# Computer Vision
# FALL 2020
# Problem Set #5

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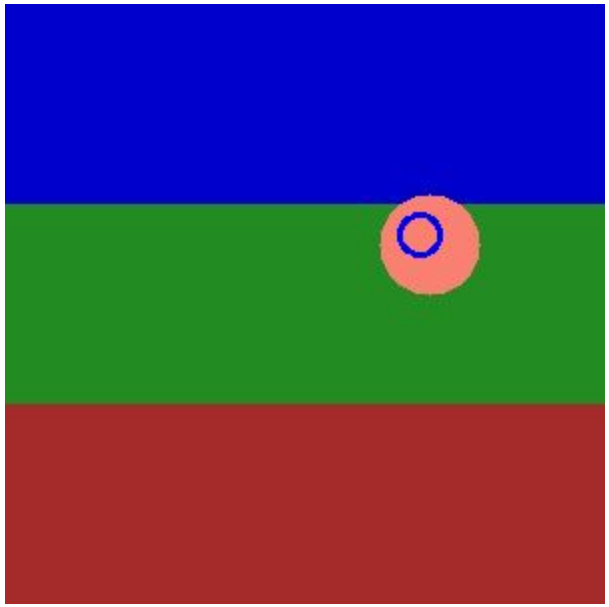
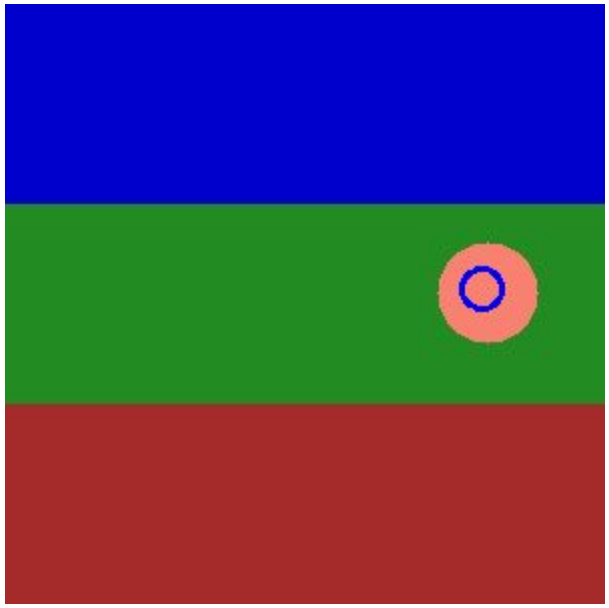
# 1b. KF Tracking a circle



