OpenOrbiter Ground Station Software

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About
OpenOrbiter is a student project at the University of North Dakota to design and build a low cost and open-hardware / open-source software CubeSat. The Ground Station is the user interface for operators of the satellite. The ground station software must manage spacecraft communications, track its orbital location, manage task assignment, provide security and retrieve the data from the spacecraft. This will be presented via a graphical user interface that allows a user to easily perform these tasks.

The goals of this project are to:

i) create an intuitive, powerful graphical user interface for ground-station personnel to send commands to an unmanned small satellite

ii) develop a centralized task / spacecraft database that allows for multiple concurrent ground-stations to send and receive commands or data to the CubeSat, as it becomes accessible to each ground-station

iii) design a ground-to-space data link that automatically sends commands to and receives data from the unmanned small satellite as it passes over the ground-station

Scientific Merit
A modular, unmanned small satellite is being designed as a fully open-source software / open-hardware university-class satellite that aims to reduce the costs of placing a satellite in space significantly. The design allows academic institutions to develop their own modules for additional functionality at a small cost. To increase the usability of OpenOrbiter and decrease the technical requirements of end-users, an intuitive graphical user interface that converts basic commands into powerful commands is strongly desired. Since communications windows are limited, the prioritization of command and data transmissions and the ability to connect multiple ground stations over a wide geographic area are of paramount importance.

In order to satisfy these requirements, a centralized database will be created, allowing multiple ground stations to:

i) see the current prioritization queue

ii) add to the prioritization queue

iii) see commands that have been sent to the OpenOrbiter and are expecting results

iv) see all results returned by the OpenOrbiter.

The initial graphical user interface will be designed to support the OpenOrbiter’s image-processing mission, the interface will be built to facilitate later extension and enhancement.

Broader Impact
Lowering the technical hurdles required for spacecraft development, including the critical element of satellite communications provides a significant benefit to academic institutions wishing to conduct research involving space imaging, geo-location or other research. This, in turn, markedly reduces the cost of such research and allows for continuous innovation due to the fully open-source nature of the OpenOrbiter project. Additionally, allowing multiple ground stations to send and receive commands and data from the same satellite, or potentially multiple, satellites, may increase collaboration among institutions, even over wide geographical spreads, further reducing the costs of research.

Starting from Standard Open-Source Software Components
We have selected several open-source software packages which are used to power the ‘behind-the-scenes’ functionality of the ground station. These include:

i) Python is a widely used general-purpose, high-level programming language. This is our primary development language

ii) Django is a high-level Python Web framework that encourages rapid development and clean pragmatic design. This will increase the development speed of the ground station.

iii) MySql is a popular open source relational database system. It is our primary data storage mechanism and facilitates data storage and organization.

iv) Apache is a web server application. We use this to host the static and dynamic content and make it available to remote users.

v) Cesium is an open-source JavaScript library that can be used to create 3D and 2D map-graphics. It can be used in many browsers without requiring a special applet or plugin.

The use of open-source software components facilitates the adoption and adaptation of this software by other institutions.