ME 218a Fall 2024: Interactive Elaborate Ethereal Entertainment or, Staying Sane In The Enveloping Nothingness Of Outer Space

Grading Session on November 20 from 1-5 pm.
Project Presentation on November 20 starting at 7:00 pm.
Revision 0: 10/28/24

Goal:

The goal of this project is to provide a framework in which you can apply your knowledge of microcontrollers to provide an enjoyable experience for users and observers.

Purpose:

The underlying purpose of this project is to give you some experience building an electromechanical widget. We expect that this will involve working with sensors, driving actuators, designing event-driven software, and implementing that software in C on a PIC32 microcontroller. We expect to see all of these elements in every solution. Your lab kit contains sensors and several kinds of display, although you are not limited to using only these. You are limited to an expenditure of $120.00 / team *of your own money* for all materials and parts used in the construction of your project. Materials from the lab kit, the Cabinet of Freedom and any consumable supplies do not count against the limit; all other items count at their Market Value.

Background:

After decoding the signal in Lab 4 from the crashed UFO, you now have definitive proof that life does exist outside planet Earth. Because of this proof, you have now been recruited for a task force that will search for this extraterrestrial life. Unfortunately, you don't know how long your team will be searching for this life, and you won't be able to come home until you find it. Life in space is boring; there isn't really much to do. That's where your task comes in. You have been tasked with creating a Space-themed Diversion from Listlessness (SpaDL) for members of the task force to retreat to when the long search gets boring. This should be a fun space-themed game that rejuvenates players' enthusiasm for being in space.

The Task:

Your task is to design and build a Space-themed Diversion from Listlessness (SpaDL), which is a device that provides an entertaining game for task force members exploring space. Which aspect of the space theme you choose to focus on can vary. The part to keep in mind is to include both visual and tactile components in your game as described below. We want the game to be as engaging as possible!

Specifications

Operation:

- ☐ The SpaDLs will power up into a welcoming mode, it should prompt the user to insert **two poker chips** in order to play the game. **Chips must be passed through** and not stored in the machine (this means that your SpaDL needs a coin return tray). The SpaDL should track and indicate the number of coins inserted (up to 2).
- ☐ It should take a player approximately 60 seconds to complete the game with your SpaDL. Even if a player becomes very skilled at such interaction, it should never take less than 30 seconds.
- ☐ To provide the player with a sense of progress toward task completion, each SpaDL should include a creative display of the passage of the time elapsed since starting the game. 7-segment displays don't count.
- ☐ To avoid leaving the game unfinished, each SpaDL should display an error/timeout condition after 20 seconds after the last input from the user. After this, it should reset to the welcoming mode.
- ☐ The game should involve at least 3 distinct interactions with the user and 3 distinct feedback from the SpaDL.

- ☐ When the SpaDL determines that the game is complete, it should provide a clear audio and/or visual indication of such completion. This indication may last no more than 30 seconds before the SpaDL resets to the welcoming mode. If the game has varying degrees of completeness (e.g. number of points scored, etc.), the SpaDL should also display the degree of completeness at this time.
- ☐ The SpaDL should be usable without the guidance of a ME 218 design/applications engineer. Any static instructions must be only in pictorial form (Think IKEA instructions).

Basic Specifications:

