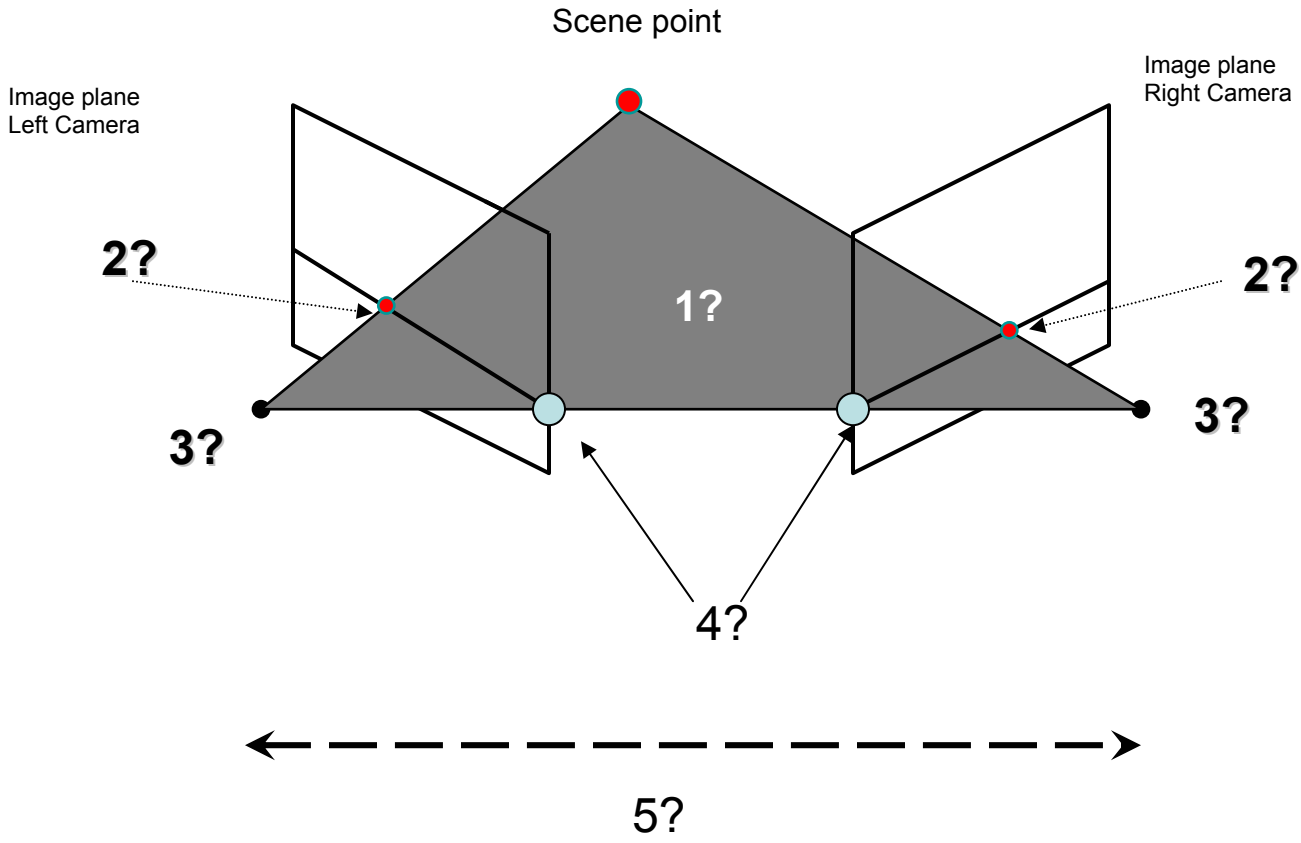
CMSC 426 Final Exam Spring 2005 2 hours 05/18/2005

Please place all bags on the floor. You may use your 2 "cheat sheets".
Pease attach the cheat sheets to the exam when you are done. [2 points bonus]

1. A schematic picture of a stereo pair of cameras looking at a scene point is shown in the figure below.
   Name all the labeled quantities 1-5. [5 points]
   What is the process of converting the images taken by a pair of cameras with the geometry below, to those taken by a pair of parallel cameras called? [1 point]
   What constraint reduces stereo correspondence to a line search? With reference to the figure, explain how this constraint arises. [4 points]



2. Why is correspondence hard? Describe how the SSD algorithm for correspondence works. [4 points]

3. What property must hold for an N stage assignment problem to be solved via dynamic programming? What constraint allows the use of dynamic programming in stereo? Does this constraint always hold? [5 points]

4. A scene point P has coordinates (X_1,Y_1,Z_1) in the coordinate system that is centered at one location and (X_2,Y_2,Z_2) in the coordinate system centered at another location.

Write down a general rigid transformation that relates the coordinates of the point P in these two coordinate systems. [4 points]

Express this transformation as a matrix-vector product using homogeneous coordinates. Describe how you would get real ("Euclidean") coordinates from the homogeneous coordinates. [4 points]

5. What is the aperture problem in computation of optical flow? [4 points]

6. A large image database is to be searched for images of buses using Computer Vision techniques to classify the images. The database contains all kinds of images collected from a wide variety of sources, but there is no textual information about them. The pictures that are to be found are those in which a bus forms a substantial part of the image.

   (a) Discuss the criteria that might be used to try to discriminate between pictures of buses and other pictures. Explain any assumptions underlying your criteria, and state how reliable you think each one might be. Consider whether combinations of criteria may be useful. [6 points]

   (b) Outline the algorithms that you would employ in order to analyze the image data and implement a bus-recognition system based on the criteria you have discussed. Take care to specify any preprocessing that might be needed before a given algorithm can be applied, and any processing needed to combine the results of different operations. [6 points]

7. Is this statement true:
   If A and B are independent, $P(A,B) = P(A)P(B)$ [2 points]

8. Write down Bayes' rule and explain how it can be used to update the probability of a hypothesis from measurements. [5 points]

9. Suppose an image has 10 points. 5 come from a line, and 5 are due to noise. We randomly select a pair of points, and use them to form a line, for RANSAC. What is the probability that this pair of points comes from the line? How many pairs of points must we sample to have greater than .5 probability that at least one pair will come from the line? [10 points]

10. **K-means clustering**: Suppose we have points at the locations: (1,4) (5,7) (2,6) (2,2) (3,6), and we pick centers at (1,4) (4,4). Which points will be assigned to each center? What will be the location of the new centers after one step of the algorithm? Do you think subsequent steps will change the assignments of the points to the centers? [10 points]