Advanced Construction Information Technologies (Applied Informatics and Artificial Intelligence in Construction)

CGN6905 Section DUJI

Class Periods: Wednesday Period 9-11 (4:05PM – 7:05PM EST)

Location: MAEB 0238

Academic Term: Fall 2025

Instructor:

Eric Jing Du
eric.du@essie.ufl.edu
(352) 294-6619
Office Hours: W: 1:50PM-2:50PM, Zoom: https://ufl.zoom.us/j/4369404526

Course Description

Delves into the use of emerging technologies for automation in construction. Students will engage with both hardware and software systems such as sensors, scanning techniques, big data tools, machine learning, artificial intelligence, and visualization methods. Practical applications using tools such as Arduino and TensorFlow will be employed to develop solutions that enhance the design, construction, inspection, and management of civil infrastructure systems (course credits: 3).

Course Pre-Requisites / Co-Requisites

Pre-requisites: Linear algebra, Differential equations
Co-requisites: None

Course Objectives

Students will:

1. Analyze the principles and functionalities of advanced information systems and informatics in construction engineering.
2. Evaluate methods and tools for key phases of information processing: sensing, scanning, analyzing, decision-making, and visualization.
3. Apply fundamental concepts of robotics and automation technologies in engineering contexts.
4. Construct basic sensing systems using open-source platforms such as Arduino.
5. Develop solutions applying machine learning and artificial intelligence techniques to real-world engineering challenges.

Materials and Supply Fees

No materials and supply fees.

Required Textbooks and Software

No required textbooks. Recommended readings will be provided in class. The following books are optional reading materials:

- *The Construction Technology Handbook (1st ed)* by Hugh Seaton, Wiley
- *Python Machine Learning by Example: Unlock machine learning best practices with real-world use cases (4th Edition)* by Hayden Liu, Packt Publishing
- *Linear Algebra and Optimization for Machine Learning: A Textbook (1st ed)* by Charu C. Aggarwal, Springer

Students are required to have the following software programs installed on their Windows or Mac systems at the beginning of the course:

- **Arduino IDE:** Essential for programming and testing Arduino-based projects.
- **TensorFlow:** Required for machine learning and AI development.
- **Python:** Necessary for TensorFlow and general programming tasks.
- **Jupyter Notebook:** Used for interactive coding sessions, especially in AI and machine learning modules.
- **Anaconda:** Recommended for managing Python environments and dependencies.
- **Optional but Recommended:**
  - **MATLAB:** Useful for numerical computations and simulations that complement AI studies.
  - **Unity:** For students interested in virtual and augmented reality applications.

Course Schedule *(team project demo/presentations/exams highlighted in red)*

Dates		Topics	Homework Due	Paper reading
1	8/27	**Course Overview** **Information Science Basics**: 1) information science; 2) information systems; 3) Cyber-Physical Systems; 4) Human-in-the-loop; 5) applications in civil engineering and manufacturing.	--	--
2	9/7	**Big Data I**: Principles; Curse of Dimensionality; MapReduce method.	--	--
3	9/10	**Big Data II**: Apache Hadoop basics; Applications of big data in civil engineering and manufacturing.	--	Paper #1: CPS
4	9/17	Class presentation: History of IT for engineering	HW#1: Facebook	Paper #2: Big Data I
5	9/24	**Sensors**: Working principles of sensors; Arduino basics; Barcodes; RFID; indoor localization techniques; smart phone app development for civil engineering and manufacturing.	--	Paper #3: Big Data II
6	10/1	**Sensor development:** In-class Arduino projects (materials will be provided by instructor) for construction sites.	--	Paper #4: Sensing I
7	10/8	**Scanning**: LiDAR; depth camera; photogrammetry; Smart Phone App Demo	HW#2: App demos	Paper #5: Sensing II
8	10/15	**Machine Learning/Artificial Intelligence/Deep Learning I**: Review of statistics; uncertainties; linear algebra review; feature extraction methods (PCA and sparse coding). Smart building design proposal presentation	HW#3: Smart building design	Paper #6: Sensing III
9	10/22	**Machine Learning/Artificial Intelligence/Deep Learning II**: regression analysis and artificial neural networks (ANN); TensorFlow and Jupyter Notebook environment; ANN programming (prediction and classification of civil engineering problems).		Paper #7: Visualization I
10	10/29	**Machine Learning/Artificial Intelligence/Deep Learning III**: Convolutional Neural Networks (CNN) and programming (image classification of construction objects).	--	Paper #8: Visualization II
11	11/5	**Machine Learning/Artificial Intelligence/Deep Learning IV**: Recurrent Neural Network (RNN) and Long short term memory (LSTM) methods; LSTM programming (time series prediction of construction process); CNN programing (voice recognition); Autoencoder and generative adversarial networks (GANs) (principles).	--	Paper #9: Machine Learning
12	11/12	**Machine Learning/Artificial Intelligence/Deep Learning V**: Natural Language Processing (NLP) and programming (sentiment analysis); Large Language Models (LLMs) – transformer architecture; reinforcement learning (RL: Q-learning and genetic algorithm) and programming for construction resource and space planning.	--	Paper #10: VR/AR/MR/XR
13	11/19	**Visualization and Robotics**: Virtual reality, augmented reality and mixed reality; robotics basics; applications in civil engineering and manufacturing; technology demos.	HW#4: AI project demo(Individual)	--
14	12/3	TERM PROJECT PRESENTATIONS/DEMO	--	--
15	TBD	**Final Exam**	Final Presentation file and Report Due	--

