Computer Vision
Fall 2021
Problem Set #5

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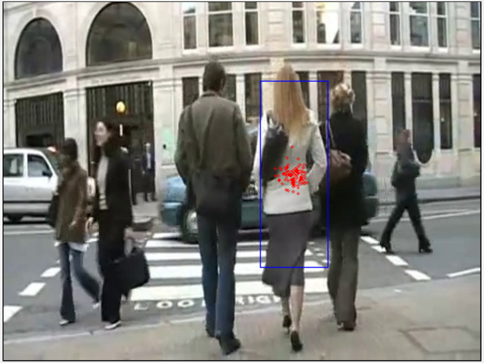
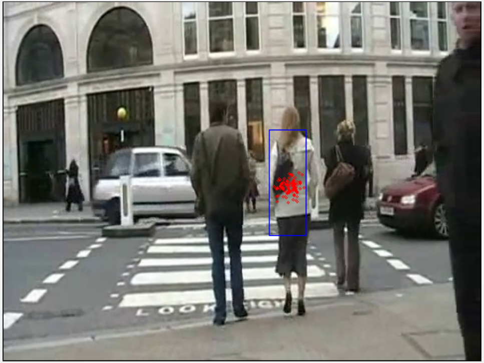
4a: PF Occlusions



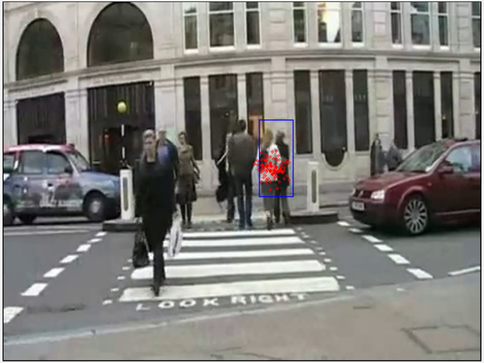
ps5-4-a-1

4a: PF Occlusions (cont.)



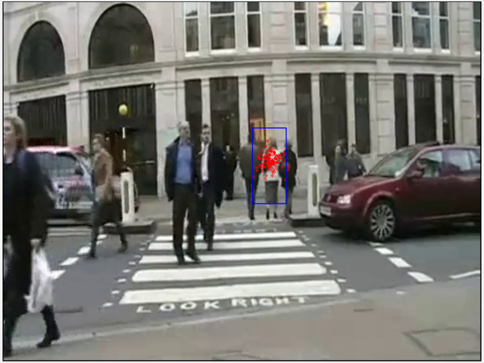
ps5-4-a-2

4a: PF Occlusions (cont.)



ps5-4-a-3

4a: PF Occlusions (cont.)



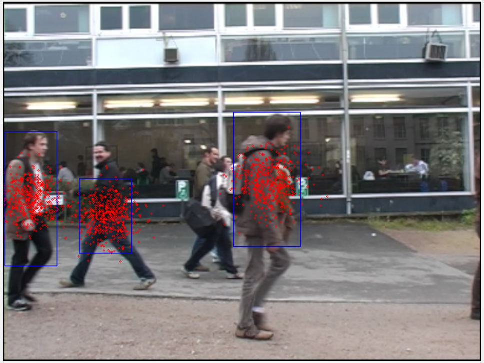
ps5-4-a-4

4: Text response

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

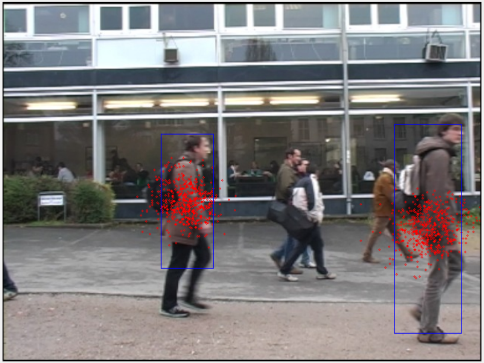
In part 4, there was a minimal change in the appearance of the template. Therefore, only a minimal update to the template was needed. However, I was faced with two more issues: the tracked person was getting smaller, and sometimes it is occluded. To solve the sizing of the template issue, I have randomly reduce the size of template for each particle by a maximum of 1.5% per iteration. I have also tracked each particle's error along with its new size template. Then, the new template was chosen based on the particle with the lowest error (highest weight) in that iteration. This resulted in a good tracking as it is illustrated in part 4's images. The occlusion problem was solved by introducing a conditional statement for updating the particles location. The condition was checking if the mean of the error (normalised over the image area) is less than a certain value. If this condition is not met, it means that there was a jump in the error , and hence it is likely that the tracked person is occluded. In this case, the particles freeze until the occlusion ends (stop re-sampling and updating the location). This worked well since the tracked person in part 4 is mostly moving along the depth of the image frame.

