Louisiana State University
Department of Electrical and Computer Engineering
EE 4780 – Introduction to Computer Vision
Spring 2007

Problem Set 4

Assigned: March 30, 2007
Due: April 13, 2007 (Beginning of the class)

Problem 1:
Consider a camera moving along its optical axis toward a planar surface.

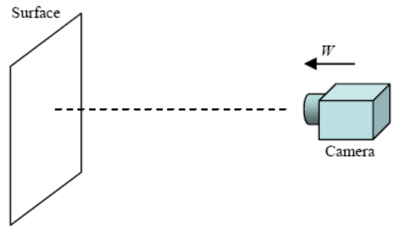

Figure 1. Illustration of the scenario.

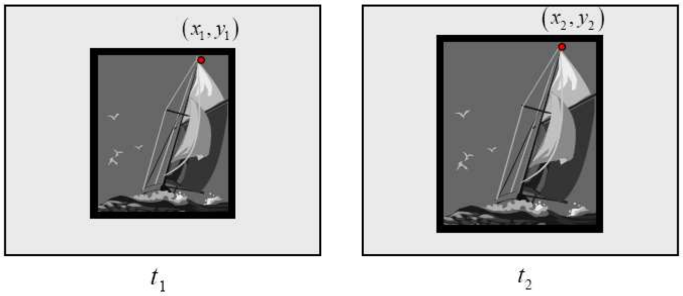

Figure 2. Images captured at times t_1 and t_2.

Two images are captured at time t_1 and t_2. An image point (x_1, y_1) at time t_1 moves to position (x_2, y_2) at time t_2. The speed of the camera, *W*, is also known.

(a) Find the distance of the camera to the surface at time t_2.
(b) Find how much time left before the camera hits the surface.

Problem 2:
Two images are given below.

H

11	14	14	16	18
9	11	13	15	18
8	10	10	12	14
8	9	10	10	13
7	8	8	9	9

$y \uparrow$

$\rightarrow x$

I

10	12	13	14	15
7	11	9	14	15
8	8	9	11	12
7	7	8	10	11
6	6	8	9	10

(a) Find the motion vector at the center (x = 3, y = 3) of image *H* based on the following notes:

1. Assume that the motion vector at (x, y) is equal to the motion vector at (x-1, y-1).
2. Estimate the horizontal derivative at (x, y) as I(x+1, y) – I(x, y).

(3) Estimate the vertical derivative at (x, y) as I(x, y+1) – I(x, y).

(b) If image I is warped onto image H, what is the intensity value at (x = 3, y = 3) of the warped image. (Use bilinear interpolation to estimate a sub-pixel intensity.)

Problem 3:

Suppose there are two images of a scene. The images are related to each other by a global transformation. The goal is to determine this global transformation so that a panoramic image can be created by stitching these images.

A number of correspondences between the images are chosen manually.

Suppose the image coordinates are related by an affine transformation:

$$x' = a_1 x + a_2 y + a_3$$
$$y' = a_4 x + a_5 y + a_6$$

(a) At least how many correspondences must be chosen to find $a_1, \ldots, a_6$?

(b) Given N correspondences $(x_i, y_i) \leftrightarrow (x'_i, y'_i), i = 1, \ldots, N$, set up the matrix-vector equations to solve find the least squares estimate of $a_1, \ldots, a_6$. (Note that if $\mathbf{Av} = \mathbf{b}$, the least squares solution for **v** is $\mathbf{v} = \left(\mathbf{A}^T\mathbf{A}\right)^{-1}\mathbf{A}^T\mathbf{b}$.)

(c) Now, consider the perspective model with eight parameters:

$$x' = \frac{a_1 x + a_2 y + a_3}{a_7 x + a_8 y + 1}$$
$$y' = \frac{a_4 x + a_5 y + a_6}{a_7 x + a_8 y + 1}$$

Set up the equations to find the least squares estimate of these eight parameters.