CMSC828D Exam 1 1 Nov 2000 (25 points)

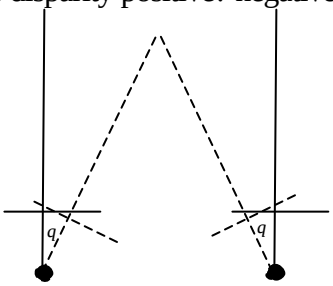
1. Suppose we are viewing an object 2 meters in front of a camera with a focal length of 50 mm. How far behind the lens will the image of this point be brought into focus? (2 points)

2. A camera with focal length f = 250 pixels has horizontal pixel rows and is pointing down at 45 degrees toward a horizontal plane. Where does the camera see the horizon of that plane? (in other words, where is the vanishing line for that plane located in the image plane of the camera?). Explain your conclusion. (4 points)

3. Given a stereo pair of images who optical axes intersect at some 3D point, we say that the stereo pair is verged on that 3D point (see figure below). Consider the special case in which the two cameras share a common x and y axis, but are then both rotated by the same (absolute) angle, q, around the y axis to create the verged pair. Disparity for the 3D point at which the optical axes intersect is then obviously 0.

a) What is the formula for the z- coordinate of the 3D point given its conjugate pair in this configuration. (2 points)

b) For what 3D points is disparity positive? negative? (2 points)



4. A matrix **Q** is said to be *idempotent* if applying it once to any vector **x** has the same effect as applying it to **x** several times:

$$\mathbf{Qx} = \mathbf{Q}^k \mathbf{x}$$

for any positive integer k.

(a) If **Q** is an idempotent matrix of size $m \times n$, what can you say about m and n, and why?

(b) Show that to prove that a matrix **Q** is idempotent it is only necessary to check that $\mathbf{Q} = \mathbf{Q}^2$.

(c) Let **P** be a matrix that projects that any given vector **a** onto a given vector **c**. Show that the matrix **P** is idempotent.

(d) What is the null space of the matrix **P**? (5 points)

5. Define the following terms. Be brief. If necessary draw a sketch (1 point each)

1. Camera intrinsic calibration parameters.
2. Camera extrinsic calibration parameters.
3. Epipoles and Epipolar lines.
4. Singular Value Decomposition
5. Fovea, rods and cones
6. Cross ratio of 4 points
7. Bayes rule

6. Write a Newton iteration algorithm for obtaining the square root of a number a. Use your algorithm to obtain $\sqrt{5}$ starting with a guess of 2 (3 points)