**ECE 4822: Engineering Computation IV**

**Homework No. 11: Final Project – Image Processing**

**Challenge:** Produce the fastest GPU implementation of a system that computes the distribution of spectra for a database of images.

**Description:**

In this challenge, you will iterate over a database of images located here:

nedc\_130\_[1]: find /data/isip/data/tuh\_dpath\_breast/deidentified/v3.0.0/svs -name "\*.svs" | head -3

/data/isip/data/tuh\_dpath\_breast/deidentified/v3.0.0/svs/eval/00006695\_aaaaaadg/s000\_2015/breast/00006695\_aaaaaadg\_s000\_0hne\_0000\_a001\_lvl002\_t000.svs

/data/isip/data/tuh\_dpath\_breast/deidentified/v3.0.0/svs/eval/00006695\_aaaaaadg/s000\_2015/breast/00006695\_aaaaaadg\_s000\_0hne\_0000\_a003\_lvl003\_t000.svs

/data/isip/data/tuh\_dpath\_breast/deidentified/v3.0.0/svs/eval/00006695\_aaaaaadg/s000\_2015/breast/00006695\_aaaaaadg\_s000\_0hne\_deep\_a001\_lvl003\_t000.svs

nedc\_130\_[1]: find /data/isip/data/tuh\_dpath\_breast/deidentified/v3.0.0/svs -name "\*.svs" | wc

 3505 3505 529921

Your task is the following:

1. Loop over all images in the database, and for each image, loop over the entire image using a 256x256 pixel window and a 128x128 frame size. (The software we provide will handle this for you.)
2. Filter the data using a 2D Gaussian smoother that is 7x7 taps. (See the Wiki page.)
3. Compute the 2D FFT and convert each frequency value to a magnitude. (See below for details on this.)
4. Compute a histogram of the values of the magnitude spectrum.
5. Print the average and stdev of your histogram.

There are 3,505 images in the database above. By the time of the final, we will be able to give you access to 100,000 images. ☺. These images are color images, but the spectrum should be independent of the color, so you can merge the spectra for each color channel.

Let’s walk through this task step by step:

First, the code to read these files and loop over the image frame by frame can be found here:

$NEDC\_NFC/class/python/nedc\_image\_tools

I would suggest you start with this application program:

**https://isip.piconepress.com/courses/temple/ece\_4822/homework/current/hw\_11**

to learn how to process a list of files, loop over an image frame by frame, and retrieve the image data.

Second, a Gaussian smoother, often referred to as a Gaussian blur, is a simple 2D FIR filter. A good tutorial can be found here:

[**https://datacarpentry.org/image-processing/06-blurring.html**](https://datacarpentry.org/image-processing/06-blurring.html)

and a nice overview can be found here:

**https://en.wikipedia.org/wiki/Gaussian\_blur**

Next, a tutorial on the 2D FFT can be found here:

**https://www.geeksforgeeks.org/python-numpy-np-fft2-method/**

**https://en.wikipedia.org/wiki/Multidimensional\_transform**

Finally, the histogram should be computed with a bin size of 16.

It is recommended you write this in C++ or Python first, and then migrate the code to a GPU. The interface to your program should be:

**myaverager files.list**

Your solution will be timed on the database mentioned above running on nedc\_012. To obtain final numbers for your presentation, run this on nedc\_012 interactively and use the Unix time command. Measure wall clock time.

To complete the assignment, you will submit the source and executable code in the directory $HOME/ece\_4822/homework/hw\_11/lastname\_firstname. You will also provide a two-page tightly formatted paper discussing your results. Use the template here:

**https://isip.piconepress.com/courses/temple/ece\_4822/resources/templates/template\_paper.docx**

The paper should be a complete two pages of content with references and acknowledgements on the third page.

Your final grade will be based on your ranking in the class (50%) and your presentation (50%). You will make a short presentation during the final exam period.

The student that produces the overall fastest solution that runs on a GPU will receive an automatic A for the class.