- ☐ A team of three or four class members will construct a SpaDL.
- ☐ The SpaDL must have parts that visibly move under the control of the PIC32.
- ☐ While it is permissible to use consumer devices as components in a SpaDL, in order to avoid intellectual property (IP) issues, such devices must be substantially modified before being incorporated into your project. We don't want you to just buy significant portions of your project. If there is any question as to whether or not the purchased component has been modified significantly enough, please see the teaching staff.
- ☐ Each SpaDL must respond to at least **3 distinct inputs/interactions** from the user and provide **3 distinct modes of feedback** to the user
- ☐ At least one of the user interactions must be interpreted as an **analog input** to the PIC32 from the user (such as IR, Joy Stick, Potentiometer, etc.)
- ☐ The analog input must be used to produce some behavior by the SpaDL that makes use of the analog nature of the input. No simple thresholds.
- ☐ Each SpaDL must provide the user with feedback about his/her actions. The feedback can take the form of an expression or gesture that the SpaDL displays. The feedback must include at least one of: haptic/audio/tactile feedback. Multiple modes of feedback, including modes not listed here, are encouraged.
- ☐ At least one of the feedback must be **eletromechanical actuation** (Such as servo, motor, buzzer, fan etc)
- ☐ At least one of the user interactions **must involve non-contact sensing**. (Such as IR or Audio etc)
- ☐ The SpaDL must require the user to insert two coins to start the game. Coins must be passed through. It must track and display the number of coins inserted. **Coin insertion counts as one of the inputs/interactions, and counting coins may count as a feedback**
- ☐ Interactions that involve cumulative action (e.g. counting repetitions over a set time period) are encouraged.
- ☐ The complete SpaDL must be a self contained entity, capable of meeting all specifications while connected only to the provided project power supply.
- ☐ Due to limited space inside the spacecraft, all components of the SpaDL MUST fit into a total volume no more than 50 cm wide by 50 cm deep by 100 cm high. During operation, the SpaDL should not require user input from more than 75 cm away from any part of the SpaDL. Two teams' SpaDLs must both be usable while sitting together on one of the 1.5 m wide tables in our classroom (550-200). The entire SpaDL must be easily and safely moved from the SPDL to the grading session and then to the trade gallery (i.e., to the 550 Atrium) for evaluation. Make sure that you plan for this.
- ☐ The emphasis in the project is on robust electronics, software and mechanical systems built with real craftsmanship. Paint alone does not add to either functionality or craftsmanship. This is not to say that you may not decorate the machine, but simply that it should not become a focus. Any painting that is done near the SPDL must be done using appropriate masking so that no paint residue is left on the building, furniture, sidewalk, driveways, grass, or trees. No painting in the SPDL! And no glitter!

- ☐ While it is normally not a good practice, the finished circuitry may be constructed on your solderless breadboards. This has been done to allow you the maximum time to spend on your project, without having to learn electronic prototyping techniques as well. Be sure to secure the bread-board and connections so that they will not be disturbed during turbulence, take-off, landing or the moving process.
- ☐ Accurate schematics and state diagrams are such a useful aid in debugging that you should be prepared to show your up-to-date schematic or state diagram to any coach or TA whenever you ask them for help on your project.

Safety & Hygiene:

- ☐ The SpaDLs must be safe for both users and spectators.
- ☐ No glitter!
- ☐ Be considerate of your neighbors in the lab when debugging any audio output; use headphones.
- ☐ There is a strict ban on toxic materials. This prohibition includes Volatile Organic Compounds (VOCs) (i.e. hydrocarbon based spray paints or other noxious fumes). This prohibition also includes while you are working on the SpaDL in the SPDL.
- ☐ No painting in the SPDL (or anything attached to the SPDL).
- ☐ No part of the SpaDLs may become ballistic unless completely constrained within the SpaDL.
- ☐ No pyrotechnics or fire of any kind! Be advised that smoke contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.
- ☐ If the SpaDLs contain any liquids, they may not be conductive (with the exception of water) or corrosive, and MUST be packaged in a fail-safe manner while always being shaken, not stirred.
- ☐ The use of gremlins in you project is ferby-dden.

Checkpoints

Design Review:

During the day on **11/4/24** in room 162 of the Peterson building (our classroom building) we will conduct design reviews. Signups for the hour-long slots for 3 teams will happen via a Google Sheet. Each group should prepare a few **simple** PowerPoint slides (scans of sketches are OK). **No code, no state diagrams, no circuits.** The slides should show your concepts, a preliminary event list with responses, and a list of how you are going to meet the user interface requirements along with the feedback from the meeting with your coach. One member of the team must bring a laptop and any necessary adapters to produce a VGA or HDMI video signal to connect to the screen for your presentation. You will present these to other members of the class, members of the teaching staff and coaches (crewmates) so that all may hear about your ideas and provide feedback and advice. At this time you will be required to identify the core functionality of your proposed design and how it meets the interaction requirements.

First Checkpoint:

On or before **11/6/24**, you must submit a schematic of at least the core functionality initially identified on **11/4/24** and a refined set of events with details on the responses. Modifications to the core functionality may take place up to this point. A KiCad schematic within a word document describing your core functionality should be uploaded to Gradescope. Only one team member needs to submit your checkpoint documentation.

Second Checkpoint:

On or before **11/13/24** you will be required to demonstrate a minimal level of function:

1. The hardware & software necessary to do each of the following:
   (a) sense inputs (at least 3 user inputs)

   (b) make decisions (state machine with at least 3 states driven by keyboard input)
   (c) implement electromechanical actuation and user feedback
2. Submission of a KiCad schematic of your circuit will also be required.

