MEC 510: Object-Oriented Programming for Scientists and Engineers;
Visual Analytics and Sensing

The State University of New York Korea – Stony Brook University

Spring 2024

INSTRUCTOR	Dr. Jongseong Choi	jongseong.choi@sunykorea.ac.kr	B625 or MEIC Lab
CLASSES	F	12:30 – 3:20 pm	A117 or MEIC Lab
OFFICE HOURS	F	3:30 – 5:30 pm, or by appointment	B625 or MEIC Lab

COURSE TEXTBOOK

This course is not based on any particular textbook. The instructor will provide relevant search keywords, reading materials, and website links in each lecture.

PREREQUISITE

This course requires basic knowledge in linear algebra and probability and skills at a sufficient level of a non-trivial computer programming (with Python or MATLAB). Students also need to know how to use Markdown. If you are not familiar with or would revisit these topics, students should complete the following tutorials and questions inside:

MATLAB installation & license
Python installation & tutorials
Markdown

TASKS

There will be six tasks and they will be posted on this Brightspace in advance**. The instructor encourages students to work in groups through collaborative learning, but to submit their assignments individually**. The task will have programming components or photography components, where you will use your own camera to capture and process their own images and discuss the results. You are supposed to complete all tasks and turn their work in by the due date. You may search and access similar problems and solutions online. However, the students must not copy or rely only on those materials.

The late submission policy allows students to have **a maximum one-week delay** for **two among the first five assignments** (You must submit the last assignment on time). I will just count the number of delays in your submissions. I will inform the students when they delay their submission two times. If the number of delays is more than two, the third delayed homework will be zero. Students must pay close attention to deadlines. No further late submission will not be accepted unless accompanied by a valid excuse and some marks might be deducted depending upon the circumstances.

The six task grades will be a major factor for your final course grades. Thus, not submitting homework assignments is a really bad idea and your final score will significantly drop. If you have difficulty in doing the assignments, please speak to the instructor.

RESEARCH PAPER INVESTIGATION & PROJECT PROPOSAL ABSTRACT SUBMSSION

Investigate one paper and present. It can be any research paper related to your own work or a subject you are interested in, but should be related to Visual Analytics, Computer Vision, Metaverse, Digital Twin, XR, or Machine learning. This investigation be very important knowledge for your own study. Thus, please choose the paper you've been wanting to read or interpret. A week before the first presentation day, you have to submit your project proposal abstract and confirmed by the instructor.

FINAL PRESENTATION & REPORT

Based on the abstract you submitted for your individual project as well as the knowledge from this course and your investigation of the paper, you will generate final presentation and report. **The presentation will be 30 minutes and report should not exceed 10 pages**. It can be related to your own research as long as visual analytics is used in the method.

COURSE GRADE

Tasks	55%
Paper presentation	15%
Final report	30%
TOTAL	100%

Grading will be curved and normalized to 100% then given in a scale of:

92 ≤	A	< 100	74 ≤	C+	< 78
88 ≤	A-	< 92	70 ≤	C	< 74
85 ≤	B+	< 88	67 ≤	C-	< 70
81 ≤	B	< 85	64 ≤	D+	< 67
78 ≤	B-	< 81	60 ≤	D	< 64

COURSE LEARNING OBJECTIVES	ASSESSMENT TOOL
1. Describe visual analytics and prognostics and health management applications in mechanical engineering.	Task / Final Report
2. Explain the working principle of a digital camera, and their data acquisition process.	Task / Final Report
3. Interpret the concept of image processing techniques through signal processing theory	Task / Final Report
4. Develop programs (Python or MATLAB) to process and analyze 2D and 3D optical data for structural assessment.	Task / Final Report
5. Demonstrate how to implement machine learning algorithms in solving real-world problems.	Task / Final Report
6. Devise innovative visual analytics for mechanical engineering application and research.	Task / Final Report

COURSE OVERVIEW

This course offers an introduction to the emerging visual analytics and prognostics and health management technologies in mechanical engineering. Prognostics and health management integrates sensing, data processing, actuation, analysis, and control capabilities so that a structure can sense and respond to its changing external conditions in a rapid and automated manner. Among several topics, this course focuses on structural assessment using optical sensor data by implementing state-of-art image processing and computer vision techniques. As a special topic, basic concepts in machine learning, neural networks, convolutional neural networks (deep learning) are covered and relevant applications in mechanical engineering are introduced. An application-based learning approach is emphasized, and tasks are designed in such a way that students implement prognostics and health management technology to address contemporary problems in mechanical engineering.

