Student Handout

APSC 150 Project: Remotely Controlled Satellite Launcher Design [Feb.2015]

Summary

Through the course of 4 lab components (Lab 2-2, 2-3, 2-4, and 2-5) you will be given the opportunity to work as a group designing and building a remotely controlled satellite launcher device. During the course of these labs you will have the opportunity to learn to form sheet metal with hand tools, perform simple electronic commands with a microcontroller, and go through a structured design process. After the final lab, your groups will be given an opportunity to justify your design choices, and compete against other students in the robotic satellite launcher for a prize. This final presentation / demonstration will take place instead of a quiz for this case study II.

Goal

To have a functional prototype built after a series of 4 labs to compete in the remotely controlled satellite launcher competition and poster presentation session. This will be a competition in which total of 8 satellites are launched into 4 different orbits.

Properly documenting and presenting the procedure leading up to a functional prototype in the poster session is an essential part of this project. Groups will be expected to record their ideas, choices, and iterations of project ideas to present in the form of a poster presentation on the competition day (3 March, 2015). While the shot-put competition is to be for a prize, the marking will come from the poster presentation session and peer review process.

Method

All students will participate in the following steps to complete the project:

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1. **Lecture Components**: The lecturer for this course will go over the design cycle, proper design procedures and practices, as well as additional project information as the course progresses. Please attend the lectures.
2. **Lab component 1 (Lab2-2: Build Your Launcher Undercarriage):** During this lab you will learn how to use hand tools to work with sheet metal and (working in pairs) build your launcher undercarriage. This unit won't be able to move until you add Arduino control to it in lab component 2, but this lab will give you an idea of what you can accomplish with the tools available. After building this undercarriage, teams (of 8 students = one row of 4 workbenches) will brainstorm project ideas, and come up with a minimum of 3 potential prototype design ideas.
3. **Lab component 2 (Lab 2-3: Motorize Your Launch Platform):** During this lab you will learn about simple electronic components, and how to use the Arduino microcontroller to operate them. After learning how to use the Arduino, groups will be able to motorize their launcher platforms so that they are able to aim up and down, and rotate through a range of motion. For the last 45 minutes of this lab, groups of 8 will have to choose 2 of their initial project ideas. Groups of 8 will then split up into teams of 4 to fully design and specify each selected project idea. This stage will determine how easy your final lab day is. The more an idea is specified, generally the easier it is to put together and test quickly.
4. **Lab component 3 (Lab 2-4: Build Your Prototypes):** During this lab each team of 4 will be given an hour and 50 minutes to complete building and some may have enough time to test their prototypes.
5. **Lab component 4 (Lab 2-5: Complete Your Prototypes and Testing for Performance Evaluation):** This time, groups will come back together to their original 8 to reflect on each prototype. Each group will have to choose only 1 prototype to bring to the presentation night. *An analysis exercise might be introduced into this section of the lab as an opportunity for bonus marks.*
6. **Case II Quiz night (3rd March 2015):** Students will participate in a poster gallery walk where they will create a poster and have a chance to take part in some peer review. Evaluators will also come by to ask questions of students, and the students will submit their poster, done in a power point format, as a final report for this project. Following the gallery walk, there will be a demonstration of final launchers in a competition format. Students will have 8 satellites to launch, for 4 different obits. Prizes (which will be determined by the time of

demonstration event) will be awarded for the "best" designs.

Specifications

The robotic satellite launcher is a competition in which small “satellite” will be launched with minimal force. The best designs will transfer energy in the most efficient manner to precisely send the satellite into specific “orbits”. While building the "launcher mechanism" component of your launcher the following rules must be adhered to:

- Students must only use the materials made available to them in the lab. No more than 4 pieces of new sheet metal per team (plus 4 sheet-equivalent amount of sheet metal from the recycle bins at the back of the room) and six elastic bands per launcher should be used.
- The launcher mechanism must have a system for holding the satellite in a "ready to launch" state without being held by a student. This can be in the form of a quick release, a trigger, a latch etc.
  (This is one of the most important components to design well)
- The launcher mechanism must be able to launch multiple times without breaking.
- The launcher should not be touched when launching. It is allowed to tape the launcher to the table (or tray) during launches.
- If a counter-weight is needed, any material that will not in any other way enhance the design can be used.

Measurement Judging

When measuring projectile distances the following will be considered:

- For each elastic added after the first, ½ point will be taken off of the final score.
- If units get touched during launches (other than for resetting the launcher), ½ point will be taken off from the final score.
- The accuracy will be announced on the final day, so it will be necessary to know how to properly adjust your robots for given distances before hand.

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Poster Presentation

Instead of a final examination in this module, students will participate in a poster gallery walk and a demonstration of their final products.

The poster will consist of each group's design process and the justification for their choices moving forward. This will be in the form of a PowerPoint presentation that is printed out and attached on a poster board. During the gallery walk each group of students will be assigned to evaluate 2 other groups, and there will also be instructors walking around to check on presentations. This PowerPoint presentation will also be electronically submitted in for a final evaluation.

After/before the gallery walk there will be a demonstration of each group's final product. During this demonstration students will line up to show off their satellite launcher's capability to launch the satellites into various obits. This demonstration will not be for marks, but there will be a prize awarded for the group who does the best in the competition.

When creating posters for presentation the following information must be included:

- Initial brainstormed ideas (pictures if possible)
- Ideas carried through to the design in full phase with justification for choice
- Iterations of the building phase if the design did not work perfectly the first time
- Prototype decided on for final showcase with justification
- Speculation on:
  -How group size affected the project.
  -How the team functioned together.
  -Why it might be good to sometimes take 2 designs all the way through prototyping and testing **(usually 1 is standard)**
- Detailed analysis of final launcher according to expectations set by professor.

Have fun!

Appendix – List of materials you could use for two launchers for the team:

- 6 x 2 elastic bands

- 1 m of strings

- 4 pieces of sheet metal plus 4 sheet-equivalent of recycled metals from recycle bins

- 1 roll of electric tape

- Pop rivets

- 2 cardboard fast-food style “fries” containers

- 20 cm of black plastic rod and tubing for joints and hinges

- 4 satellites (aka corks) for testing