IE 5995: IoT and Edge AI Programming
(3 Credits)
Course Syllabus - Winter 2022

Instructor: Yanchao Liu, Ph.D.
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Time & Location: Friday 05:00pm - 07:30pm
Office Hours: TBA
Web Sites: http://canvas.wayne.edu

Description: Learn sensor programming on an embedded device; use Wi-Fi, Bluetooth and MQTT to implement data streaming, remote control, and multi-device networking; explore the IoT data processing life cycle which includes capturing, cloud storage, and data analysis; develop and deploy machine learning models for use in mobile and edge computing environments.

Expected Learning Outcomes:
After completing the course, students should be able to:
- Identify different components of IoT
- Select development boards and tool chains for application prototyping
- Program MCU and SoC to read sensor data and control actuators
- Analyze sensor data using machine learning tools
- Use TensorFlow Lite to deploy neural networks on capable MCUs

Prerequisites: Working knowledge with C and Python is required.

Textbook: TinyML by Pete Warden and Daniel Situnayake, O'Reilly, 2019

References: Various online resources, including:
https://micropython.org/
https://www.adafruit.com/
https://www.arduino.cc/

Grading:
Homework 40%
Attendance & Participation 10%
Course project(s) 50%

Final Grade: A (>= 90), A- (>=85), B+ (>=80), B (>=75), B- (>= 70), C (<70)

Attendance Policy: Students attending any given class are required to join the class within the first five minutes to minimize any class disruptions.

Academic Dishonesty – Plagiarism and Cheating: Academic misbehavior means any activity that tends to compromise the academic integrity of the institution or subvert the education process. All forms of academic misbehavior are prohibited at Wayne State University, as outlined in the Student Code of Conduct (. Students who commit or assist in committing dishonest acts are subject to downgrading (to a failing grade for the test, paper,
or other course-related activity in question, or for the entire course) and/or additional sanctions as described in the Student Code of Conduct.

- **Cheating**: Intentionally using or attempting to use, or intentionally providing or attempting to provide, unauthorized materials, information or assistance in any academic exercise. Examples include: (a) copying from another student's test paper; (b) allowing another student to copy from a test paper; (c) using unauthorized material such as a "cheat sheet" during an exam.

- **Fabrication**: Intentional and unauthorized falsification of any information or citation. Examples include: (a) citation of information not taken from the source indicated; (b) listing sources in a bibliography not used in a research paper.

- **Plagiarism**: To take and use another's words or ideas as one's own. Examples include: (a) failure to use appropriate referencing when using the words or ideas of other persons; (b) altering the language, paraphrasing, omitting, rearranging, or forming new combinations of words in an attempt to make the thoughts of another appear as your own.

- **Other** forms of academic misbehavior include, but are not limited to: (a) unauthorized use of resources, or any attempt to limit another student's access to educational resources, or any attempt to alter equipment so as to lead to an incorrect answer for subsequent users; (b) enlisting the assistance of a substitute in the taking of examinations; (c) violating course rules as defined in the course syllabus or other written information provided to the student; (d) selling, buying or stealing all or part of an un-administered test or answers to the test; (e) changing or altering a grade on a test or other academic grade records.

**Student Disability Services:**
If you have a documented disability that requires accommodations, you will need to register with Student Disability Services for coordination of your academic accommodations. The Student Disability Services (SDS) office is located at 1600 David Adamany Undergraduate Library in the Student Academic Success Services department. The SDS telephone number is 313-577-1851 or 313-202-4216 for videophone use. Once you have met with your disability specialist, I will be glad to meet with you privately during my office hours to discuss your accommodations. Student Disability Services’ mission is to assist the university in creating an accessible community where students with disabilities have an equal opportunity to fully participate in their educational experience at Wayne State University. You can learn more about the disability office at [http://studentdisability.wayne.edu/](http://studentdisability.wayne.edu/)

Students who are registered with Student Disability Services and who are eligible for alternate testing accommodations such as extended test time and/or a distraction-reduced environment should present the required test permit to the professor at least one week in advance of the exam. Federal law requires that a student registered with SDS is entitled to the reasonable accommodations specified in the student's accommodation letter, which might include allowing the student to take the final exam on a day different than the rest of the class.

**Course Drops and Withdrawals:**
In the first two weeks of the (full) term, students can drop this class and receive 100% tuition and course fee cancellation. After the end of the second week there is no tuition or fee cancellation. Students who wish to withdraw from the class can initiate a withdrawal request on Pipeline. You will receive a transcript notation of WP (passing), WF (failing), or WN (no graded work) at the time of withdrawal. No withdrawals can be initiated after the end of the tenth week. Students enrolled in the 10th week and beyond will receive a grade. Because withdrawing from courses may have negative academic and financial consequences, students considering course withdrawal should make sure they fully understand all the consequences before taking this step. More information on this can be found at: [http://reg.wayne.edu/pdf-policies/students.pdf](http://reg.wayne.edu/pdf-policies/students.pdf)

**Deferred Grade:**
A grade of 'I' can only be assigned if all of the following criteria are met:
1. the student IS NOT currently failing the class and,
2. there is NOT a substantial quantity of work yet to be completed,
3. there is no extra work required of the instructor beyond the normal duties of grading the paper/exam,
4. there is no need for the student to attend the class in subsequent terms.

The final decision to assign an incomplete grade rests with the instructor. An 'I' grade MUST be made up within one year of assignment of the grade.
Tentative Modules:

Overview
- Internet of Things (IoT)
- Cloud computing
- Edge computing
- Neural networks and TinyML overview
- Industrial applications

Programming refresher
- Python programming
- C programming (language, environment, and tools)

Development boards (STM32 Nucleo, ESP32)
- Embedded systems development overview
- Read datasheets
- Read serial via PuTTY
- MicroPython firmware and environments
- STMCubeIDE environments

Use ADC, UART, SPI, I2C, PWM, Timer
- Temperature sensor – thermocouple type J, K
- 9 DOF Gyroscope
- Reading and decoding GPS signals
- Servo motor

Communication & Networking
- Wifi setup, operating modes, send and receive
- Bluetooth Low Energy (BLE) protocol and usage
- MQTT protocol and usage
- Binary data packing and unpacking
- Real-time database

Edge AI development
- Train neural networks with TensorFlow
- Convert model using TensorFlow Lite
- Deploy model on MCU for real-time inference

Develop & deploy OpenCV applications on SoC (e.g., Raspberry Pi 4)
- Get started with RPi ecosystem
- Build the ML and CV toolchain on RPi
- Using OpenCV via Python
- Build sample applications

Project workshops