Fast Slew Gimbaled Optics for Real-time EO
"Nimble Gimbal"

Ben Taylor

University of Surrey

In-Space Missions Ltd.

NCEO/CEOI Conference

Fast Slew Gimbaled Optics for Real-time EO

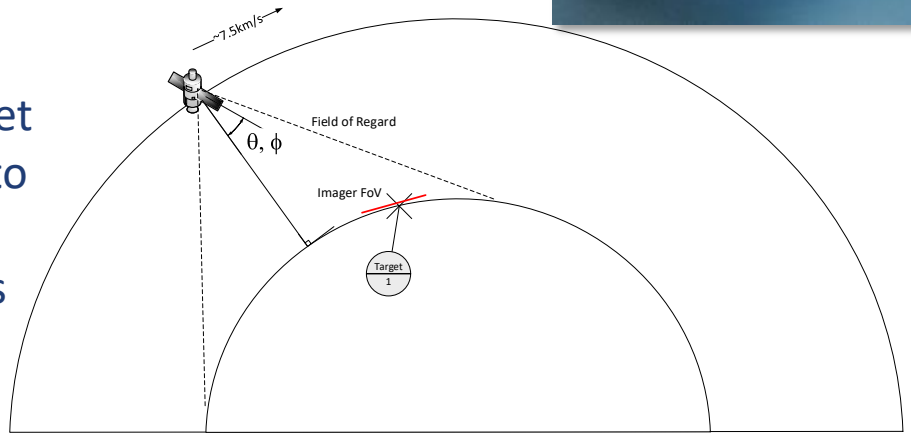
Project Introduction

- System to be mounted on microsat platform for independent imaging operations
- System should be able to target and track ground targets without slewing host platform
- Capture stills and video imagery on high duty cycle at variable zoom level – 10m to 50m GSD
- Smaller scale version of IRIS system on ISS operated by Urthecast

- Two fundamental modes of operation:
  - Fast Slew - >5deg/s fast slew to target
  - Tracking - <1deg/s precise pointing to track target in centre of FoV
- Also need to have idle initialisation states and active self-test modes
- Pointing accuracy of 0.1deg (2sigma)

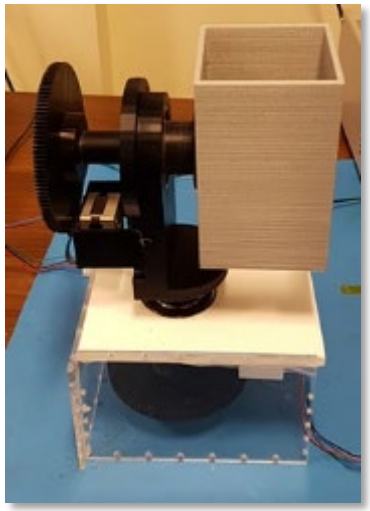
IRIS System
(image credit: UrtheCast)

