Master in Computer Vision Barcelona

Project Module 4 Coordination

Video Surveillance for Road Traffic Monitoring

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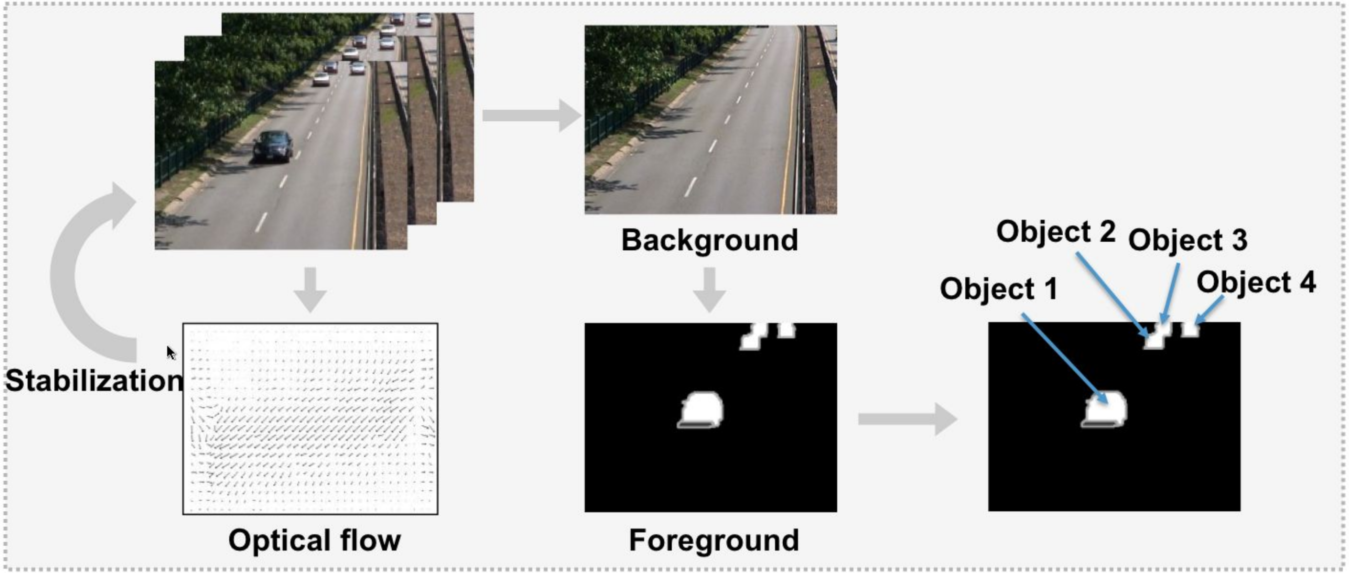
Week 2: Tasks Description

Project Schedule



Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
• Introduction • DB • Evaluation metrics	• Background estimation • Stauffer & Grimson	• Foreground segmentation • Area filter • Hole filling • Shadow removal	• Optical flow • Video stabilization	• Region tracking • Kalman filter	• **Presentation**

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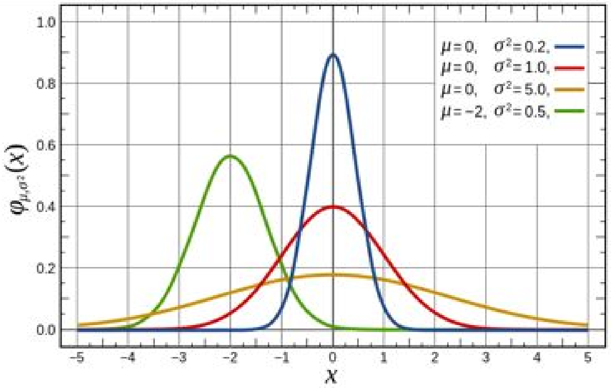
Goals Week 2

- **Background estimation**
    - Model the background pixels of a video sequence using a simple statistical model to classify the background / foreground
        - Single Gaussian per pixel
        - Adaptive / Non-adaptive
    - The statistical model will be used to preliminary classify foreground