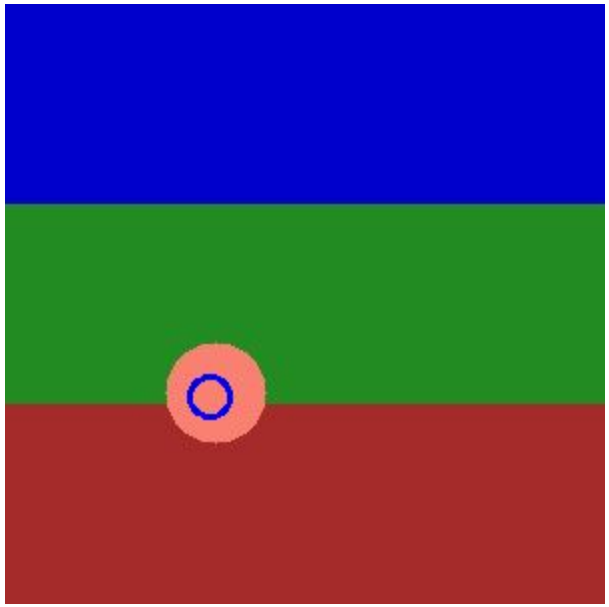
ps5-1-b-1.png

# 1b. KF Tracking a circle (cont)



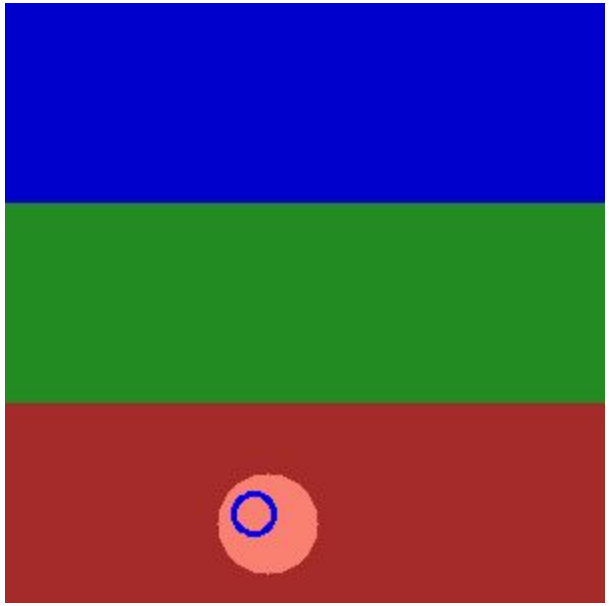
ps5-1-b-2.png

# 1b. KF Tracking a circle (cont)



ps5-1-b-3.png

# 1b. KF Tracking a circle (cont)



ps5-1-b-4.png

# 1c. KF Tracking pedestrians

ps5-1-c-1.png

# 1c. KF Tracking pedestrians

ps5-1-c-2.png

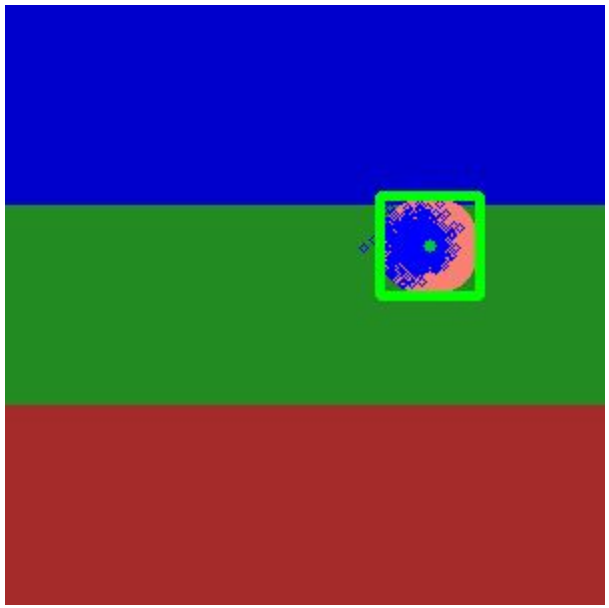
# 1c. KF Tracking pedestrians

ps5-1-c-3.png