Third Checkpoint:

On **11/19/24** you will be required to demonstrate integrated functionality of all sensing inputs, plus software and timing, plus activating all actuators that will be required. In other words, everything should be complete with the exception of improvements in user experience and fit, finish, and appearance.

Grading Session:

On **11/20/24** from **1:00 pm** to **5:00 pm** you will be required to demonstrate your fully integrated and finished machine.

Public Presentation:

This will take place on **11/20/24** starting at **7:00 pm** in the Atrium of Building 550. At this event, members of the public will be encouraged to act as a listless space explorer, and will interact with your SpaDLs in hopes of being rejuvenated.

Report:

Draft due on **12/2/24** by **4:00 pm**. The final version (with revisions incorporated) is due by **5:00 pm** on **12/6/24**.

Evaluation

Performance Testing Procedures:

All SpaDLs will be tested by a demonstration, performed by a team member, that should show all of the possible user interactions.

Grading Session Presentation:

Each team should prepare a 30 second (no more) presentation to introduce their SpaDL. This presentation should highlight the unique features of the design, not the circuit or software details. As an example, think back to the xylophone descriptions that were played on the first day of class. You will be setting up your SpaDL, one at a time, and delivering your presentation in room 202 Thornton between 1:00 pm & 5:00 pm on the day of the presentations. During this time each team and their SpaDL will be photographed. Starting at 5:00 pm you will move your SpaDL into the Atrium for the public presentation, which will begin at 7:00 pm.

Grading Criteria:

- ☐ **Concept (20 %)** This will be based on the technical merit of the design and coding of your project. Included in this grade will be evaluation of the appropriateness of the solution, as well as innovative hardware, software and use of physical principles in the solution.
- ☐ **Implementation (20 %)** This will be based on the prototype displayed at the evaluation session. Included in this grade will be evaluation of the physical appearance of the prototype and quality of construction. We will concentrate heavily on craftsmanship and finished appearance.
- ☐ **Performance (40 %)** Half of this (20 %) will be based on the results of the checkpoints, the other half will be based on the results of the performance testing during the evaluation session. Full performance credit will be given only if the machine works on the first attempt during the grading session. Performance will be judged first on the ability to demonstrate the core functionality and second on any embellishments to the core functionality. **To earn the performance points, you must demonstrate at least the core functionality.**

- ☐ **Report (10 %)** Preliminary project reports are due **12/2/24** at **4:00 pm**. The report should be in the form of a stand-alone web site and must include schematics, pseudo-code, header & code listings, dimensioned sketches/drawings showing relative scale, a complete Bill-of-Materials (BOM) for the project as well as a 1 page description of function and a "Gems of Wisdom for future generations of 218ers" page. The actual website must be hosted and you must submit the URL to your site in the specified spreadsheet. It is critical that the URL to your report be in the spreadsheet on time so that the peer reviewing team will have an adequate opportunity to review it before class the following day. Final versions of the reports, incorporating the review comments are due by **5:00 pm** on **12/6/24**.
- ☐ **Report Review (10 %)** These points will be awarded based on the thoroughness of your review of your partner team's report. Read the explanations, do they make sense? Review the circuits, do they look like they should work? Could this project realistically be built for $120? If, during grading, we find things that don't make sense or circuits that won't work we will consult your review. If the review caught them, then the team will lose points on their report. If the reviewers missed it, then they will lose points for their review. The report review should be submitted on Gradescope by **5:00 pm** on **12/6/24**.

Resources

Websites:

SparkFun (www.sparkfun.com)
Jameco (www.jameco.com)
Newark (www.newark.com)
Adafruit (www.adafruit.com)
Digi-Key (www.digikey.com)
HobbyKing (www.hobbyking.com)
Seeed Studio (www.seeedstudio.com)
Mouser (www.mouser.com)
Ponoko (www.ponoko.com)
Hackaday (www.hackaday.com)
McMaster-Carr (www.mcmaster.com)
ServoCity (www.servocity.com)

You may also find PlantUML and PlantText helpful for creating diagrams of various types.

Local Stores:

Anchor Electronics in Santa Clara
Sheldon's Hobbies in San Jose
Jameco in Belmont
TAP Plastics in San Mateo

Gems of Wisdom:

Be sure to check out The ME218 Archive for guidance from past generations.

Revision History

Revision 0: Initial version. (10/28/24)