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CEG 7560 Visualization for image Processing for Cyber Security

Report: Video Processing and Object Tracking

1. Introduction

In this assignment, I worked with two CCTV videos from the VAST Challenge dataset.
My goal was to detect moving objects, remove noise, track each object and show all results in one combined display.
I also generated a final output video and saved a few screenshots automatically.

2. Preprocessing

I loaded both videos using OpenCV.
Since both videos had slightly different brightness and content, I resized the second video to match the first.
I used MOG2 background subtraction to separate moving objects from the background.

To clean the masks, I used:

- Gaussian blur
- Thresholding
- Morphological open + close
- Median blur

These steps helped me to reduce shadows and noise.

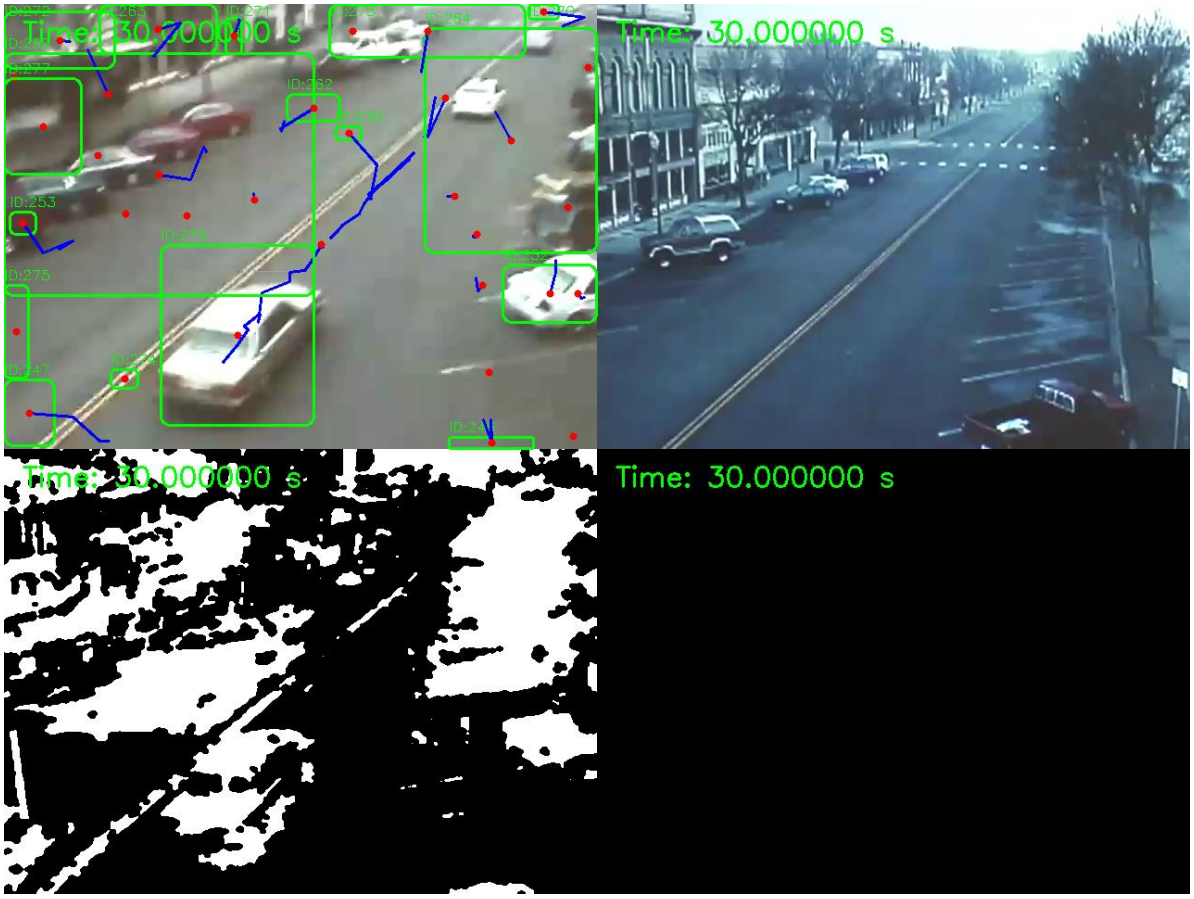


Figure 1: Binary mask generated after background subtraction and cleanup.

3. Object Detection

After getting the binary mask, I used contour detection to find moving objects.
Very small contours were ignored to avoid noise.
For every valid contour, I created a bounding box and calculated the centroid.

