# HW1 Report: Object Tracking with OpenCV

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Overview:

The Open CV library contains eight different trackers that all have various benefits and detriments that are associated with each tracker. For this assignment we have chosen to focus our attention on the following four trackers: MIL, TLD, MOSSE and CSRT. The MIL tracker takes in both positive and negative examples of the object the user wants to track. However in addition to that is also looks around the object to generate additional positive examples. In the long run this may lead to the bounding box to be slightly off centered. It is able to handle partial occlusion but is unable to recover from full occlusion. TLD stands for Training, Learning, and Detection. When utilized this tracker it breaks the task of long term tracking into three separate tasks: short term tracking, learning, and detection. The learning task is able to utilize the detector to be able to avoid future errors once an error has been detected. The MOSSE tracker, otherwise known as Minimum Output Sum of Squared Error tracker, uses an adaptive correlation for tracking purposes which outputs stable correlation filters. Essentially the MOSSE tracker applies a series of filters in order to find the correlation between the what is being tracked and what is being shown when the filter is applied. CSRT is otherwise known as Discriminative Correlation Filter with Channel and Spatial Reliability. It essentially uses spatial reliability to adjust the filter to the part of the object suitable for tracking. One important fact to note about the CRST is that it offers higher accuracy for lower frames per second (FPS).
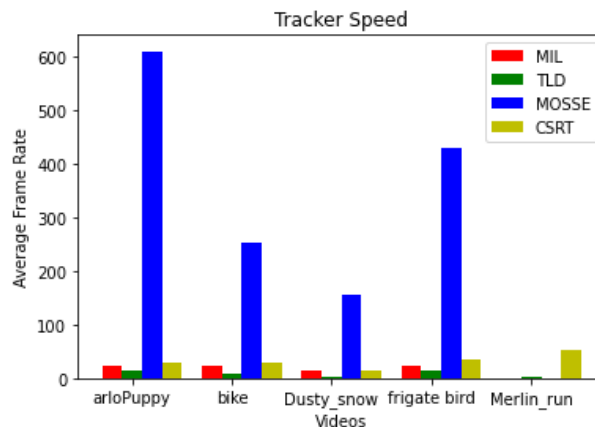
We decided to track the average frames per second within each video for each tracker. We did this by adding all the frames per second while the video was running and then dividing it by the total number of frames at the end. Through our calculations we were able to learn that MOSSE has the highest average FPS by a wide margin while TLD has the lowest. The other two trackers have very similar average FPS's.

MIL
Overall the MIL tracker was able to successfully track each of the selected objects in each of the videos, except for when it came to tracking Merlin. For the video of Arlo and Dusty when the face was selected the bounding box did not stay in the exact location that was selected but it did manage to stay on the dogs the whole time. For the biker and bird video the tracker was able to stay in the exact location on the object that was selected, even in the case of occlusion which occurred in the bike video. While the MIL tracker worked fairly well for the first four videos and only struggled a little bit when the object grew closer, it was not able to track Merlin. The bounding box stayed in the same spot that was initially selected instead of following Merlin.

TLD
The TLD tracker worked slightly better than the MIL tracker, in which it attempted to change the size of the box as the object grew closer. For the videos of Arlo, the biker, Dusty, and the bird the TLD tracker was able to track all four objects and change in size as the object grew closer. It attempted to encompass what was originally selected throughout the duration of the video. However for Merlin it managed to track the dog for a few seconds until it got completely thrown off and started tracking the ground instead.

MOSSE
While the MOSSE tracker had the highest average FPS it struggled the most with tracking some of the objects. While with most of the trackers they would work if you only selected the face/head, MOSSE required the entire object to be selected otherwise it would result in a tracking failure. For the videos of Arlo, Dusty and the bird, the tracker managed to stay nearly in the area selected the entire time. On the other hand for the videos of the biker and Merlin the tracking displayed a tracking error and was unable to track either object.

CSRT
The CSRT tracker seemed to work the best out of all the trackers because it was able stay in pretty much the exact location that was selected throughout the duration of the video. It was also the only tracker that was able to track Merlin longest and only lost him in the end resulting in a tracking failure.

Conclusion
All around CSRT seems to be the better tracker when compared to the others when applied to the videos. TLD works best for objects with varying size but fails to track when the object is too fast. MIL works fairly well on objects whose size does not change too much. MOSSE is similar to MIL in most cases sometimes outperforming MIL. It also has high frames per second making it better at tracking fast objects. However even though CRST does not have high FPS it is still able to successfully track the objects more efficiently than the other trackers.