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AI385

Lab 9

Image Sequence Analysis

Learning Objectives:

By the end of this lab, students will be able to:

- *Understand and implement image sequence analysis using OpenCV in Python.*
- *Apply background subtraction techniques to detect moving objects.*
- *Utilize both manual and built-in OpenCV methods for foreground detection.*
- *Visualize detected objects using bounding boxes and morphological operations.*

Introduction:

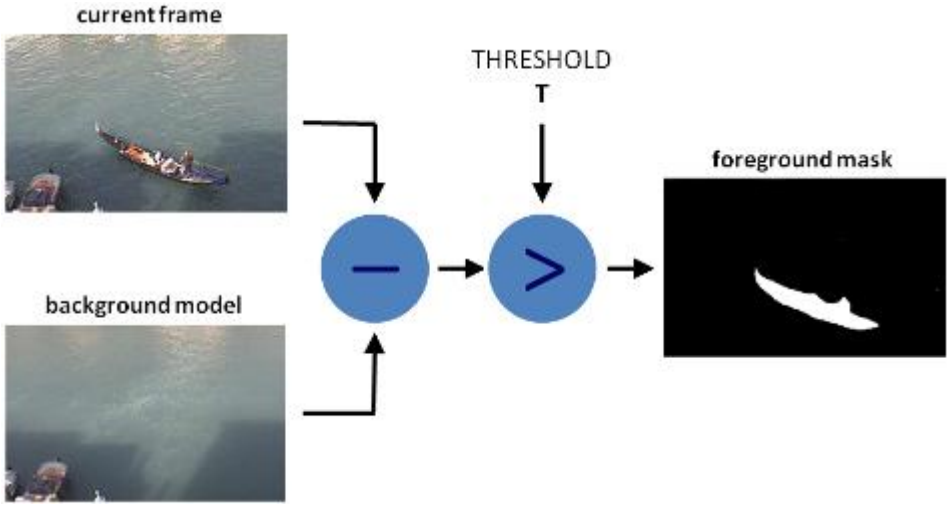
What is Image Sequence Analysis?

Image sequence analysis involves processing a series of frames (images from a video or a set of time-based images) to extract meaningful information—such as motion, object detection, or activity tracking.

What is Background Subtraction?

Background subtraction is a fundamental technique in computer vision used to detect moving objects in videos from static cameras.

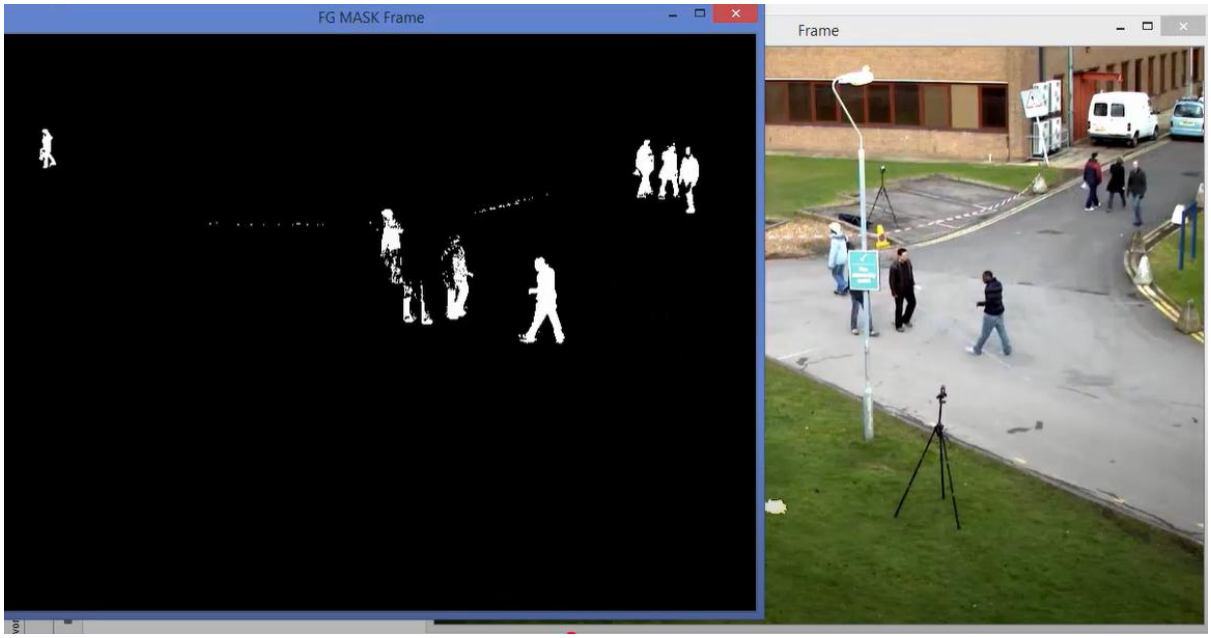
The basic idea is to compare each new frame to a background model (static or dynamic) and isolate the regions that change over time—these are typically moving objects.



