CS 4/6/791E Computer Vision

Spring 2001 - Dr. George Bebis

Final Exam

Duration: 4:30 - 6:30 pm

Name:

1. **[20 pts]** For each of the following statements, indicate whether it is true or false. To get credit, you must give reasons (very briefly) for your answer.

T F Both perspective and parallel projection preserve parallel lines.

T F The rotation matrix shown below rotates about the z-axis by an angle of 90 degrees.

$$\begin{bmatrix} 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

T F Convolution of an image with the filter shown below will blur sharp image edges.

1 1 1
1 1 1
1 1 1

T F The eight-point algorithm is used for camera calibration.

T F The first step in edge detection is computing the magnitude of the gradient.

T F The Laplacian operator is useful in calculating the direction of an edge.

T F The essential matrix encodes info on both the extrinsic and intrinsic stereo parameters.

T F The Canny edge detector uses hysteresis thresholding in order to bridge gaps between edge points.

T F The direction of an edge is the same as the direction of the gradient vector.

T F It is cheaper to implement the Laplacian operator than the gradient operator.

2. **[10 pts]** This question is about camera calibration.
[2.5 pts] (a) What is the goal of camera calibration?

[2.5 pts] (b) What are the two major categories of methods for camera calibration?

[5 pts] (c) In the method we discussed in class for camera calibration, SVD has two distinct uses (i.e., it is used to solve two distinct problems). What are these problems?

3. **[10 pts]** Prove that $\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$, $\begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}$, and $\begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$ form a basis of R^3. What is the representation of vector $\begin{bmatrix} 2 \\ 1 \\ -1 \end{bmatrix}$ in this basis?

4. **[10 pts]** Let us consider the eigenface approach. Describe the steps involved in face detection (you can assume that you have already computed the average face Ψ and eigenfaces u_1, u_2, ..., $u_{M'}$).

5. **[10 pts]** How many coordinate systems are needed in determining the relationship between 3D points and their 2D projections? Describe the purpose of each coordinate system as well as the transformations involved from one to another (i.e., write down the equations corresponding to these transformations using very clear notation).

6. **[10 pts]** State and prove the equations of perspective projection.

7. **[15 pts]** Define the following terms:

Vanishing point

Weak perspective projection

Epipole

Rectification

Epipolar constraint

8.**[5 pts]** What is the parametric line representation of the line segment passing through points (1,2) and (5,3)? What are the coordinates of its midpoint?

9.**[10 pts]** Compare correlation-based with feature-based approaches for solving the correspondence problem in stereo.