DemoSat Final Report Fall 2020

Modeling Vertical Velocity

Brooke Olsson, ACC

January 4, 2021

Mission Overview

The main goal of the mission was to create a payload that would record temperature, pressure, humidity, direction, and acceleration. The aim was to have the payload be able to record this data for the duration of the flight. The next goal was to analyze the data collected using a java program designed to return a linear regression line which would allow me to graph the flight path of the payload.

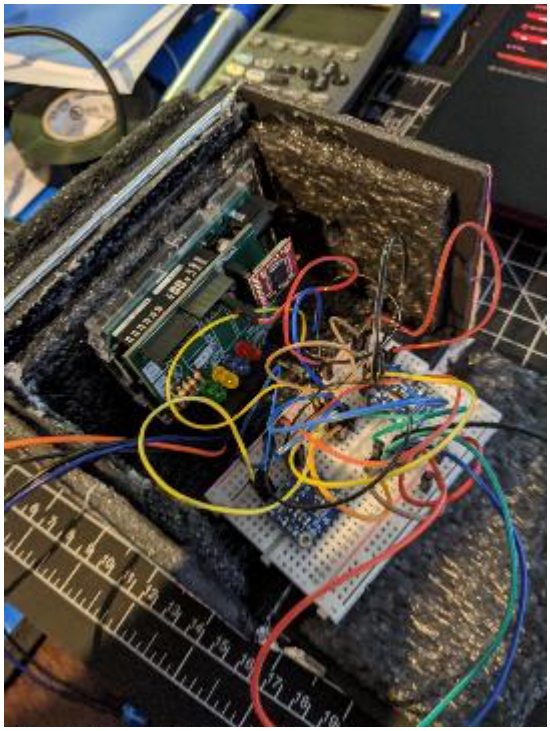
Requirements Flow Down

The primary requirement was to design a payload that has the ability to record data for the duration of the payload flight. I had to assemble sensors and ensure that they all recorded data accurately and would continue to do so for the entire flight.

The secondary requirement was to design a java program that could analyze the collected data.

Design

From when the payload is powered on, the sensors will start collecting data which will be stored on an SD card all attached to an Arduino. The payload will collect data every 15 seconds and save this data on the SD card to be analyzed after the flight**.** Once the payload is retrieved, it will be turned off at which point it will stop collecting data**.**



Schedule

My original schedule was as follows. Slight changes were made depending on the week.

- **Week of Sept 21**

PDR

Get Supplies

- **Week of Sept 28**

Assemble Sensors and Arduino

- **Week of Oct 5**

Assemble Payload

Prepare for CDR

- **Week of Oct 12**

Complete code for Arduino

Finalize equations

Critical Design Review

- **Week of Oct 19**

Do Tests

Tie up Lose End

- **Week of Oct 26**

Tests

Prepare for Launch Readiness Review

- **Week of Oct 19**

Assemble Arduino and sensors

Program Arduino

Prepare for LRR

- **Week of Oct 26**

Finalize payload construction

Run Tests

- **Week of Nov 2**

Finish Tests

Prepare for launch

- **Nov 7**

Launch

Budget

I spent $180.68 out of a $500 budget.

Tests and Results

I did not have time to run tests prior to launch other than a basic bench test to ensure that the payload ran and recorded data. When running this bench test, I found that the payload ran properly and appeared to record accurate data. I did not do the bench test with the hand warmer.

I have explained my post-launch tests in the Results, Analysis, and Conclusion section of this report.

Expected Results

I expected to collect data regarding acceleration and direction, temperature, pressure, and humidity.

I data collected for acceleration and direction would allow me to calculate the flight path of the payload. I expected to see the payload accelerate upwards and then reach a terminal velocity at some point and stop accelerating. I expected to see the payload reach up to 32,000 m and knew that it would not be an exactly straight path depending on wind patterns that day. Once the payload reached its maximum height and began its decent, I expected to see the payload accelerate again until it hit terminal velocity.

I expected my temperature to read from 5˚C down to – 45˚C.

I expected the pressure to read in the range of 101325 Pa to 1116.951 Pa.