# 1c. KF Tracking pedestrians

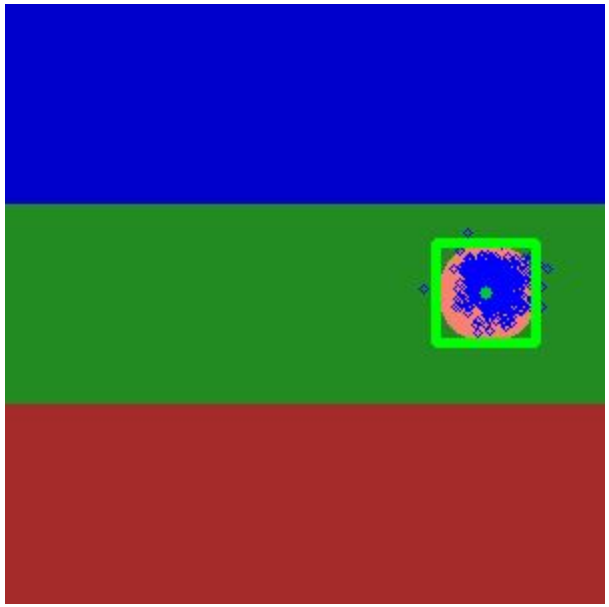
ps5-1-c-4.png

# 2a: PF Tracking a circle



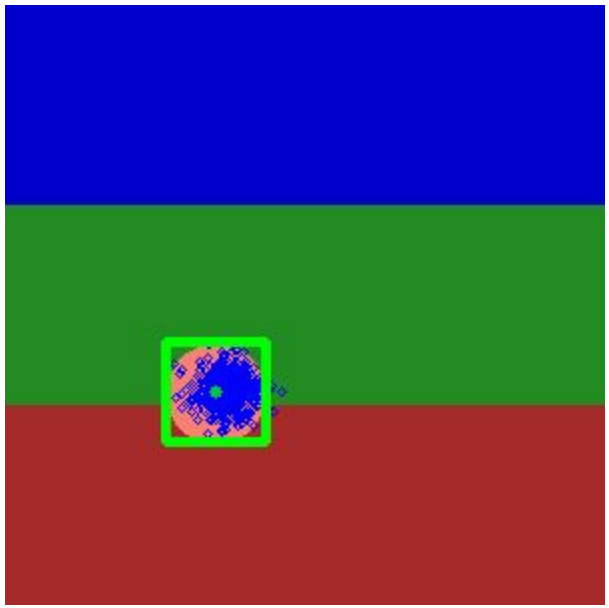
ps5-2-a-1.png

# 2a: PF Tracking a circle (cont.)



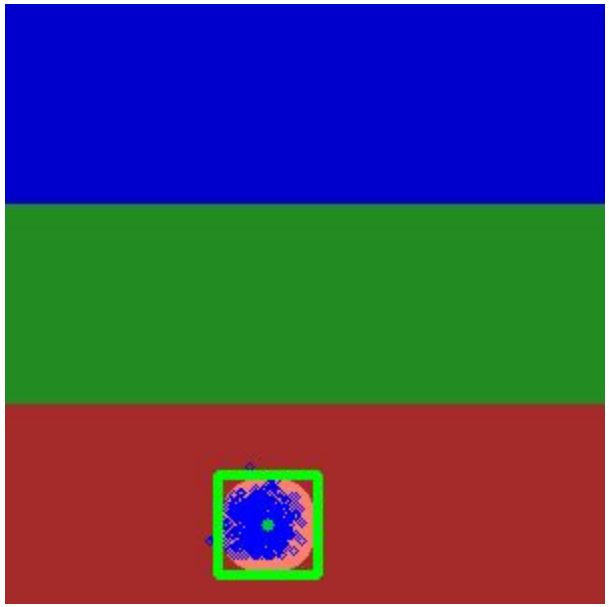
ps5-2-a-2.png

# 2a: PF Tracking a circle (cont.)



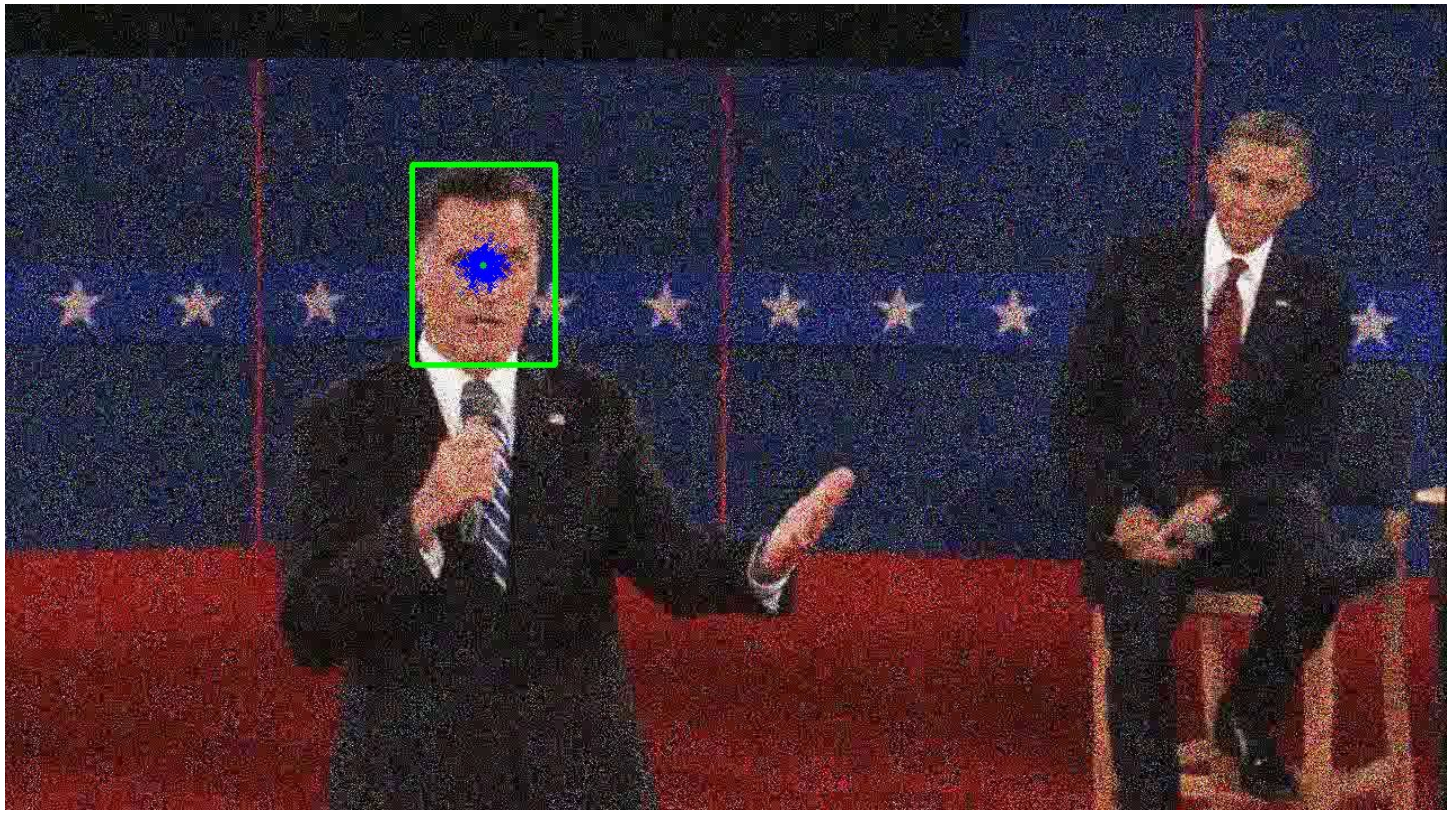
ps5-2-a-3.png

# 2a: PF Tracking a circle (cont.)



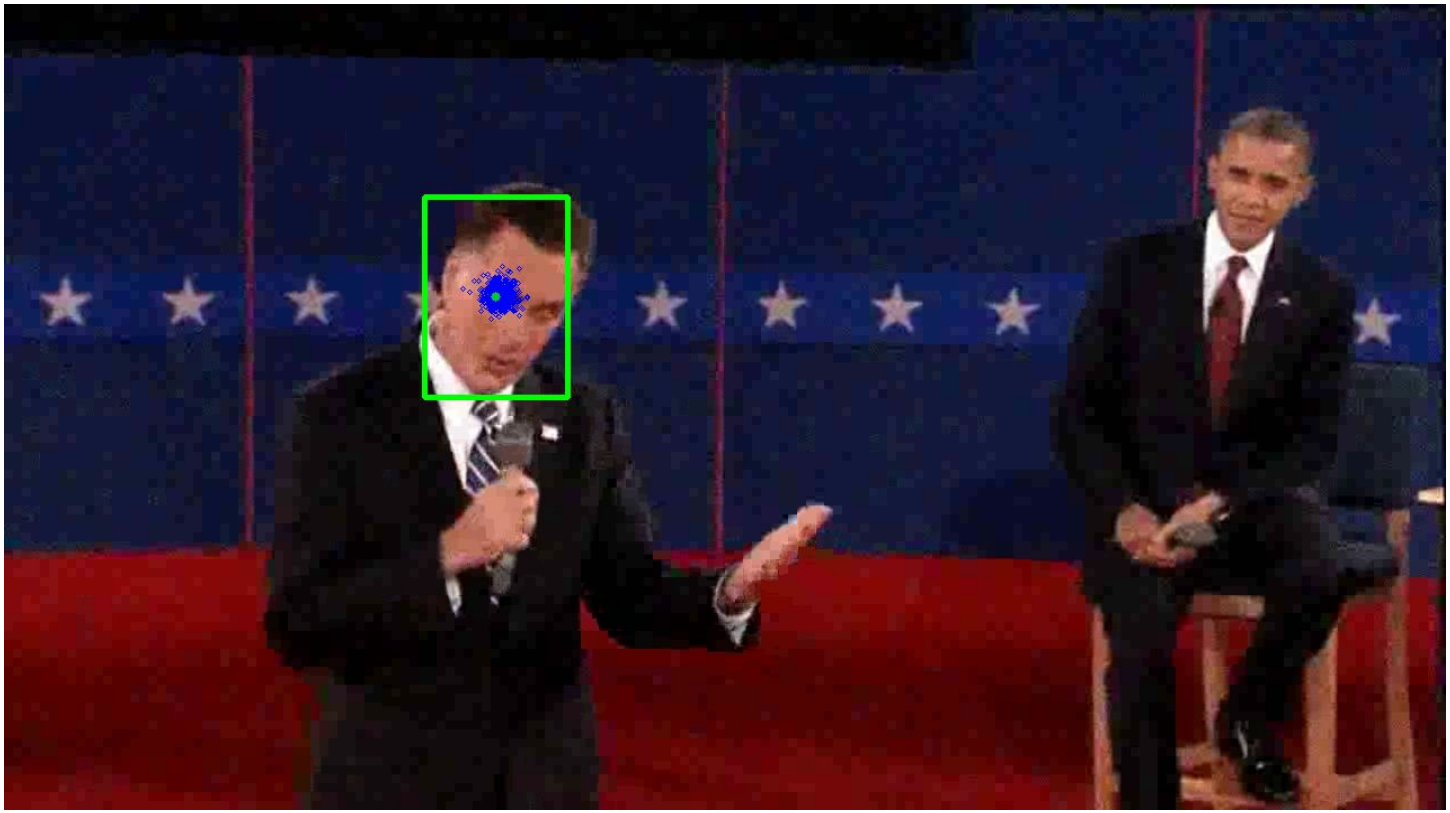
ps5-2-a-4.png

# 2b: PF Tracking noisy video



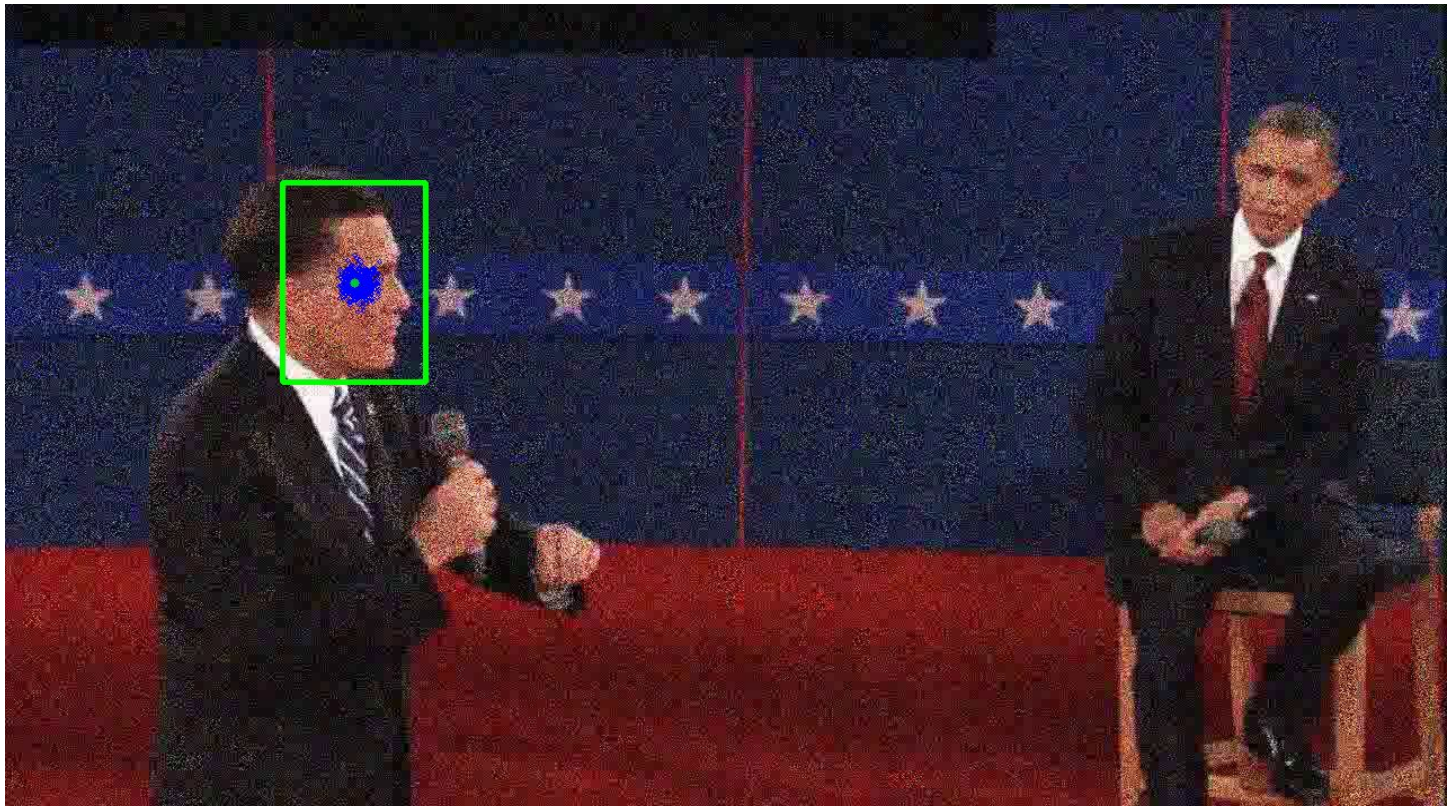
