Emailed October 19, 2000
Due back October 25 2000

Homework 8

Baye's rule, affine transformation, color indexing, pose, stereo imaging.

1. Suppose we are trying to distinguish cats from dogs and the only measurement we have is weight. Let the prior probabilities for cats and dogs be P(CAT) = 0.3, p(DOG) = 0.7 and let the class conditional density functions for (integer-valued) weight given class be uniformly distributed as follows:
–P(Weight|CAT) is uniform on [20, 39]
–P(Weight|DOG) is uniform on [30,59].

Explain how Bayes' rule can be used to classify an unknown animal having weight 35 pounds given the prior and conditional probabilities defined above.

2. What conditions must the homogeneous coordinates of two coplanar lines meet for these lines to be parallel? Show that two lines transformed by an affine transformation remain parallel.

3. You are given as a model of yellow flower the rectangular region with corners (65, 110), (160, 110), (65, 210), (160, 210) measured from the top left corner in the Matlab `flowers.tif` image. You are asked to detect yellow flowers using this model. The goal is to apply the color indexing technique, using the whole `flowers.tif` image itself as a test for this technique.

a. Compute a 3D histogram of the model region, using an 8x8x8 matrix.
b. Compute a 3D histogram of the `flowers.tif` image using an 8x8x8 matrix.
c. Compute a 3D confidence table obtained by dividing the bin counts in each model histogram bin by the corresponding bin counts in each image histogram bin.
d. Compute a gray level image in which pixel values reflect the confidence that `flowers.tif` pixels belong to a yellow flower (using white as the highest confidence in the image and black as the lowest confidence in the image). Print this image.

4. Read Chapter 20 "Correspondence and Pose" of the book draft "Computer Vision – A Modern Approach" at http://www.cs.berkeley.edu/~daf/book3chaps.html
Summarize the end of the chapter from Section 20.6 to the end in half a page.

5. Write a Matlab function that computes the three coordinates of a point in space given the coordinates of its images for two cameras with parallel optical axes, equal focal lengths, coplanar image planes and parallel pixel rows and columns ("ideal" geometry). The arguments of the function should include the coordinates of the two image points with respect to the top left corners of the images, the positions of the image centers in pixels for each camera, the focal length of the cameras and the baseline distance. The outputs should be the 3D coordinates of the point in the "cyclopean" Euclidean coordinate system of the camera system.

6. A robot vehicle is equipped with two cameras in the ideal configuration of Problem 5. The cameras have a focal length of 690 pixels, and a baseline distance of 1 meter. The image center is at pixel location (x=300, y=250) in each camera.
We place a cubic structure in front of the vehicle. We detect the cube corners at the following pixel positions in the left camera image:

```
452   323
209   323
163   483
528   483
473    73
196    73
133   117
578   117
```

We detect the same cube corners at the following pixel positions in the right camera image:

```
391   323
148   323
 72   483
437   483
404    73
127    73
 22   117
467   117
```

Find the 3D coordinates of the cube vertices in the "cyclopean" reference of the camera system by applying the Matlab function written for Problem 5. What is the size of the cube? Verify that the edges of the cube are perpendicular to each other.