Week04 • Semester 2 • 2018

Video Data Representation & Processing

Appendix

- Optical flow computation
- Reading: *Estimating Motion in Image Sequences*

Appendix

Motion Estimation

Optical Flow Computation

- Optical flow computation is based on two assumptions:
  - The observed brightness of any object point is constant over time;
  - Nearby points in the image plane move in a similar manner (the velocity smoothness constraint).
- Suppose we have a continuous image; $f(x, y, t)$ refers to the grey level of (x, y) at time t.
- Representing a dynamic image as a function of position and time permits it to be expressed as a Taylor series;

$$f(x+dx, y+dy, t+dt) = f(x, y, t) + \frac{\partial f}{\partial x}dx + \frac{\partial f}{\partial y}dy + \frac{\partial f}{\partial t}dt + O(\partial^2)$$
$$= f(x, y, t) + f_x dx + f_y dy + f_t dt + O(\partial^2)$$

(Eq. 1)

Motion Estimation

Optical Flow Computation

- We can assume that the immediate neighbourhood of (x, y) is translated some small distance (dx, dy) during the interval dt; that is, we can find dx, dy, dt such that:

$$f(x+dx, y+dy, t+dt) = f(x, y, t) \quad \text{(Eq. 2)}$$

- If dx, dy, dt are very small, the higher order terms in Eq.1 vanish and:

$$-f_t = f_x \frac{dx}{dt} + f_y \frac{dy}{dt} \quad \text{(Eq. 3)}$$

Motion Estimation

Optical Flow Computation

- The goal is to compute the velocity:

$$\mathbf{c} = \left(\frac{dx}{dt}, \frac{dy}{dt}\right) = (u, v) \quad \text{(Eq. 4)}$$

- f_x, f_y, f_t can be computed or, at least, approximated, from $f(x, y, t)$. The motion velocity can then be estimated as:

$$-f_t = f_x u + f_y v = grad(f)\mathbf{c} \quad \text{(Eq. 5)}$$

  where $grad\,(f)$ is a 2D image gradient.

- It can be seen from Eq.5 that the grey level difference f_t at the same location of the image at times t and $t+dt$ is a product of spatial grey level difference and velocity in this location according to the observer.