ps5-2-b-1.png

# 2b: PF Tracking noisy video (cont.)



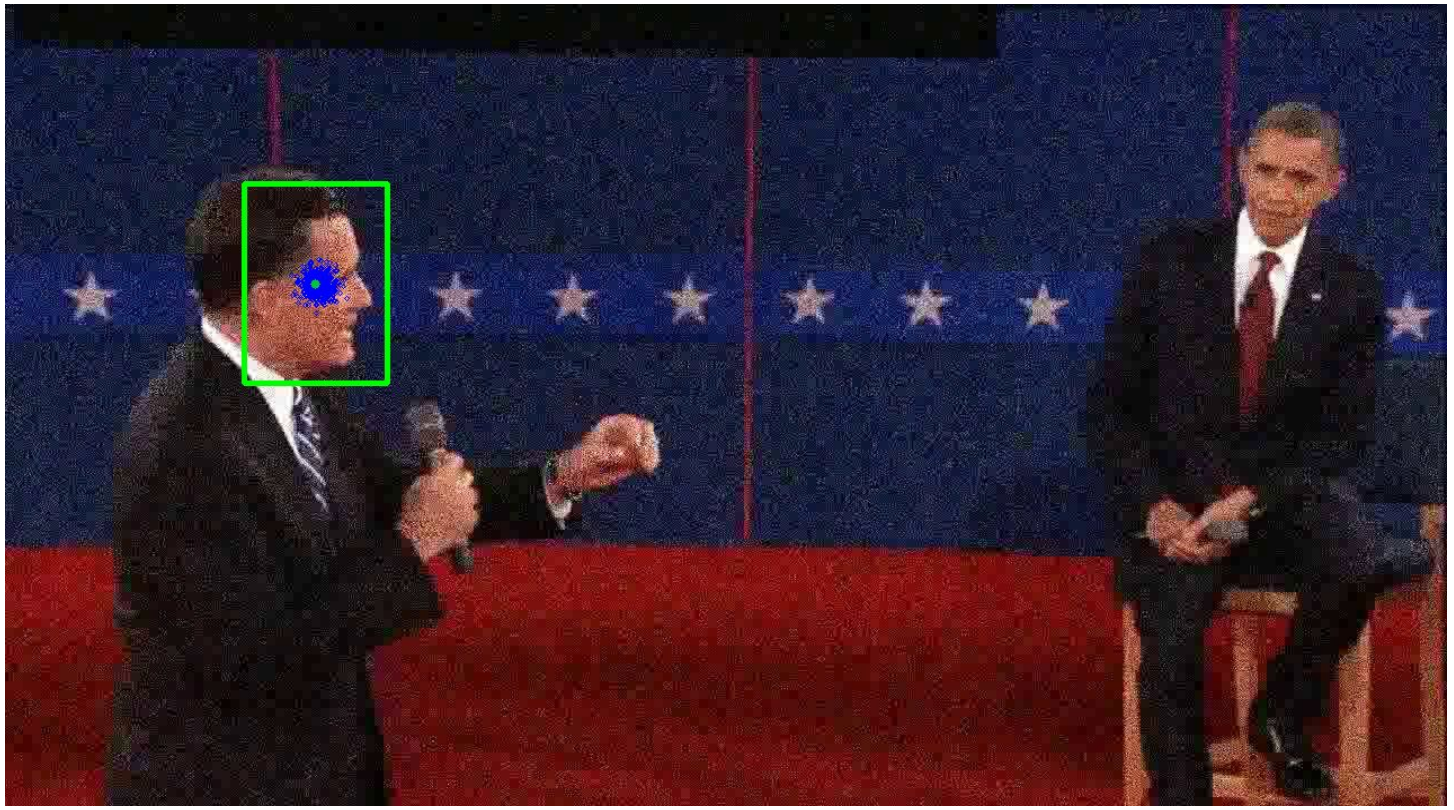
ps5-2-b-2.png

# 2b: PF Tracking noisy video (cont.)



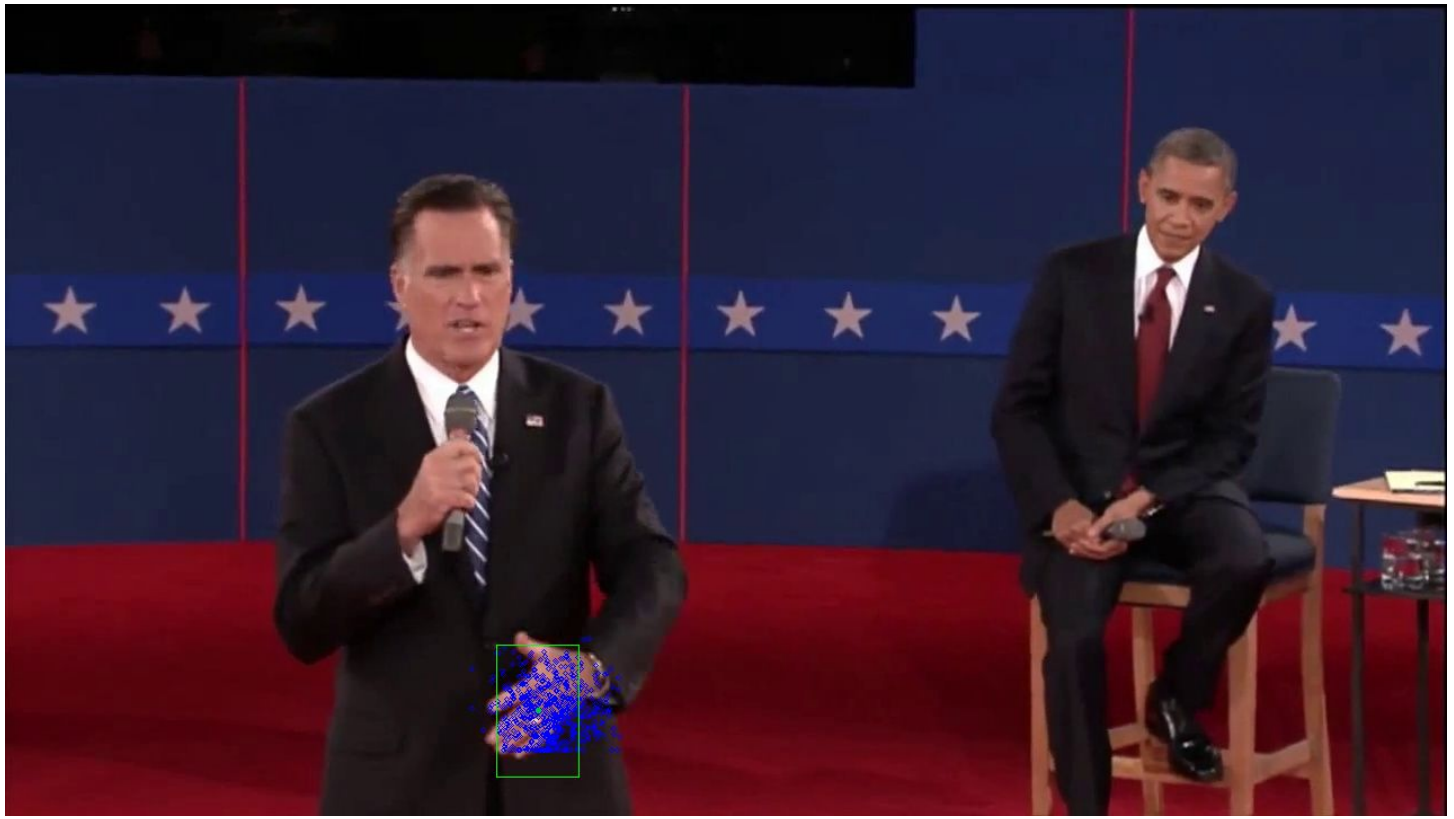
ps5-2-b-3.png

# 2b: PF Tracking noisy video (cont.)



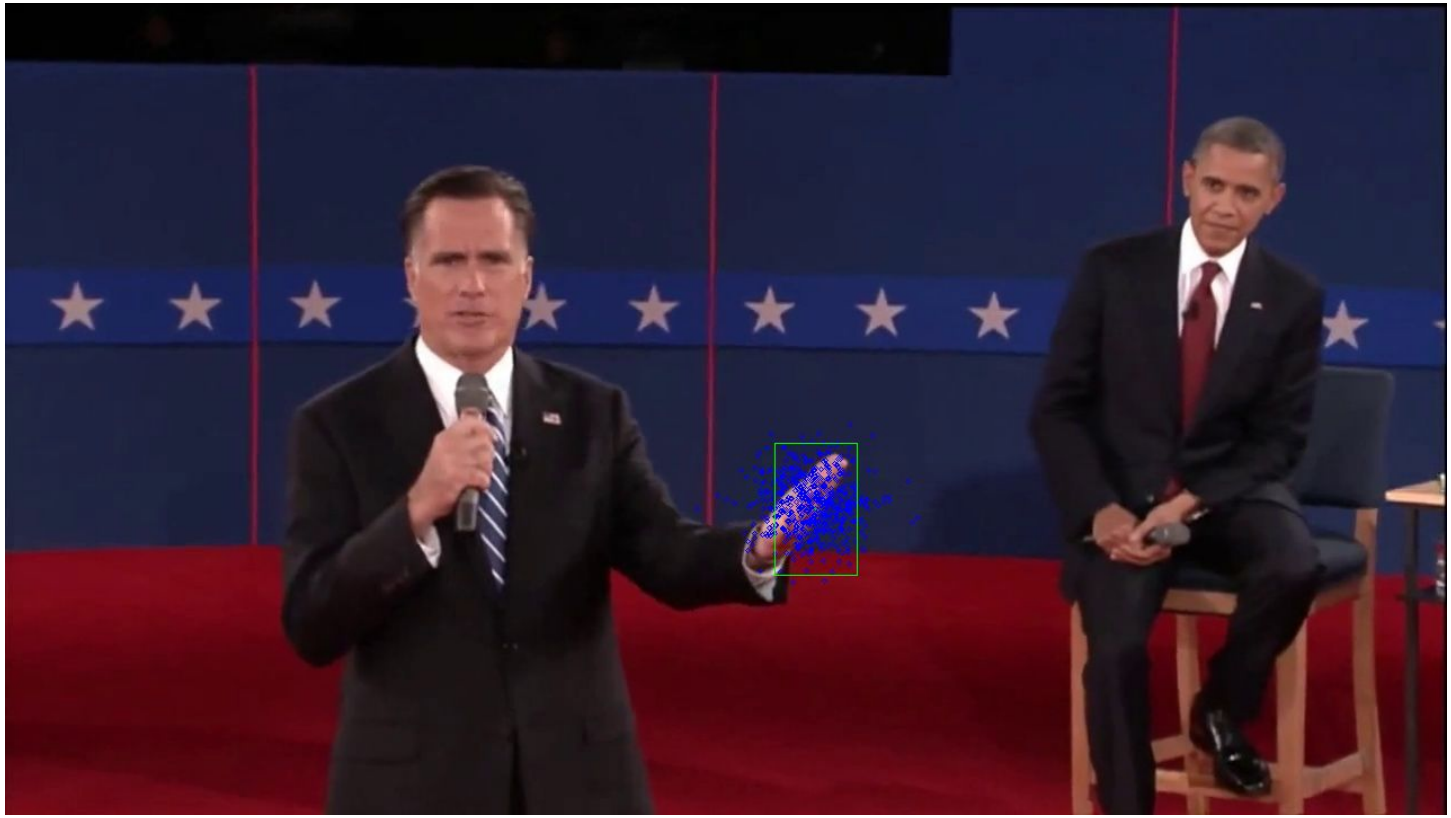
ps5-2-b-4.png

# 3a: PF Changes in Appearance



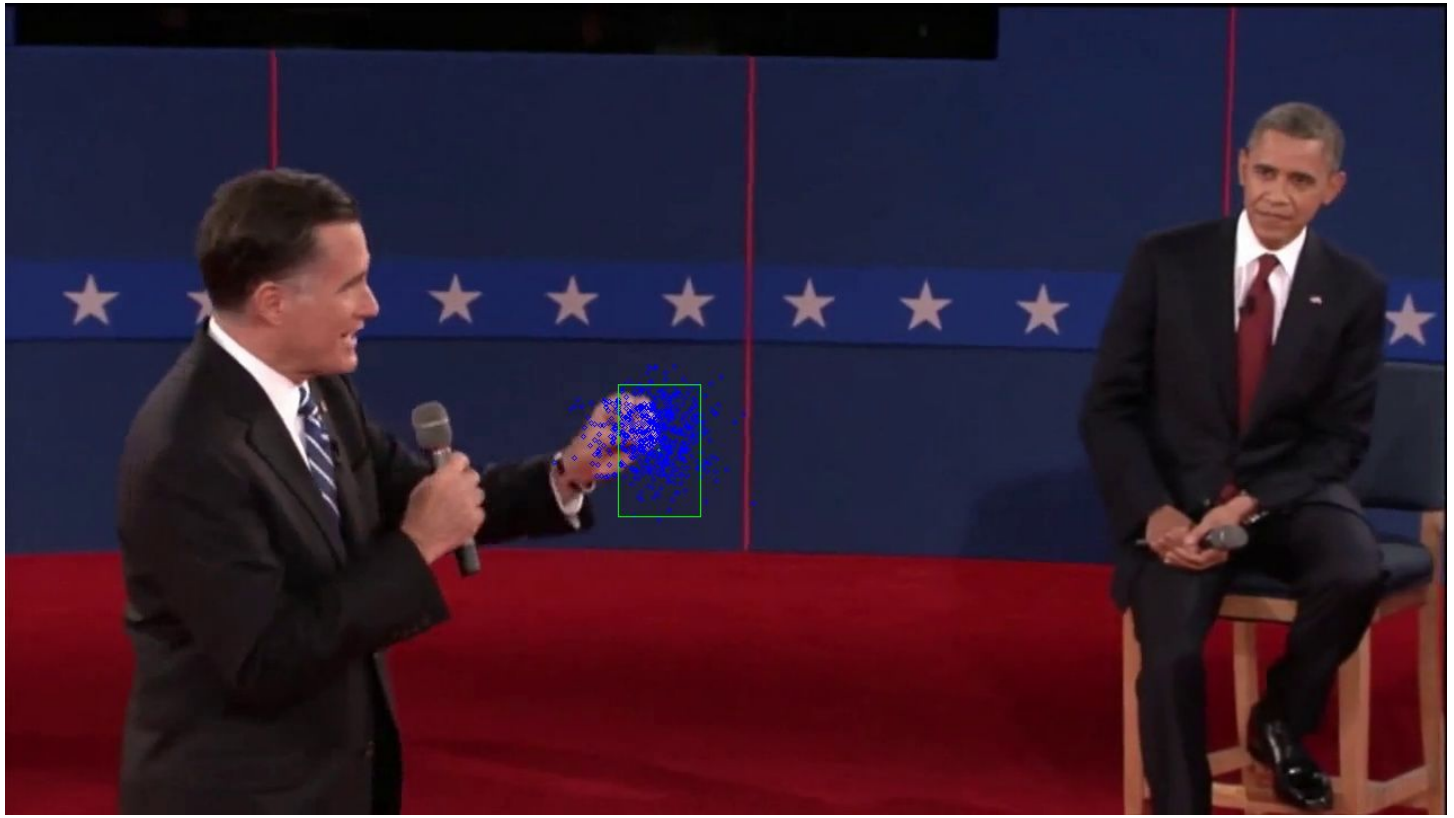
ps5-3-a-1.png

# 3a: PF Changes in Appearance (cont.)



ps5-3-a-2.png

