

**ECE 442/510**

**Internet of Things and Cyber Physical Systems**

**Design Project**  
**Summer 2022**

# Description

Design an embedded system that would be an IoT device by retrieving, analyzing, and graphically/numerically displaying information based on the sensor data. Sensor data should be retrieved and analyzed on single board computer(s)/microcontroller(s), then sent to a server over any type of Internet connection, where your output will be displayed.

This is an open-ended project. Your group is free to choose any topic/theme. Topics are not limited to the following:

- Smart Lighting, Smart Parking, Smart Workout Detection System
- Home Automation System using Machine Vision and Distributed Sensors
- Remote Patient Healthcare System, Fall Detection System
- Computer Vision System for Assisting Visually Impaired Individuals
- Air Pollution Monitoring System, Smart Irrigation System, Smart Greenhouse System

Visit **ECASP Research Laboratory** (<http://ecasp.ece.iit.edu>) for more student projects in IoT, computer vision, embedded systems and more.

# Description

1. You are required to work in groups of two. Members of your group must submit their own independent reports except Proposal Reports and Video Recordings of your Presentation and Demo.
2. You must use one Raspberry Pi and one Arduino for this project. You are welcome to use other single board computers/microcontrollers, but you must have at least one Raspberry Pi and one Arduino in your project.
3. Use any programming language that you are comfortable with. (C, JAVA, Python, etc.)

# Description

4. You must use **at least three different types of sensors/actuators** for this project, where they would be connected to either Arduino or Raspberry Pi in low-level peripheral interfaces (I<sup>2</sup>C, SPI, GPIO, USB, ADC, PWM, Audio, etc.). *Your sensors should correlate each other to represent meaningful data.*
5. Communication between the Arduino and the Raspberry Pi must be **wireless**, and you must transfer sensor data from/to Arduino and Raspberry Pi. This can be done using either Bluetooth, Wi-Fi, ZigBee or any other wireless protocol.
6. All sensor data/information must be displayed graphically/numerically on the server. The server can be your laptop/desktop, running a simple client-server application, web server solution stack (e.g., XAMPP), or web application solution (e.g., ThingSpeak)

# Project Proposals

## Part 0. Preliminary Project Proposal (Due: Wednesday, May 25th, 9 AM; Points: 5)

- Prepare a brief report describing your group's project topic
- Your report should be 2 to 5 pages, and should include the following:
  - Your choice of Project Topic
  - Describing briefly on approach towards your design including hardware and software components
  - Group member listing
- ***Submit to Blackboard, and prepare for an in-class discussion***

## Part 1. Project Proposal (Due: Thursday, May 26th, 9 AM; Points: 5)

- Submit a brief report describing your project topic to the Blackboard
- Your report should be 3 to 6 pages, and must include the following:
  - Problem statement (describe your topic)
  - Hardware and software components that you will use
  - Describing the approach towards your design
  - Specific timeline of work
  - Group member listing and work distribution
- ***Submit to Blackboard, and prepare for an in-class discussion***

# Progress Report

## Part 2. Progress Report & Presentation (Due: Wednesday, June 8th, 9 AM; Points: 15)

- Submit a progress report detailing progress you/your group has made, **including a 10-minute recorded video presentation.** (A follow-up **5-minute Q&A in class**)
- Purpose of this progress report is to assure your project can be completed before the due date
- Your progress report (minimum 7 pages) must include the following:
  - Summary of your project and technical aspect of your project
  - Describe the hardware that you are using, including the single board computer/microcontroller, sensors, desktop/laptop...
  - Describe the software tools that you are using for your project
  - Any current results to share? Show your current results
  - List of materials, milestone, team member tasks and work distributions
  - Lessons Learned and Future Work to complete your project
  - Conclusion
  - References
- ***Submit to Blackboard, and prepare for an in-class discussion.***

# Final Presentation and Project Demo

## Part 3. Final Presentation and Project Demo (Class Time, June 22nd & 23rd, Points: 30)

- You/your group will have 20-25 minutes to present your project.
  - 15 minutes of recorded video presentation and demo, 5-10 minutes Q&A
- Your system must be fully operational in your recorded demo as a whole/one system.
- Timeslots of your presentation will be announced later.
- Your presentation should have the following information (but not limited to):
  - Brief overview of what your IoT device does and how it works
  - A summary of the hardware used, including the single board computer/microcontroller
  - Specific timeline of work, and work distribution within your group
  - Describe the sensor hardware and how you interfaced them.
  - Describe how you approached to display the output
  - A summary of the operating system (if applicable), programming language(s) that you used, any frameworks, and etc. Explain why you chose them
  - Hardware constraints; describe any power concerns, processing limitations, etc.
  - Software constraints; describe any real-time constraints, security concerns, etc.
  - List any challenges you faced in this project; Team Member Work Contributions
  - Future work; things you would add more feature/functionality to this project
- ***Submit your presentation to the Blackboard with your recorded demo video***

# Final Report

## Part 4. Final Report (Due: Thursday, June 23rd, 11:59PM; Points: 45)

- Submit your final report in a PDF form to the Blackboard by the above deadline
- Your report should be minimum of 15 pages (excluding title page, and your code which should be attached as an appendix) and must contain the following sections:
  - Abstract of your report
  - Introduction
  - Description of your topic/IoT Device, system flowchart
  - Hardware
    - Description on the single-board computer/microcontroller that you used
    - Description of the sensors that you used
    - Description of how you interfaced the sensors to the single-board computer/microcontroller
    - Include a link or append any datasheets for hardware that you used
    - Schematic of any circuit that you designed



- Software
  - Programming language: which one did you use? Why? Briefly explain the tradeoffs between the language you chose, and other languages that you may have chosen for this project
  - Real-time: Does your device have real-time constraints? What would happen if your code encounters an unexpectedly large delay?
  - Security: Describe any security issues that might encounter on your system.
  - Explain how much of the code is original to you or your group
- Related work
  - Has anyone done a project like yours? Find any similar projects and describe them.
  - How does your project compare to those you find similar?
- Results and Discussion
  - Show your results and describe your system (BB or Google Drive Video Upload)
  - Discuss any issues that you faced, any improvement made since the progress report, etc.
- User's Manual for usage of your IoT system
- Team Member Work Contributions
- Conclusion and Future Work
- List of references
  - Write one paragraph about each of the references and its relevance to completing your project.
- Appendix
  - Entire Source code of your project with comments
  - Other documents such as bill of materials (BOM), sensor specifications, cost evaluation, power usage, ....