CS4111 – Embedded Systems Programming

Final Project – Fall 2023

1. Introduction

Your final project is meant as a way for you to showcase what you've learned this semester. The goal is for you to use a combination of sensors and actuators to accomplish something of your choosing.

2. Topics:

Your project should be creative and address a problem related to the following areas:

- Smart home
- Gaming
- Logistics
- Hajj and Omrah
- University campus

You can check the following links for inspiration as a starting point (too many other resources available online for projects' ideas):

- https://www.youtube.com/watch?v=QUQta4f_87E
- https://www.youtube.com/watch?v=9ItEPmwfBqg

3. Guidelines:

- You may work either alone or in groups of two or three. If you work in a group your end project will have higher expectations.
- You may use code/libraries found online as long as licensing allows it and you properly document it. There must be some original code done by your group. You cannot just stitch together code found online.
- Your board will have to take input from a user, and display some manner of output. Both of these need to go through one of the low-level hardware interfaces discussed in class.
- Your project may complement one being done in another class. However your project must be a new implementation, you cannot just turn in previously done work.

4. Expectations:

The project idea is acceptable if it meets the following criteria (minimum):

- Use at least two sensors
- Uses at least one actuator or output device
- The use of the sensors/actuators is coherent with the project
- Implements an application with complexity approved by the course instructor

The List of Sensors, Actuators, and Output Devices that can be used in the project is (you can use others if you want):

- Sensor
  - Ultrasonic distance
  - Passive Infrared (PIR)
  - Temperature & Humidity
  - Soil Moisture
  - Potentiometer
  - Sound
  - Light
  - Flex
  - Magnometer
  - IMU (accelerator, gyroscope, etc)
  - Color
  - IR Distance
  - Magnetic Reed Induction Switch
  - Human Body Pulse
  - IR Receiver (and remote)
  - Laser Distance (complicated, but cool)
- Actuator
  - Relay (turn on/off AC wall power)
  - Buzzer
  - Speaker
  - Car with motors
  - Standard DC motors (and motor driver circuits)
  - Servo Motors (various)
  - Pan-Tilt Servo Motors
- Output Device
  - Various 7-segment displays
  - Various 4-digit, 7-segment displays
  - LCD Character displays (like from the beneater kit)
  - LED Matrix Display (64 LEDs in a grid)
- Communication
  - ESP-01 WiFi device
  - HC-05 Bluetooth Modules

Please be aware that ordering sensors and actuators might take up to three weeks. So, you need to place your order by the time of submitting the project proposal.

5. Deliverables

5.1 Project Proposal [10 points]

Deadline: Thursday, October 19th, 2023 at class time

Your project proposal document should be submitted on Blackboard. Please work with the course instructor to scope a project that is appropriate for the course.

The project description should include the following:

- Overall goal of the project
- Team Members
- Hardware components (including the senesors and actuators).
- Software components (including).
- What you intend to deliver for the checkpoint

Since each project is different, please consult with the instructor regarding the checkpoint deliverables for your project.

5.2 Checkpoint [20 points]

Deadline: Wednesday, November 15th, 2023 at class time

During class time, each team will give a brief checkpoint demo to the class. At this point you should have something substantial from your project working, which likely means having both some hardware and software functional and able to demo something significant. You will know what should be working because you will have to write it into your proposal.

5.3 Video Demo [10 pts]

Deadline: Wednesday, December 6th, 2023 at class time

Before the live demo (see Section 2.4), you need to submit a video demo of your project. It should be about 2-5 minutes.

5.4 Final Demo and Presentation [35 pts]

Deadline: Wednesday, December 13th, 2023 at class time

You will present and demo your project to the class in the last week of classes. (That, of course, means everything needs to be working before that.) You should plan for a 10-15 minutes presentation/demo.

5.5 Final Report [25 pts]

Deadline: Wednesday, December 13th, 2023 at class time

This will be a short paper (at least 6 pages, but you can include pictures, diagrams, etc.) that must contain all of the following:

1. **Introduction**: What the device is and high-level overview of what it does. Also, be sure to make clear what is actually working in your implementation (as opposed to things you wanted to get work but for various reasons did not).
2. **Hardware**
   (a) Embedded Board Description: Describe the hardware, circuit schematics, shields, etc.
   (b) Input device description: Describe the device you are interfacing with, how you access it in software, and document the protocol you use to communicate with it.
   (c) Output Device description: same as for the input device.
3. **Software**
   (a) Different sketches you have for the project.
   (b) If you use code not written by your group (code found online, libraries, etc) explain what the extra code does, and how your code interfaces with it. Explain how much of the code is original to your group.
4. **Related Work**
   (a) Has anyone done a project like this before?
   (b) How does your project compare to existing similar projects?
5. **Conclusion**
   (a) If you worked in a group: List who worked on what part.
   (b) Challenges: List any challenges you had, and if things didn't work, explain why.
   (c) Future Work: List any improvements you might make if you had more time and resources to work on the project.

6. Rubrics:

Each milestone will have some marks as shown in the section 5 above. The rubrics for the final submission (report and prototype) are:

CATEGORY	5-4	3-2	1-0
Presentation			
Effectiveness	Project includes all material needed to gain a comfortable understandingof the topic.	Project is missing more than two key elements.	Project is lacking several key elements and has inaccuracies.
Sequencing of Information	Information is organized ina clear, logical way. It is easy to anticipate the type of material that might be on the next slide.	Some information is logically sequenced. An occasional slide or item of information seems out of place.	There is no clear plan for the organization of information.

Use of Graphics	All graphics are attractive(size and colors) and support the theme/contentof the presentation.	All graphics are attractive but a few do not seem to support the theme/content of the presentation.	Several graphics are unattractive AND detract from the content of the presentation.
Organization	PowerPoint contains a minimum of 10 slides. All parts of the task are completed fully and support the theme/contentof the presentation.	PowerPoint contains fewer than 10 slides, or some slides designed do not support the theme/content of the presentation.	PowerPoint contains fewer than 10 slides and is missing several parts of the task. Slides designed do not support the theme/content of the presentation.
Project Prototype			
Idea	Having an excellent projectidea	Having a good project idea and doing a prototype	Having a project idea with no prototype
Prototype Implementation	Implementing the prototype properly	Implementing the prototype with mistakes	No prototype
Prototype Functionality	The prototype is functioning properly	The prototype in not functioning well or not as it is meant to be.	Prototype is not working at all
Project Report			
Introduction	Provides an introduction to the subject. Address the problem with clarity and a strong rationale/justification. States the objective of the study	Provides an introduction to the subject but does not address the problem with clarity and a strong rationale/justification. Objective not clear	Provides an introduction but does not describe the problem to be solved; fails to explain the details and objectives of the study.
Related Work	Provides extensive background research into the topic and summarizes important findings from the review of the literature, including critical reading, justifies the current study, explains the significance of the problem.	Provides some background research into the topic and describes the problem to be solved. Some important findings from the review of the literature are listed but no critical reading or justification	Provides some background research into the topic but does not describe the problem to be solved; fails to summarize important findings from the review of the literature including critical reading.
Hardware	Detailed and comprehensive description for all the hardware components in the project	Provides a reasonable explanation for the hardware components in the project	Dose not adequately provide an explanation for the hardware components in the project
Software	Detailed and comprehensive description for all the software part of the project	Provides a reasonable explanation for the software part of the project	Dose not adequately provide an explanation for the software part of the project
Conclusion	Presents a logical explanation for findings; addresses recommendations and/or implications for further research or use/application	Presents a reasonable explanation for findings	Does not adequately explain findings