PRP Assignment 2

Visual Tracking

Presented by:
Rama Krishna Reddy,
17110094,
Electrical Engineering,
Indian Institue of Technology,
Gandhinagar.

Under the guidance of:
Dr. Shanmugha
Assistant Professor,
Electrical Engineering,
Indian Institute of Technology,
Gandhinagar.

Contents

1 Introduction

1.1 Description

- In this assignment we detect changes, occurring in video from frame to frame.
- **Background Subtraction** is any method which allows us to detect the foreground and differentiate from background.
- Here we try to fix or model the background and detect the changes that occur.

1.2 Background Subtraction

- We try to segment the foreground from the background.
- It's mathematical equation is given by:

$$|P[F(t)] - P[F(t+1)]| > \text{ Threshold}$$

- For calculating the background image we calculate the average of previous t frames.

$$B(x,y,t) = \frac{1}{N}\sum_{i=1}^{N} V(x,y,t-i)$$

1.3 Running Gaussian Average

- We change mean, variance according to the following equaitons.

$$\begin{aligned} \mu_t &= \rho I_t + (1-\rho)\mu_{t-1} \\ \sigma_t^2 &= d^2\rho + (1-\rho)\sigma_{t-1}^2 \\ d &= |(I_t - \mu_t)| \\ \tfrac{|(I_t-\mu_t)|}{\sigma_t} &> k \longrightarrow \text{ foreground} \\ \tfrac{|(I_t-\mu_t)|}{\sigma_t} &\le k \longrightarrow \text{ background} \end{aligned}$$

$$\mu_t = M\mu_{t-1} + (1-M)\left(I_t\rho + (1-\rho)\mu_{t-1}\right)$$

1.4 Background Mixture Models

At any time t, a particular pixel's history is given by,

$$X_1, X_2, ...X_t = \{V(x_0, y_0, i) : 1 \leq i \leq t\}$$

The history is modeled by a mixture of K Guassian distributions,

$$P\left(X_t\right) = \sum_{i=1}^{K} \omega_{i,t} N\left(X_t | \mu_{i,t}, \Sigma_{i,t}\right)$$

where

$$N\left(X_t | \mu_{it}, \Sigma_{i,t}\right) = \frac{1}{(2\pi)^{D/2}} \frac{1}{\left|\Sigma_{i,t}\right|^{1/2}} \exp\left(-\frac{1}{2}\left(X_t - \mu_{i,t}\right)^T \Sigma_{i,t}^{-1}\left(X_t - \mu_{i,t}\right)\right)$$

The probability of observing any arbitrary pixel is given by

$$P\left(X_t\right) = \sum_{i=1}^{K} \omega_{i,t} N\left(X_t | \mu_{i,t}, \Sigma_{i,t}\right)$$

The first B Gaussian distribution which exceeds the threshold T is retained for a background distribution

$$B = argmin\left(\Sigma_{i-1}^{B} \omega_{i,t} > T\right)$$

When a new frame is read at time $t+1$, it is checked for a match. A pixel matches a Gaussian distribution if the Mahalanobis distance

$$\left(\left(X_{t+1} - \mu_{t+1}\right)^T \Sigma_{i-1}^{b}\left(X_{t+1} - \mu_{t+1}\right)\right)^{0.5} < k \cdot \sigma_{i,t}$$

where k is 0.6(threshold).

Match is found: A match is found with one of the K Gaussians and should be updated as follows.

$$\sigma_{i,t+1}^2 = (1-\rho)\sigma_{i,t}^2 + \rho\left(X_{\alpha+1} - \mu_{x+1}\right)\left(X_{x+1} - \mu_{x+1}\right)^T$$

$$\sigma_{i,t+1} = (1-\alpha)\omega_{i,t} + \alpha P\left(k | X_t, \varphi\right)$$

where α is the learning rate and $P\left(k | X_t, \varphi\right)$ is 1 if match or 0 if not a match.

No Match: No match is found with any of the K Gaussians. So, the least probable distribution is replaced with parameters

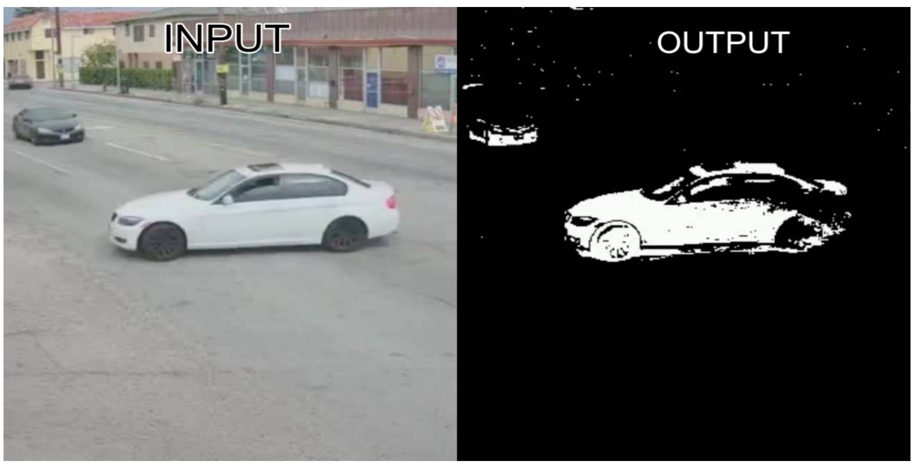
$$k_{i,i} = \text{ low prior weight}$$

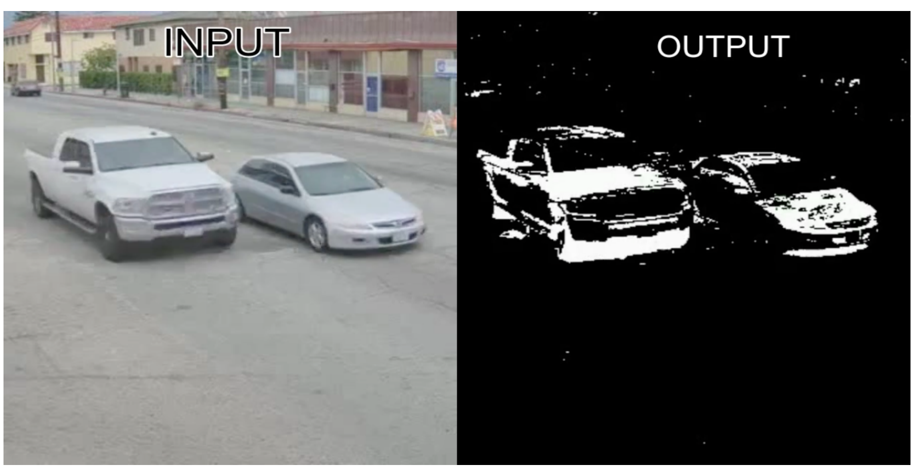
$$\mu_{i,t+1} = X_{t+1}$$

$$\sigma^2_{i,t+1} = \text{ large initial variance}$$

2 Results

My input video contains moving cars. We can see the output recieved.





3 References

- Adaptive background mixture models for real-time tracking, https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=784637
- https://www.youtube.com/watch?v=sSNis3mleMc
- http://www.cse.psu.edu/~rtc12/CSE586Spring2010/papers/emBGsubtractAboutSandG.pdf
- https://github.com/artificertxj1/Background-Subtraction-with-Gaussian-Mixture
- https://en.wikipedia.org/wiki/Background_subtraction