# Optimizing the Attitude Control of Small Satellite Constellations for Rapid Response Imaging

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## MOTIVATION

- Distributed Space Missions are emerging as realistic methods to improve spatio-temporal-angular sampling of the Earth
- Cubesat ADCS, constellation design, single S/C and aerial planning and scheduling is developing
- Gap in literature for open-access software tools for scheduling constellation operations in terms of pointing and observing targets

**GOAL:** Develop a tool for scheduling pointing ops for NFOV sensors on LEO sats to maximize global coverage + minimize image distortion under ADCS, cloud cover, BRDF or downlink constraints.

## IMPLEMENTATION

Orbital Mechanics => Access Times for Satellite, given discrete pointing options

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Attitude Analysis => Extended Kalman filter + PID control

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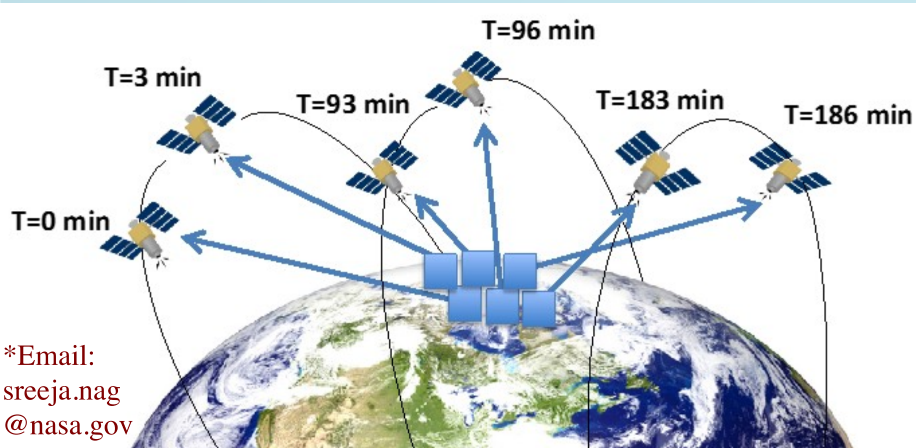
Optimization over Time => Dynamic Programming

***LandSat Case Study***

Landsat takes ~24 s to transverse over its FOV of ~185 km, 710 km/98.2 deg orbit, snaps 236/s + integrates pushbroom images over 30 s. 16896 land/coastal images.

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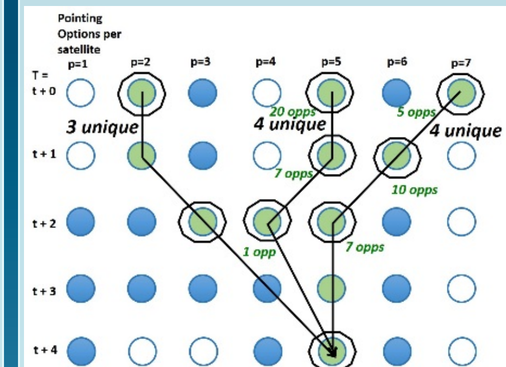
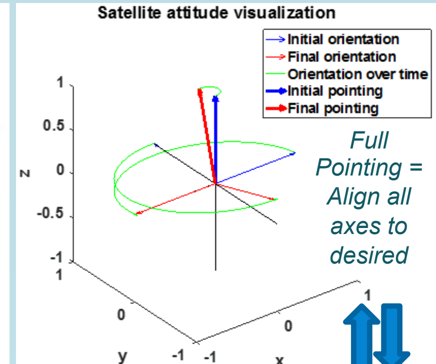
## RESULTS

***Dynamic Programming w/ time as constraint***

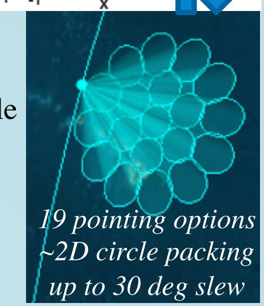



***Fast Pointing (E = 2.8J) vs. Full Pointing (38.2J)***

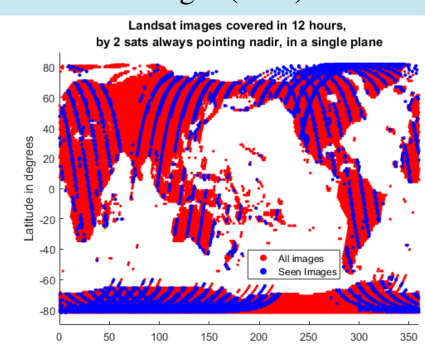



***Nadir Pointing vs. Agile Pointing***

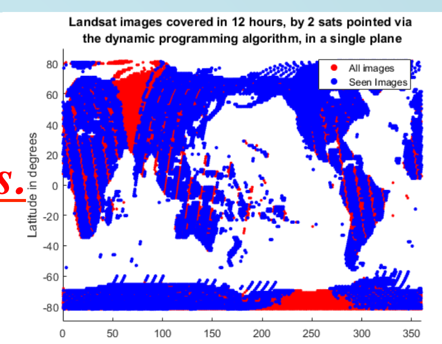
- Over 24h, only 4711 images seen (28% of total, 32% of possible)
- Over 12h, 2 sat constellation sees 4367 images (30%)
- 11418 images seen (67% of total, 77.5% of possible so 140% more)
- 11034 unique images seen by 2 sats (150% improvement in spite of 1411 common images)



*19 pointing options ~2D circle packing up to 30 deg slew*




***vs.***




**FUTURE WORK:** Validate optimality using MILP, add random cloud cover + ground station downlink and charging constraints, Constellation trades