San José State University
Electrical Engineering Department

Computer Vision with Artificial Intelligence Applications

Course and Contact Information
Instructor(s): Prof. Chang “Charles” Choo
Office Location: ENG253 (Virtual during Spring 2021)
Telephone: (408) 924-3980
Email: chang.choo@sjsu.edu
Office Hour: Zoom office hour (Fri, 2pm-3pm). In addition, you may email your questions to the instructor 7/24. He will be able to answer within 1-24 hours. On your request, a zoom meeting may be held at mutually convenient time if absolutely necessary.

Class Days/Time: Tue, Thu, 4:30pm-5:45pm
Classroom: On-Line
Prerequisites: Graduate standing or instructor consent

Course Description
Fundamental concepts of computer vision and image processing in the context of artificial intelligence (AI). The course first covers basic techniques of digital image processing and computer vision, including image convolution, transformation, segmentation, and pattern recognition. In connection with these techniques, the theory of Convolutional Neural Network (CNN) is covered, with AI applications including object recognition and scene understanding for various autonomous systems.

Course Learning Outcomes (CLO)
Upon successful completion of this course, students will be able to:

1. Describe and analyze image formation, acquisition, and digitization process.
2. Describe and design image correction and transformation process.
3. Describe and design image filtering (convolution).
4. Describe the behavior of and design image transform for desired applications.
5. Describe and compare traditional boundary extraction and following techniques
6. Describe and list traditional region segmentation techniques.
7. Describe feature vector based machine learning techniques and their computational characteristics.
8. Describe and mathematically model components of human vision system and neural network.
9. Understand and describe the basic theory of AI, machine learning and deep neural network, and their computational requirements
10. Describe major convolutional neural networks (CNN) for AI applications.
11. Design and simulate CNNs for simple autonomous vehicle and robot application.
12. Use and experiment major deep learning frameworks, including Matlab, Caffe and Tensorflow.

**Required Texts/Readings**

**Textbook**
Lecture Notes by Instructor

**Other Recommended Readings**
- Dean, Jeffrey, et al., "Large Scale Distributed Deep Networks," NIPS, 2012


Other technology requirements/equipment/material

- Matlab with Image Processing, Computer Vision, Deep Learning Toolbox
- Tensorflow (open tool) will be used in-class demo/presentation and some assignments

Course Requirements and Assignments

There will be 6-8 assignments, including lab problems. Your reports are to be submitted electronically to Canvas. Late submission will have a penalty of -10% of total score per each late day.

There will be a term project requiring report and class presentation. In the term project, you will design, simulate, and verify the working of computer vision system, based on CNN. You will design a novel CNN or modify an existing CNN for your application, simulate and analyze the object recognition performance. The whole process is to be documented in the report to be submitted. Your term project report will have to be submitted to Canvas. Class presentation and demo will be required. If class size is too large to accommodate all presentations in-class, recording and uploading of your presentation to YouTube may be required.

Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally three hours per unit per week) for instruction, preparation/studying, or course related activities, including but not limited to internships, labs, and clinical practice. Other course structures will have equivalent workload expectations as described in the syllabus.

Evaluation

There will be one midterm and one final exam.

The weighting among exams, assignments, and homework will be:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Term project</td>
<td>25%</td>
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<tr>
<td>Homework</td>
<td>25%</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>20%</td>
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<tr>
<td>Final Exam</td>
<td>30%</td>
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Midterm will cover first half of the course materials, and will be closed-book/note, with 2 cheat sheets (both sides) allowed. Problems will ask simple quantitative questions that test if you understand the concepts of the topics covered.

Final Exams will be comprehensive and will be closed book with 4 cheat sheets (both sides) allowed. Problems will ask simple quantitative questions that test if you understand the concepts of the topics learned.

### Grading Information

<table>
<thead>
<tr>
<th>From (%)</th>
<th>To (%)</th>
<th>Grade</th>
</tr>
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<tbody>
<tr>
<td>91.00</td>
<td>100.00</td>
<td>A</td>
</tr>
<tr>
<td>88.00</td>
<td>90.99</td>
<td>A minus</td>
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<tr>
<td>84.00</td>
<td>87.99</td>
<td>B plus</td>
</tr>
<tr>
<td>81.00</td>
<td>83.99</td>
<td>B</td>
</tr>
<tr>
<td>78.00</td>
<td>80.99</td>
<td>B minus</td>
</tr>
<tr>
<td>74.00</td>
<td>77.99</td>
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<td>C</td>
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<tr>
<td>68.00</td>
<td>70.99</td>
<td>C minus</td>
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<tr>
<td>64.00</td>
<td>67.99</td>
<td>D plus</td>
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<tr>
<td>61.00</td>
<td>63.99</td>
<td>D</td>
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<td>58.00</td>
<td>60.99</td>
<td>D minus</td>
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<tr>
<td>0.00</td>
<td>57.99</td>
<td>F</td>
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### University Policies

