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This summer, I worked on two projects for the Olin-NASA summer internship, both of which involved CubeSats. Working for Vanderlei Martins and his team at UMBC and Goddard Space Flight Center, we developed a sun sensor and an attitude control system for his Cloud CubeSat. The goal of the cloud CubeSat is to try photograph side profiles of clouds, to determine whether it is feasible to do this profiling from space. These images will allow scientists to study cloud formation and study the temperature profile of clouds. To effectively take these photographs, the satellite needs to have its cameras pointing directly away from the sun. To this end, we developed a sun sensor to determine the exact location of the sun relative to the satellite. The full documentation of this project is available at http://nasa.ece.olin.edu/2008/sos/. In brief, we decided to eschew the widely used CMOS sensor technology and instead developed a sensor using a position sensing photodiode (PSD). With a light source completely normal to it, our sensor has a FWHM of 0.027°, exceeding our specification of 0.1°. Slewing our sensor though a wide variety of angles, it remained accurate to within 1.5° up to a 60° half angle field of view.

The other project I worked on was the attitude control system for the satellite. For this project, we developed control algorithms in Simulink, and an environment within which to test them. The satellite has to execute 4 basic tasks. It has to de-tumble from any initial roll caused by launch, search out and find the sun once it has stopped rolling, align to the sun once the sun has been found and point a radiator toward dark space, and maintain alignment even when the satellite goes behind the Earth. All of these tasks had to be executed using magnetorquers, electromagnetic coils of wire used to torque the satellite relative to the Earth's magnetic field. This proved difficult, as no roll about the magnetic field could be stopped, and no rotation could be created about the magnetic field. A full explanation of our simulation and the manner in which the control tasks are executed is available at http://nasa.ece.olin.edu/2008/acs/. In the end, we managed to get the satellite to de-tumble, find the sun, align to the sun, and maintain its position. We were not, however, able to determine a method such that the satellite would align the radiator to a specific 'dark' vector in space. This task proved much more challenging than we expected. If we had another two weeks, we could probably finish aligning to the dark vector, however, we do not.

In working on these projects, I developed a better understanding of what it is like to work on extended team engineering projects. Though the total project time was only 2 months, it was the longest amount of time I had ever put into any two projects. Working with a team of dedicated, incredibly intelligent fellow students, I learned how to delegate tasks and how to have tasks delegated to me. Perhaps the keenest understanding that I will take away from this program, however, is to know that there comes a time when good is good enough. We reached a point on both projects when we had to accept how far we had come and compile our results, rather than continuously pushing for improvements. Though I can still see ways in which both projects can be improved, we have reached the end of our allotted time, and both function to most of the specifications given to us. I think that overall the experience was an extremely positive one, and I would fully recommend this internship to students in the future.