CS Capstone Progress Report

December 3, 2017

NASA University Student Launch Initiative

Prepared for

Mechanical Engineering, Oregon State University NASA

Dr. Nancy Squires

Prepared by

Group 33
Code Monkeys in Space

Mark Bereza
Joseph Struth
Kevin Turkington

Abstract

This document serves as a retrospective of all work done to the website, avionics DLM, and rover over the fall term.

CONTENTS

1 Purposes and Goals

Overall, the goals of this competition are the following:

1) Construct and launch a rocket carrying a payload at least a mile (5,280 feet) above ground.
2) Have the rocket deploy a parachute and safely land within 2,500 feet of the launch point.
3) After landing and after a button press, deploy a rover.
4) Have the rover drive autonomously at least 5 feet away from the rocket landing site.
5) Have the rover deploy solar cells after being at least 5 feet from the landing site.
6) The solar cells will increase in surface area after deployment (unfold).
7) Create formal technical reports regarding rocket/payload design and present them to a NASA review panel during several formal design review meetings.
8) Participate in educational outreach and get at least 200 individuals involved in the project.
9) Maintain a website detailing project information and hosting all competition deliverables. The subset of these overall goals that pertain to the CS capstone students involves the research, design, implementation.

In particular, the CS seniors on the OSU USLI team, otherwise known as Code Monkeys in Space, are responsible for goal 9, their shares of goals 7 and 8, and the software needed to facilitate goals 4 and 5. Furthermore, Code Monkeys in Space are responsible for the design and implementation of software that will run on a data logging module inside every test launch vehicle for the purposes of data collection, which indirectly assist with goals 1 and 2. Thus, the scope of this project for Code Monkeys in Space is limited to these facets of the competition. The others will be handled by the mechanical and electrical engineering seniors on the team. If every subteam successfully completes their responsbilities in a timely, complete, and safe manner, the team as a whole will accomplish the overall goal of scoring well in this competition.

2 Progress Thus Far

2.1 General

Preliminary Design Review score sheets are in; OSU USLI team finished in the top 20% in the competition which equates to 11th out of 50 teams! This result is very good for a first year rookie team. CS Team members contributed to the 200 page document by writing the verification plan, creating the website to post deliverables, and writing the software design section.

2.2 Educational Outreach

The team as a whole conducted three educational outreach events, with Code Monkeys in Space participating in two of these three events. The team as a whole has already exceeded the education outreach minimum requirement of 200 students with plenty of time to go before the competition's conclusion.

- Silver Crest School (K8) - The team hosted over 35 eighth-graders here at OSU. Together, the team members and the middle school students built and launched model rockets (A-motors) on the OSU campus after a presentation about rocketry. Additionally, the team provided a tour of the local AIAA chapter lab space.
- Philomath Middle School (K6-7) - A science classroom of over 30 sixth- and seventh-graders was given a presentation about rocketry and STEM at OSU. Additionally, the team conducted a Q&A session and decorated and launched model rockets!

- Sprague High School (K9-12) - To over 200 high schoolers, over the course of four class periods, the USLI team conducted electrical and magnetic science experiments. The team also gave a presentation about rocketry and STEM at OSU. Finally, model rockets were decorated and launched.

2.3 Rover

First, the team decided which microcontroller, operating system, software framework, and programming language were the best choices for software development for the rover researching several alternatives for each category. After deciding on a Raspberry Pi running Raspbian and ROS with code written in C++/Python, Raspbian was installed on a Raspberry Pi and connected to internet via a subdomain of the domain name used for the team website. Additionally, ROS was installed on the Pi and accounts were made for every team member planning to work on the rover software. Said team members also completed some Robot Operating System tutorials for practice. Finally, Code Monkeys in Space start creating some basic hardware-independent simulations of the rover's movement in ROS.

2.4 Avionics

The team researched and selected the Adafruit Python IO Library made for the BeagleBone Black micorcontller which supports GPIO, PWM, ADC, I2C, SPI, and UART serial communication. Additionally, the development plan was created, which starts with getting reading/storing data to work one sensor at a time and integrate more as they arrive and as funding allows. Overall, the Data Logging Module is on track to be ready for sub scale launch before the Critical Design Review.

2.5 Website

The osuusli.com domain name was purchased and the team website (hosted via GitHub.io on the team's repository) was made accessible to the public via this url. USLI team information and useful links wer also made available via a sidebar on the website. Final Website designs were also implemented to meet NASA and competition requirements. Most recently, the project proposal and the PDR document, presentation, and flysheet were posted on the team website and made available for both online viewing and download. Beyond that, slight aesthetic improvements were made to the website along the way, including reorganizing the textbox layout for team member emails and making the team name appear more clearly against the various background images.

3 Stumbling Blocks and Solutions

3.1 General

- Problem: From our Preliminary Design Review (PDR), we received only 40% of the total possible points for the safety category.
  - Solution: We increased focus on safety by all team members, and began to rewrite environmental safety bullet points in document (as we had previously misunderstood the expectations).
- Problem: Underclassmen leaving or losing interest in the USLI competition as a result of this term being almost entirely composed of designing, documentation, and planning.
  - Solution: Now that parts have arrived and more hands-on work is available, we can begin trying to reach out to underclassmen again and promise them more fun work to do than simply attending design meetings.