Attendance Policy, Class Expectations, and Make-Up Policy

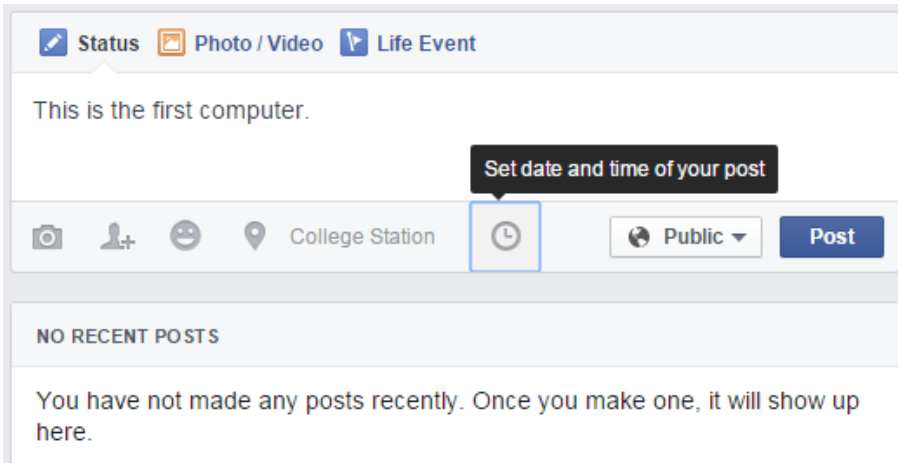
Class attendance is required and will be monitored though random attendance checks. Students are responsible for any information communicated during class. Project presentation attendance is mandatory. Missed presentations can only be made up when it is an excused absence. Excused absences must be consistent with university policies in the graduate catalog ((https://catalog.ufl.edu/graduate/regulations) and require appropriate documentation. Student must contact the instructor as soon as the student knows that he/she will have an excused absence to arrange for makeup. Additional information can be found here: https://gradcatalog.ufl.edu/graduate/regulations/

Evaluation of Grades

ID	Assignment	Total Points	Percentage of Final Grade
	Individual project		
A	HW#4: AI project	100	15%
B	Final Exam	100	30%
C	Weekly paper review	100	5%
	Team projects*		
D	HW#1: Facebook timeline	100	10%
E	HW#2: Smart app demo	100	10%
F	HW#3: Smart building design	100	10%
G	Term project	100	20%
H	Peer Evaluation (team members)	1.0	Multiplier
Final Grade=A *15%+ B*30%+C*5%+H*(D+E+F)*10%+H*G*20% ***Note: Team Grade subject to individual adjustment (+/-) based on peer evaluations.**			

HW#1: Facebook Timeline – History of Construction Technologies

1. Form a team of 2.
2. Pick a technology focus area, such as BIM, AI, Robotics etc.
3. Add "ITee" as your friend on Facebook.
4. Log into "ITee" and add new statuses on your selected tech. Please research the HISTORICAL milestones of the selected tech, and add articles, pictures, and/or videos about it. Please note, you also need to set time and date of your posts to when it actually happened. For example, if you added an article about the first computer, you should date your post "February 14, 1946", when the first computer was announced, even though you added the article on **September 17.**



Facebook "ITee" account info
Username: dujing82@gmail.com
Password: To be provided in class.

