Microcomputer Applications in Rocketry

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Abstract

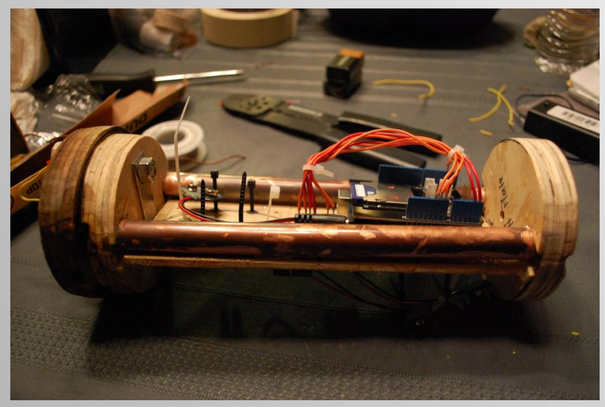
In participation with NASA and the California Space Grant Consortium, we are a group that has been given the opportunity to explore various microcomputer applications in rocketry. We have, with this project, dedicated ourselves to utilizing a microcomputer to reproduce the path of a rocket in 3D, to the best of our ability.

Materials and methods

Our payload consisted of an Arduino UNO Rev3 connected to an MPU-6050 sensor and attached with an SD card shield . The sensor has an MEMS accelerometer and MEMS gyro both within a single chip, and it captures the accelerations and angular accelerations along the x-, y-, and z-axis, with each channel containing 16-bit analog-to-digital conversion hardware. The SD card shield was used for recording the data that the MPU-6050 produced onto an SD card.

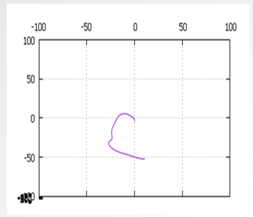
The parts of the rocket were constructed primarily using cardboard tubing, which included the body tube, payload tube and the motor mount. The nosecone used belonged to previously used rocket. The payload tube featured a pair of butterfly-screw/bolt combinations, with each bolt running through copper tubes and a pair of wooden bulkheads. Screwing these in allowed for a tightly compressed payload, preventing jostling of the electronics inside.

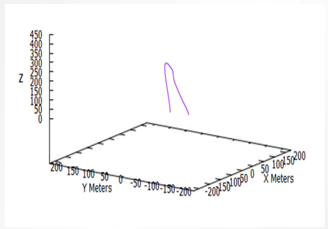
Pre-launch payload



Results

Payload Data



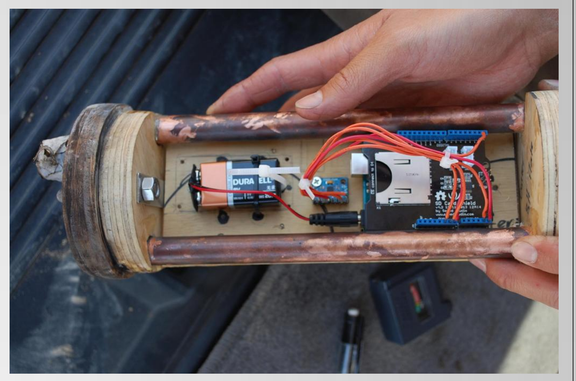


Rocket launch

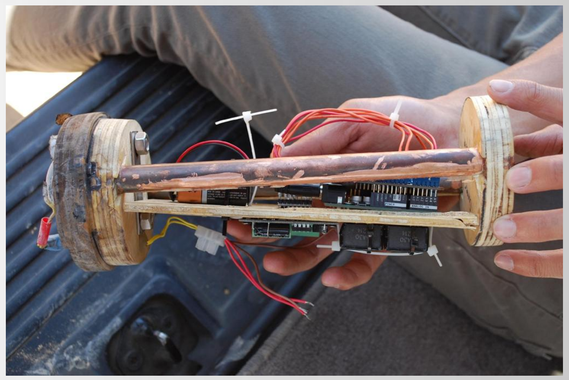
Our launch went as non-smoothly as possible, featuring a failed parachute ejection, a hard impact against a parched desert landscape, and knocking the SD card out of its reader at the last second. Fortunately, due to the structure of our payload tube, no damage was inflicted on any of the components, and the data for the majority of the flight was retrieved unsullied.

Although our launch was successful in providing sufficient data to analyze, several factors lead to inaccuracies for the modeling of the rocket flight path. First, the accelerometer's 16-bit limit only allowed for recording of forces in the range of +/- 4g in any direction. Our launch provided a G-force that overflowed the bit-depth, resulting in initial graphs that displayed large drops in height from the moment of launch to impact even though the launch site was relatively level. Therefore, we had to add a parabolic multiplier to these acceleration values in order to provide a more logical plotting of the flight. As a result, the z-values had to be analyzed theoretically. However, the x- and y-accelerations did not run into any overflow, so they required no correction.

Another source of inaccuracy lied in the data primarily consisting of accelerations, including angular accelerations, as opposed to position-coordinates. As a result, any noise or inaccuracies in the data were compounded over time; each inaccurate acceleration lead to an even more inaccurate velocity, which lead to an increasingly more inaccurate displacement. While this must certainly not be ignored, the launch took place over a fairly small time interval and featured relatively consistent motion. As such, any inaccuracies would have not have a highly significant influence given by the magnitude of acceleration that persisted throughout the majority of the launch.



Post-launch payload : top view



Post-launch payload : side view

Conclusion

Despite a rough landing, our launch could be tentatively considered a complete success. The retrieved payload provided valuable data on the impact of wind in regards to the movement of our rocket. In addition, the layout of the rocket could perhaps be considered more to automatically straighten launches and prevent scatter. Beyond that, the project provided a rather interesting narrative of a rocket's flight path after being brought to life in a GNUplot graph from its clean, straight launch to its tumultuous end.

Acknowledgement

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