Week 10

Background Modeling

Video Analysis
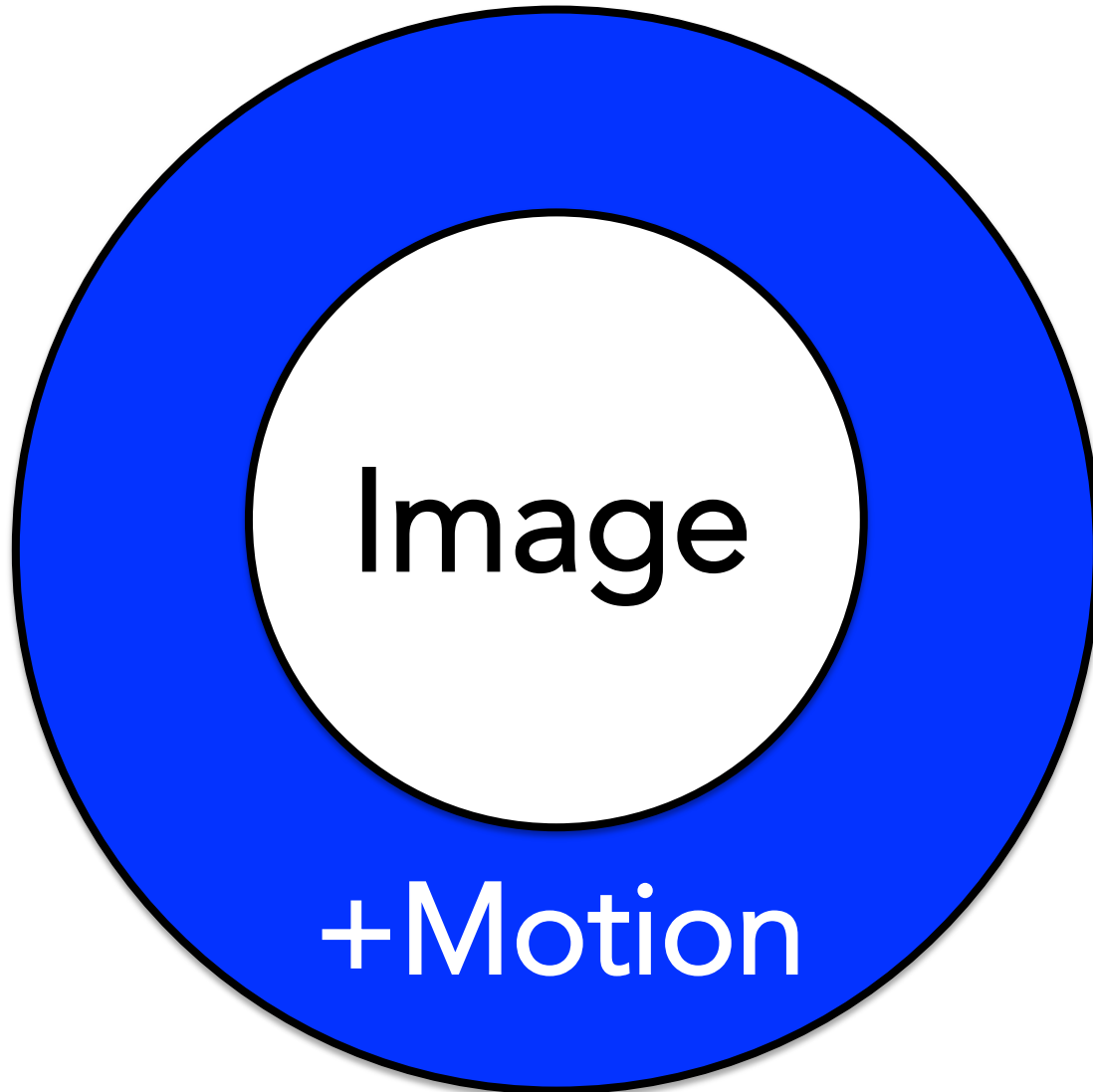
Image

+Motion

Motion

1. Motion of blocks – Motion Vectors

2. Motion of Objects – Object Tracking

3. Motion Regions – Background Modeling

Object: regions of the image that are semantically important

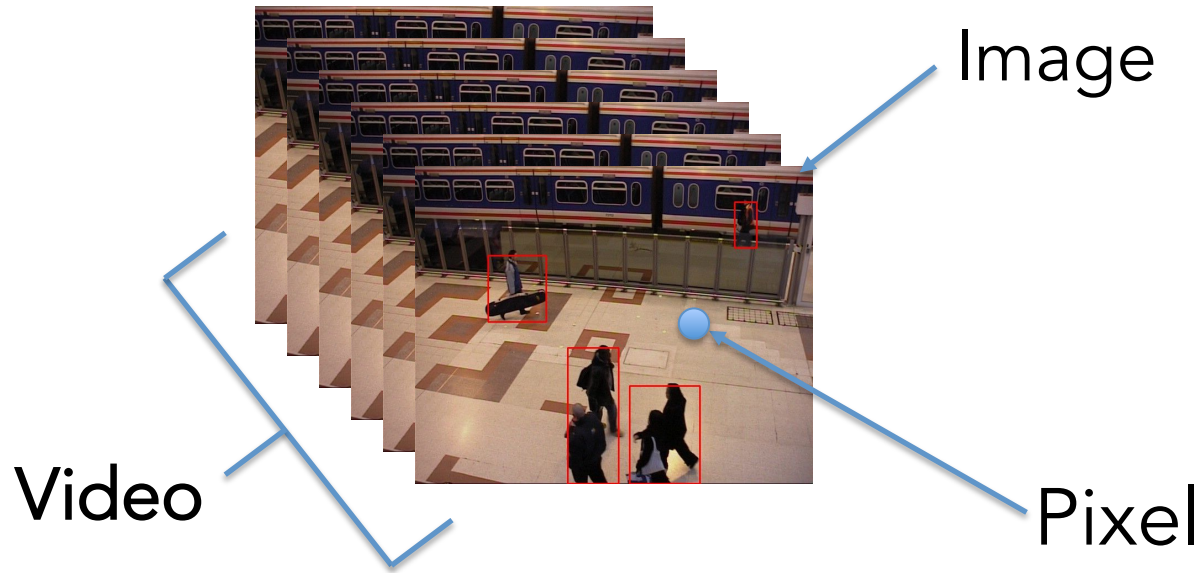# Moving Object Detection in Fixed Camera Videos

Idea: Model the Background!

Task: differentiate the moving objects from the background!

