Sub-Pixel Inter-Satellite Imagery Cross-Calibration via Image Decomposition and Dynamic Filtering

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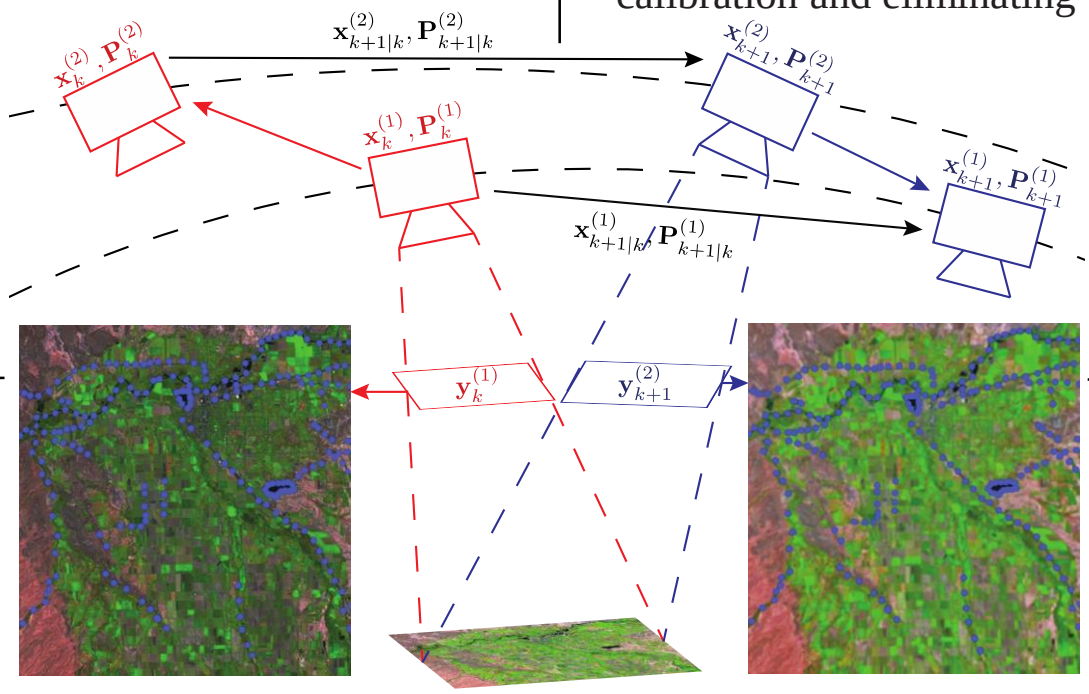
Research Objectives

- Create new, autonomous, on-orbit calibration scheme for imaging satellite constellations
- Innovation is to use primary satellite imagery for cross-calibration instead of dedicated measurements
- Advance over the SOA by enabling continuous cross-calibration and eliminating calibration-specific down-links and uplinks
- Raise concept from TRL 1 (preliminary mathematical formalism) to 2 by publishing formalism and software demonstration on synthetic data



Schematic representation of an update step between two satellites. Two satellites image the same location at different times, share derived invariant feature sets (blue dots in the insets) and update their internal state knowledge accordingly.

Approach

- Implement filter whose state captures full satellite dynamics and camera model with measurements including invariant features extracted from surface images. Share feature sets and state estimates between satellites to improve global state knowledge and detect transient events.
- Create new, fourth-moment Unscented Kalman Filter to propagate full states and uncertainties.
- Use PCA-SIFT implementation for efficient invariant feature extraction and encoding

Potential Impact

- Will enable continuous geometric calibration for constellations at any scale
- Provides a path towards fully automated event of interest detection and automation of followup observations
- Development of mathematical formalism will be an important addition to the optimal estimation literature, and have multiple other applications in general autonomy and computer vision.