International Space Station and UC Aerospace Student Link via Real-Time Space Satellite Control Mission

By: Desiré Bennett

Aerospace engineering student Alex Walker buys timeslot to test his thesis work, *Fuzzy Logic Attitude Control of a Magnetically Actuated CubeSat*, in space on the ArduSat satellite. This groundbreaking endeavor is a first for UC.

Currently docked on the International Space Station (ISS) and set to deploy on November 25 of this year is the ArduSat, a satellite that contains a set of Arduino boards, or microcontrollers, and sensors and is an open source, Arduino based Nanosatellite (a satellite that weighs between 1 kg and 10 kg), based on the CubeSat standard.

The general public will be allowed to use these Arduinos and sensors for their own creative purposes while the satellite is in space. The ArduSat will be the first open source satellite to provide such open access to the general public.

Aerospace engineering masters student Alex Walker will be among those of the general public who have purchased time to control the satellite and is the first UC student to research anything involving CubeSats. He will also be the first UC student to test his thesis work in space.

During Walker’s undergraduate co-op work at Sierra Lobo, Inc., where he is currently employed, Walker found out about ArduSat on Kickstarter, an American-based private for-profit company founded in 2009 that provides tools to raise funds for creative projects via crowd funding through its website. “I was planning to research magnetic attitude control of a CubeSat for my Master's Thesis, so I thought that purchasing time on this satellite would give me the ability to test the algorithms I came up with,” he said. “I will be one of the first users, if not the first user, to presumably run attitude control software on this satellite. Although Nanosatisfi has their own attitude control software, they will assume some risk in letting me, a paying customer, take control of the satellite,” he said. “This will set a precedent for Nanosatisfi as far as allowing future users to take control of their satellite(s).”
Through funds shared equally by the Department of Aerospace and Sierra Lobo, Inc., Walker was able to purchase access to a two-week window which will open during the spring of 2014 to access the ArduSat. Additionally, Walker’s research “Fuzzy Logic Attitude Control of a Magnetically Actuated CubeSat,” was partially supported by the OSGC grant.

Walker says his research is on controlling the attitude, or orientation, of a CubeSat, a 10 cm cubed satellite, by using electromagnets. “An algorithm is used to make the electromagnets produce a magnetic field that is the correct strength and direction to cause the satellite to orient itself as desired, much the same way a magnetic compass needle orients itself to point North,” he explains. “The algorithm I use to do this is based on fuzzy logic, a multivalued logic which uses the concept that statements can be partially true and partially false at the same time.”

According to Walker, many CubeSats are designed to use magnetorquers, or electromagnets, because the magnetorquers provide a mechanism to point the spacecraft in a desired direction. “Some of the missions that require pointing control are Earth, moon, or sun observation missions, which can potentially collect data on solar activity, Earth vegetation, climate change, algal blooms in the Great Lakes, weather patterns, upper atmosphere composition and Earth’s magnetic field for example,” he said. “These data allow us to understand changes that are happening to our planet and provide clues as to what actions we can take to improve our lives, protect our infrastructure, and develop or protect our lands.”

Walker will collect attitude and attitude rate data during his timeframe of controlling the ArduSat. “We have requirements for pointing accuracy and rates,” he said. “If the requirements are met, the project is successful.”

According to Walker he has been researching this topic since the summer of 2012 but “the broader topic of aerospace vehicle dynamics control has been an active area of research at UC for decades.”

Walker’s thesis Chair and associate professor Kelly Cohen, PhD, is excited about Walker’s research and the opportunity that controlling the satellite presents. “This is clearly a first for us at UC,” Cohen said. “We do not have an experimental facility that enables us to test attitude control systems of satellites in a zero gravity environment and so it is wonderful to have this opportunity to test our unique fuzzy control algorithms in space.”
Walker plans to continue his research after graduation. “I am planning to take a slight break from academia, but I will be continuing research in this area through my work at Sierra Lobo. Maybe in about a year’s time I will return for a PhD.”