Refined Problem

Image

Pixel

Video

The pixel is Foreground or Background?

Idea:
-single value modeling of background

Challenge: Acquisition noise

Idea: Single Gaussian Model

- **If** $\left| X_t - \mu \right| < 2.5 * \sigma$
  - background,
- **Else**
  - foreground

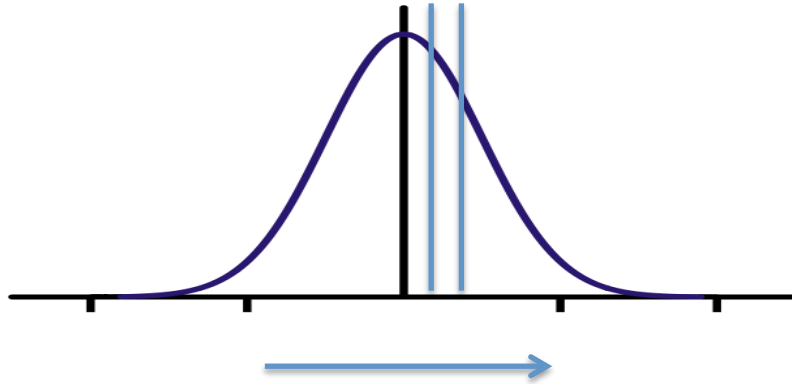Foreground   Background   Foreground
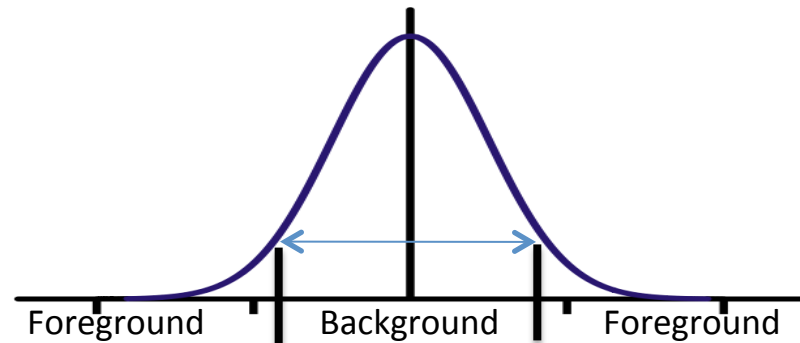
$$N(\mu, \sigma^2)$$