# 3a: PF Changes in Appearance (cont.)



ps5-3-a-3.png

# 4a: PF Occlusions

ps5-4-a-1.png

# 4a: PF Occlusions (cont.)

ps5-4-a-2.png

# 4a: PF Occlusions (cont.)


ps5-4-a-3.png

# 4a: PF Occlusions (cont.)


ps5-4-a-4.png

# 4: Text response

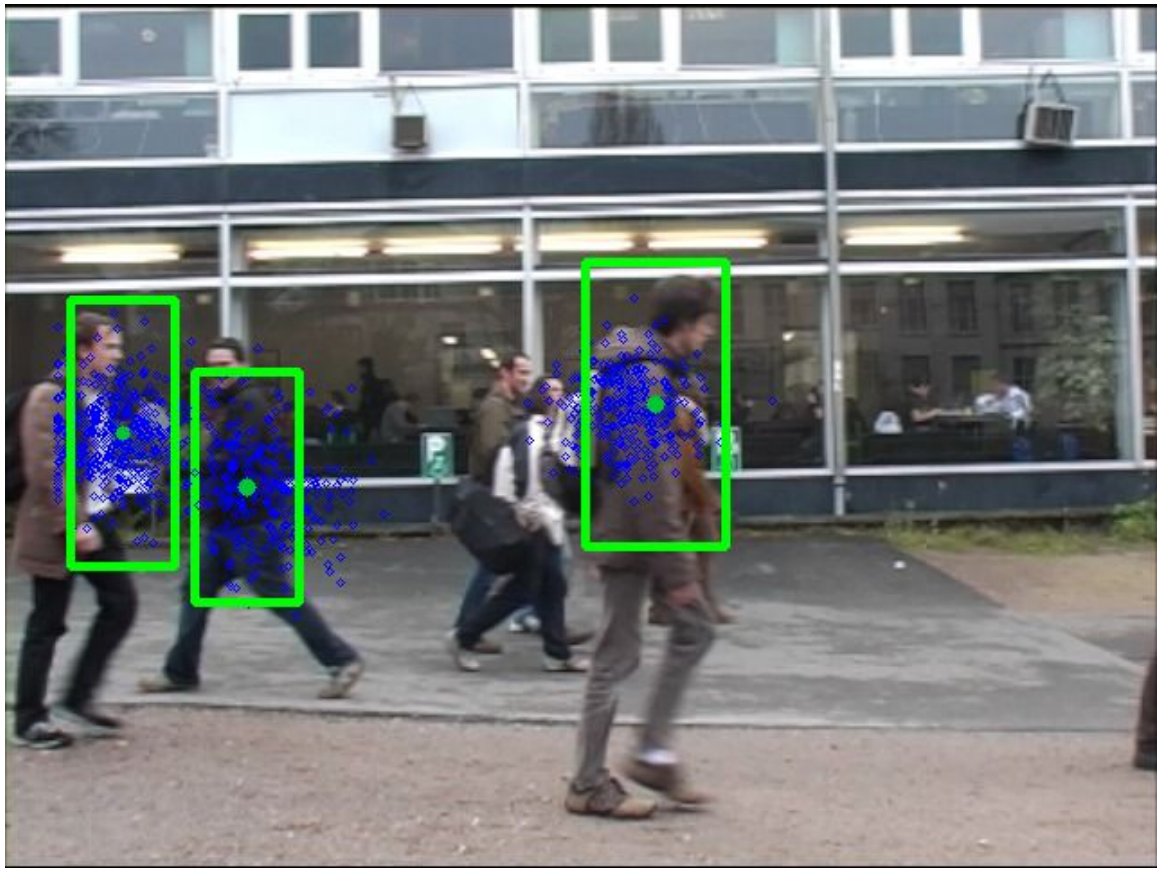
**Describe what you did. How did you modify the Particle Filter class to continue tracking after occlusions?**

I used the inherited Process method and made adjustments to the Particle Filter class. The particle filter needed to resize the template as the lady walked farther away. Also, the particle filter needed to know when the lady was blocked (occlusion) by other people. I base both these conditions on the mean weight for all particles, from the Gaussian Equation.

The mean weight was extremely small whenever a person/object blocked the lady. Therefore, I set a condition for every frame to check if the mean weight was greater than (in this case) 10^-70. If it was less than this number, then this would mean a person/object is blocking the lady. If the lady was blocked, the mean weight would not be updated, the particles would not be updated, and the template would not be updated. If the lady was NOT blocked, then the particles would continue to be updated by adding noise, resampling, and clipping, and the template would also be resized (cv.resize) by a 98.5%.

