CSE321 Project 3

Assigned: November 12, 2021
Lab required week of 11/15 - bonus/penalty structure applies
Midpoint Due: November 19, 2021
Project Due: December 10, 2021, 11:59 pm ET

Important Notes:

- **THIS IS A SOLO PROJECT** (based on in class vote)
- A score of at least 50% must be earned across the weighted sum of the projects to maintain eligibility to pass the course
- Incorrect file types and files without your name in them will not be graded
- Incorrect file names (when specified) will result in 2 points taken from the overall grade for the project

Objective

You will be creating a real-time embedded system that can be used to help solve a problem. This system will incorporate core embedded operating systems elements including the principles of RTOS. You'll have a limited set of constraints and requirements- beyond that it's up to you to have fun.

Problem

You need to design a system to help solve a problem. There are many problems out there, so to help narrow down your options, your system will need to help in one of the following areas:

- Food Waste Minimization
- Environmental
- Social distancing
- Accessibility support
- Autonomous devices
- Education support
- Safety

If you are taking the class for a second time, your project can't be in the same area as what you chose previously and will need to use at least 1 peripheral from the project 3 list that you did not use the first time. If you choose the same area or choose not to include the new peripherals, it will be an academic integrity violation.

Implementation Requirements

Peripherals

All peripherals used must be from the list provided as we need to be able to build your project and test it while grading the submission.

- A minimum of one previous external output peripheral
    - LCD, LEDs
- A new external input peripheral
    - DHT11
    - Transducers
        - UltraSonic
        - Audio
    - Rotary Encoder
    - IR
    - Tilt sensor
- A new external output peripheral
    - Buzzer
    - Servo
    - Vibration Motor
    - 7 Segment Display
    - Dot-matrix array

Internal Elements

Part of the criteria is the utilization of embedded and real-time operating system features. The following OS elements are required in the implementation of the project.

- Watchdog timer must be configured appropriately
- Synchronization technique
- At least 1 direct bitwise driver configuration
- Critical Section protection is required for entire implementation
    - Make sure that two threads don't try to access and/or modify the same memory at the same time
    - See Lecture 16 for more details
- A task/thread intentionally incorporated
- At least 1 interrupt

Stage 1: Getting Started

Decomposing a problem and creating a preliminary plan is a good way to set yourself up for success. Note that the answers for this stage may change between the time they are submitted and your final project, that is okay.

Part A: Project statement (20 Points)

(Due 11/19)

Write a statement detailing the purpose of your project along with the area you chose. Make sure you answer all of the questions in the rubric below.

For example, in project 2 the project statement was “design a stopwatch timer”. Your statement should be somewhat more elaborate.

	Beginning	Developing	Accomplished
What is it?	Not answered (0 Points)	Attempted but not clear. (2.5 Points)	Answered and is clear what you will be making. (5 Points)
What is the purpose?	Not answered (0 Points)	Attempted but not clear. (2.5 Points)	Answered and is clear what you will be making. (5 Points)
What is the area of application?	Not answered (0 Points)	Attempted but not clear. (2.5 Points)	Answered and is clear what you will be making. (5 Points)
How does it help in that area? Or what purpose does it serve there?	Not answered (0 Points)	Attempted but not clear. (2.5 Points)	Answered and is clear what you will be making. (5 Points)

Part B: Initial Constraints and Specifications (20 Points)

(Due 11/19)

Detail the constraints and specifications of the project you are planning to implement. Refer to your project 2 submissions for an example of how to do this.