5. **Present your findings and initiate discussions (30 minutes) in the class on September 18.**
6. It will be peer evaluated based on: (1) Contents (full length articles; videos, images) – 30%; (2) Relevance and Connection to the trend of the selected technology – 20%; (3) Ability to engage class in discussion – 20%.

HW#2: Smart app development and demo

1. Form a team of 2.
2. Design a smart phone app using any development platform of choice. Note, there are many idiot-proof development platforms that you can use, such as AppSheet: https://www.appsheet.com.
3. Consider including the following functions:
    a. GPS tracking
    b. Camera
    c. Barcode scanner
    d. Map
    e. Interactive charts
4. Write a user's manual.
5. **Demonstrate the app (15 minutes) to the class on October 8.**
6. It will be peer evaluated based on: (1) Purpose (how relevant is it to a realistic construction management problem?) – 25%; (2) Development (Did the development follow software development process? (identify needs → User requirement → Architecture → Development → Testing) -25%; (3) Functionality (how effectively and efficiently the app can solve the identified problem? How well does the app meet user needs?) – 25%; (4) Usability (how easy it is to use the app?) – 25%.

HW#3: Smart building design proposal

1. Form a team of 2.
2. Propose a cost-effective renovation plan for Weil Hall to make it smarter.
3. Consider including the following functions:
    a. Indoor air quality monitoring
    b. Indoor localization
    c. Occupancy status
    d. Energy monitoring and optimization
    e. Emergency system
4. Prepare a presentation file.
5. **Demonstrate the proposal (15 minutes) to the class on October 15.**
6. It will be peer evaluated based on: (1) Purpose (how relevant is it to the needs?) – 30%; (2) Functionality (how effectively and efficiently the proposal can solve the identified problem?) – 30%; (3) Economy (how cost effective is the proposed solution? Please include an estimate of cost) – 40%.

HW#4: AI Project

1. Select a problem related to civil engineering or construction. Examples include but not limited to:
    a. Predicting commodity/material price
    b. Construction object detection on jobsite
    c. Voice recognition for human resource management
    d. Jobsite optimization solution
    e. Other applications
2. Use the AI methods learned in class to develop a solution.
3. Develop working model with Jupyter notebook
4. **Demonstrate your AI model in class on November 19.**
5. It will be evaluated based on: (1) Relevancy (how relevant is it to the domain?) – 30%; (2) Technical development (how well was the AI model developed?) – 30%; (3) Creativity (By the end, did the student present a reasonable solution to the problem?) – 40%.

Term Project (team project)

1. Form a team of 2
2. Pick a technology focus area from the followings:
    a. Scanning (LiDAR or Photogrammetry)
    b. Sensing
    c. Indoor localization
    d. VR/AR

e. Machine learning
f. Human-Robot Collaboration
g. Human factors in construction projects

3. Design a research project in the selected technology focus area, including: (1) A technical report (~3,000 words) to describe the background, the problem, the objectives, the design of the study or experiment, the results, the findings and conclusions; (2) A demonstration of the technology; (3) A final presentation to the class.
4. **Final demo and presentation (30 minutes) to the class on December 3.**
5. Equipment and devices will be loaned by the instructor if available. STUDENTS MUST MAKE SURE ALL LOAN EQUIPMENT AND DEVICES ARE RETURNED TO THE INSTRUCTOR IN ORIGINAL CONDITIONS.
6. The term project will be evaluated based on: (1) Relevancy (how relevant is it to the domain?) – 20%; (2) Technical development (how well the project was developed to meet the research needs?) – 20%; (3) Technology demonstration (how well did the team demonstrate the developed technology) – 20%; (4) Final report – 40%.

Grading Policy

Percent	Grade	Grade Points
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
81.0 – 83.9	B	3.00
78.0 - 80.9	B-	2.67
75.0 - 79.9	C+	2.33
72.0 – 74.9	C	2.00
69.0 - 71.9	C-	1.67
66.0 - 68.9	D+	1.33
63.0 - 65.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at: https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/

Academic Policies & Resources

To support consistent and accessible communication of university-wide student resources, instructors must include this link to academic policies and campus resources: https://go.ufl.edu/syllabuspolicies. Instructor-specific guidelines for courses must accommodate these policies.

Commitment to a Positive Learning Environment

The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University's core values.

If you feel like your performance in class is being impacted, please contact your instructor or any of the following:

- Your academic advisor or Undergraduate Coordinator
- HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@ufl.edu