

CAP 5400 Digital Image Processing: Assignment # 1

Normalization and Fourier Features

Due 3:30 pm on Oct 15, 2001 (100 pts)

1 The Data Set

The data set for this project consists of 60 palm images of 10 subjects (2 hands and 3 position of the fingers each). (We will be making this available soon.)

2 Ground Truth Creation (10 pts)

For *each* image identify the tip of the index finger and the middle of the wrist and store them in an file in plain ascii format shown below:

```
FileName R-index C-index R-wrist C-wrist
```

where, `R-index` is the row number of tip of index finger, `C-index` is the column number of tip of index finger, `R-wrist` is the row number of the wrist center, and `C-wrist` is the column number of the wrist center. Thus, each line of this file would consist of a string followed by 4 integers. And, the number of lines would correspond to the number of images.

You can use any image editor (`xv`, `display`, `gimp`, etc.) to perform this step.

3 Coding (50 pts)

Your coding task consists of TWO subtasks: image normalization and computation of Fourier features.

1. Normalization:

- Convert each image into an intensity image.
- Using the ground truth data created above, rotate, translate and scale each input image so that in the final image the tip of the index finger is at (row = 0, col = 64) and the middle of the wrist is at (row = 128, col = 64).

Also, if required, *flip* the image about the line joining the index finger tip with the

wrist middle so that the thumb is closer to the 0-th column. Note that you will have to do this for half the images.

- For interpolating the intensity values, use bi-linear interpolation.
- Normalize the intensity so that the average gray level of the normalized image is 100.
- The final image size should be 128 by 128. Note that you might have pad the left and right sides of the images by repeating the background values.

2. Fourier Features:

- Compute the Fourier transform (magnitude and phase) of the normalized images. Save the magnitude and the phases as PGM image files, so that they can be visually appreciated. Note that you will have to first center the Fourier transform, take a logarithm with base 10 to reduce the dynamic range, and then scale to between 0 and 255, before you save as PGM images.
- Perform low-pass, band-pass, and high-pass filtering and compute the inverse Fourier transform and save as PGM images.

4 Report (40 pts)

You have to produce a 6 to 8 pages report in IEEE two-column format, including all text, figures and references. A link to the format specifications is provided from the web-page, along with a link to a Latex Macro that conforms to the specifications.

Your report should have the following sections. Note: figures and images that are not discussed in the text will not be considered during grading.

- An abstract summarizing what your report is about and a brief synopsis of your conclusions

(read the instructions in the abstract writing guideline link from the class web-page).

2. A short, one paragraph introductory section that should include a synopsis of the prior work on recognition from hand images and products that are available for such.
3. A section describing the code you have written, a block diagram illustrating the interactions between the various functions, and a brief example of how an user would use and interact with your source code.
4. A section describing the programming bugs that you ran into.
5. A section showing some sample normalized images, Fourier magnitude and orientation images, and inverse Fourier transform of the low-, band-, and high-pass filtered images.
6. An analysis section studying
 - (a) the quality of the gray level interpolation using the bi-linear method. You could, of course, present results for visual assessment, however, think about some strategy for *quantitatively* evaluating the gray level interpolation strategy.
 - (b) Compare the low-, band-, and high-pass filtered images for the cases when the basic filter is rectangular and when the basic filter is Gaussian shaped. Which one is better?
7. A concluding paragraph.

5 Submission

1. Submit your source code as email attachment(s) to Tong Luo at `t.luo2@eng.usf.edu`. Make sure your code runs on `babbage` or `suntan`. It is your responsibility to make sure that it does. You might have to demonstrate your code to us if we deem it necessary.
2. Submit your written report to me.