	Beginning	Developing	Accomplished
Constraints	All other cases. (0 Points)	2-3 relevant constraints regarding the project concept are presented (high level about the project, not the code) Or code is mentioned (5 Points)	4+ relevant constraints regarding the project concept are presented (high level about the project, not the code) (10 Points)
Specifications	All other cases. (0 Points)	2-3 relevant specifications regarding the project concept are presented (high level about the project, not the code) Or code is mentioned (5 Points)	4+ relevant specifications regarding the project concept are presented (high level about the project, not the code) (10 Points)

Part C: Asks (20 points)

(Due 11/19)

	Beginning	Developing	Accomplished
Purpose	All other cases. (0 Points)	Minor errors in missing elements or clarity. (2.5 Points)	Clear, concise, and complete. (5 Points)
Inputs	All other cases. (0 Points)	Minor errors in missing elements or clarity. (2.5 Points)	Clear and complete. (5 Points)
Outputs	All other cases. (0 Points)	Minor errors in missing elements or clarity. (2.5 Points)	Clear and complete. (5 Points)
Constraints	All other cases. (0 Points)	Minor errors in missing elements or clarity. (2.5 Points)	Clear, concise, and complete. (5 Points)

Part D: Preliminary BOM (10 points)

Due 11/19

Create the bill of materials(BOM) so that we know what parts are needed for your project.

Consider this as if someone were to only use the materials in your BOM. They should not have to go get more materials if they followed the BOM.

	Beginning	Developing	Accomplished
Complete	All other cases. (0 Points)	Lacks detail or missing 1-3 items. (5 Points)	Each item needed is listed with a general description. (10 Points)

Part E: Submit and Commit (25 points)

(Due 11/19)

Verify that your name is on your file(s) and then convert them to PDF form (you can create a pdf for each part or one big one). Upload the file(s) to UB Learns.

Update your github repository README sections and then upload your files to your repository.

	Unacceptable	**Acceptable**	**Exemplary**
Main README Update	Significant issues or not done or not correct file format [0 Points]	Slight details missing or inappropriate [4 Points]	Appropriate and complete [10 Points]
Project 3 Readme	Significant issues or not done or not correct file format [0 Points]	Slight details missing or inappropriate [4 Points]	Appropriate and complete [10 Points]
Files	Missing more than 1 file. [0 Points]	Missing one file. [2 Points]	All files accounted for. [5 Points]

Stage 2: Final Submission and Evaluation

Due 12/10

Report

Use the template from Project 2 as a starting point.

Required sections:

- Cover page
- Introduction to the project
- Overview of features and specifications
- Explanations of how the required internal features are integrated
- Recap of design process
- Block Diagram
- ASM/FSM State Diagram/Flow Chart
- BOM
- User Instructions (similar to a “getting started”) section
    - Schematic
    - Instructions how to build the system
    - Instructions how to use the system
- Test Plan Instructions
- Development Timeline/Revision History
    - Include highlights of development

Where/When to cite?

When in doubt- cite it!

- Content
    - What to cite: Anything not in the lecture slides
        - If it is from one of my sources, you cite the reference repository that is at the link provided in the slides
    - Where: In the report
- Code
    - What to cite: anything not given to you (Mbed API and classwork does not need a citation)
    - Where: In the header section
        - And adjacent to the code if incorporated to your files
        - And license comments should appear in that code file as a header. And that file needs to be provided.

Demo

Assigned Lab Session: 12/8-12/9

Code Submission

Properly commented and complete code will be submitted to UB Learns and to your github repository.

Rubrics

Documentation (315 points)

	Beginning	Developing	Accomplished
Cover Page	Missing or substantially incomplete or incorrect or unprofessional (0 Points)	Missing some components or all components are there but not professionally presented. (5 Points)	Appropriate standard content (name, course, purpose, term) that is professionally presented. (10 Points)
Table of Contents	Not done (0 Points)	Present but not complete (2 Points)	Present and complete (5 Points)
Introduction	Does not describe the project as a whole, is not a high level summary, or does not mention the application of the project. (0 Points)	Summarizes the project at a high level. Describes what the application is for the project. (5 Points)	Summarizes the project at a high level. Describes what the application is for the project and how it is a benefit in that area. (10 Points)
Project Requirements	Enough issues to justify that this project does not help one of the assigned areas or meet the requirements for implementation. (0 Points)	Requirements do not fit the assigned system constraints fully, slight issues to unapproved elements or not satisfying	Project described and prototyped fits approved constraints and requirements. (10 Points)