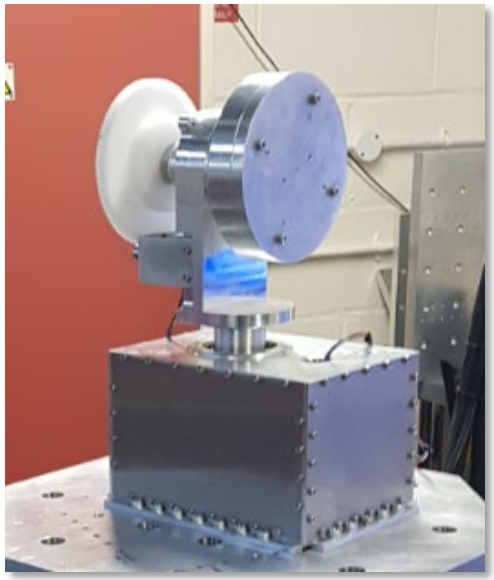
Nimble Gimbal

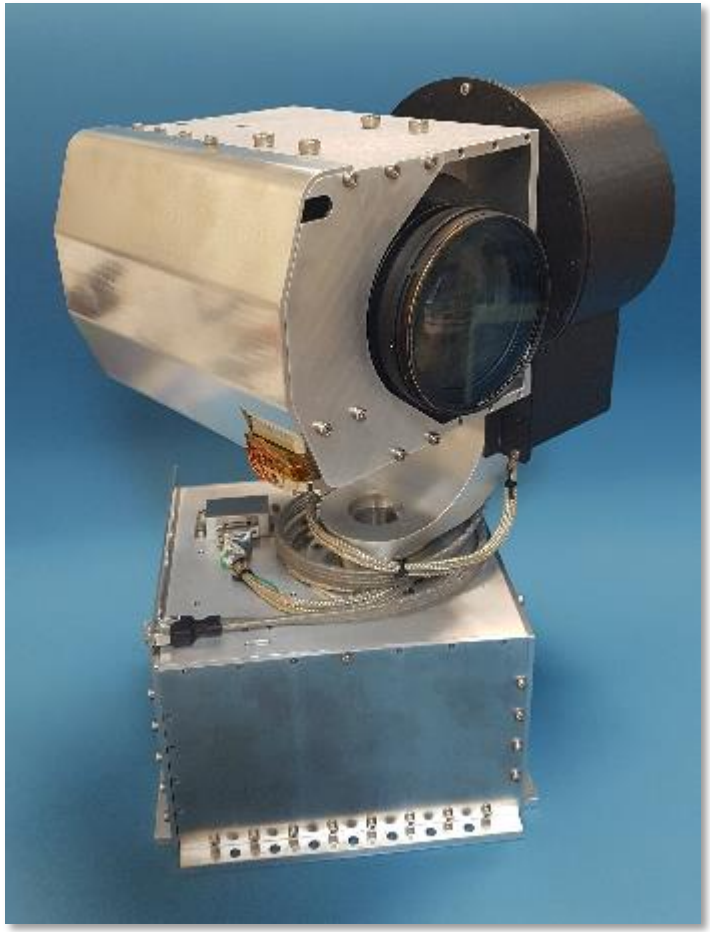


Hardware Evolution

- Multiple approaches considered: Actuating mirrors, classical gimbal, Stewart platforms, offset axes
- Simple models constructed to refine design and to act as early testbed for electronics and control software
- Development model built for actuator performance and vibration testing



