CS 479/679 Pattern Recognition
Spring 2016 – Prof. Bebis
Programming Assignment 2 - Due: 3/14/2016

1. In the previous assignment, you designed a Bayes classifier assuming the following 2D Gaussian distributions:

$$\mu_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \quad \Sigma_1 = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} \quad \mu_2 = \begin{bmatrix} 6 \\ 6 \end{bmatrix} \quad \Sigma_2 = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$$

   In this assignment, we will assume that you do **not** know the **true** parameters of the Gaussian distributions and that you need to estimate them from the training data using the Maximum Likelihood (ML) approach.

   a. Using the same 10,000 samples from the previous assignment, estimate the parameters of each distribution using ML and classify all 10,000 samples assuming $P(\omega_1) = P(\omega_2)$; then, count the number of misclassified samples and compare your results to those obtained in assignment 1.

   b. Repeat experiment (1.a) using 1/10 of the samples (randomly chosen) to estimate the parameters of each distribution using ML and classify all 10,000 samples assuming $P(\omega_1) = P(\omega_2)$; then, count the number of misclassified samples and compare your results to those obtained in experiment (1.a).

2. Repeat problem 1 assuming the following 2D Gaussian distributions:

$$\mu_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \quad \Sigma_1 = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} \quad \mu_2 = \begin{bmatrix} 6 \\ 6 \end{bmatrix} \quad \Sigma_2 = \begin{bmatrix} 4 & 0 \\ 0 & 8 \end{bmatrix}$$

3. As we have discussed in class, face detection using skin color is a popular approach. While color images are typically in RGB format, most techniques transform RGB to a different color space (e.g., chromatic, HSV, etc.). This is because RGB values are more sensitive to changes of brightness due to illumination changes.

   a. Implement the skin-color methodology outlined in Section 3.1 of [Yang96 "A Real-time Face Tracker"] which uses the chromatic color space. To build the skin color **model**, use *Training_1.ppm* (and *ref1.ppm*), shown in Figure 1, which are available from the course's webpage. To **test** your method, use *Training_3.ppm* (and *ref3.ppm*) and *Training_6.ppm* (and *ref6.ppm*), which are also available from the course's webpage. To quantitatively evaluate the performance of your method, generate **ROC** plots (i.e., false positives (FP) vs false negatives (FN)) by varying the skin-color threshold. A FP would be a non-face pixel which was classified as skin-color while a FN would be a face pixel which was classified as non-skin color. To compute the FPs and FNs for each test image, use the corresponding reference images.

   b. Repeat (3.a) using the YCbCr color space In the YCbCr color space, the luminance information is contained in Y component; and, the chrominance

information is in Cb and Cr. Therefore, Y should not be used in building the skin color model. The RGB components can be converted to the YCbCr components using the following transformation:

$$Y = 0.299R + 0.587G + 0.114B$$
$$Cb = -0.169R - 0.332G + 0.500B$$
$$Cr = 0.500R - 0.419G - 0.081B$$

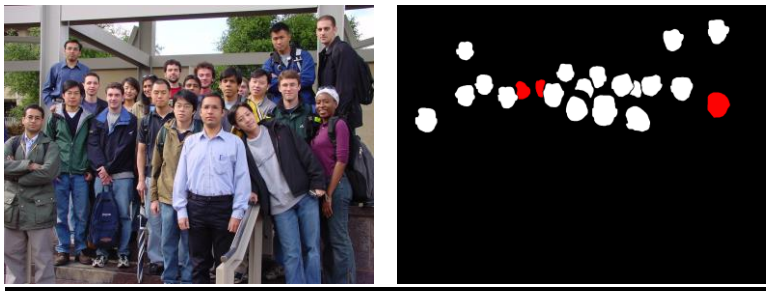

Figure 1. Training_1.ppm and *ref1.ppm* images.

For comparison purposes, plot the ROC curves in the same graph.

Note: Irfanview is a nice tool for image display/manipulation. Sample code to read/write color images in PPM format is provided on my CS 302 webpage:

http://www.cse.unr.edu/~bebis/CS302/

Information on the PPM image file format can be found here:

http://paulbourke.net/dataformats/ppm/

http://www.cse.unr.edu/~bebis/CS302/Lectures/IP.ppt

PROJECT REPORT SUBMISSION REQUIREMENTS

1. Cover Page. The cover page should contain Project title, Project number, Course number, Student's name, Date due, and Date handed in.

2. Technical discussion. This section should include the techniques used and the principal equations (if any) implemented.

3. Discussion of results. A discussion of results should include major findings in terms of the project objectives, and make clear reference to any figures generated.

4. Division of work: Include a statement that describes how the work was divided between the two group members.

5. Program listings. Includes listings of all programs written by the student. Standard routines and other material obtained from other sources should be acknowledged by name, but their listings should not be included.

You need to turn in a printed copy of your report (i.e., items 1-4), in the beginning of the class on the due date. Program listings (i.e., item 5) should be emailed to the instructor, as a zip file, before class on the due date. Each group should submit one report only.