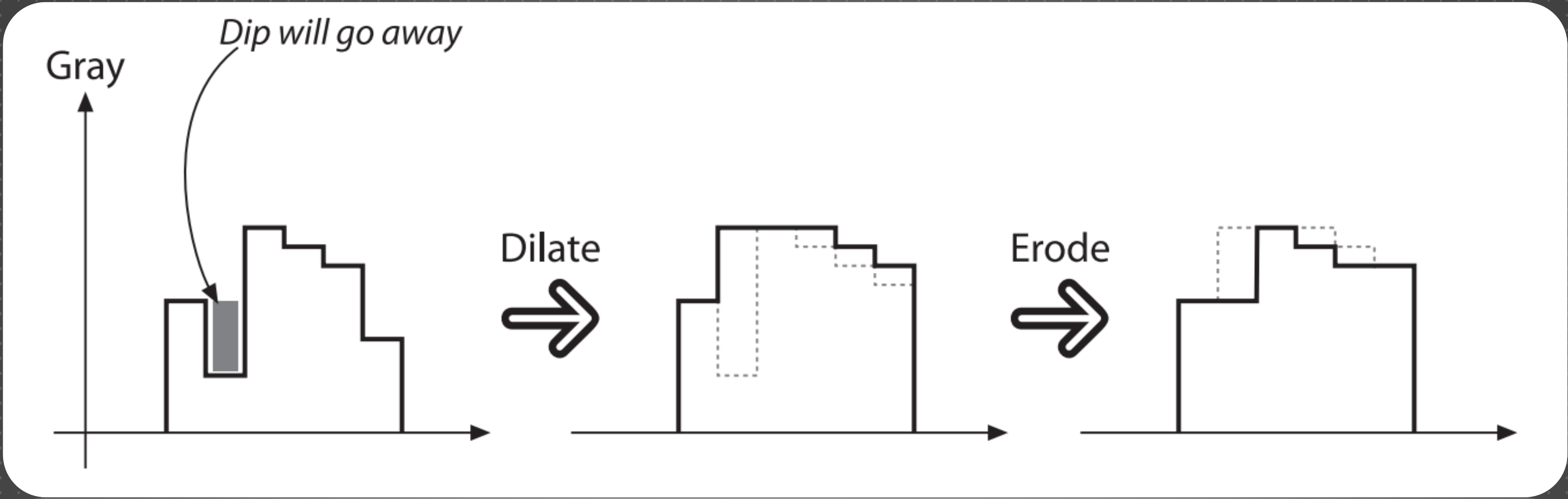
Method 4: Improved Codebook

Erode



Method 4: Improved Codebook

Dilate & Erode



Method 4: Improved Codebook

Summary

1. Frame Difference
2. Threshold
   (convert to black & white)
3. Dilate
4. FG SegmentMask
5. Erode

Method 4: Improved Codebook

Result

Input Video

Background

Foreground

Conclusion

	Methods	Problems faced
1	Mean & covariance Probability Density estimation	Slow & ghosting & small
2	Above with stop condition & improved speed	Still quite slow & ghosting & small
3	Codebook	Windscreens with holes
4	Codebook improved	Thresholds for different situation Trade off : Front cars are accurately located but cars far away are treated as a cluster

Videos Samples

Reference

1. http://en.wikipedia.org/wiki/Covariance_matrix
2. Bradski and Kaehler, Learning OpenCV: Computer Vision with the OpenCV Library, O'Reilly, 2008.