		requirements. (5 Points)	
Overview of Specifications and Features	Not done or significantly unclear or incomplete (0 Points)	Some unclear aspects or incomplete (5 Points)	Clearly presented and complete (10 Points)
Explanation of watchdog element and how it was incorporated	Substantial aspects of explanations are incomplete or inadequate. (0 Points)	Incomplete explanation or inadequate explanation for the purpose, reasoning, and methods of integration. (5 Points)	Element's purpose is explained, the decision on how integration was chosen, and general description of how it was integrated. (10 Points)
Explanation of synchronization technique and how it was incorporated	Substantial aspects of explanations are incomplete or inadequate. (0 Points)	Incomplete explanation or inadequate explanation for the purpose, reasoning, and methods of integration. (5 Points)	Element's purpose is explained, the decision on how integration was chosen, and general description of how it was integrated. (10 Points)
Explanation of bitwise driver control and how it was incorporated	Substantial aspects of explanations are incomplete or inadequate. (0 Points)	Incomplete explanation or inadequate explanation for the purpose, reasoning, and methods of integration. (5 Points)	Element's purpose is explained, the decision on how integration was chosen, and general description of how it was integrated. (10 Points)
Explanation of critical section protection and how it was incorporated	Substantial aspects of explanations are incomplete or inadequate. (0 Points)	Incomplete explanation or inadequate explanation for the purpose, reasoning, and methods of integration. (5 Points)	Element's purpose is explained, the decision on how integration was chosen, and general description of how it was integrated. (10 Points)
Explanation of thread/tasks and how it was incorporated	Substantial aspects of explanations are incomplete or inadequate.	Incomplete explanation or inadequate explanation for the	Element's purpose is explained, the decision on how integration was

	(0 Points)	purpose, reasoning, and methods of integration. (5 Points)	chosen, and general description of how it was integrated. (10 Points)
Explanation of interrupt and how it was incorporated	Substantial aspects of explanations are incomplete or inadequate. (0 Points)	Incomplete explanation or inadequate explanation for the purpose, reasoning, and methods of integration. (5 Points)	Element's purpose is explained, the decision on how integration was chosen, and general description of how it was integrated. (10 Points)
Solution Development	Substantial errors or not done. (0 Points)	Minor errors. (5 Points)	Complete, clear, concise. (10 Points)
Block Diagram	Not done or hand drawn with missing elements (0 Points)	Correct and complete but not digitally created. Or missing some elements. (5 Points)	All key blocks and interactions shown Labels present as appropriate. Digitally created. (10 Points)
Diagram	Not done (0 Points)	Complete and correct. Properly labeled. Created by hand. Or some errors in completeness/correctness/labels Created digitally (7.5 Points)	Complete and correct. Properly labeled. Created digitally. (15 Points)
Diagram Readability	Very difficult to read. Or no diagrams. (0 Points)	Some challenges due to color, font, font size or layout; but with some effort can be read. (2.5 Points)	Both are easy to read and follow. (5 Points)
BOM	Not done or substantial issues (0 Points)	Partially complete (5 Points)	Present and complete (10 Points)

User Instructions Section	The section exists but as the subsections instead of a larger section. (0 Points)	Section exists but the content is not appropriate for a general user. (5 Points)	Section exists and is written for a general user. (10 Points)
Schematic	Not done Substantial issues. (0 Points)	Not 100% clear, either confusing in spots or missing steps. Hand drawn figures present but can successfully follow your schematic. (10 Points)	Able to create your implementation. Figures (created digitally) used as appropriate to aid in creation. (20 Points)
Instructions to build	Not able to follow sufficiently. Difficult to read. Missing (0 Points)	Readable but not successful based on reading alone (10 Points)	Complete, readable and able to follow to achieve successful construction. (20 Points)
Instructions to use	Not able to follow sufficiently. Difficult to read. Missing. (0 Points)	Readable but not successful based on reading alone. (10 Points)	Complete, readable and able to follow to achieve successful use. (20 Points)
Test Plan	Not done(0 Points)	Slightly Incomplete and/or some inappropriate aspects (10 Points)	Complete and appropriate (20 Points)
Outcome of Implementation	Significant inadequate explanation or not done. (0 Points)	Outcome is mentioned but does not support design and test plan elements. (5 Points)	Explanation of the outcome of the project. Including the satisfaction of the test plan and design criteria. (10 Points)
Future Considerations - Identification of shortfalls	More errors/issues than described in “Developing” (0 Points)	Overall valid and appropriate, but mention of implementation was made as a design	Valid features identified and justification for being a shortfall explained. Features must be in

