Introduction

A group of students from the University of Northern Colorado (UNC) would like to apply to the Colorado Space Grant Consortium’s (COSGC) RocketSat-X program in which payloads are developed to perform specific tasks during a suborbital flight aboard a rocket launched from NASA's Wallops Flight Facility. The team would like to continue a RocketSat-X project started in 2011 at UNC that explored the effect of the re-entry process on a probe deployed at apogee from a rocket. In preparation, two subteams have been working to develop a balloon payload that can serve as a proof of concept. The payload will be launched as a part of the COSGC’s DemoSat program, where a high altitude balloon lifts payloads to the edge of space. The payload contains two main subsystems, one focusing on the mechanical components, and the other on the electrical and programming aspects of the payload. The mechanical team focused on creating a flight deck that accommodates computers, heating systems, a camera, and the probe deployment system (PDS). The electrical and programming team worked to put together an electronics package capable of surviving the stresses of an atmospheric re-entry while maintaining wireless communication between the probe and a flight computer.

Mechanical

Mechanical Team Objectives
- Design and develop a probe deployment system
- Develop a DemoSat payload to fit size and mass requirements
  - Payload must be less than 1.2 kg
  - No probe deployment is to occur in this experiment
  - Emulate probe deployment
  - Must be able to withstand the environment of the upper atmosphere for approximately three hours
- Develop a RocketSat-X payload to fit size and mass requirements
  - Fits payload requirements assigned by Wallops Flight Facility (WFF)
  - Payload must be less than 13.61 kg
  - Withstands g-loading of at least 25 g’s
  - Withstands temperatures of at least 500 degrees Fahrenheit
  - Withstands the vacuum of space

DemoSat Development
For DemoSat, the team developed a simplified payload consisting of a flight deck, and two protective boxes for the sensitive flight computers. The flight deck is built to the specifications of a RocketSat-X flight deck. In an effort to reduce the mass of the payload, the deck is made out of a PVC plastic, and the protective cases are made of a clear polycarbonate plastic. A flight string tube was inserted in the center of the flight deck as required by the DemoSat program.

RocketSat-X Development
Looking forward to RocketSat-X, the team will begin to develop protective cases for all components including the flight computers, the probe, and the deployment system. The team will also have to scale the prototype to match the requirements set by the flight directors at WFF. In addition to developing the probe, the team will need to account for the g-loads associated with a rocket launch and the temperatures encountered by the probe and payload throughout the flight. The primary consideration for the team will be the thermal expansion of the hardware and protective enclosures, which could result in a catastrophic failure of the payload.

Payload Components

Figure 1: This image is a CAD rendering of the DemoSat payload featuring the Raspberry Pi computers, the PDS servo actuator, and an observation camera mounted to the flight deck.

Figure 2: This image features the partially assembled DemoSat flight payload during initial testing.

Figure 3: This image shows a CAD rendering of the proposed RocketSat-X payload, including the PDS, with an unprotected Raspberry Pi computer next to it.

Electrical and Programming

Electrical and Programming Team Objectives
- Assemble an electronic data gathering system and computer program in order to collect measurements required for assessing the conditions that the probe will experience during re-entry
- Set up a wireless communication network between devices to send data
- Write a computer program that detects when the probe is at apogee
- Create a power model that has sufficient battery life
- Needs to be able to provide enough power to the electronic system throughout the flight

DemoSat
For this flight, the team created a system that includes three Raspberry Pi computers, a Raspberry Pi SenseHat, two Edimax wireless dongles, five LiPo batteries, two heating resistors, and an ethernet cord. This allowed the teams to set up a system of data collection and communication. During the flight, data will be recorded by one Raspberry Pi computer using the SenseHat that is attached. These data will be sent to a second Raspberry Pi computer through an Ethernet cord. This Pi will then wirelessly transmit the data to the third Raspberry Pi on a separate location on the flight deck. This third Pi will be the main computer that the team will take the data from to analyze. For the DemoSat flight, there will not be an actual probe deployed but there will be a camera attached to the third Pi that will record a servo actuating at the moment of apogee, emulating the probe deployment. The team hopes that this flight shows a successful wireless transfer of information between the Pi’s and a successful emulation of the probe deployment at the correct flight time.

RocketSat-X
In order to take the success of the DemoSat flight and translate that into the RocketSat-X flight, the electrical and programming team will need to replace the wireless dongles with Xbee transceivers. This will require a new computer program to set up the communication between the two Xbee’s that will be located on the two Ethernet connected Pi’s and the separate Pi. The rest of the electronic and programming setup will stay basically the same from the DemoSat flight to the RocketSat-X flight.

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