# EE435: Biometric Signal Processing

## Project 09: Iris Segmentation

Assigned: Tues 4/5/11 Due: Tues 4/13/11

### I. Background

In Project 6, you successfully segmented the pupil in several iris images. Segmentation was demonstrated by creating a color iris image that had a red circle around the detected pupil. In this project, you will segment both the inner (pupil) and the outer (limbic) boundary of the iris. The net result will be a red circle around the pupil and a green circle around the iris.

### II. Segmentation

1. Download one of the iris images from the course website under this project…it doesn't matter which one. These are all VGA iris images (480 rows x 640 columns).

2. Find the location of the pupil and its radius using the same method and code you used in Project 6.

3. Add to the code you used in Project 6 to find the location of the outer (limbic boundary). Perform the following steps.

    a. Unwrap the iris image using the *to_polar.m* function available from the course website. Use your pupil's center as the reference coordinates for unwrapping. The minimum radius should be 0 (center of pupil), and the maximum radius should be your radius of the pupil plus 100 (*pupil radius*+100). Use 360 radial lines and (*pupil radius*+100) concentric circles, such that the resultant polar image is (*pupil radius*+100) rows by 360 columns in dimension. Using these dimensions, the row number of the unwrapped image corresponds to the number of pixels away from the center of the unwrapping, and each column is a 1° angular wedge.

    b. You're looking for a ~horizontal boundary for the iris. Adjust the column center of your unwrapping to the left or right a little (perhaps 2-8 pixels) to see if you can make the boundary more horizontal. The iris may even be centered slightly above/below the pupil center (2-4 pixels). When you are satisfied that the outer boundary is as horizontal as you can get it, determine (manually) the row number of the ~horizontal line that represents the outer boundary of the iris…this row number is also the radius of the outer boundary, and the center of the outer boundary is the (row #, col #) that was the reference point for the unwrapping (remember, you probably shifted the center of the iris to be left or right, above or below the center of the pupil).

    Record your segmentation:

    Image name _____

    Pupil boundary Center row: _____ Center column: _____ Radius: _____

    Limbic boundary Center row: _____ Center column: _____ Radius: _____

    c. Now create a color image that has a red circle around the pupil (done in project 5), and a green circle around the outer boundary. Are there any eyelids or eyelashes within the area of the iris that we would need to worry about? Write out the segmented image into a file that has the same name as the original iris except has "_segmented.bmp" at the end, and email it to the professor. For example, your result might be called "0026_L_0004_vga_segmented.bmp if you used the "0026_L_0004_vga.bmp" image.

d. Look at your unwrapped image (polar coordinates), where you believe you've accurately determined that the horizontal line that represents the limbic boundary is as horizontal as it can get. At this point, you believe you have determined the center of the outer boundary. Describe in general terms how you would now go about *automatically* determining the radius of the outer boundary (what would be your approach?). Note: I'm asking you how you'd go about programming this.

**III. Poor Segmentation**

1. What happens if your estimate of the pupil center is off? Display the unwrapped iris if you do the polar transformation with a poor estimate of the pupil center: using the same iris image, SUBTRACT 25 pixels from your estimate of the pupil's column center, and at the same time, ADD 25 pixels to your estimate of the pupil's row center, then use the *to_polar* function. Write out the segmented image into a file that has the same name as the original iris except has "_poorly_segmented.bmp" at the end, and email it to the professor.

2. Compare the shape of the outer iris boundary now, with the outer boundary when you had relatively good center coordinates for the pupil in part II. My first statement when we began talking about iris processing was: if the system can't find the pupil correctly, then probably it will not be able to recognize using the image—do you agree with this statement?

**For this project report, email me the two image files, print out your code, and answer the question in Part II, step 3c and 3d, and in Part III, step 2.**