CS-E4850 Computer Vision
Exercise Round #8
Submitted by Chen Xu, ID 000000
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Exercise 1. Face tracking example using KLT tracker.
Run the example as instructed below and answer the questions.

a) Run Exercise8.ipynb

b) Run Exercise8.ipynb with a different input by changing the input to obama.avi:
frames=faceTracker('obama.avi')

c) What could be the main reasons why most of the features are not tracked very long in case b) above?

Answer: The frame rate is not high enough when the camera starts shaking.

d) How could one try to avoid the problem of gradually losing the features? Suggest one or more improvements.

Answer: Increase the frame rate.

e) Voluntary task: Capture a video of your own face or of a picture of a face, and check that whether the tracking works for you. That is, replace the input video path in faceTrackingDemo.py with the path to your own video.

Exercise 2. Kanade-Lucas-Tomasi (KLT) feature tracking.

Proof. When the geometric warping $\mathbf{W}$ is a translation. $\mathbf{W}$ can be written as:

$$\mathbf{W} = \begin{bmatrix} x + p_1 \\ y + p_2 \end{bmatrix}$$
$$\therefore \frac{\partial \mathbf{W}}{\partial \mathbf{p}} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

Equation (10) in the paper becomes:

$$\begin{aligned}
\Delta \mathbf{p} &= (\sum [\nabla I \frac{\partial \mathbf{W}}{\partial \mathbf{p}}]^\top [\nabla I \frac{\partial \mathbf{W}}{\partial \mathbf{p}}])^{-1} \sum [\nabla I \frac{\partial \mathbf{W}}{\partial \mathbf{p}}]^\top [T(\mathbf{x}) - I(\mathbf{W}(\mathbf{x}; \mathbf{p}))] \\
&= (\sum [\nabla I]^\top [\nabla I])^{-1} \sum [\nabla I]^\top [T(\mathbf{x}) - I(\mathbf{W}(\mathbf{x}; \mathbf{p}))] \\
&= \begin{bmatrix} \sum I_x I_x & \sum I_x I_y \\ \sum I_x I_y & \sum I_y I_y \end{bmatrix}^{-1} \sum \begin{bmatrix} I_x \\ I_y \end{bmatrix} [-I_t] \\
&= - \begin{bmatrix} \sum I_x I_x & \sum I_x I_y \\ \sum I_x I_y & \sum I_y I_y \end{bmatrix}^{-1} \begin{bmatrix} \sum I_x I_t \\ \sum I_y I_t \end{bmatrix}
\end{aligned}$$

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