Engineering Division Course Syllabus

Course Title: Selected Topics in Information and Computational Systems – Intro to Computer Vision

Course Number **ENGR-UH 4560**

Course Description: An important goal of artificial intelligence (AI) is to equip computers with the capability of interpreting visual inputs. Computer vision is an area in AI that deals with the construction of explicit, meaningful descriptions of physical objects from images. It includes as parts many techniques from image processing, pattern recognition, geometric modeling, and cognitive processing. This course introduces students to the fundamental concepts and techniques used in computer vision, which includes image representation, image pre-processing, Edge detection, image segmentation, object recognition and detection, and neural networks and deep learning. In addition to learning about the most effective machine learning techniques, students will gain the practical implementation of applying these techniques to real engineering problems.

Credits 2

Pre-requisites: Proficiency in programming (Python, C++ or Matlab) and familiarity with matrix arithmetic

Instructor Information

Instructor: Prof. Yi Fang (Instructor)

Contact Information: A1-189
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Intended Learning Outcomes: Upon successful completion of this course, students will be able to:

- Develop the programming skills using python to implement the basic computer vision algorithms [(a.3), (e.3)];
- Understand the fundamental concepts of computer vision algorithms for: object detection, classification, recognition and tracking [(b.3)];
- Develop a solution to an engineering problem based on learned computer vision algorithms [(c.2), (k.1)];

Course Materials

Textbook: Computer Vision: Algorithms and Applications, Richard Szeliski, 2010 (E-version is available at http://szeliski.org/Book/)

Teaching and Learning Methodologies: Students are expected to arrive at class with an understanding of the basic definitions, concepts, and applications of relevant topics. Class time will be devoted to in-depth discussions of course topics. Lab project assignments are dedicated for reinforcing course topics via solving representative problem sets and holding class discussions.

Assignments and Grades: The course will provide with two tracks of assignments and grades. Student may choose one of two tracks for the class. The first track will be based on one large deep learning project

for object detection and one presentation and the second track will be based on two mini-projects and one final exam. The distribution of grades is subject to some revision at the discretion of the instructor. Typical weighting values are given below:

Track 1	Track 2
Large Deep Learning Project: 1*90%	Mini Projects: 2*35%
One Presentation: 1*5%	Final Exam: 1*25%
Class Attendance: 5%	Class Attendance: 5%
	Homework (no grading)
Description	Description
Large Deep Learning: CNN for Object Detection and Classification	Mini Project 1: Canny's Edge Detector
	Mini Project 2: Human Detection

Course Schedule: A typical schedule for course topics, projects, and exam dates is given in the table below (The actual schedule might be slightly different from this).

Lecture Date	Lecture Topics	Notes:
Sept. 1	▪ Introduction ▪ Image Representation & properties ▪ Image Preprocessing	Track one: Deep Learning for Object Detection Released
Sept. 8	▪ Edge Detection	Mini-Project One Released
Sept. 15	▪ Image Segmentation	
Sept. 22	▪ Invariant Features & interest points (Corners, HOG, etc)	Mini-Project Two Released
Sept. 29	▪ Neural Network	
Oct. 6	▪ Region (2D Shape) Analysis	
Oct. 13	• Deep Learning for Computer Vision	

Course Structure: 7 weeks course, 1 lectures per week (155 minutes) + 155 minutes lab per week

Relationship to Outcomes:

	Shared Engineering Outcomes					Program Specific Criteria				
	(1)	(2)	(3)	(4)	(5)	CivE	CmpE	ElecE	MechE	GenE
Lectures		x	x	x	x		X			x
Labs		x	x	x	x		x			x

	Student Learning Outcomes												
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
Lectures	x	x	x		x						x		
Labs	x	x	x		x						x		

Shared Engineering Outcomes:

(1) Apply techniques in the practice of leadership and innovation [(l), (m)];
(2) Identify social, economic, ethical and other factors that shape engineering solutions and incorporate them in conjunction with engineering principles in problem solving and designing systems, components, or processes to meet desired needs within realistic constraints [(a), (c), (e), (f), (h)];
(3) Recognize and respond respectfully to cultural concerns and differences when solving problems both physical and ethical [(a), (e), (f), (h)];

(4) Exhibit guidance and organizational effectiveness in multidisciplinary teams as a participant and a leader [(d), (l)];
(5) Demonstrate competence in writing and speaking effectively, and in communicating significant technical information in a clear and concise manner [(g)].

Program Specific Criteria:

- CivE: Civil Engineering graduates will be able to work professionally in four of the technical areas of the civil engineering discipline (structural, geotechnical, transportation, and environmental), design systems, components, and processes in more than one civil engineering context, and apply the principles of project management.
- CompE: Computer Engineering graduates will be able to analyze and design complex computing and network devices and systems containing hardware and software components.
- ElecE: Electrical Engineering graduates will be able to analyze and design complex electrical, electronic, and communication devices and systems.
- MechE: Mechanical Engineering graduates will be able to analyze and design systems, components, and processes, and work professionally in both thermal and mechanical systems areas.
- GenE: General Engineering graduates will be able to analyze and design devices and systems in an interdisciplinary engineering area related to: Biomedical and Health Systems; Information, Communication, and Electronic Systems; or Urban Systems.

Student Learning Outcomes:

(a) an ability to apply knowledge of mathematics, science, and engineering;

(b) an ability to design and conduct experiments, as well as to analyze and interpret data;

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;

(d) an ability to function on multidisciplinary teams;

(e) an ability to identify, formulate, and solve engineering problems;

(f) an understanding of professional and ethical responsibility;

(g) an ability to communicate effectively;

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;

(i) a recognition of the need for, and an ability to engage in life-long learning;

(j) a knowledge of contemporary issues;

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice;

(l) an ability to apply leadership skills including risk and project management and decision making;

(m) an ability to apply innovation skills.

Assessment Plan for ENGR-UH 4560: Selected Topics in Information and Computational Systems - Machine Learning

Performance Indicators	Assessment Tools		
	Project	**Exam**	**Presentation**
(a.3) Apply knowledge and practices of engineering in solving problems.	✓	✓	
(b.3) Analyze and interpret data related to engineering experiments.	✓	✓	✓
(c.2) Design a component to meet desired needs within realistic constraints.	✓		✓
(e.3) Demonstrate the ability to solve engineering problems using appropriate methods.	✓	✓	✓
(k.1) Apply modern computational tools in design and analysis of engineering system.	✓		✓
CompE: ***Criteria satisfied by outcomes above and degree curricular requirements.***			
GenE: ***Criteria satisfied by outcomes above and degree curricular requirements.***			