Problem Set 5

Computer Vision 2020
University of Bern

1 Optical Flow

Let $I(x, y, t)$ be a video sequence taken by a rigidly moving camera observing a rigid, static and Lambertian scene. Assume that between two consecutive views there is an affine change in the image intensities, i.e. the brightness constancy constraint reads:

$$I(x + u, y + v, t + 1) = aI(x, y, t) + b \tag{1}$$

where $u(x, y)$ and $v(x, y)$ represent the optical flow (motion parameters) and $a(x, y)$ and $b(x, y)$ represent photometric parameters. Propose a linear algorithm for estimating (u, v, a, b) from the image brightness I and its spatial-temporal derivatives I_x, I_y, I_t. What is the minimum size of a window around each pixel that allows one to solve the problem?

2 Registration, Outlier Rejection

In image registration the corresponding point coordinates are related by homography, $\lambda p' = Hp$, where $p = (x, y, 1)$ and $p' = (x', y', 1)$ are the coordinates on image I and I'. Note that H is equivalent to $H' = \beta H$ for any $\beta > 0$ because all equations can be satisfied by multiplying λ for all matching points by an appropriate number. It is therefore justified to set $\|H\| = 1$ for its estimation. Estimate H by eliminating λ and writing the equations in an appropriate linear system, where the entries of H are the unknowns. Solve the system by enforcing $\|H\| = 1$. What is the minimum number of correspondences needed?