		shortfall. (5 Points)	design. (10 Points)
Future Considerations- General Improvement	More errors/issues than described in “Developing” (0 Points)	Lacks complete identification, justification and/or benefit on a small scale of error/issue. (5 Points)	Valid feature identified and justification for inclusion explained. Explanation of expected impact included. (10 Points)
Professionality - Formatting	Significant issues. (0 Points)	Slight issues with inconsistencies or use of inappropriate elements or missing elements. (5 Points)	Format of report is professional, well organized and contains appropriate formatting. (10 Points)
Professionality - Figures	More errors/issues than described in “Developing” (0 Points)	Easy to read but not digital. Digital but slight readability issues (5 Points)	Created digitally, easy to read (10 Points)
Professionality - Language	More errors/issues than described in “Developing” (0 Points)	Less than 5 incidents that are not appropriate (5 Points)	Appropriate (10 Points)
Professionality - Pronouns	5 or more uses of pronouns. (0 Points)	Less than 5 incidents (5 Points)	No Pronouns Used. (10 Points)

Code (290 points)

Implementation - the code itself (140 points)

	Beginning	Developing	Accomplished

Commenting- Header	More errors/issues than described in “Developing” (0 Points)	Minor errors. Still readable and makes sense. (5 Points)	Complete, correct and appropriate. (10 Points)
Commenting- Code	More errors/issues than described in “Developing” (0 Points)	Minor errors. Still readable and makes sense. (10 Points)	Complete, correct and appropriate. (20 Points)
Integration of a previously used input peripheral	More errors/issues than described in “Developing” (0 Points)	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. (5 Points)	Complete, correct and appropriate. (10 Points)
Integration of a previously used output peripheral	More errors/issues than described in “Developing” (0 Points)	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. (5 Points)	Complete, correct and appropriate. (10 Points)
Integration of a new external output peripheral	More errors/issues than described in “Developing” (0 Points)	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. (5 Points)	Complete, correct and appropriate. (10 Points)
Integration of a new input peripheral	More errors/issues than described in “Developing” (0 Points)	Minor errors in technique that make it incomplete or incorrect or	Complete, correct and appropriate. (10 Points)

		inappropriate, this may be an error location that prevents your code from running. (5 Points)	
Integration of a second new input peripheral (only applies to teams)	More errors/issues than described in “Developing” (0 Points)	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. (5 Points)	Complete, correct and appropriate. (10 Points)
Integration of Watchdog Timer	More errors/issues than described in “Developing” (0 Points)	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. (5 Points)	Complete, correct and appropriate. (10 Points)
Integration of a synchronization technique	More errors/issues than described in “Developing” (0 Points)	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. (5 Points)	Technique used and comments included to highlight the setup and use. (10 Points)
Integration of at least 1 direct bitwise driver	More errors/issues than described in “Developing” (0 Points)	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents	Complete, correct and appropriate. (10 Points)

		your code from running. (5 Points)	
Integration of Thread/Task element	More errors/issues than described in “Developing” (0 Points)	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. (5 Points)	Complete, correct and appropriate. (10 Points)
Integration of an interrupt	More errors/issues than described in “Developing” (0 Points)	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. (5 Points)	Complete, correct and appropriate. (10 Points)
Critical section protection	More errors/issues than described in “Developing” (0 Points)	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. (5 Points)	Complete, correct and appropriate. (10 Points)

Functionality (150 points)

Your program must run when tested by course staff to earn these points. If it doesn’t run, then you won’t receive any points. If it crashes, partial credit is still possible based on what it does before crashing.