Per [University Policy S16-9](http://www.sjsu.edu/senate/docs/S16-9.pdf), relevant university policy concerning all courses, such as student responsibilities, academic integrity, accommodations, dropping and adding, consent for recording of class, etc. and available student services (e.g. learning assistance, counseling, and other resources) are listed on Syllabus Information web page (http://www.sjsu.edu/gup/syllabusinfo), which is hosted by the Office of Undergraduate Education. Make sure to visit this page to review and be aware of these university policies and resources.

Class information, notices, course materials, FAQs (selected course related emails between students and Instructor) will be posted on Canvas. In addition, all the changes on the tentative list of homework problems (see below), as well as solutions to homework, will be available on the Canvas. Students are urged to visit the Canvas site twice a week.

*PLEASE DO NOT CONSUME FOOD IN THE CLASSROOM*

**Honesty and Respect for Others and Public Property**

**EE HONOR CODE**

The Electrical Engineering Department will enforce the following Honor Code that must be read and accepted by all students.
“I have read the Honor Code and agree with its provisions. My continued enrollment in this course constitutes full acceptance of this code. I will NOT:

- Take an exam in place of someone else, or have someone take an exam in my place
- Give information or receive information from another person during an exam
- Use more reference material during an exam than is allowed by the instructor
- Obtain a copy of an exam prior to the time it is given
- Alter an exam after it has been graded and then return it to the instructor for re-grading
- Leave the exam room without returning the exam to the instructor.”

**Measures Dealing with Occurrences of Cheating**

- Department policy mandates that the student or students involved in cheating will receive an “F” on that evaluation instrument (paper, exam, project, homework, etc.) and will be reported to the Department and the University.
- A student’s second offense in any course will result in a Department recommendation of suspension from the University.

**EE Honor Code**

In addition to EE Honor Code, EE267 students understand that professional attitude is necessary to maintain a comfortable academic environment. For examples:

- I do not just skip the lecture and then ask the instructor to summarize the lecture for me later on. Office hours are for students to have questions, not for the instructor to summarize the lecture for any specific student.
- I come to the class on time and leave the class at the end of the lecture.
- To minimize possible tension during the exams, I WILL follow the exam rules closely.
- I understand that long-term learning is my responsibility and so I always keep it up.
- I strongly believe that NOT any statement similarly to examples below can be used:
  1. I am working full-time and so do not have enough time for the class.
  2. I have quite many classes this semester and so I do not have enough time for the class.
  3. I just need a passing grade to graduate this semester.
  4. I live far away from the campus and so I cannot come to the class often.
  5. etc., etc....

**EE267: Computer Vision with Artificial Intelligence Applications**

**Tentative Spring 2021 Course Schedule**

*Subject to change with fair notice on class Canvas and by email*

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction; History and Overview of Deep Learning and Computer Vision</td>
</tr>
<tr>
<td>2</td>
<td>Image Formation, Human Vision, Human Neural Network</td>
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<tr>
<td>3</td>
<td>Image Convolution and Multi-Resolution Filtering Techniques</td>
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<tr>
<td>Week</td>
<td>Topics</td>
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<td>------</td>
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<tr>
<td>4</td>
<td>Review of Traditional Digital Image Processing (DIP) Techniques</td>
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<tr>
<td>5</td>
<td>Review of Traditional Computer Vision (CV) and Pattern Recognition (PR) Techniques</td>
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<tr>
<td>6</td>
<td>Introduction to Artificial Intelligence (AI) and Deep Learning (DL)</td>
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<tr>
<td>7 (Midterm)</td>
<td>In-Class; Thu, Mar. 11</td>
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</table>
| 8    | Convolutional Neural Networks (CNN) Part I  
  o AlexNet  
  o VGGNet  
  o GoogLeNet  
  o ResNet |
| 9    | Convolutional Neural Networks (CNN) Part II  
  o SqueezeNet  
  o YOLO  
  o MobileNets |
| 10   | DNN Optimization Techniques: Quantization, Pruning, etc. |
| 11   | DL Frameworks |
| 12   | Localization, Detection, and Segmentation Techniques |
| 13   | Applications of DNN to Autonomous Vehicles |
| 14   | Introduction to Hardware Platforms for DNN: CPU, GPU and FPGA |
| 15   | Class Presentation of Student Term Projects |
| Final Exam | In-Class; Friday, May 21, 2:45pm-5pm |