Report for Mass Space Grant Consortium

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This summer I worked on two different projects, an Attitude Control System for a cloud-observing satellite and a control system for a Continuous Adiabatic Demagnetization Refrigerator for use in X-ray astronomy.

I was group leader for the Attitude Control System team. This was my first time leading a research project, but I developed both my presentation skills during my daily updates to our professor and my leadership skills in working in a peer group.

Our mission in the Attitude Control System was to have the satellite autonomously point a camera fixed on the satellite toward the earth in the direction exactly opposite the sun. We used magnetorquers, coils of wire that rotate the satellite toward or away from the earth's magnetic field, to orient the satellite. This method has extremely low mass and power requirements; however, it does not give complete control over all rotations of the satellite and therefore requires a complex control algorithm.

My contribution to this effort was programming most of the algorithms into Simulink, as well as the logic that controls the algorithms themselves. From the project, I improved my background in differential equations, transfer functions, and Matlab programming. I also increased my comfort level with working on and scheduling long-term projects. My other group members worked on the hardware integration, documentation, and orbit and rotation simulators.

The second project I worked on involved a Continuous Adiabatic Demagnetization Refrigerator, or CADR, a cooling device for an X-ray detector. This project goal was to improve the existing control software to reduce the fluctuations in the temperature of the detector.

Progress on this project was slow because we took a long time to understand the existing control code, which was poorly documented and written in Labview, a programming language that no one in our group had previous contact with. However, by the end of the project we were able to add several modifications to the software that added to the realism of the simulator and the effectiveness of the control algorithm.

My contribution was providing the thermodynamics background required for modeling the CADR. I was also responsible for modeling the superconducting heat switch and improving the PID capability of the controller. Through this project I gained a significant background in both low temperature physics and in Labview, a program used extensively in engineering, especially robotics. For more information about either project, you can visit our websites at http://nasa.ece.olin.edu/.

Overall, I feel that this summer was a valuable experience that increased my comfort level with engineering problems, concepts, and tools. I also believe that I now have the competency to produce products with real utility in the space industry.