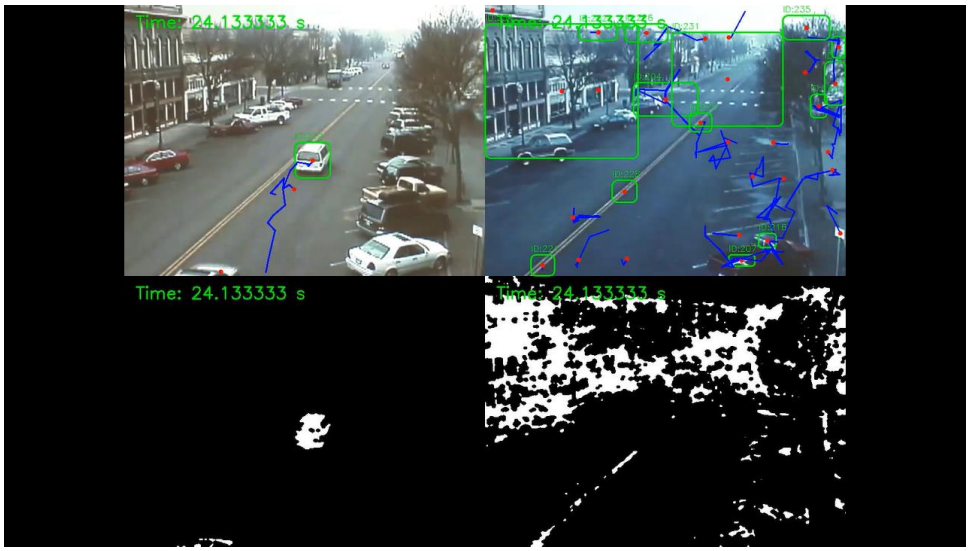


Figure 2: Detected moving objects with bounding boxes and centroids.

4. Tracking

I used a simple centroid-based tracking method.
Each object got an ID, and the ID stayed the same until the object disappeared.
I also drew a movement trail using previous centroids.
This helped me see the direction and path of each moving object.

Figure 3: Object detection with ID labels and tracking trails

Even though this is a simple tracker, it still worked well for the video.
Crowded scenes naturally created many IDs, which is expected.

5. Combined Display

I created a 2x2 layout:

- Top-left: Video 1
- Top-right: Video 2
- Bottom-left: Mask 1
- Bottom-right: Mask 2

I also added the timestamp on all four panels.

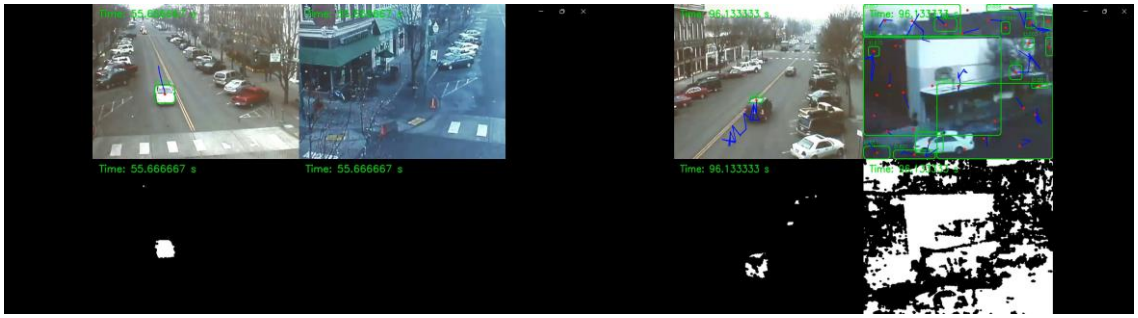


Figure 4. Full 2x2 layout showing both camera views (top) and their corresponding foreground masks (bottom).

This layout made it easy for me to compare original videos with the masks and tracking results.

6. Output Generation

I saved:

