Electronics (Engn/Phys 208) Final Project Report Guidelines

Winter 2021

LIVE PRESENTATION AND DEMONSTRATION

(2.30 - 4.00 pm, Thursday, April 08, 2021)

Each team will present an overview of their design and do a live demonstration. Each of 5 teams will have the floor for approximately 15 min total (nominally, 10 min presentation and demonstration + 5 min for questions). The presentation should cover in succinct format the same 4 main pillars described below for the written report (1. Problem Statement; 2. System Design; 3. Performance and Test Results; 4. Discussion). The presentation should also include a live demo (or video) showcasing your project's state of the art. The order/schedule is TBD.

WRITTEN REPORT

(Due: 11.59 pm Tuesday, April 13, 2021)

Each project group will submit a *single* written report to a folder on box. Please make the final name obvious (e.g. ElectronicsFinalReport_SwimStrokecounter.pdf). See also *What to Submit: Checklist* below. You are invited (read: strongly encouraged) to submit a rough draft for review and feedback anytime up until Apr 06, 2021 (this will leave sufficient time for the instructor to read it and provide feedback, as well as the project team to incorporate feedback).

Formatting:

Double space all text. Figures and tables should be numbered successively with captions (use right click > Insert Caption…). Place figures and tables on their own lines, NO text wrapping. Number/Label each section per subject heading described below.

Style/Target Audience:

The final report should be written targeted for an audience competent with basic Engineering and Electronics principles. The prose/style is flexible, so long as it clearly, concisely, and accurately communicates the following detailed in I thru IV below.

I. INTRODUCTION/PROBLEM STATEMENT

What are you building and why? What is the real world application of your electronics-based system?

II. SYSTEM DESIGN

a. **System Overview**:

i. **Photo of Completed Prototype**: This may include electronics as well as any other mechanical components. Annotate the photo with text arrows, as appropriate. This helps guide the reader's eye to important aspects of the device and design.

ii. **Theory of operation** "block diagram" level: the overarching big picture how multiple components (microcontroller, motors, pumps, touch screens, etc.) work together to achieve the project aim. Be sure to include the actual block diagram as a figure in your final report.

iii. **User interaction**: How does the user control and/or interact with the system? How does the user get information from the system? Or start-up the system (e.g. how does one rock up to the Puck Buddy Air Hockey Table and tell it 'game on!'?)

iv. Sample writing: In this section, you might have sentences something to the effect of "*Our system uses an orientation sensor that measures 3-axes of linear acceleration plus 3-axes of rotational velocity. It is interfaced to a Teensy 3.6 microcontroller using I2C. In order to compute the number of stim strokes, we programmed the Teensy to compute {overview description signal processing routine here}. The user communicates with the system via {describe Bluetooth connection or similar}. For waterproofing, the system is mounted inside of a watertight case {insert model number}. In practice, the swimmer wears it on the wrist fasted with _______. The swimmer can view swim stroke counts updated every 30 s on their mobile device paired via Bluetooth.*"

b. **Technical Details: Component Selection, System Integration, and Algorithms:** This section should fill in the details of the system overview.

i. **System Integration: Schematic & Wiring List**. Develop a schematic indicating how all components are integrated into a coherent working system. Recommended strategies are to use an online schematic editor (e.g. Digikey schemeit) and/or grab photos of your components from sparkfun/adafruit/etc, import to powerpoint, use autoshape lines/wires to show wiring connections.

ii. **Wiring list/table**: This specifies which pins are connected together on two devices. These need to be included only if your schematic does not already clearly indicate all connections between components For example:

Neopixel 12-LED ring	Adafruit Feather 32u4
5V DC power	+5V
GND	GND
Data Input	D6 (digital output)
Data Output	N/C (no connection)
Pulse Sensor amped	
+5V	+5V
GND	GND
Analog signal	A1 (analog input)

iii. **Hardware component selection rationale**: What is the rationale for each hardware component selected? What is rationale for each software package, if applicable (e.g. OpenCV to process puck position vs. time)? For instance, if your system required a temperature sensor, there are many choices out there—why did you choose the one you did? Ditto for the microcontroller/computer boards (e.g. Feather 32u4 vs. Arduino Uno3 vs. RasPi). Briefly justify rationale for *each* component in the system. For instance, "*We selected the Adafruit Feather 32u4 BLE development board because its small form factor (dimension go here) make it comfortable to wear by end-user. Additionally, it offers analog input for measuring heart beat, I2C for measuring temperature, and digital output to control the neopixel ring dispaly. Additionally, the on-board lipo battery power supply makes it especially well-suited for a human wearables. Finally, the board is compatible with the Arduino IDE making it easy to program.*"

iv. Bill of Materials and Cost Estimate: Make a detailed list (Excel Table format) of all parts used (electronics and mechanical) in your final design. Column heading should include: Description | Part Number | Vendor| Quantity

|Cost. Yes, you can and should copy and paste, revising as needed, from your BoM submission earlier in the term! In short, provide enough information that someone wishing to replicate your project knows exactly which parts to order and how much to anticipate in terms of monetary expense.

