Advanced Computer Vision HW2

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1 Lucas-Kanade Tracking

1.1

1. It's a Jacobian matrix, which is an identity matrix since the warp function is simply a translation.
$$\frac{\partial \mathcal{W}(\mathbf{x};\mathbf{p})}{\partial \mathbf{p}^T} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

2. $\mathbf{A} = \frac{\partial \mathcal{I}_{t+1}(\mathbf{x}')}{\partial \mathbf{x}'^T}\frac{\partial \mathcal{W}(\mathbf{x};\mathbf{p})}{\partial \mathbf{p}^T}$. It is a $(D, 2)$ matrix if we consider all the pixels in $\mathbb{N}$.
$\mathbf{b} = \mathcal{I}_t(\mathbf{x\prime}) - \mathcal{I}_{t+1}(\mathbf{x\prime})$.

3. $\mathbf{A}^T\mathbf{A}$ must be invertible.

1.2

1.3

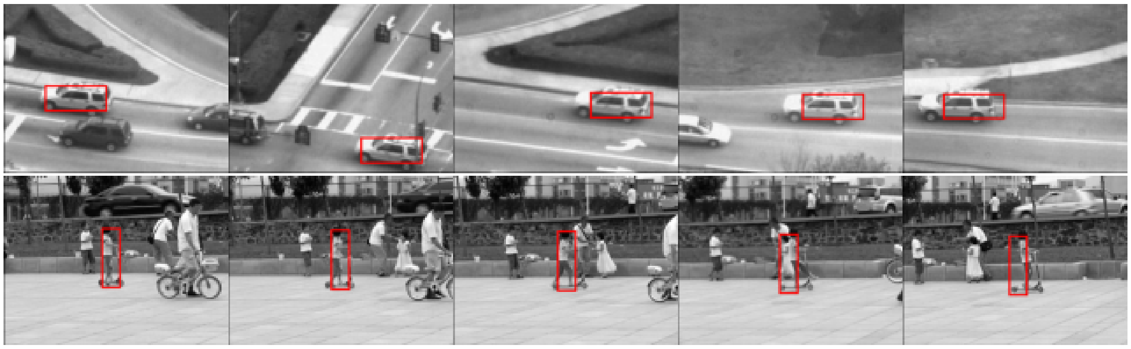


Figure 1: Lucas-Kanade Tracking with One Single Template

1.4

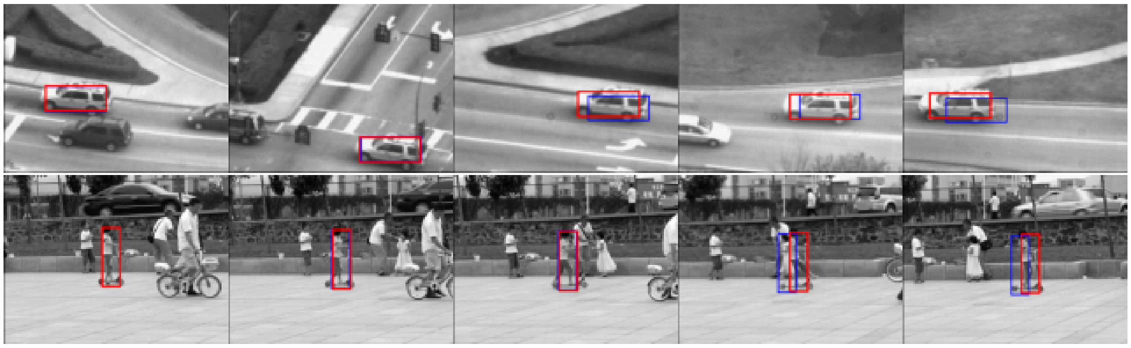


Figure 2: Lucas-Kanade Tracking with Template Correction

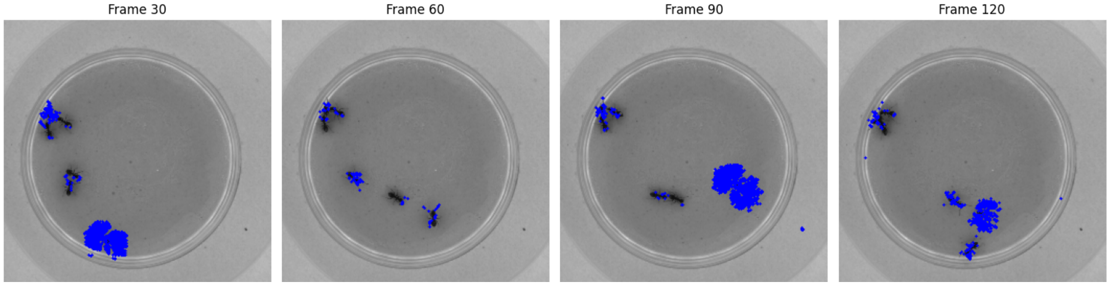
2

2.1

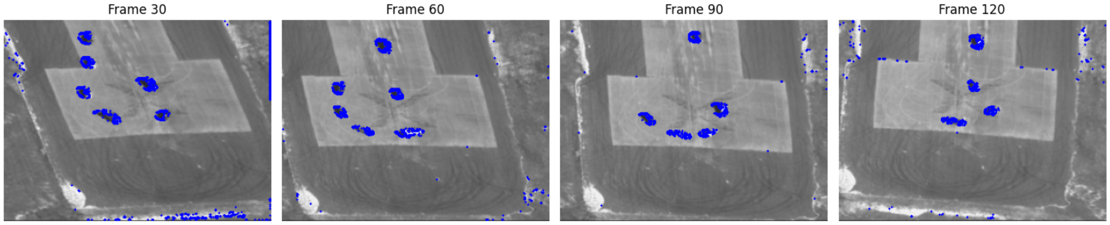
2.2

2.3

Below are my results and configurations.



(a) Threshold=0.001; Tolerance=0.01; Erosion/Dilation Iteration=1



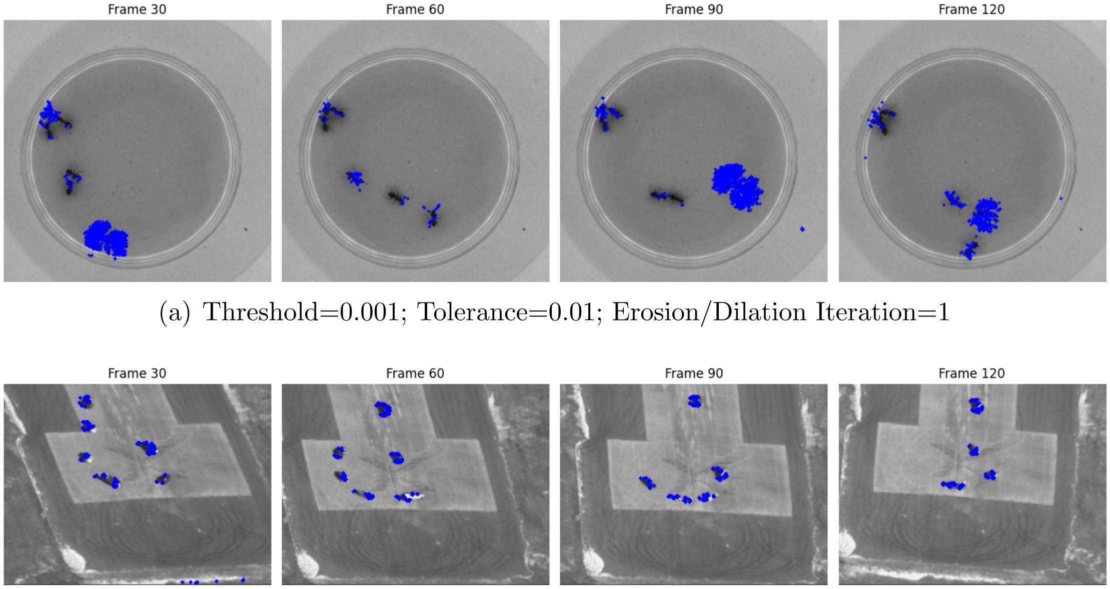
(b) Threshold=0.001; Tolerance=0.02; Erosion/Dilation Iteration=2

Figure 3: Lucas-Kanade Tracking with Motion Detection

3

3.1

Below is my results and configurations. The parameters are the same as Q2, and the results look similar.



(a) Threshold=0.001; Tolerance=0.01; Erosion/Dilation Iteration=1

(b) Threshold=0.001; Tolerance=0.02; Erosion/Dilation Iteration=2

Figure 4: Lucas-Kanade Tracking with Inverse Composition

3.2

The inverse compositional approach is faster because we do not have to re-calculate the Hessian matrix in each iteration. Instead, we pre-compute and re-use the result. Also calculating the inverse of warping matrix (3x3 matrix) is very fast. Therefore the overall computation cost is reduced. However, in my experiment, I noticed that the inverse compositional approach is not significantly faster. The reason might be that, in each frame, the images does not differ a lot, therefore it only takes a few iteration for LK algorithm to converge, so that we do not fully utilize the benefits of pre-computation.

4 Collaboration

For this homework, I discussed with Ethan Lai, Daniel Yang, Yu-Hsuan Li, Tian-Zhi Li, and Rena Ju.