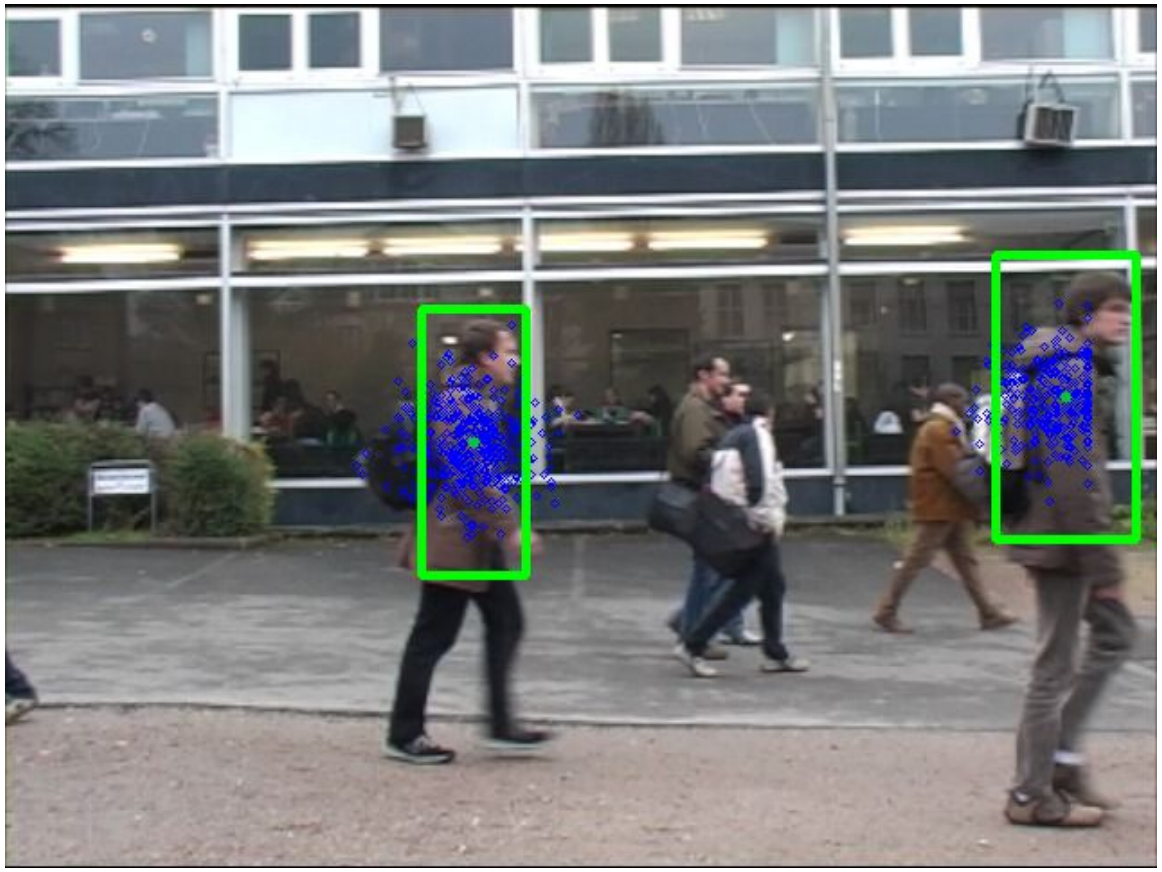
The template must be resized because the lady gets smaller the farther she walks and more objects/people enter the template, which increases the possibility of false detection from the particles. I use 98.5% because if it was too close to 100%, then the template would not resize fast enough for the lady. If the resizing was less than 98.5%, then the template would resize too fast.

# 5: Tracking multiple targets



ps5-5-a-1.png

# 5: Tracking multiple targets (cont.)



ps5-5-a-2.png

# 5: Tracking multiple targets (cont.)

ps5-5-a-3.png

# 5: Text response

**Describe what you did. How different it was to use a KF vs PF? Which one worked best and why? Include details about any modifications you had to apply to handle multiple targets.**

I used the particle filter because it handled the occlusions better. In several instances, there were people walking in front of our tracked targets, which would have confused the Kalman Filters. Unlike question 4, there was no need to resize the template because our tracked targets remained the same size, therefore I added a parameter to the Particle Filter class to disable template resizing.

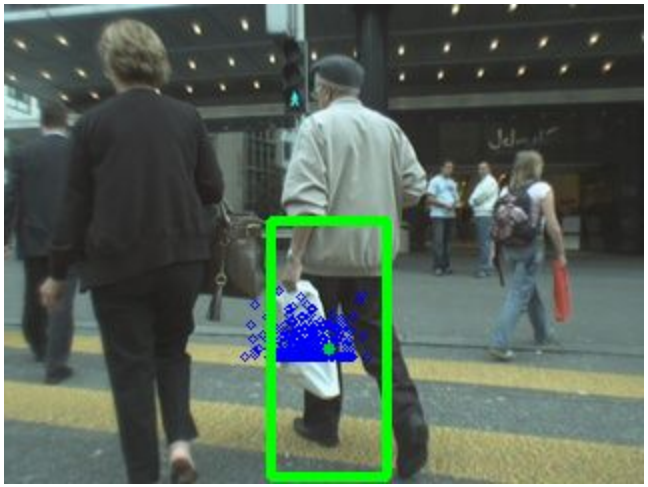
Multiple targets needed the particle filter to be applied three times on the same frame. The starting position template position was incredibly important. For example, for person 3, if the template box was slightly off, it would incorrectly pick up person 2. Furthermore, each target requires their individual sigma_dyn. Increasing sigma_dyn, allowed the particles to move more erratically, allowing for better detection on faster moving individuals.

As for the occlusions, I handled it the same way as in question 4. If the mean weight for all particles was below 1*-70, then a person/object blocked our target. If the target was blocked, the mean weight would not be updated, and the particles would not be updated. Furthermore, I used frames in which the target was clearly present, this is so that when the target leaves the frame, then the template would leave as well.

# 6: Challenge Problem

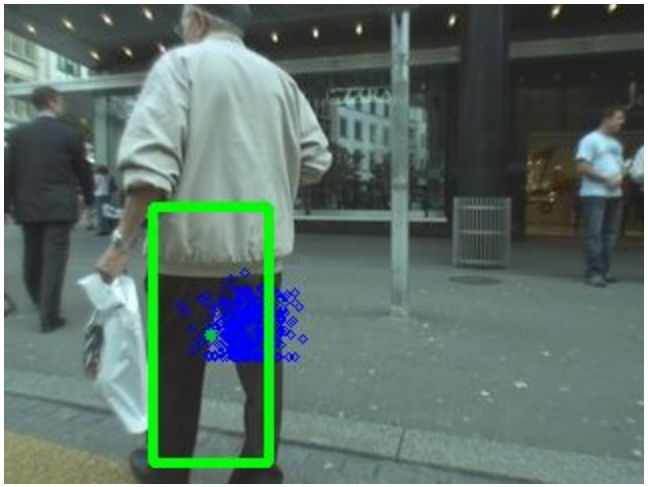
ps5-6-a-1.png

# 6: Challenge Problem (cont.)



ps5-6-a-2.png

# 6: Challenge Problem (cont.)



ps5-6-a-3.png

# 6: Challenge Problem Text response

**Describe what you did. Did this task present any additional challenges compared to the previous sections? Include details about any modifications you had to apply.**

This problem and occlusion is different from the occlusion and targets in the other questions because of how fast the movements of the target and occlusions occur. Furthermore, the camera is also moving compared to the stationary problem 4 and 5. The alpha value must be increased because of our formula:

```
self.template = self.alpha * framed + (1. - self.alpha) * self.template
```

The higher the alpha value, the more weight will be toward the mean of the particles (before the resizing of the template) instead of the particles of the resized template. Furthermore, I tweaked the resizing percentage to make it slower because the camera is following the target and the target relatively stays the same size. The MDParticle Filter detected the occlusion, but they were so fast that they minimally affected the tracking.