Assignment 1 - Report

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Trackers selected – MIL, KCF, MOSSE, MEDIAN_FLOW
abbreviations used to save space - bbox – bounding box

For this assignment, I did not select any deep learning based trackers to keep things simple and understand the basic trackers first before moving to NN trackers. I observed that selection of bounding boxes has a very large impact on the accuracy of tracking, therefore, it would be interesting to study bounding box formation using techniques like non-max suppression[1].

Qualitative analysis -

Methodology - Ran the script multiple times on each video. Kept the bbox parameters same for each iteration to minimize error and increase consistency in results

1> Dusty_snow - If only the main body (excluding tail) was included then the performance increased significantly compared to when the body with tail was included in the bbox. MIL performed good overall, it successfully tracked most of the frames except a few towards the end. KCF's performance in terms of fps was dismal. However, it had fairly good accuracy and recovered twice after failing to track. MOSSE was fast comparatively and adjusted the bbox dynamically. MEDIAN_FLOW failed to track when the dog was moving too fast but recovered once his speed slowed down. It did the best job of adjusting the bbox dynamically

2> frigatebird - Speed is crucial in this video and all trackers except MEDIAN_FLOW were able to perform tracking flawlessly. MEDIAN_FLOW was able to track only a few frames. It did recover partially towards the end though. The performance (fps) in order was MIL < KCF < MOSSE.

3> Merlin_run - Selecting bbox for this video is counter intuitive as the accuracy increases if you select some background elements in addition to the dog. Instead of perfectly selecting the outline of the dog. MIL and KCF were bad and could not track after a few first frames. MOSSE and MEDIAN_FLOW were able to track the dog till the very end. MEDIAN_FLOW did comparatively better than MOSSE in fps and adjusting size. However, both of them failed to scale the bbox at the end, probably due to lack of contrast in the object (dog)

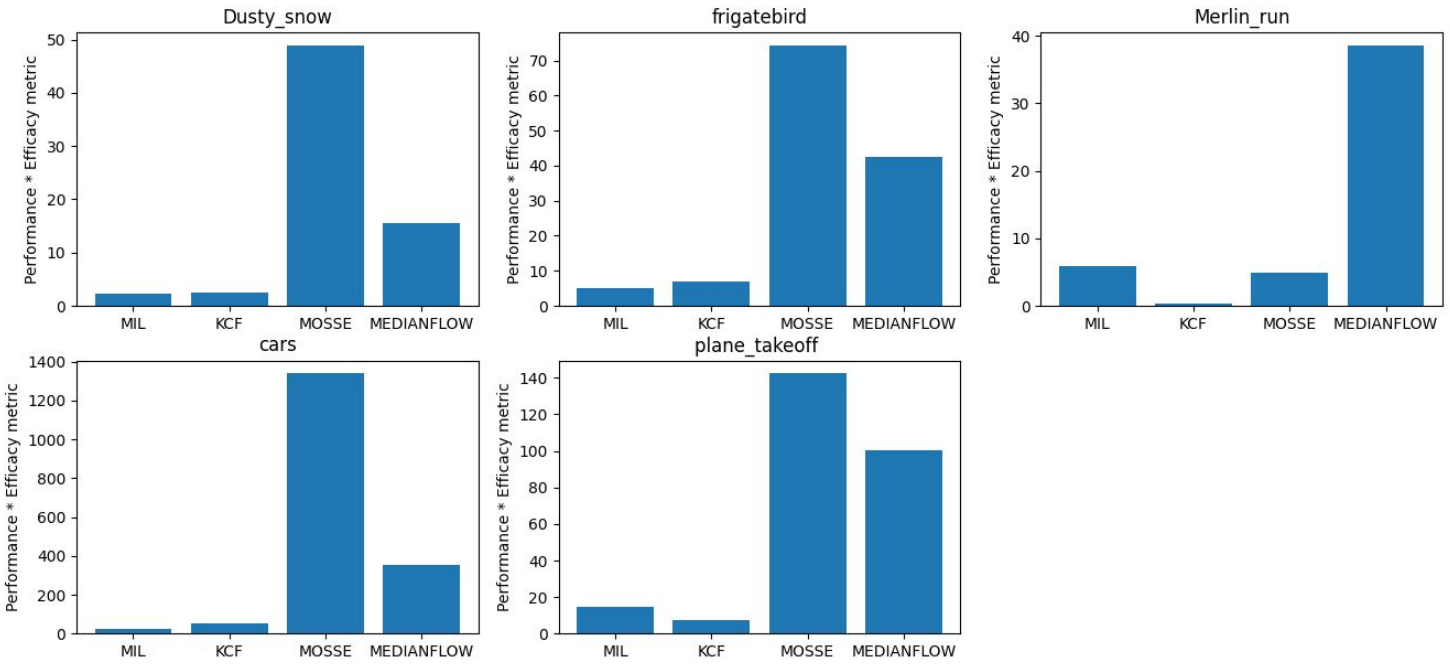
4> cars - [Rationale behind selecting this video - in the video, a mini truck does lane change and the car recording video overtakes it. The lane change motion is not abrupt and the mini-truck wobbles a bit in its lane before changing lanes. I selected this video to see how trackers scale the bbox in this one as the car overtakes the mini-truck and also to see how trackers react to the micro wobble.] MIL does not adjust the bbox dynamically and also fails to detect tracking failure. KCF's accuracy was similar to MIL but it detects tracking failure. MOSSE's performance (fps) is better than MIL and KCF but it also fails to adjust bbox size. It does reports tracking failure. MEDIAN_FLOW does the best job of scaling bbox and registering minute changes in target. However, similar to other videos MEDIAN_FLOW requires a perfect fitting bbox without any background elements in it. Otherwise, the accuracy deteriorates rapidly compared to other trackers

5> plane_takeoff - [Rationale behind selecting this video - In the video, a plane on the runway takes off. It goes into around 90% occlusion behind a hill while taking off and then passes a metal tower which is around 80%

transparent. I selected this video to observe performance of trackers in the event of occlusion] All of the trackers fail to track the plane past the metal tower. This was surprising and interesting, as the width of the tower is small and it is not even fully opaque. MIL, KCF and MOSSE recover from the partial occlusion but MEDIAN_FLOW fails to do that.

Quantitative analysis -

FPS Performance - I calculated median fps for each tracker on all the videos. I took into account only the frames that the tracker was indicating as being tracked. I then multiplied the fps values with the number of frames tracked to penalize failing to track objects.



False positives - I manually calculated the number of frames for which tracking was not working but it was not detected.

Tracker	Dusty_snow	frigatebird	Merlin_run	cars	plane_takeoff
MIL	6	0	286	90	260
KCF	2	0	0	1	254
MOSSE	0	0	0	0	248
MEDIAN_FLOW	0	15	0	0	279

References -

[1] https://www.pyimagesearch.com/2014/11/17/non-maximum-suppression-object-detection-python/
[2]https://www.youtube.com/watch?v=LAdC4I0VaTs
[3] https://www.youtube.com/watch?v=txQMGgjX3_Y
[4] https://learnopencv.com/object-tracking-using-opencv-cpp-python/