3.2 Rover

- Problem: Robotics Operating System (ROS) learning curve is greater than anticipated.
  - Solution: Work on simulations, using other team members' ROS simulation code from their robotics class as a starting point.
- Problem: Serious development delayed until the rover testbed was completed.
  - Solution: Testbed finished at the end of November. Development proceeded using hardware-independent ROS simulations until then.

3.3 Avionics

- Problem: Lack of initial funding prevented expensive data sensors from being ordered sooner.
  - Solution: NASA funding grant approved on 11/28/17, parts were ordered soon after.
- Problem: Sensors to be used in the Data Logging Module were unknown, which hindered development.
  - Solution: Sensor decisions finalized by avionics subteam lead and Code Monkeys in Space on 11/03/17.
- Problem: Development on the Data Logging Module bottlenecked by lack of hardware.
  - Solution: Started research on serial communication libraries until sensors arrived.

3.4 Website

- Problem: Details for expected features and website design were unknown and changed frequently.
  - Solution: Discussed desired website layout with team leads during October and the design was finalized before the PDR was due in November.
- Problem: Difficulties in making web development work available to underclassmen USLI team members.
  - Solution: Github issues were created to help organize and delegate desired work.

4 Weekly Worklog

Week	Work Done	Problems Encountered
1	• Created tutorial for Git workflow. • GitHub repositories setup for team. • Joined team Google Drive, Slack, and Trello. • Research Raspberry Pi performance/hardware limitations.	• Desired GitHub organization and permissions unclear. • Team existed for weeks before CS members joined, so CS members had to play catchup.
2	• Raspberry Pi 3 selected as microcontroller. • Presented tutorial on Git workflow. • Started work on team website. • Signed up for outreach event. • Filled out Media Release Forms for NASA. • Purchased osuusli.com domain name.	• Don't yet have access to Raspberry Pi.
3	• Finished Problem Statement rough draft.. • Attended NASA kickoff teleconference. • Attended tour of Blue Origin. • Attended PDR review session w/ Dr. Squires and John Lindal.	• Potentially antagonistic volunteer joined team.
4	• Reserved room for CS-specific team meetings. • Onboarding of underclassmen and exchange of contact info. • Setup ROS on Raspberry Pi, started tutorials. • Finished Problem Statement final draft. • Created high level state diagram for rover movement. • Began discussion of data logger requirements/design.	• Many of the underclassmen unfamiliar with software tools. • Scheduling a CS meeting time that works for everyone.
5	• Defined what sensors will be used in the DLM. • Prebuilt rocket parts for educational outreach activity. • Educational outreach activity w/ Silver Crest students. • Wrote software section of PDR document.	• Hard to write code for rover/DLM without hardware prototypes.
6	• Finished writing/editing PDR document. • Finished Requirements Document. • Posted competition deliverables on website.	• Delay on shipping of rover/DLM parts. • Many parts not ordered due to lack of funds.
7	• Finished high level design of rover movement algorithm. • Finished technology review rough drafts. • Contacted Sprague High School about educational outreach.	• None.
8	• Gave PDR presentation to NASA judges. • Completed technology review final drafts. • Attended ROS tutorial session. • Researched sensors and Python IO libraries for DLM.	• Low turnout of CS underclassmen.
9	• Completed Design Document rough draft. • Educational outreach w/ Philomath Middle School. • Started work on ROS simulations for rover movement.	• Mark gone this week.
10	• Finished Design Document final draft. • Created progress report slides. • Recorded voiceover for progress report slides.	• Initially recorded video in front of projection of slides instead of screen capture.

5 RETROSPECTIVE

Positives	Deltas	Actions
• Successfully qualified for the comptetion. • Scored in the top 20% of teams for the PDR despite being a rookie team. • Already completed website for the competition on our custom domain name. • Educational outreach requirements for competition already met, with many more activities planned for future months. • At least two dedicated CS underclassmen will be assisting us with software going forward. • Won over $10,000 for the project via Space Grant. • Got to attend tour of Blue Origin. • All capstone writing assignments completed on time.	• Safety scoring needs to improve for CDR and FRR. • Need method to test rover code directly and regularly on target hardware. • Get more underclassmen involved with the project. • Team needs social media presence. • Rover needs to move based on sensor input. • DLM needs to record in-flight data from sensors during test flights. • CS team members need to help more with educational outreach.	• Consultation with the safety officer will be done before working with any potentially dangerous hardware. • Test playpen will be created for rover with webcam to allow for remote development and testing. • Once more hands-on work is available, team will advertise competiton participation to peers. • Social media integration (Twitter or Facebook) will be added to the team website. • Movement and sensors communication modules will be created in ROS. • Python code will be written for DLM that will write sensor data during flight. • Code Monkey in Space will particiapte in at least one more educational outreach activity.