Computer Vision Cheat Sheet

March 18, 2022

1 Image Filtering

1.

2 Feature detection and description

2.1 Harris Corner Detector

1. Process:
   - Compute x and y derivatives of an image
     $$I_x = G_x * I; \quad I_y = G_y * I$$
     where G is a filter e.g. Sobel filter
   - At each pixel, compute the matrix M
     $$M = \sum_{x,y} w(x,y) \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix}$$
   - Calculate detector response
     $$R = \lambda_1 \lambda_2 - k(\lambda_1 + \lambda_2)^2$$
   - Detect interest points which are local maxima and whose response R are above a threshold

2.2 SIFT

1. Process:
   - Detection of scale-space extrema
   - Keypoint localisation
   - Orientation assignment
   - Keypoint descriptor

3 Image classification, detection and segmentation

4 Motion estimation and tracking

4.1 Optic flow

1. Optic flow assumptions:
   - Brightness constancy: A pixel has constant brightness across time.
   - Small motion: Between frames, motion is small.
   - Spatial coherence: Pixels move like their neighbours i.e. flow is constant within a small neighbourhood.
2. Constraints:
   - Brightness constancy assumption:

     $$I(x+u, y+v, t+1) = I(x, y, t)$$

     where I: Intensity, (x, y, t): Spatial and temporal coordinates, (u, v): Displacement
   - Small motion assumption:

     $$I(x+u, y+v, t+1) \approx I(x, y, t) + \frac{\partial I}{\partial x}u + \frac{\partial I}{\partial y}v + \frac{\partial I}{\partial t}$$

   - Optical flow constraint equation (Combining both):

     $$\frac{\partial I}{\partial x}u + \frac{\partial I}{\partial y}v + \frac{\partial I}{\partial t} = 0$$