Data Visualization Software for the MinXSS CubeSat

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What is a CubeSat?

- Very small satellites built to standard dimensions 10cm cubed
- 1U, 2U, 3U, or 6U in size
- Typically weigh less than 1.33 kg (3 lbs) per U.
- Science purposes vary from one to another
- Short life spans
MinXSS CubeSat

- Second CubeSat build & designed by AES/LASP
- Part of a graduate project course
- 40 students have worked on it
- Performing solar research
- 3U in size
MinXSS CubeSat

- Science Purpose:
  - To better understand solar flare soft x-ray (SXR) emission of the sun and its effect on the earth’s ionosphere, thermosphere, and mesosphere (ITM)

- Resolution better than 0.15 keV full-width half-max.

- Spectral range that hasn’t been fully observed
Data Vis & Orbital Software

- **Purpose of software:**
  - create ground software for visualizing & comparing the CubeSat’s state of health with it’s orbital location

- **Housekeeping Data** - such as temp of instruments & power levels

- Made with IDL user-interactive widget

- **Why does it help us?**
  - Monitoring HK data is key part of satellite operations during flight & also during pre-flight tests
  - To fully understand the changes in housekeeping data
- Convert raw data packets from CubeSat into useful engineering units (C, V, A, etc.)
- TLE to Lat/Long calculation courtesy of Chris Jeppesen
- Currently reads ISS TLE

**Housekeeping & Science Data**

**Time**

**User Selected Options**

**Lat/Long Calculations**

**Orbital Location Map**

**X-Ray Spectrum Graph**

Graphs of subsystem temperatures/power supply voltage/battery state of charge
Software Features
Mission Tests

- **Purpose:**
  - To prove capabilities of Data Vis Software and DataView commands
  - To assemble a functioning integrated prototype

- **Mission Early Operations**
  - Phoenix Mode
    - Comm powered on
    - Antenna deployed
  - Safe Mode
    - ADCS powered on
    - Command Solar Panels Deployed
  - Science Mode
    - X123, SPS-XPS power on
  - For ground testing: Power Supply/Solar Panel Simulator powered on/off
Mission Tests: DataView
Mission Tests 1-7

- First seven were debugging flight & ground software
- Comm board got too hot in this structure
- Radio command worked sometimes
- Found that DataView has problems receiving mouse actions when processing too much data

(Assembled on CubeSat Card Cage)

(Mission Test 6 Data)
Mission Test 8

- “Integrated prototype”
- Power Supply used to simulate the sun charging the solar panels
- Ran for little over one complete (ISS) orbit
- Used Heavens Above
- Battery heater toggled on/off to test command
- Radio command returned error
Mission Test 8
Mission Test 9

- Solar Panel Simulator used to simulate the sun charging the solar panels & batteries
- Pre-entered power on/off time delays
- Ran for multiple (ISS) orbits
- X123 Powered off during eclipse
Mission Test 9

Orbital Location & Data Visualization
Made By: Christina Wilson
Summer of 2014

Currently Displaying: 07-26-14
Orbit #1 in dataset
LASP Selected Time: 12:966130 Hours of day

Key:
- In Shadow
- Out of Shadow

Latitude: 13.1382
Longitude: -35.1976
Elevation (km): 6703.7666
Period (hrs): 1.54354
Inclination: 51.6476
Eccentricity: 0.0003898600

Temperature Monitor

Power Monitor

X123 Soft X-Ray Spectrum at Selected Time

Counts

Channel Number #
Mission Test 9

Orbital Location & Data Visualization
Made By: Christina Wilson
Summer of 2014

Currently Displaying: 07-25-14
Orbit #2 in datafile
LASP Selected Time: 14:00:00
Hours of day

Key:
- Red line: In Shadow

Temperature Monitor
- mcb_Temp
- batt_Temp
- batt_Temp
- DBT_Temp
- EPS_Temp
- EPS_Temp

Power Monitor
- X123 X-Ray Spectrum at Selected Time
- Count Rate (counts/sec)
- Channel Number #

Latitude: 80.7069
Longitude: 49.8650
Elevation (km): 6793.7665
Period (hrs): 1.54354
Inclination: 51.6470
Eccentricity: 0.000389000
Summary of Accomplishments

- Battery testing for NanoRacks
- Created Data Visualization Software
- Performed Mission Tests
  - Validated functionality of MinXSS hardware monitors
  - Helped to improve MinXSS flight software operations modes
  - Proved capabilities of Data Vis Software
Future Work

- Improvements to perform real time analysis and plotting during ground tests
- Data Vis Software will be used to analyze flight data
Questions?