	Beginning	Developing	Accomplished

Functionality of a previously used output peripheral	More errors/issues than described in “Developing” (0 Points)	Peripheral implementation either doesn’t fully meet the report’s description of functionality or the functionality of the peripheral. (5 Points)	Based on the report, this works as described. And it works in line with the functionality of that peripheral. (10 Points)
Functionality of a new external output peripheral	More errors/issues than described in “Developing” (0 Points)	Peripheral implementation either doesn’t fully meet the report’s description of functionality or the functionality of the peripheral. (10 Points)	Based on the report, this works as described. And it works in line with the functionality of that peripheral. (20 Points)
Functionality of a new input peripheral	More errors/issues than described in “Developing” (0 Points)	Peripheral implementation either doesn’t fully meet the report’s description of functionality or the functionality of the peripheral. (10 Points)	Based on the report, this works as described. And it works in line with the functionality of that peripheral. (20 Points)
Functionality of Watchdog Timer (You can not get points here if you don’t get points for it in the code)	More errors/issues than described in “Developing” (0 Points)	Setup but doesn’t work in a way that makes sense. (5 Points)	Based on the report, this works as described. And it works in line with the functionality of the watchdog. (10 Points)
Functionality of a synchronization technique (You can not get points here if you don’t get points for it in the code)	More errors/issues than described in “Developing” (0 Points)	Minor issues (10 Points)	Part of the system that uses this makes sense and it works considering that. (20 Points)
Functionality of at least 1 direct bitwise driver (You can not get	More errors/issues than described in “Developing” (0 Points)	The thing configured bitwise has no impact. (5 Points)	Elements described as bit wise configured in the code works correctly in the

points here if you don't get points for it in the code)			system. (10 Points)
Functionality of thread/task element. (You can not get points here if you don't get points for it in the code)	More errors/issues than described in "Developing" (0 Points)	The thing configured bitwise has no impact. (5 Points)	Elements described as bit wise configured in the code works correctly in the system. (10 Points)
Functionality of interrupt. (You can not get points here if you don't get points for it in the code)	More errors/issues than described in "Developing" (0 Points)	The thing configured bitwise has no impact. (5 Points)	Elements described as bit wise configured in the code works correctly in the system. (10 Points)
Functionality matches project description and objective.	More errors/issues than described in "Developing" (0 Points)	Some minor deviations in meeting requirements for the project. (15 Points)	Based on the report, this works as described. Also matches the specifications/requirements/constraints for the project. (30 Points)
Functionality- runs forever	No (0 Points)	----------	Yes (10 Points)

Implementation Demo (100 Points)

- Do not show any code during the demo
- If code submitted does not run, you forfeit these points
- Everyone demos individually
- If you don't do this part, there's a 15% penalty on the entire project

	Beginning	Developing	Accomplished
Overview of Project	More errors/issues than described in "Developing" (0 Points)	Incomplete description of the system, application and/or benefit. (2.5 Points)	Explains the point of the project, including: functionality, situation it is designed to help with and how it will help. (5 Points)
Runs	No (0 Points)	----------	Yes (10 Points)
Functionality of a previously used output peripheral	More errors/issues than described in "Developing" (0 Points)	No code shown but errors with what the peripheral is, what it does, and the roll in the system, and then shows it does that. (5 Points)	No code shown. Tells what the peripheral is, what it does, and the roll in the system, and then shows it does that. (10 Points)
Functionality of a new external output peripheral	More errors/issues than described in "Developing" (0 Points)	No code shown but errors with what the peripheral is, what it does, and the roll in the system, and then shows it does that. (10 Points)	No code shown. Tells what the peripheral is, what it does, and the roll in the system, and then shows it does that. (20 Points)
Functionality of a new input peripheral	More errors/issues than described in "Developing" (0 Points)	No code shown but errors with what the peripheral is, what it does, and the roll in the system, and then shows it does that. (10 Points)	No code shown. Tells what the peripheral is, what it does, and the roll in the system, and then shows it does that. (20 Points)

Functionality matches project description and objective	More errors/issues than described in “Developing” (0 Points)	Does not match the project description fully. (15 Points)	Matches completely (30 Points)
Functionality- runs forever	No (0 Points)	----------	Yes (5 Points)