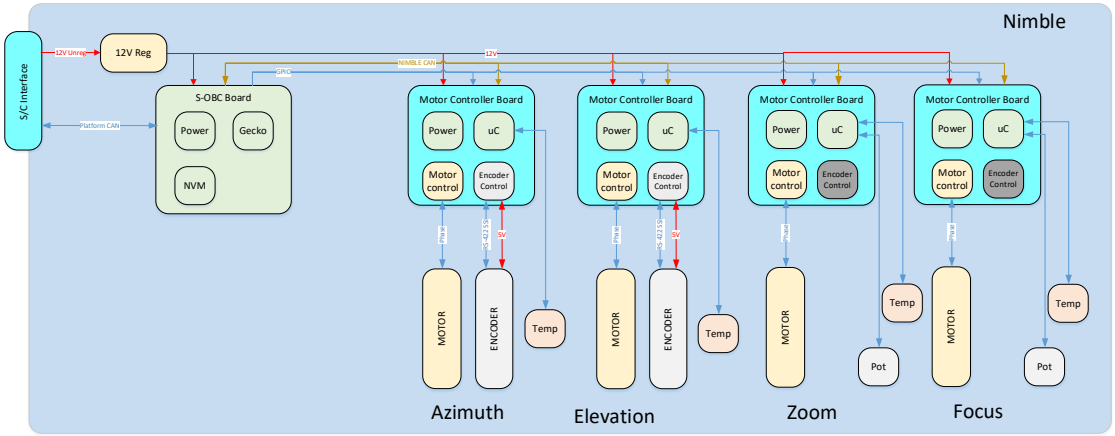




Fast Slew Gimbaled Optics for Real-time EO

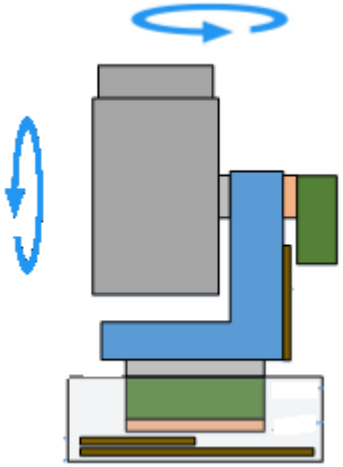
Electrical System design

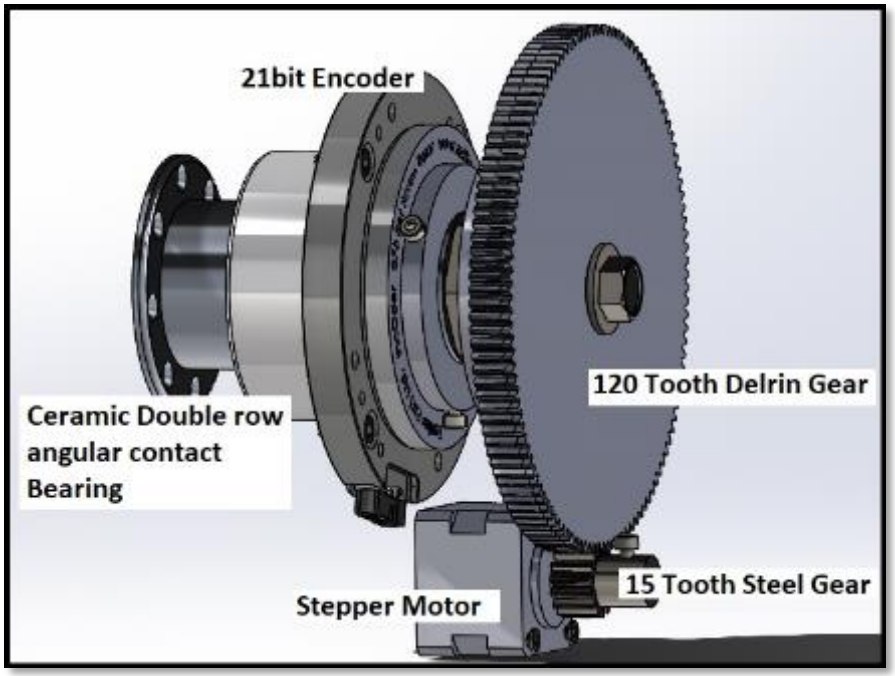
- Single 12V and external CAN interface
- Electrical system uses distributed approach
- Core OBC for control and external interface using Surrey CubeSat OBC
- Four Motor Controller Boards – one per degree of freedom with local peripheral interfaces and intelligence
- Internal CAN bus
- Common power line, MCBs individually switched by OBC – allows for ease of testing and future expansion of system



Pointing System

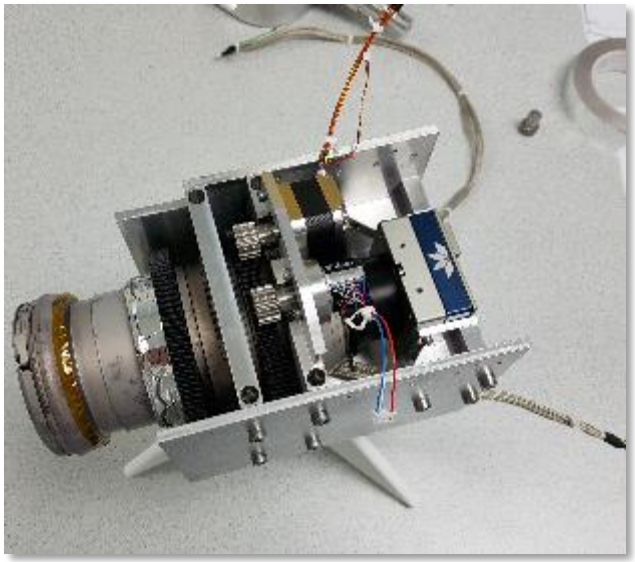
- Classic Azimuth Elevation system – identical actuation system in each axis
- Spur gear solution selected due to required lifetime in 8:1 gear ratio
- Driven by Vacuum rated Stepper motors in 1/256 microstepping mode
  - Gives 3.16arcsecond control resolution (not including backlash)
- Position feedback from 21-bit inductive encoders
  - Provides 0.6arcsecond resolution
- Torque, speed, offsets all separately configurable by telecommand