5: Tracking multiple targets



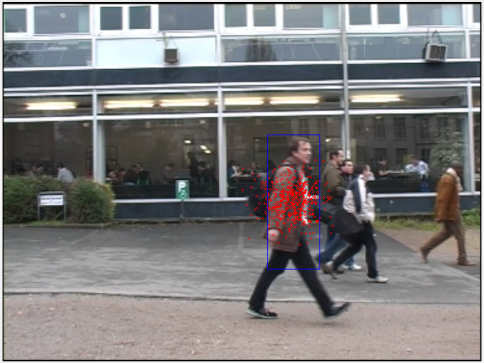
ps5-5-a-1

5: Tracking multiple targets (cont.)



ps5-5-a-2

5: Tracking multiple targets (cont.)



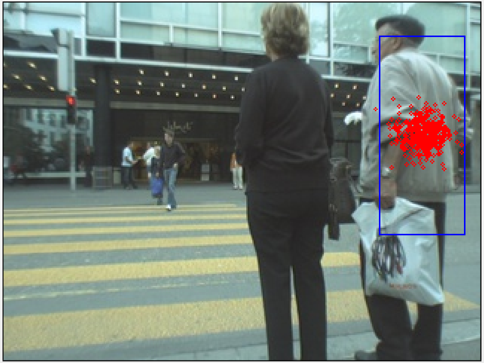
ps5-5-a-3

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.

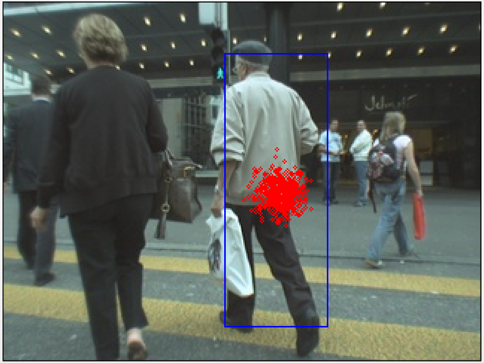
I have first tried Kalman filter (KF), and since the model used in the KF is the constant speed model, and the tracked people in part 5 are moving in same direction with almost the same speed, I was expecting KF to work well. However, it seems that the measurement method used in the KF was not good enough especially with the occlusion which introduced non-linearity to the filter. Thus, a non-linear filter was needed here for better performance (PF). The Particle filter here also suffered especially with occlusion. The guy with the black jacket was not easy to track since the template is very similar to the background.To get this part to work, I had to only take the upper body of each person to minimize the change in the template (only focus on the distinctive part of that person). I also had to hard-code the start and end frames that the tracked person was visible in the video. For the occlusion, I have used the same technique as part 4 with with different parameters (stop re-sampling and moving the particle when occlusion is detect).Note, no resizing was necessary for this part as the size of tracked people was almost uniform in the entire video. However, there was a small template update (with small alpha) to ensure the accuracy of the tracking. To handle tracking multiple people at the same time, a modified function of run_particle_filter function was introduced. In this function, multiple PF instances was initiated (three instances since we are tracking 3 people). Each PF object was created at the start of specific frame (passed to the function), and also destroyed at specific frame (also passed to the function). The new modified function also takes the location of all the template of the objects needed to be tracked.

6: Detect Pedestrians from a moving camera



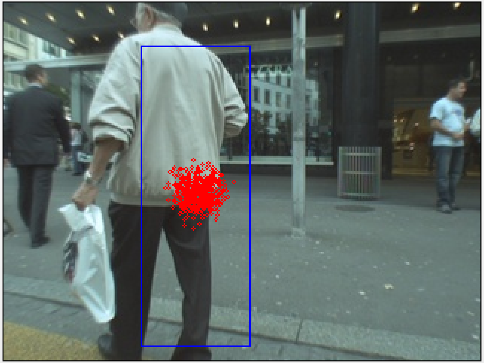
ps5-6-a-1

6: Detect Pedestrians from a moving camera (cont.)



ps5-6-a-2

6: Detect Pedestrians from a moving camera (cont.)



ps5-6-a-3

6: Detect Pedestrians from a moving camera

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.

In part 6, I have used similar implementation to part 5. Mainly, I have used the idea of stop re-sampling and moving the particle when occlusion is detected, also updating the template with the Infinite Impulse Response (IIR) filter. I also started with the upper body of the old man as the starting template because it resulted in better tracking. Yes, there was a new introduced challenge which is the unexpected change in the size of the tracked person since the camera is moving which resulted in the tracked person getting smaller or bigger in the image. It was very hard to predict the new/next size of the tracked person in the image. I have tried to randomly up-sample and down-sample the template and then choose the best template based on the lowest error (per iteration). However, this method didn't work every well since up-sampling and down-sampling caused the quality of template to be very bad. I finally had to introduced a hard-coded scale increase to the size of the template since the old man appear bigger in the frame for the majority of the frames compared to the start. This scale was also needed since the template started with only half the height of the tracked person (upper body only)