III. PERFORMANCE TESTS AND RESULTS

This purpose of this section is to establish proof-of-concept that your system works as intended, and/or examine and quantify any limitations thereof. You should establish that the system functions as intended. To this end, include details regarding:

a. **Testing/evaluation procedures**. How exactly did you evaluate the system, what were your procedures for doing so, what did you measure/quantify?
   For example: *"To test our soil moisture monitor, we added 1 TBSP of tap water incrementally to initially dry soil. We recorded the soil moisture readings at each step. This process was repeated 3 times. The results are summarized in figure 3, which show a _____ relationship between sensor reading and total volume of water added. In practice, we quantified "too dry" as a reading < __________ (units). "just right" between____ and ____ , and "too wet" as > _________. "*

   As another example, you might have something like: "*We used openCV to track puck trajectory vs. time. We analyzed 2 second intervals of video captured by the RasPi camera frame-by-frame. In each video the puck is hit toward the robot-arm end of the air hockey table. The puck position determined by openCV was highlighted as a bright green circle and the puck velocity vector is indicated by the red arrow (see Figure 4). Moving frame-by-frame, a human observer identified the number of frames with a good estimate vs. an obviously erroneous one. Simultaneously, we displayed the motor commands to move the robot's air hockey paddle to a position that should block the puck. Similarly, a human observer verified whether the command was sensible or not. We repeated this procedure for 10 different videos, each with 10 different puck trajectories. Overall, we quantified the percentage of frames for which openCV algorithms implemented properly estimated the puck motion leading to a proper movement of the robot paddle."*

b. **Results and interpretation:** What were the outcomes of your testing? How do you interpret those? Does your system work as intended? If not, what limitations/shortcoming do you note? For example, you might have something like:

"We noted that the biomedical mood bracelet performed satisfactorily on 4 out of 5 human subjects (product testers). The coloration and LED display scheme was clearly correlated to heart rate (y = mx+b, R^2 = 0.82). As illustrated in figure 5, the number of lights illuminated red was clearly correlated to the subject's heart rate over a 10 min testing period. However, the dynamic range of the light display was not as tightly correlated (R^2 = 0.3) , thus not as easy to control, based on skin surface temperature."

c. **Short video demonstration**: This should be an approximately 1-2 min video showing your wonderful Electronics project in action (to impress and inspire future generations of Electronics students)! Provide a brief text description and/or annotations within the video to clue in the viewer to the important aspects---guide their eye and mind. For instance, *"Our demo video shows the mood bracelet changing color as the subject's heart rate decreases from 180 bpm (just after intense exercise) to 60 bpm (resting heart rate). Note the change in color from red to blue and the number of illuminatedLEDs changes from 12 to 4."*

IV. DISCUSSION:

This section should critique how well did your final product met the design objectives outlined in the Introduction/Problem Statement. Highlight design aspects which were particularly nice (go ahead, toot your own horn, you deserve to!) Also, remark upon any features which could be improved (there are always aspects that could be modified, improved, added, etc.). Make specific suggestions of future work and improvement. For example: *"The hydroponic gardening system was shown to accurately measure electrical conductivity and pH over a 3 day testing period. Additionally, using the relatively simple control algorithm, the pH was controlled to 7.2 +/- 0.1 during a 24 hour testing period. This precision should be beneficial for plant growth (target pH = 7.3) and reduce the risk of acidification. The control algorithm could be improved by __________. It should also be noted the motor/pump selection was limited at this time. The flow rate of the current model is ____ L/hr, which is plenty sufficient though unnecessarily high, making it difficult to finely control the amount of electrolyte added to the hydroponic garden system. In the long run, this system will prove useful for _________."*

WHAT TO SUBMIT: CHECKLIST

Please be sure to verify you submit all of the following context in electronic format. All materials should be the corresponding box subfolder here (with your team name). Please return all unused hardware components must be returned to the instructor. Upon consultation/approval from the instructor, you may take part or all of your project home with you!

- ✓ Live presentation materials (powerpoint slides, vidoes, etc)
- ✓ Final written report in .docx or .pdf format
- ✓ Live demo/walk-through video
- ✓ All code for Arduino, RasPi, etc. Please submit native file formats—e.g., .ino and .py (not copied and pasted text)
- ✓ All unused hardware + mechanical components returned to instructor
- ✓ Brief statement that your lab station/project space is thoroughly cleaned up, all parts put back in proper location. Thank you in advance for contribution in minimizing entropy in the universe!

GRADING SCHEME and CRITERIA

The final report (live presentation + written) counts for 60% of your total grade in the course (per course syllabus).

Grading will be based on the following criteria:

- Is design based on proper electronics principles?
- Is design properly implemented?
- Is design fully documented and described in rigorous and beautiful detail? Has full justification for design been provided, demonstrating mastery of electronics knowledge?
- Was the system properly tested to evaluate overall performance?
- Does a cogent narrative discuss the pros and cons (benefits and limitations) of the current design, and offer suggestions for how to improve the system?

The final report grading scheme will be as follows:

1. The final report will be assigned an overall grade; 100 point is the maximum possible score.

2. The total number of points to be distributed amongst your group members is equal to Final Report Points x Number of Group Members.

3. ***Each group must submit a joint statement of each group member's contributions (including your own) and apportion the points as deemed fit***. For example, let's say you write an awesome report which receives a score of 100. If you all agree you did an equal amount of work, everyone gets a 100, hooray! Another example: Let's say one group member was really outstanding and went out of his/her way to make the project really happen. You might decide to award them a bonus 10 points, sacrificing 10 points from other team member, so the scores would be 110 and 90, respectively. If the final report of this group had received a score of, say, 90, then the final points awarded to each student would be 90 and 90 or 100 and 90, respectively, for the examples above.