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

The State University of New York Korea – Stony Brook University
Spring 2022

INSTRUCTOR	Dr. Jongseong Choi	jongseong.choi@sunykorea.ac.kr	Academic Building B625
CLASSES	TUTH	10:30 – 11:50 am	A704
OFFICE HOURS	TU	3:00 – 4:00 pm, or by appointment	B625

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 7 tasks and they will be posted on this course website weekly or bi-weekly**. 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 students will use their own camera to capture and process their own images and discuss the results. Students are supposed to complete all tasks and turn their works in by the due date. You may search and access similar problem and solution online. However, the students must not copy and paste the codes or texts in those reports.

The late submission policy allows students to have **a maximum one-week delay** for **three among the first six 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 three times. If the number of delays is more than three, the fourth 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 7 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, Metabus, 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

Base 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)
12. Introduction to Machine Learning
13. Gradient Descent
14. Training Linear Model
15. Neural Network

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	TU	Feb 28	A704	Syllabus; Basic concept		
2	TH	Mar 2	A704	Introduction of Visual Analytics and Sensing in Structural Engineering		
3	TU	Mar 7	A704	MATLAB Tutorial		
4	TH	Mar 9	A704	Data Acquisition		
5	TU	Mar 14	A704	Digital Image		Task #1
6	TH	Mar 16	A704	Projective Geometry I	Project Abstract Due	
7	TU	Mar 21	A704	Projective Geometry II		
8	TH	Mar 23	Online or make-up	Linear Filtering		Task #2
9	TU	Mar 28	A704	Research Paper Investigation & Presentation I		
10	TH	Mar 30	A704	Research Paper Investigation & Presentation II		
11	TU	Apr 4	A704	Edge Detection I		Task #3
12	TH	Apr 6	A704	Edge Detection II		
13	TU	Apr 11	A704	Feature I		
14	TH	Apr 13	A704	Feature II		Task #4
15	TU	Apr 18	A704	RANSAC		
16	TH	Apr 20	A704	Camera Model		
17	TU	Apr 25	A704	Two-View Geometry		Task #5
18	TH	Apr 27	A704	Structure-from-Motion (SfM)		
19	TU	May 2	A704	Structure-from-Motion (SfM)		
20	TH	May 4	Online or make-up	Introduction of Machine Learning		
21	TU	May 9	A704	Gradient Descent		
22	TH	May 11	A704	Training Linear Model		Task #6
23	TU	May 16	A704	Neural Network I		
24	TH	May 18	A704	Neural Network II		
25	TU	May 23	A704	Final Presentation I		
26	TH	May 25	A704	Final Presentation II		
27	TU	May 30	A704	Final Presentation III		Task #7
28	TH	Jun 1	A704	Report Generation		
-	TU	Jun 6		Memorial Day- No class		
-	TH	Jun 8		Reading Day – No class		
-		TBD	TBD	Final Report and PPT submission		