CSE/EE 576: TAKE-HOME FINAL EXAM
Still Due Dec 14 for Flexibility
But Should Only Take a Weekend
Open Book, Open Notes, Individual Work
Answers should be typed or written very neatly

1. (20 pts) Geometric hashing and pose clustering are two voting methods for finding the identity and pose of a 2D (or 3D) object. Give their similarities and differences in terms of the following factors.

   (a) offline preprocessing time

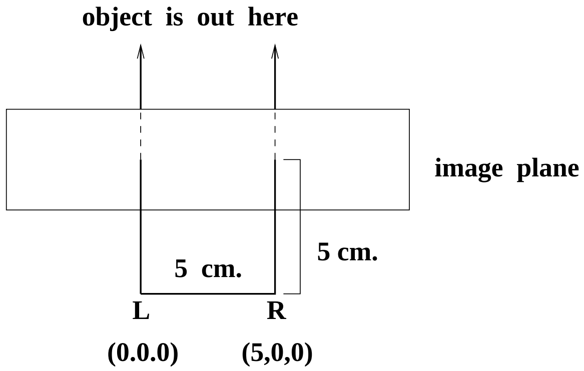
   (b) storage for data structures

   (c) what a vote is for

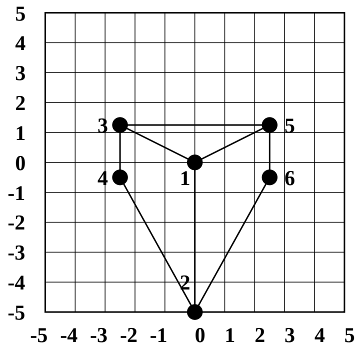
   (d) online recognition time (without the verification) and without any perceptual grouping or other attempts at intelligence

   (e) verification procedure

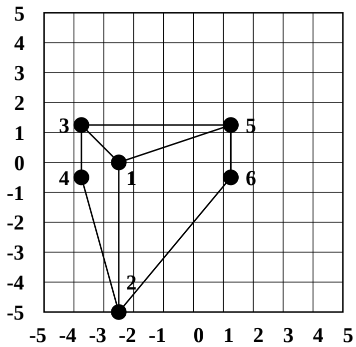
2. (27 pts) This problem is about stereo imaging. There is a simple stereo setup as in Figure 12.10 and as simplified below. The left camera is at (0,0,0), and the right camera is at (5,0,0). The image plane is the plane z=5. The optic axis of the left camera is the z axis of the world ($x = y = 0, 0 \leq z < \infty$). The optic axis of the right camera is parallel to the z axis. ($x = 5, y = 0, 0 \leq z < \infty$).



The images seen by the left and right cameras are shown below. Units are all in **centimeters**, not pixels.



Left Image (centimeters)



Right Image (centimeters)

Left image:

1. **(0,0)**
2. **(0,-5)**
3. **(-2.5,1.25)**
4. **(-2.5,-.625)**
5. **((2.5,1.25)**
6. **(2.5,-.625)**

Right image:

1. **(-2.5,0)**
2. **(-2.5,-5)**
3. **(-3.75,1.25)**
4. **(-3.75,-.625)**
5. **(1.25,1.25)**
6. **(1.25,-.625)**

(a) Compute the 3D coordinates (x_i, y_i, z_i) of each 3D point P_i for points 1, 2, 3, 4, 5, and 6. (You'll need a blank sheet of paper; show your work.)

(b) Of course, we really have to start with pixels in real problems. The images are very low resolution, 11×11. Each pixel is .91 cm. $\times$ .91 cm. There is no distortion. The points detected as pixels are shown below in images defined in a standard row-column coordinate system with rows $0 \leq r \leq 10$ and columns $0 \leq c \leq 10$. The principal point is at the center of the images (5,5).

	0	1	2	3	4	5	6	7	8	9	10
0											
1											
2											
3			3						5		
4											
5						1					
6			4						6		
7											
8											
9											
10						2					

Left Image (pixels)

	0	1	2	3	4	5	6	7	8	9	10
0											
1											
2											
3		3						5			
4											
5			1								
6		4						6			
7											
8											
9											
10			2								

Right Image (pixels)

In particular, $p_{1l} = (5,5)$, $p_{1r} = (5,2)$, $p_{5l} = (3,8)$, and $p_{5r} = (3,7)$. Compute the **measurement error in centimeters** for the line segment P_1P_5. ie. What is the difference between its length computed from the perfect points you found in part a) and the length you would get starting from these pixel coordinates, converting to centimeters,and recomputing the 3D points and distance from that.

3. (20 pts)

The spin-image method allows for recognition and pose estimation of free-form 3D objects from range images.

(a) Can this method be used for object classes (such as chair or four-legged-no-arms chair) or only for particular instances? Explain why or why not.

(b) Given that all the required spin images have been computed, how does the algorithm decide that point P of the model might correspond to point Q of the range image?

(c) If the model has n mesh points, and the image has m mesh points, and a spin-image has a constant size c, what is the time complexity of determining the best correspondences?

(d) Suggest a procedure for verification that would be suited for the spin-image method. Give it as steps in English.