Summer Research with NASA Goddard SFC at Olin College

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Summary

This summer, I and seven other undergraduate students at the Franklin W. Olin College of Engineering in Needham, MA undertook a unique research experience under the guidance of scientists at NASA's Goddard Space Flight Center in Greenbelt, MD. Each of the eight students worked in teams of 4 on two different projects; there were 4 projects total. I will be a Junior in the Fall 2008 semester (one of three rising Juniors; the other five participants were rising Sophomores); as such, I brought my extensive knowledge of circuits and programming experience to the projects and helped my peers learn more through the projects we undertook over the course of the summer.

USB Microchannel Analyzer

In conjunction with NASA Goddard Space Flight Center (GSFC) High-Energy Astrophysics Division scientist Keith Gendreau, we developed a USB Microchannel Analyzer, or MCA for short. An MCA processes the output of an X-ray detector and records the time and peak height of each pulse – a pulse is produced by a single X-ray photon striking the detector. Collecting this data enables rapid troubleshooting and diagnosis of complex systems involving X-ray detectors. However, currently-available high-precision MCAs cost many thousands of dollars and are impractical for widespread use as a diagnostic tool. Our goal was to design, build and test an MCA for significantly less, at the expense of some accuracy in its measurements. Our MCA communicates in real-time with a computer, so that there are no limits to the amount of data that can be captured by the instrument; in addition, data can be streamed over the internet to any number of monitoring computers, so data can be gathered even from remote locations and testing facilities. Over the eight weeks we worked on the MCA, we developed and tested our own custom analog circuitry, learnt extensively about the digital circuit components needed to build our device, and learned a great deal about embedded programming and pushing our microcontrollers to the limits of their capabilities. We learned significantly by the creation of this electronic device from conception to functional prototype. You can read more about our progress on the MCA at http://nasa.ece.olin.edu/projects/2008/mca/

Cloud CubeSat Solar Sensor

The Goddard SFC, in conjunction with the University of Maryland, Baltimore County is proposing a CubeSat mission to send a 30x10x10cm satellite with mass no greater than 3kg into space. This would enable our primary contact, Vanderlei Martins, and the rest of the satellite team to monitor clouds from a low-Earth orbit to learn more about cloud formation in the atmosphere. To do this, the satellite must keep itself pointed directly opposite the sun to ensure that photographs are always properly aligned. We were given the task of building a sensor capable of determining the angle to the sun relative to the satellite to within an accuracy of 0.1º. We were directed towards a new type of large photodiode. We investigated many options before choosing to implement and test the photodiode-based pinhole

camera. We extensively documented our rationale and the space-worthiness of every technology we considered. After designing and obtaining parts and assembling our pinhole camera, we developed custom electronics to process the output of the device on a computer. A hemispherical rotating platform built by a previous Olin-NASA project (the FIR Jig) was used along with a laser pointer in order to test the accuracy of our sensor. After gathering extensive data and writing extensive documentation on the construction and operation of the sensor, we were able to determine that our sensor had an accuracy of 0.04º - better than twice the specified accuracy of 0.1º. This project incorporated significant mechanical, electrical and software components. None of us had ever designed anything intended for (after revisions) spaceflight, so we learned much about launch and temperature conditions and basic orbital considerations for small low-Earth satellites. You can read more about the Solar Sensor project, including our extensive documentation, at http://nasa.ece.olin.edu/projects/2008/sos/