Syllabus for
CR311– Image Processing in Java
Cross listed as ECE430

Course Description:

A first course in Image Processing; Image algebra,arithmetic operations,boolean operations, matrix operations
Achromatic and Colored Light
Selecting Intensities, Gamma Correction
Chromatic Color, psychophysics, Color models
Color Space Conversion, low-level pattern recognition.
Students will learn the theory of 2-D Fast Fourier Transform Class, 2D convolution and frequency space processing, compression and 2D streaming.
Students will apply the theory by creating programs that read processing and write image streams. They are exposed to the elements of multi-resolution multi-media network streaming. They learn about a wide class of transforms, including Wavelets, DCT, the PFA FFT and others.
This course requires substantial programming effort and emphasis is place on good software engineering practices.
Students will learn enough signal processing to write their image processing applications.

Prerequisite: .....CR310, Voice and Signal Processing

Textbook:.....Image Processing, in Java by Douglas Lyon
Reference Material:..... Java Digital Signal Processing, By Lyon and Rao
E-mail.....access is required.
Computer Usage: …… Students **MUST** have access to a computer with Java .
Course Notes: .....**Handouts**/diskettes/e-mail, web page

Contact Information

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Office Hours

Monday, Tuesday..... 1:00 pm - 2:00 pm
Wednesday ..... 5:00 pm - 6:30 pm

Course Offerings

CR311, Image Processing..... Mc 203 Mon 2:00-4:30
CR 325, Computer Graphics..... Mc 203 Tues 2:00-4:30
SW 409, Java Programming II..... Mc 203 Wed 6:30-9:20
CR311 -> ECE 430
CR324 -> ECE 440.
ECE510, Thesis I..... By Appointment
ECE420, Readings ..... By Appointment

Course Objectives:

This course is designed to support the signal processing and computer systems domain in the Computer Engineering program. When the course is done, Students will have written their own Java applications for doing image processing.

1. The students will learn the principles of Image Processing.
   Expected learning outcomes:
   a. Applies transform concepts in programming situations
   b. Recognizes interrelationships among signals and spectra
2. The student will become proficient with the usage of the Java language.
   Expected learning outcomes:
   a. Demonstrates the ability to utilize Java in practical image processing problems.
   b. Uses appropriate object-oriented design patters to solve problems.

After the student take this course, they will know how to write programs that display and manipulate 2D images. They will also have a basic understanding of image filtering. Finally, the students will make use of data structures, linear algebra, design patterns, voice and 1D signal processing.
This course requires substantial programming effort and emphasis is place on good software engineering practices.
Outcomes:
When the course is done, Students will have deployed Java applications of their own design, on the web.
Performance Indicators:
Aside from the basics assessment procedures based on homeworks and tests, Students must obtain 75% or better on all tests. Additionally, students must perform at least 75% on the homeworks.

Student Activities: Learning a new computer language is very much a hands-on activity, which cannot be learned from lectures or textbook reading alone. It does require those lectures and textbooks, but the real learning results from the laboratory trials and the homework assignments. To achieve the course objectives, the student must have good class attendance and participation, conduct the computer programming tasks during the laboratory periods as well as the assigned homework. Homework assignments and laboratory trials are due at the beginning of the class following the assignments. They are to be placed in an envelope containing the student's name. The contents of the envelope will be a diskette and a paper copy of the requested Java source code.

Course Requirements: The schedule of activities and topics to be covered each week are outlined below. Each week will begin with responses to questions and a brief review on the previous week's topics. The first week will begin with administrative announcements and a review of this syllabus.

Grading Policy:

Homework and Laboratory Trials: 1/3
Midterm Exam : 1/3
Final Exam : 1/3

Assignments are due at the beginning of class. Assignments handed in during class lose 5 points, after class 10 points. Late submittals lose 10 points per day including weekends and holidays. Missing a test results in a zero unless a written excuse is presented.

Homework requirements:

Print out a listing of the program. Print out the program intput and output. You may need to do this at various levels of detail. Hand in a labeled disk with a printout. Place the disk in a #10 letter envelope and staple the envelope to the printout.

Topics: (coverage paced will be altered to accomodate the class):

Digital Image Processing Fundamentals
- Overview of Image Processing and its application
- Image Storage and Display
- image models
- cameras video and scanners
- Current state of streaming video on the Internet
- Problems and solutions
- Sampling
- Spectra and Spectra
- Preview of Image processing

Reading and Writing Images
- Reading GIF and JPEG
- Writing GIF
- Reading PPM
- Writing PPM

Edge Detection
- Roberts, Prewitt, Frei-Chen,
- Kirsch, Sobel,
- boxcar, pyramid, argyle, Macleod,
- derivative of Gaussian, Robinson,
- Canny
- Laplacian generation, Laplacian of Gaussian
- Hat

Boundary Processing
- XY to Vector Conversion
- vector ordering using Dijkstras' algorithm
- Edge following and Martellis' algorithm
- Divide-and-conquer boundary detection
- Range finding via diffraction
- Range map to boundary representation

Image Enhancement Techniques
- Blur
- mean, median, unsharp
- smoothing binary images by association
- local area contrast enhancement
- histogram equalization
- lowpass filtering
- highpass filtering
- averaging multiple images

Achromatic and Colored Light
- Selecting Intensities-Gamma Correction in Java
- Chromatic Color
- psychophysics
- Color models (CIE, RGB, YUV, CMY, HSV, YIQ)
- Color coordinate systems
- RGB to L*u*v*, L*u*v* to RGB
- RGB to L*a*b*, L*a*b* to RGB
- RGB to XYZ, XYZ to RGB

- RGB to YIQ, YIQ to RGB
- RGB to YUV, YUV to RGB
- RGB to HSV, HSV to RGB
- RGB to HLS, HLS to RGB

Thresholding techniques
- Global thresholding
- multilevel thresholding
- variable thresholding
- thresholding using image statistics
  - using mean and standard deviation
  - using maximization of between-class variance

Morphological filtering
- set theory
- arithmetic operations
- boolean operations
- erosion and dilation
- medial axis transform
- skeletonization

Warping
- scaling
- rotation
- shear
- cutting and pasting
- conformal image mapping
- warping

The Cosine Transform
- The Discrete Cosine Transform
- The Inverse Discrete Cosine Transform
- The Fast Cosine Transform Class
- Reading and Writing JPEG Images

The InLine MPEG CODEC
- Compressed MPEG movies images
  - decoding MPEG
  - encoding MPEG
- reading MPEG files
- writing MPEG files
- displaying MPEG files
- measuring loss
- Implementing in-line Java Decoders

The Wavelet Transform
- The Discrete Wavelet Transform
- The Inverse Discrete Wavelet Transform
- The Fast Wavelet Transform Class
- Writing a wavelet encoded file
- Decoding the wavelet encoded file
- Incorporating the decoder with the data
- Distribution of wavelet images on the Net.