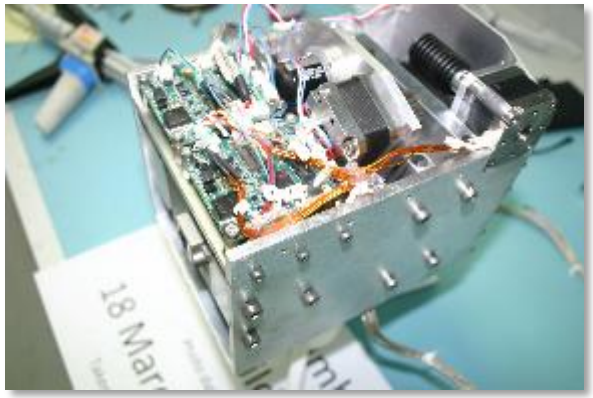
Optical System

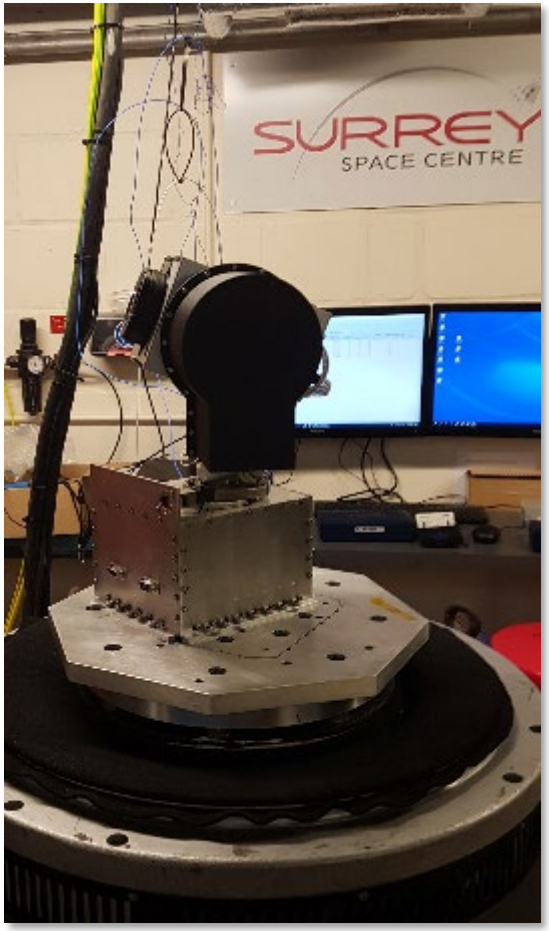
- Use of COTS optics elements:
  - Teledyne DALSA Genie NanoXL
    - 25MP imager
    - Gig-E Vision interface (Ethernet)
  - Lens, Nikon AF-S 28-300
    - Grease replaced with vacuum rated
    - Internal motorised systems removed
    - PVD Aluminium coating over plastic barrel
- Lens mounted with clamps around Focus window and Base
- Zoom and Focus control, using manual elements driven by same type of motors and electronics as pointing system- Zoom uses worm drive for increased torque
- Vibration testing conducted at early stage to refine design



System Testing

- Two final models produced:
  - **Life Test Model (LTM)**
  - **ProtoFlight Model (PFM)**
- Models subjected to similar test campaigns:
  - Integration Testing
  - Functional Testing
  - Optical
  - Pointing
  - Vibration
  - Thermal

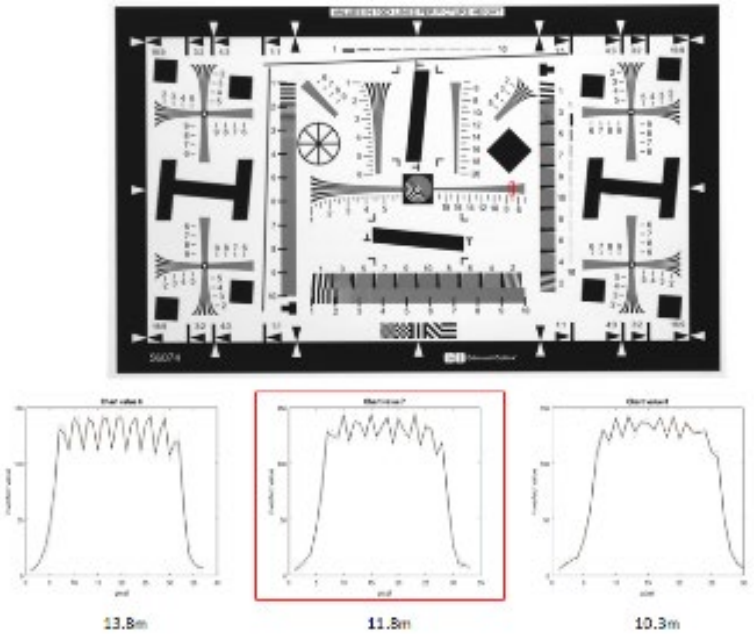




System Testing

- Optical testing shows equivalent to 12m ground resolution
- Life testing currently ongoing – 60,000 cycles completed (equivalent to >1 year at 50% duty cycle)

- Pointing testing to be conducted two ways:
  - Real world – Pointing to bright stars/planets and tracking satellites as they pass overhead
  - Simulated targets on large display screen – both fixed positions and moving targets



Questions?