COURSE TOPIC
1. Data Acquisition
2. Signal Processing
3. Digital Image
4. Projective Geometry
5. Linear Filtering
6. Edge Detection
7. Feature
8. RANSAC
9. Camera Model
10. Two-view Geometry
11. Structure-from-Motion (SfM)

ACADEMIC HONESTY

The campus policies on academic honesty are available on the Web (http://naples.cc.sunysb.edu/CAS/ajc.nsf/pages/info). Academic dishonesty is an extremely serious offense and will not be tolerated in any form. Academic dishonesty in general is the presentation of intellectual work that is not originally yours. Examples include, *but are not limited to*, copying or plagiarizing class assignments including homework, reports, and other submitted materials; copying or otherwise communicating answers on exams with other students; bringing unapproved aids, either in physical (written) or electronic form to an exam; obtaining copies of an exam prior to its administration, etc. Academic dishonesty violates both the ethical and moral standards of the Engineering profession and all infractions related to academic dishonesty will be prosecuted. Faculty members are required to report any suspected instances of academic dishonesty to the Academic Judiciary. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website: http://www.stonybrook.edu/commcms/academic_integrity/index.html

SPECIAL NOTE ON ADA

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact One-Stop Service Center, Academic Building A201, (82) 32-626-1117. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.

CRITICAL INCIDENT MANAGEMENT STATEMENT

The State University of New York, Korea expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn.

ATTENDANCE POLICY of SUNY KOREA

1. All students of SUNY Korea are required to attend every class.
2. Unexcused absences will affect seriously the student's final grade in the course.
3. If a student has over 20% unexcused absence, the student's final course grade will be an 'F'.
4. Students should report the reason of absence to the instructor in advance, or immediately after the absence.
5. When a student excuses his/her absence, the student must provide documentation of the reason for the absence to the instructor.
6. The instructor of the course reserves the right to excuse absences.
7. The course instructor may excuse the absence if the submitted documentation fulfills the conditions below. • Extreme emergencies (e.g. death in the family) • Severe medical reasons with doctor's note (Not a slight illness) • Very important events (e.g. national conference, official school event)
8. At the end of semester, the course instructor should submit a copy of the attendance sheet to the Academic Affairs Office.

Course Schedule
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Lecture	Day	Date	Location	Topic	Task given	HW due
1	F	Feb 23	A117 or MEIC Lab	Syllabus; Basic concept		
2	F	Feb 23	A117 or MEIC Lab	Introduction of Visual Analytics and Sensing in Structural Engineering		
	F	Mar 1	A117 or MEIC Lab	No class, Independence Movement Day		
	F	Mar 1	A117 or MEIC Lab	No class, Independence Movement Day		
3	F	Mar 8	A117 or MEIC Lab	MATLAB Tutorial		
4	F	Mar 8	A117 or MEIC Lab	Data Acquisition		
5	F	Mar 15	A117 or MEIC Lab	Digital Image I		Task #1
6	F	Mar 15	A117 or MEIC Lab	Digital Image II		
7	F	Mar 22	Online or Make-up	Projective Geometry & Homography I	Project Abstract Due	
8	F	Mar 22	Online or Make-up	Projective Geometry & Homography II		
9	F	Mar 29	A117 or MEIC Lab	Research Paper Investigation & Presentation I		Task #2
10	F	Mar 29	A117 or MEIC Lab	Research Paper Investigation & Presentation II		
11	F	Apr 5	A117 or MEIC Lab	Linear Filtering I		
12	F	Apr 5	A117 or MEIC Lab	Linear Filtering II		
13	F	Apr 12	A117 or MEIC Lab	Edge Detection I		Task #3
14	F	Apr 12	A117 or MEIC Lab	Edge Detection II		
15	F	Apr 19	A117 or MEIC Lab	Feature Detection & Matching I		
16	F	Apr 19	A117 or MEIC Lab	Feature Detection & Matching II		
17	F	Apr 26	A117 or MEIC Lab	RANSAC		Task #4
18	F	Apr 26	A117 or MEIC Lab	Camera Model		
19	F	May 3	A117 or MEIC Lab	Two-View Geometry I		
20	F	May 3	A117 or MEIC Lab	Two-View Geometry II		
21	F	May 10	A117 or MEIC Lab	Structure-from-Motion (SfM) I		Task #5
22	F	May 10	A117 or MEIC Lab	Structure-from-Motion (SfM) II		
23	F	May 17	A117 or MEIC Lab	Final Project Generation and Advising		
24	F	May 17	A117 or MEIC Lab	Final Project Generation and Advising		
25	F	May 24	A117 or MEIC Lab	Final Project Presentation I		Task #6
26	F	May 24	A117 or MEIC Lab	Final Project Presentation II		
27	F	May 31	A117 or MEIC Lab	Final Project Presentation III		
28	F	May 31	A117 or MEIC Lab	Report Generation		
-		TBD	TBD	Final Examination	Final Report & PPT Due	