SSDLCAM

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Cubesats and Cameras?

Cubesats historically have had very limited imaging capabilities

- Low processing power
- Inaccurate pointing
- Power consumption constraints
- Limited data downlink

- Poor support for interconnectivity
- High-end cameras don’t fare well in space
SSDLCAM

1.5U Payload

• Primary payload consists of high-resolution imager paired with high-end processing
• Integrates with stand-alone bus from industry partner (with attitude control)
• Part of Cubeview mission with launch in Q2/Q3 2010

Applications

• Vegetation / algae bloom monitoring
• Oil spill tracking
• Forest fire detection
• Pollution monitoring
• Land mass characterization
System Architecture

- Lippert Cool Spacerunner LX800
  - PC/104 SBC (fits 1U dims)
  - 500 MHz AMD Geode
  - 256 MB RAM, 2 GB SSD
  - Linux Debian 5 OS
- TCP/IP communications
- USB 2.0/RS232 support
  - Modular and expandable
  - 2.5 W allotment/peripheral
- LPT used for device control/fault management
System Architecture

Bus

TCP/IP, 5V

CPU, 2 GB SSD, Linux, TCP/IP

USB/5V, LPT devices, PL Connections, Fault management

5/12V

Camera

USB/5V/12V

Flash Experiment HEPL

USB/5V

EED

USB/5V

CubeView Payload
Imaging Hardware

- Pumpkin camera
- Kodak color interline CCD
- 11 MP resolution
- USB 2.0 interface
- 12 V external power
- 520g
Imaging Software

- Open Source Software
  - Linux 2.6 (x86)
  - Open source driver
  - OpenCV
  - GraphicsMagick

- Advantages
  - Abstraction
  - Leverage existing tools
  - Rapid development
  - Ease of development

System Applications instead of System Firmware
Imaging Data Flow

- Camera Driver
- Control Script
  - Metering Algorithm
  - Picture Capture
  - Image Pre-Processing
    - Compress High-Res
    - Compress Thumbnail
  - Science Processing

- High-Res Image
- Thumbnail Image
Flash Memory Reliability Experiment

• Aim
  ▪ Characterize susceptibility of flash memory in space environment
  ▪ Number of SEUs and burnouts
    ◦ As a function of time
    ◦ As a function of position in the orbit

• Hardware
  ▪ 4 Atmel 64Mb serial Flash memory chips
  ▪ 2 shielded and 2 unshielded
    ◦ Modeled in SPENVIS
  ▪ Mounted on nadir surface cover plate
  ▪ Shielded MSP430 microcontroller
  ▪ USB 2.0 interface
Energetic Electron Detector

- Lightning $\rightarrow$ Whistler waves (VLF)
- Whistler waves $\rightarrow$ Precipitating electrons
- Precursor to a dedicated future mission

- Hardware
  - Analog front-end board
    - Avalanche photodiode
    - Pre-amplifier
  - FPGA-based signal processing
    - Digital pulse shaping
    - Pulse height measurement
    - Energy histogram
  - High voltage power supply
Additional Science Payloads

• Possible additional payloads
  ▪ VHF signals from micrometeoroid impacts
  ▪ Space qualification of UV-LEDs and Photodiodes
    ♦ Possible use for charge mitigation on LISA
How do they all fit together in 1.5U?
Conclusions

• We’re able to put a camera on a Cubesat
• Open architecture simplifies programming and compatibility with other standards
• Plug-and-play environment with multiple experiments allows for rapid development
Questions?