- **Comparison with more complex models (Stauffer and Grimson)**

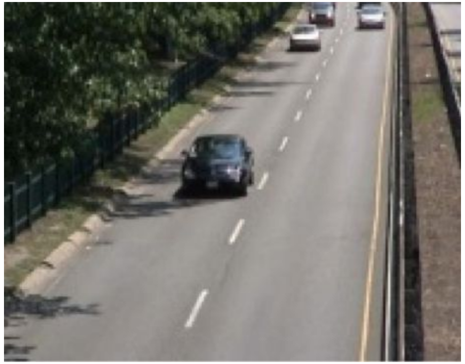


Tasks

- **Mandatory**
  - Task 1: Gaussian distribution
  - Task 2 & 3: Evaluate results
  - Task 4: Recursive Gaussian modeling
  - Task 5: Evaluate and compare to non-recursive
- **Optional**
  - Task 6: Compare with S&G
  - Task 7: Color sequences

Sequences

ID	FRAME RANGE	TYPE
Highway	1050 - 1350	Baseline
Fall	1460 - 1560	Dynamic background
Traffic	950 - 1050	Camera jitter



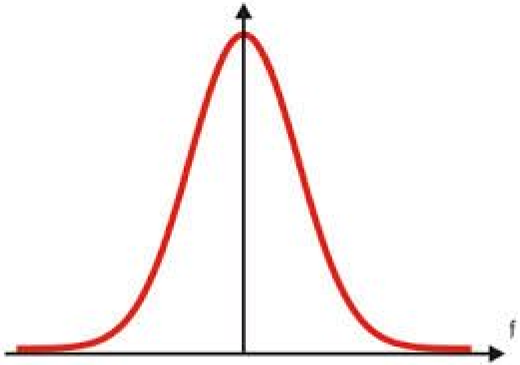
Reminder: metrics

- **The groundtruth images contain 5 labels namely**
  - 0 : Static
  - 50 : Hard shadow
  - 85 : Outside region of interest
  - 170 : Unknown motion (usually around moving objects, due to semi-transparency and motion blur)
  - 255 : Motion

- **We will use:**
  - Background: 0, 50
  - Foreground: 255
  - Unknown (not evaluated): 85, 170

Task 1: Gaussian modelling

- **1 Gaussian function to model each background pixel**
  - First 50% of the test sequence to model background
  - Mean and variance of pixels

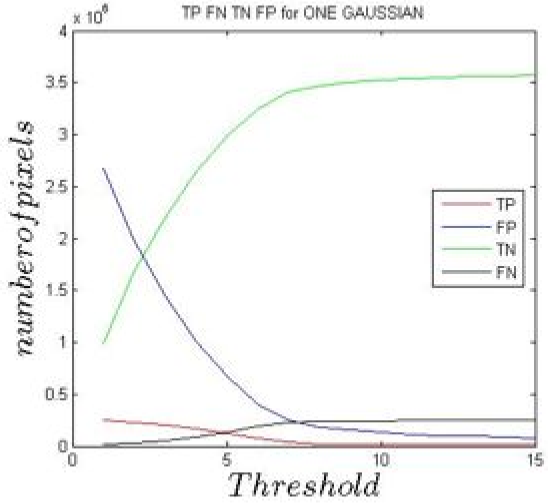


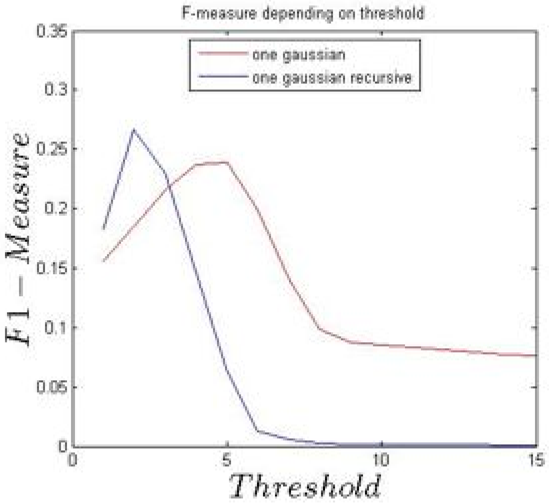
- **Second 50% to segment the foreground**

for all pixels i **do**
    if $|I_i - \mu_i| \geq \alpha \cdot (\sigma_i + 2)$ **then** $\triangleright$ +2 to prevent low values of σ_i
        pixel $\rightarrow$ Foreground
    else
        pixel $\rightarrow$ Background
    end if
end for

