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Homework 3

Problem 1

Q 1.1

A.

In the scenario of two-dimensional tracking with a pure translation, warp function is defined as:

$$W(x; p) = x + p \tag{1}$$

Therefore, we can calculate $\frac{\partial W(x;p)}{\partial p^T}$ by taking derivative of equation (1) with respect to p^T, we get:

$$\frac{\partial W(x; p)}{\partial p^T} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \tag{2}$$

B.

By comparing the equation (4) and (5) from the question, we can find A and b as:

$$A = \frac{\partial I_{t+1}(x^{'})}{\partial x'^T} \frac{\partial W(x; p)}{\partial p^T} \tag{3}$$

$$b = I_t(x) - I_{t+1}(x + p) \tag{4}$$

C.

The matrix $A^T A$ should be full rank so that a unique solution to Δp can be found. In other words, it should be non-singular as we need to find inverse of the it to find the solution for Δp.

Q 1.3

The results of lucas kanade for car sequence is shown in figure (1) and for girl sequence in figure (2) with bounding box in red.

(a) frame 1 (b) frame 100 (c) frame 200 (d) frame 300 (e) frame 400

Figure 1: Lucas Kanade on Car Sequence

(a) frame 1 (b) frame 20 (c) frame 40 (d) frame 60 (e) frame 80

Figure 2: Lucas Kanade on Girl Sequence

I tried changing the hyperparameters and was able to see this changes as:

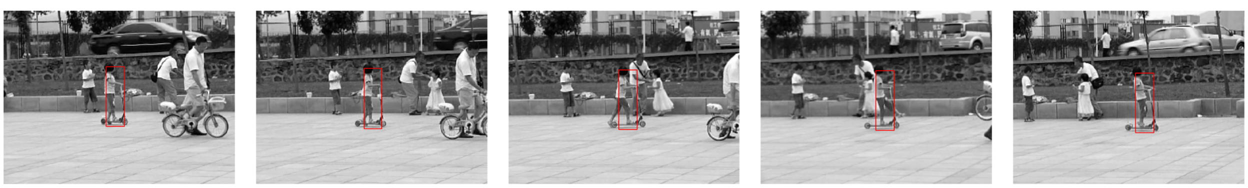
- Keeping the threshold constant, If I increase the number of iterations, there is no change as the job is done in less than 20 iterations. I also decreased the iterations to 10 and it didn't made any much of a difference. There was some error but it was minor.
- Keeping number of iterations constant, If I increase the threshold to 0.8, I'm able to finish the job in just a few iterations and almost any nearby solution satisfies the condition. Because of this the result was very noisy. I also decreased the threshold to 1e-6, It gives me a good result but takes longer time as compared to other runs as it needs more iterations to bring the difference down.

Q 1.4

The results of lucas kanade with template correction for car sequence is shown in figure (3) and for girl sequence in figure (4) with bounding box in red. We can easily see the improved in the tracking. After template correction, it is able to track the girl even when the people in the background come just behind the tracking girl. Whereas before this correction, the tracker was not able to track the girl properly when the people in the background were near (figure (2)).

(a) frame 1 (b) frame 100 (c) frame 200 (d) frame 300 (e) frame 400

Figure 3: Lucas Kanade with template correction on Car Sequence



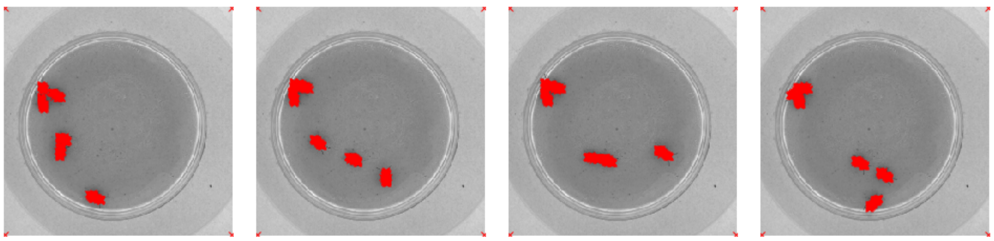
(a) frame 1 (b) frame 20 (c) frame 40 (d) frame 60 (e) frame 80

Figure 4: Lucas Kanade with template correction on Girl Sequence

Problem 2

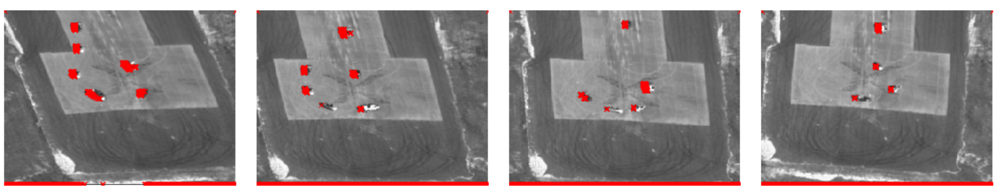
Q 2.3

The results for the Lucas Kande Tracking with motion detection on act sequence is shown in the figure (5) and for aerial sequence in the figure (6). The motion detection is indicated by the red markers.



(a) frame 30 (b) frame 60 (c) frame 90 (d) frame 120

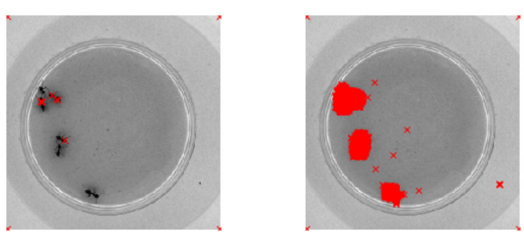
Figure 5: Lucas Kanade Tracking with Motion Detection on Ant Sequence



(a) frame 30 (b) frame 60 (c) frame 90 (d) frame 120

Figure 6: Lucas Kanade Tracking with Motion Detection on Aerial Sequence

I tried different tolerance values and wanted to see the change. So, If I lower the tolerance below 0.2, I start to get less motion tracking points as a very few points pass the condition. If I go above 0.2, the points are increased and give a noisy result. (study figure (7))



(a) Tolerance = 0.06 (b) Tolerance = 0.4

Figure 7: Change in tolerance

Problem 3

Q 3.1

The inverse compositional approach is more computationally efficient than the classical approach as we do not need to recompute Hessian in every iteration of the gradient descent instead it can be pre-computed once making the process much faster.