There are two major approaches:

1. ***Manual Background Subtraction:***
    - *Uses a static frame as the background.*
    - *Subtracts new frames from this background.*
    - *Simple and fast but not adaptive to scene changes (e.g., lighting).*
2. ***Gaussian Mixture-based Model (MOG2):***
    - *A more robust and adaptive method.*
    - *Uses multiple Gaussian distributions to model each pixel over time.*
    - *Can handle gradual background changes and detect shadows.*

This lab explores both techniques to provide a solid understanding of how background subtraction works and its practical applications in surveillance, motion detection, and object tracking.



Exercise 1: Manual Background Subtraction for Object Detection

Objective:

Detect moving objects by subtracting each frame from a static background frame.

Code:

```
#Read video or image sequence using:
cap = cv.VideoCapture('video.mp4')

#Capture the first frame as the static background:
ret, background = cap.read()

#Subtract the current frame from the background:
diff = cv.subtract(background, current_frame)

#Apply thresholding to highlight changes:
ret, thresh = cv.threshold(diff, 20, 255, cv.THRESH_BINARY)

#Clean the binary mask using morphological closing:
kernel = np.ones((5, 5), np.uint8)
closing = cv.morphologyEx(thresh, cv.MORPH_CLOSE, kernel)

#Draw bounding boxes around detected objects:
coords = cv.findNonZero(closing)
x, y, w, h = cv.boundingRect(coords)
cv.rectangle(frame, (x, y), (x + w, y + h), (0, 255, 0), 2)
```

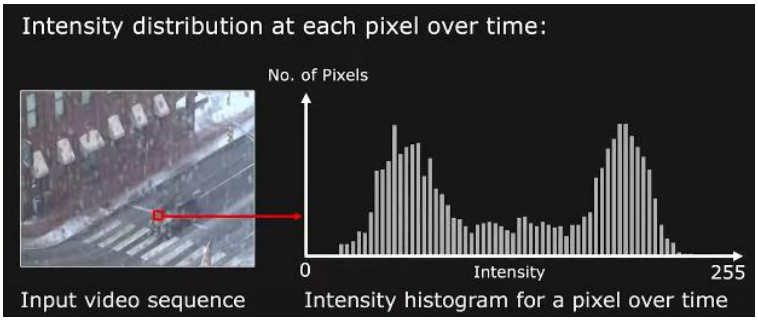
Exercise 2: Object Detection Using MOG2 (OpenCV Built-in)

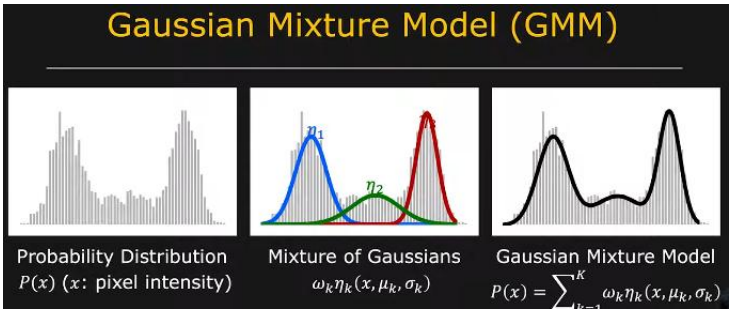
Objective:

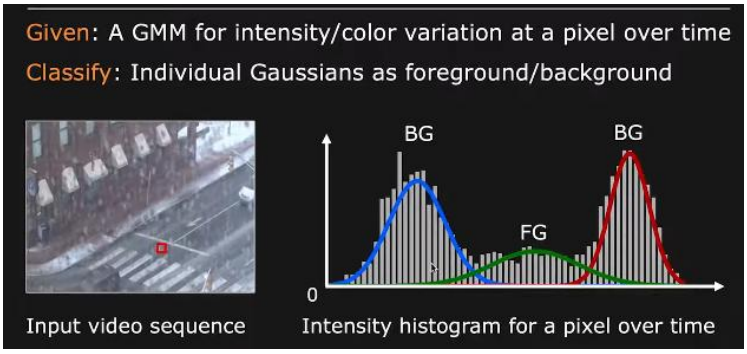
Detect moving objects using OpenCV's built-in MOG2 background subtractor for dynamic environments.

How MOG2 Works (Simplified):

- Each pixel is modeled as a mixture of Gaussians over time.
- Frequently observed colors form the background.
- Unusual colors (outliers) are flagged as foreground (moving objects).
- This method adapts to scene changes, making it suitable for real-world environments.







Code:

```
#Create the background subtractor object:
backSub = cv.createBackgroundSubtractorMOG2(history=100, varThreshold=40,
detectShadows=True)


#Apply the subtractor to each frame:
fg_mask = backSub.apply(frame)


#Display the result:
cv.imshow('Foreground Mask', fg_mask)


#Post-process and draw contours or bounding boxes as in Exercise 1.
```

For more details:

1. https://www.simonwenkel.com/notes/software_libraries/opencv/background-subtraction-using-opencv.html
2. Gaussian Mixture-based Background/Foreground Segmentation Algorithm
   https://www.youtube.com/watch?v=0nz8JMyFF14&ab_channel=FirstPrinciplesofComputerVision