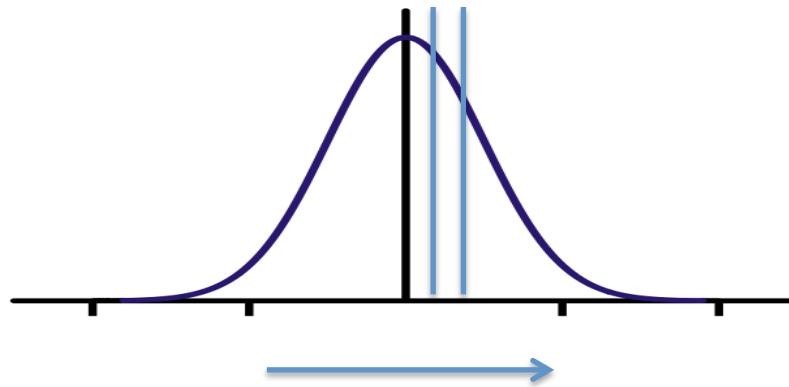# Challenge: Illumination Variation

Idea: adapt the parameters!

$$\mu_t = (1 - \rho)\mu_{t-1} + \rho X_t$$

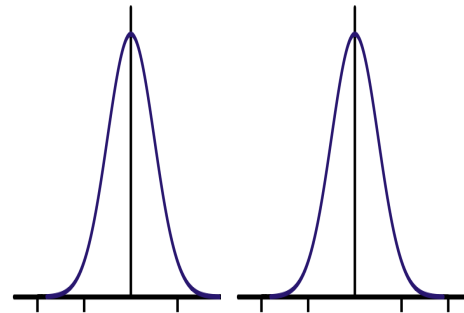$$\sigma_t^2 = (1 - \rho)\sigma_{t-1}^2 + \rho(X_t - \mu_t)^T(X_t - \mu_t)$$

where

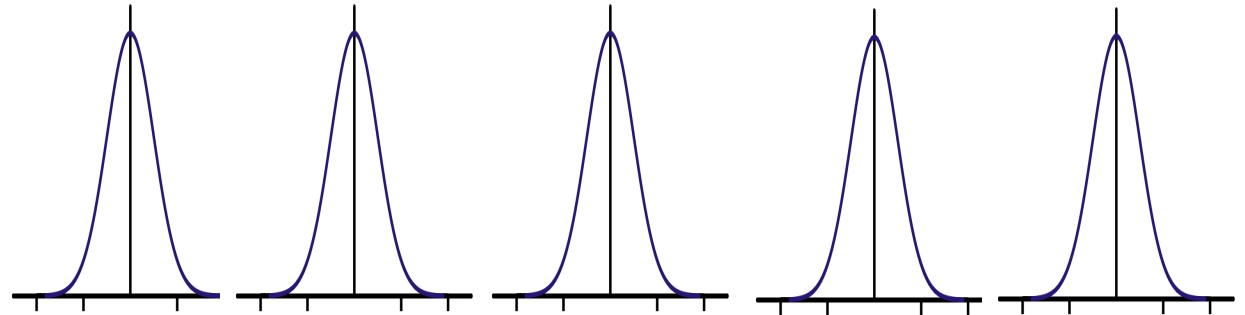$$\rho = \alpha\eta(X_t|\mu_k, \sigma_k)$$

Challenge: Clutter

Idea: Use multiple Gaussians

Challenge: new objects in the scene!

Idea: more Gaussians, store foreground as well!

Persistence

- Modeled as prior weight *w*
- If a new pixel does not match to any exiting Gaussians, least persistent Gaussian is replaced with a new Gaussian with:

$$\mu_t = P_t$$

And standard variation

σ_t = a large value

Background Selection

- A background Gaussian will have
  - More persistence – high *w*
  - Less variation – low σ_t
  - Sort Gaussians wrt w/σ_t

$$\arg\min_k \left(\sum_{i=1}^{k} w_i > T \right)$$

Adaptive Background Model

Outline of Object Detection

REAL SCENE   CHANGE DETECTION

CLEANED UP

Connecting the Dots

- Dilation/Erosion

- Contour drawing

- Bounding boxes

Revisiting Challenges

- Acquisition noise

- Illumination variation

- Clutter

- New object introduced into background

- Object may not move continuously

All models are wrong but some are useful.
-George E. P. Box