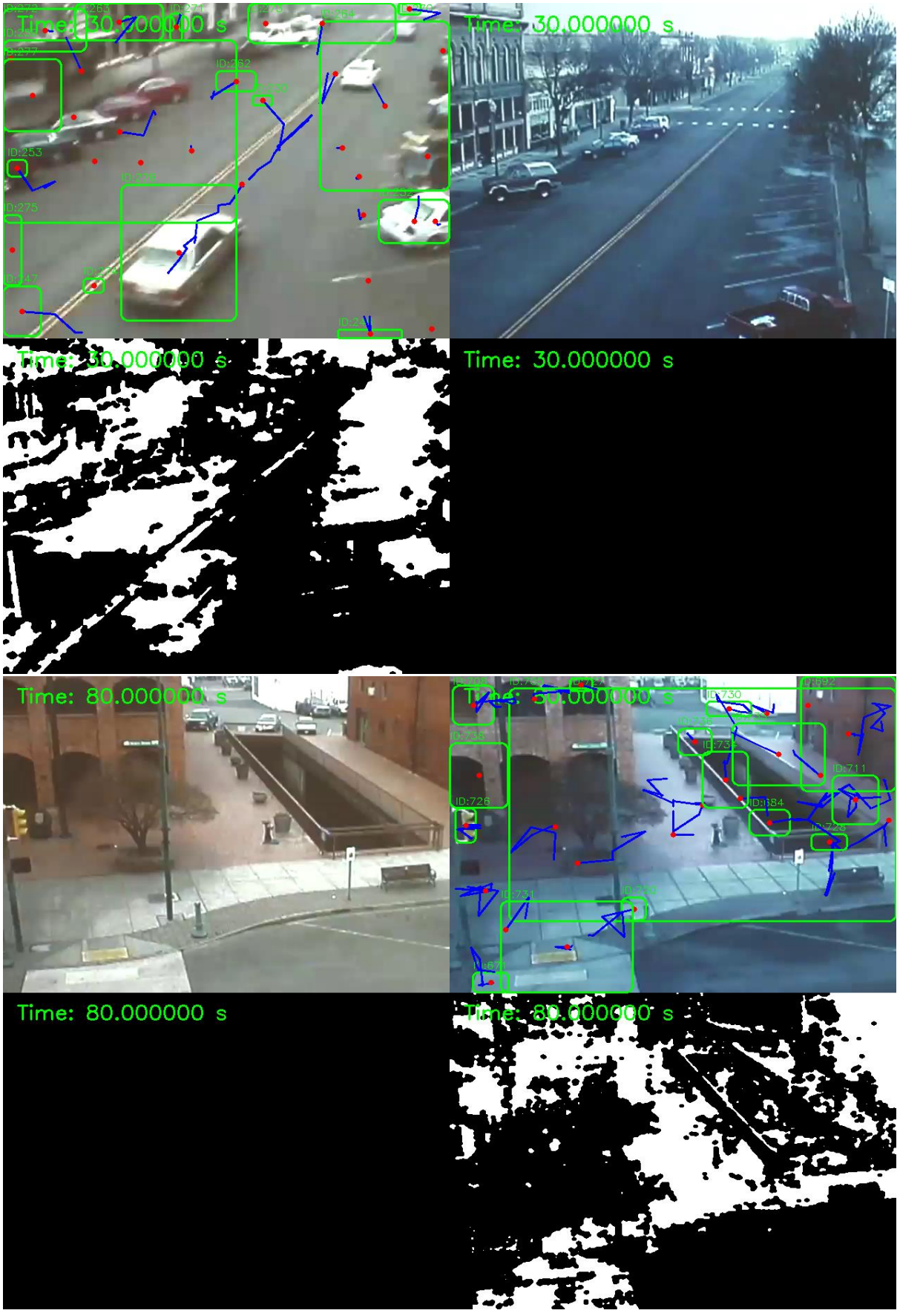
- The processed combined video (CombineVideosOutput.avi)
- Screenshots every 150 frames

VTK was used to display the frames while the program ran.
Execution was stable on my machine. I tested multiple segments and saved screenshots and a final video.

Following are some saved screenshots:


Time: 70.000000 s
Time: 70.000000 s
Time: 70.000000 s
Time: 70.000000 s
Time: 60.000000 s
Time: 60.000000 s
Time: 60.000000 s
Time: 60.000000 s


Time: 50.000000 s
Time: 50.000000 s
Time: 50.000000 s
Time: 50.000000 s
Time: 40.000000 s
Time: 40.000000 s
ID:409
ID:408
ID:397
ID:414
ID:402
ID:390
Time: 40.000000 s
Time: 40.000000 s


Time: 30.000000 s
Time: 30.000000 s
Time: 30.000000 s
Time: 30.000000 s
Time: 80.000000 s
Time: 80.000000 s
Time: 80.000000 s
Time: 80.000000 s

7. Results and Observations

- The system tracked vehicles and some people correctly.
- When the street became crowded, the mask became noisy. This is normal for MOG2.
- The timestamps were accurate and visible in all panels.
- The bounding boxes and trails helped visualize movement patterns clearly.

Overall, my program met the assignment requirements.

Limitations: simple tracker fails in heavy occlusion and mask noise increases when the scene is crowded

8. Conclusion

I successfully processed both videos and built a full visualization system using OpenCV and VTK.
The code detects motion, removes noise, tracks objects, draws boxes and shows everything in one combined view.
I also saved output videos and screenshots. The results look correct and the system works as expected.