Course Syllabus : Applied Physics 186 - Instrumentation Physics II

Schedule : 1st sem AY 2019-2020 TTH 8:30-11:30 CSRC
Section : THRU and THRU-1
Course Description : Imaging systems and image processing; multidimensional detection techniques; pattern recognition
Objectives : At the end of the course the learner will be able to

1. Measure physical variables from image or video
2. Enhance images for further processing
3. Implement basic machine learning algorithms
4. Understand articles on image processing and pattern recognition

Course Requirements :

- Short reports 60%
- Midterms and Finals 20%
- Integration project 20%
- Total 100%

Grade

Grade Equivalent for Raw Score X

X >= 90	:	1.0	70 <= X < 75	:	2.0	50 <= X < 55	:	3.0
85 <= X < 90	:	1.25	65 <= X < 70	:	2.25	40 <= X < 50	:	4.0
80 <= X < 85	:	1.5	60 <= X < 65	:	2.5	X < 40	:	5.0
75 <= X < 80	:	1.75	55 <= X < 60	:	2.75			

Teaching Strategies : Active learning, peer instruction, interactive lecture demos. There is no hard distinction between lecture and lab in this course- Tuesday and Thursday sessions will each have discussions and hands-on.

Class Policies

A. Activities and Self-evaluation

1. Your short report will contain all the outputs you produce from this course which include, but are not limited to, graphs, images and results writeups from short activities, etc.
2. You will write a **self-evaluation** of the results of your activity detailing what went right or wrong. You will also grade yourself in a scale of 1 to 10, 10 being the highest. You may freely write about your FeELiNgs regarding the activity (e.g. ”I enjoyed it”, ”I'm so frustrated”).
3. Always **acknowledge** your information sources such as your classmates, the webpage you got the image from, or the journal where you scanned the graphs or figures from.
4. Bonus points are given to those who go BEYOND the minimum requirement , such as when one contributes a useful piece of code, or when one investigates the limitations of the technique taught.
5. Use the Rubrik below as a self-grading guide.

	SCORE					Person (s) who helped me/ Books, references I've consulted	TOTAL
	5	4	3	2	1		

Technical correctness	Understood the lesson completely and was able to produce all required output	Was just able to get all the required . One or two technical mistakes.	Three to four technical mistakes.	Reported for class, worked on the activity, but produced no output by deadline time.			
Quality of presentation.	All text and images are of good quality. Captions can stand alone. All plots are properly labeled and are visually understandable.	One or two mistakes in image and plot preparation	Sloppy images and graphs, no captions	Posted pictures only.			
Initiative				Self-studied on advanced techniques; integrated past lessons; Investigated limitations of technique.	Went beyond requirements; tested technique on other samples and application;		

B. Synthesis Project

1. The project is individual and should try to solve an image processing or pattern recognition problem which may come from the following sources:
    a. your thesis (e.g. deblurring of images from your lab setup)
    b. a local problem (e.g. Traffic, pedestrians)
    c. your interest (e.g. astronomy, face recognition)
    d. Physics 10x.1 experiments that can be automated by image processing
    e. Other sources you can think of
2. Project presentation will include a full paper of SPP quality and orals.

C. Exams

1. A student with a standing of 80% or better at the end of classes shall be exempt from taking the finals and will be given a grade of 1.0 or 1.25 depending on the total score.

2. I never allow open books in my exams, only open codigo.

D. General Guidelines

1. Keep your **cellphones in silent mode or OFF** during my class because it is impolite to hear it during lecture. If I hear a cellphone beep in my class I will give a **Quiz** the next lecture day.
2. Unexcused absence during a **Ringing Tone Quiz** day results in a score equal to the **negative** of the total score.
3. **Absences** are deemed **excused** only for the following reasons and must be backed by written proof: death in the family, illness, participation in a university-recognized event.
4. Activities are posted before the start of the class. You may start working on it as soon as you receive it.

Meeting	**Lessons**	**Activities**
Aug 6	Course overview, practical image processing 1	Resizing images for publication, presentation, or fun
Aug 8	Practical image processing 2	Extracting data from hand-drawn graphs
Aug 13	Preprocessing - Grayscale images	Contrast enhancement by histogram manipulation
Aug15	Preprocessing - Rectification	Homography matrix
Aug 20	Preprocessing - Color images	Color correction
Aug 22	Image segmentation - Grayscale	Otsu's segmentation
Aug 27	Image segmentation - Color	Parametric vs. non-parametric segmentation
Aug 29	Feature extraction - Position	Playing notes
Sep 3	Feature extraction - Size	Green's theorem vs Pixel counting
Sep 5	Feature extraction - Color	Color segmentation
Sep 10	Feature extraction - Shape	Hough Transforms, Eccentricity
Sep 12	Feature extraction - Texture	Variance, GLCM, LBP
Sep 17	Set theory applied to images	Morphological operations
Sep 19	Automating tasks	Region analysis
Sep 24	Basic video processing	Kinematics and dynamics from video
Sep 26	Buffer day	
Oct 1	Buffer day	
Oct 3		MIDTERM EXAM
Oct 8	Machine learning overview	Perceptron
Oct 10	Predicting continuous outcomes	Linear Regression

Oct 15	Maximizing class separability	Support Vector Machine
Oct 17	Neural Networks	Multi-layer perceptron
Oct 22	Preparing data for classification	Data prepping exercises
Oct 24	Assessing network performance	Separability
Oct 29	Convolutional Neural Networks	Fourier Transform + Activation functions
Oct 31	Buffer days	
Oct 31	Buffer days	
Nov 5	Synthesis Project	
Nov 7	Synthesis Project	
Nov 12	Synthesis Project	
Nov 14	Synthesis Project	
Nov 19	Synthesis Project	
Nov 21	Synthesis Project	
Nov 26	Project Presentation Days	
Nov 28	Project Presentation Days	
Dec 3		FINAL EXAM

References

- Digital Image Processing by Gonzales and Woods
- Python Machine Learning by Raschka
- Convolutional Neural Networks for Visual Recogniton (cs231n.stanford.edu)