Computer Vision I

SAMPLE EXAM II

November 13, 2018

NAME:____________________

Prob. 1		20 pts
Prob. 2		20 pts
Prob. 3		20 pts
Prob. 4		20 pts
TOTAL		80 pts

Remember to:

- Read the whole test first.
- Stay in motion.
- Budget your time.
- Think partial credit.
- Show your work.
- Try to keep it legible.
- Check your answers if you have time at the end.

Computer Vision I: SAMPLE EXAM II

1. (20 pts) Answer True (T) or False (F):

   (a) ______ Given the focus of expansion (FOE) of an object translating with respect to the camera, it is possible to find out how fast the object is moving.

   (b) ______ Optical flow calculations are more reliable at edges because of the "aperture problem".

   (c) ______ The rank of the Hankel matrix of the coordinates of a target measures the complexity of the dynamics of a target.

   (d) ______ The essential matrix depends on both intrinsic and extrinsic parameters.

   (e) ______ The epipoles of a stereo system are on its baseline.

   (f) ______ The circulant tracker uses the dynamics of the target to update the classifier from frame to frame.

   (g) ______ The motion field of a planar surface can be described by a second order polynomial.

   (h) ______ The brightness constancy assumption relates the FOE to the normal optical flow.

   (i) ______ The Kalman filter is an unbiased, maximum variance estimator

   (j) ______ The Fundamental matrix can be estimated using 4 point correspondences

2. **(20 pts) Stereo.** Consider a stereo rig whose top view is shown in Figure 1.

Figure 1: Stereo Setup

3. Draw the front views of the two 2D images and show and clearly label the epipoles and epipolar lines for this configuration of cameras.

   (a) Given a pair of corresponding points, at pixel coordinates $p = (x_l, y_l)$ in the left image and $q = (x_r, y_r)$ in the right image of a stereo pair, give the equation that describes the relationship between these points when neither the intrinsic nor extrinsic parameters of the cameras are known. Also specify, how many correspondences are needed to solve for all the unknowns in your equation.

   (b) Can scene depth be recovered from a stereo pair of images taken by a single perspective projection camera that has been rotated around its center of projection? Explain your answer.

4. **(20 pts) Motion.** Consider a fly located at *world coordinates* $(10, 0, 10)$ at time $t = 0$. A camera system with unit focal length is located such that its lens center is at the origin of the world coordinate system, its optical axis is looking directly at the fly at time $t = 0$, its y axis coincides with the world Y axis, and the x axis is as shown in the figure below. The fly is moving with uniform velocity $(5, 0, 0)$, measured with respect to the *world coordinate system*.

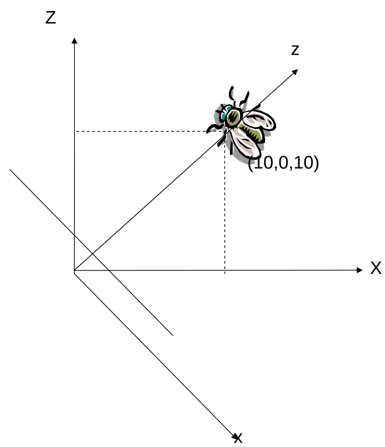

Figure 2: Diagram for problem 4.

(a) Find the *image coordinates* of the **image of the fly** on the image plane at time $t = 1$ and time $t = 2$.

(b) Find the *image coordinates* of the **image of the fly** in the image plane at time $t = 1$ and time $t = 2$ when the camera also translates with a uniform velocity of $(0, 0, 5)$, measured with respect to the *world coordinate system*.

(c) Find the FOE (focus of expansion) when the camera is stationary

Represent the velocity vector in camera co-ordinates and in image co-ordinates.

(d) Find the FOE (focus of expansion) when the camera also translates with a uniform velocity of $(0, 0, 5)$, measured with respect to the *world coordinate system*.

Use the new matrix of transformation at t=2 from world to camera coordinates - multiply with the (10,0,0)

(u/f , v/f) - will give the vectors

5. **(20 pts) Tracking.** Consider the temporal sequence $x_0 = 0, x_1 = 1, x_2 = 1, x_3 = 3, x_4 = 5$.

(a) Write the corresponding 3×3 Hankel matrix.

(b) What is the complexity of the underlying dynamics?

(c) Find a regressor for the sequence of the form: $x_k = \sum_{i=1}^{n} a_i x_{k-i}$

(d) Predict the next value in the sequence x_5.