Task 2: Evaluation

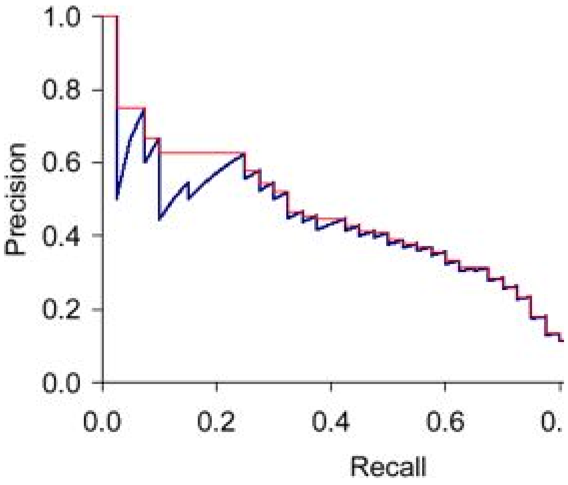
- **Evaluate Task 1**
  - True Positive, True Negative, False Positive, False Negative, Precision, Recall, F1-score vs alpha





Task 3: Evaluation

- Evaluate Task 1
    - Precision vs Recall curve
    - Area Under the Curve (AUC)



Task 4: Adaptive modelling

- **Adaptive modelling**
  - First 50% frames for training
  - Second 50% left background adapts

$$
\begin{aligned}
&\textbf{if } \text{pixel } i \in \text{Background } \textbf{then}\\
&\quad \mu_i = \rho \cdot I_i + (1-\rho) \cdot \mu_i\\
&\quad \sigma_i^2 = \rho \cdot (I_i - \mu_i)^2 + (1-\rho) \cdot \sigma_i^2\\
&\textbf{end if}
\end{aligned}
$$

- **Best value of α, p to maximize F1-score**
  - Two methods:
    - Obtain best α non-recursive and then obtain p for the recursive cases
    - Optimize them together

Task 5: Comparison

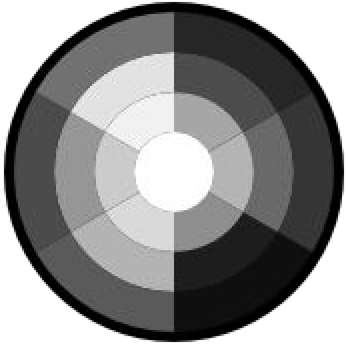
- Compare both the adaptive and non-adaptive version and evaluate them for all 3 sequences proposed
    - F1-score / AUC

Task 6: Optional

- **Compare with Stauffer and Grimson**
  - Implementation
    - Matlab → Computer Vision Toolbox (preferred) or provided (StGm.zip)
    - Python → OpenCV
    - Select the best number of Gaussians (3 to 6)
  - Evaluate precision vs recall to comment which method (single Gaussian programmed by you or S&G) performs better
  - Evaluate the sequences than benefit more of the multiple Gaussians and try to explain why

Task 7: Optional

- Update your implementation to support color sequences
  - Decide color space? RGB vs YUV?
  - Number of Gaussians needed?



Deliverables

- **Google drive with slides per tasks**
- **Code used for the week assignment**

- **6th January**
    - **Upload link to GitHub**
    - **Fill the intra-group evaluation**

Scoring Rubric

Grade is assigned based on the satisfactory accomplishment of...

Grade	Common meaning	Succesfully completed tasks
9-10	Excellent	All mandatory and two optional tasks
7-9	Very good	All mandatory and one optional tasks
5-7	Average	All mandatory tasks
3-5	Difficulties	All mandatory tasks but one
0-3	Fail	All mandatory tasks but two or more