I expected to see humidity reading in the begin around 30% and increase as it approached the dew point rising possibly up to 100% depending on the weather that day. After that point I expected to see the humidity decrease at it continued to rise. I would expect the reverse to happen on the decent beginning with very low humidity and increasing at it reaches the dew point and then decreasing again back to around 30%.

Launch and Recovery

The payload was finished the day before flight which did not allow for some of the planned tests including the drop, whip, and cold test. The payload had passed a bench test and appeared to be accurately recording data.

Launch went smoothly and we were able to recover our payloads fairly easily. Upon retrieving my payload, it appeared to be turned off while the switch was still tape in the on position. I was able to switch the payload back on at that point in time.

Results, Analysis, Conclusions

After looking at the data collected from the flight, it appeared that my payload turned off as soon as it took off from the ground. I noticed very high humidity reading coming from inside the payload as well as temperatures that were lower than the outside sensor was reporting.

I had a number of theories as to why my payload turned off at launch. One is that there could be a loose connection somewhere on my breadboard. Another theory is that the handwarmer inside of the payload increased the humidity and interfered with the temperature sensor. I ran a number of tests afterwards to try and see if I would be able to determine the source of the failure.

The first test I ran post flight was to reseal the payload without a hand warmer inside. I whipped the payload around on a string and shook it and then set it down to collect data for approximately two hours. The payload did not turn off and recorded data the entire time. The

data collected during this test shows consistent readings for the internal and external temperature, pressure, and altitude. The humidity inside the payload gradually increased from initially reading the same as the outside sensor at around 50% to 97%. The outside readings ranged from 40% to 50%. This tells me that my payload itself produced humidity on its own after being turned on. I wonder if other materials I used could have contributed to this but I am not sure how to determine that.

The second test I did was very much the same as the first test, except this time I included a hand warmer to see if that would give me different results. The payload remained turned on and recorded data during both trials. I had hypothesized that the handwarmer had interfered with my payload and was the cause of it turning off upon launch. I was unable to recreate those results and I am not sure why my payload turned off. The data collected during these tests show again consistent readings consistent readings for the internal and external temperature, pressure, and altitude. Again, the humidity inside increases but with the hand warmer in very quickly increased to 100% humidity inside the payload. This tells me that the handwarmers increased the humidity in the payload.

A third test I ran was to put a magnet in with the payload to see how that affected its ability to record data. Since the magnetism can vary in the hand warmers I used, it is impossible to know whether the hand warmer used during the flight was more or less magnetic than the ones used for testing afterwards. The payload ran just fine with a magnet inside and did not turn off because of it. The data collected during this test shows that the payload collected data very similar to the first test without a handwarmer or a magnet. This tells me that any possible magnetic charge inside my payload was not responsible for the payload turning off and not collecting data.

The wires were all hot glued in place to did not budge even when I whipped the payload with so much force that the tube with the paper clip was pulled through. This seems to be significantly more force than the payload experienced during flight, yet it remained turned on and recording data after the tube was pulled out.

I was unable to determine why my payload turned off and did not record data. Since the switch was still taped in the on position and the payload did not turn off during my tests, I am not able to determine the source of the problem. The day of the launch was colder than the temperature that any of my tests were preformed at but I do not think this was a factor since the payload ran and recorded data up until the moment of launch.

There are also a number of obstacles that I came across while constructing the payload. I thought that the shield provided as part of the modules would work with all of my sensors as well. I ended up using my breadboard and hot gluing the wires in. I learned I needed a proto-shield that I could solder directly to. I also assumed that the template for the payload would be large enough for my electronics, but once I realized I needed to include my breadboard, there was very little room in the payload.

The java program was not able to be used for several reasons, the first being no real data was collected. I also discovered that I was not recording time which made it hard to analyze the velocity of the payload over time. I will need to make sure I record time along with my other data in the future. The program runs correctly when given the correct data but since I did not gather data nor did I record it properly, I did not use the program to analyze any data.

I have gained a much better understanding of the process of building a successful payload and feel prepared to not only fly a payload next semester but successfully collect data as well. I have learned a lot about coding, soldering, running tests and much more that makes me feel more confident and prepared for my next project.