Capturing reality: Assignment sheet 3

December 1, 2011

In this assignment, you are required to solve exercises 1 and 2. For the practical exercise, place the code and image files in a single .rar file. The directory that you pack and submit should contain a text file README that contains your name and student ID. Submit the file via e-mail to: el-hayek@mpii.de.

Theoretical Exercise: Illumination Invariant Optic Flow (10 points)

The most common constancy assumption is the Grey Value Constancy assumption. With this assumption, the optic flow algorithm assumes that the grey value of objects remains constant over time. However, this fails in case of illumination changes. The Grey Value constancy assumption under global additive illumination changes can be written as:

$$f(x, y, t) + c_1 = f(x + u, y + v, t + 1) + c_2, \tag{1}$$

where c_1 and c_2 are the additive illuminations at time t and $t + 1$, respectively. This equation shows that Gray Value constancy is invalid once $c_1 \neq c_2$. In such a case, it makes sense to formulate constancy assumptions on image features that are based on higher derivatives such as the spatial image gradient or hessian. If we assume that the gradient remains constant over time the constancy assumption can be written as:

$$f_x(x, y, t) = f_x(x + u, y + v, t + 1) \tag{2}$$

$$f_y(x, y, t) = f_y(x + u, y + v, t + 1) \tag{3}$$

Since the illumination constants c_1 and c_2 do not exits any more, they become invariant under global additive illumination changes.

a. Derive the corresponding linearized optic flow constraints.

b. What is the advantage of having two equations instead of one equation?

c. Use these constraints to extend the Horn-and-Schunck approach to an illumination invariant optic flow approach.

d. Derive the Euler-Lagrange equations associated with the new approach.

Practical Exercise: Optic Flow using OpenCV (10 points)

OpenCV (Open Source Computer Vision Library) is a library of programming functions mainly aimed at real time computer vision. The goal of this exercise is to use the OpenCV library to compute optic flow between two consecutive images captured by Kinect SDK camera. To this end:

a. Download and install OpenCV library. (Note: The OpenCV is installed on the lab's computers).

b. Use Kinect SDK to get two consecutive images.

c. Write a simple program that extract the edges of these images.

d. Write a program that compute a sparse feature points set from the first images.

e. Extend the program in part d to calculates optical flow for the sparse feature set using iterative Lucas-Kanade method.

f. Display the resulting optic flow as lines on the first image.

Hints:

- You can use the online OpenCV Installation Guide for help in OpenCV installation and project configuration.
- You can use the online "CV Reference Manual" for information about the existing OpenCV functions.
- Convert the color images to gray value images to be able to use them in the OpenCV optic flow methods.