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Hyperion

March 2021

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Hyperion Overview

Problem Space

Frequency and density of new satellites being launched into orbit

Semi-autonomous movements by satellites

Hypothesis

Impact of leveraging high fidelity commercial sensor assets

How an automated toolset may provide ability for decisive action

Demonstrations of Toolset

Mega-Constellation Management through Machine Learning

Sensor Parameterization

The development of an enterprise capable software calibration system that allows for automation and interaction with continuous machine learning will provide a significant benefit to follow on cloud-based systems.



Mega Constellation Management

- Increasing Populations
 - Starlink Constellation Plan FCC filing 4408 Satellites
- Constant Change
 - 3-5 Year design life
 - Evolving deployment strategies

Autonomous Behaviors

- Orbit raising
- Collision avoidance
- End of life
- Anomalous behaviors
- Transparency Issues
 - Data connectivity
 - Non-cooperative constellations



Mega Constellation Management

• Training

- Supervised labeling
- Strong candidate for unsupervised
- Classification
 - Orbital Data only
 - Deep learning RNN
 - 95% Validation accuracy
 - Unstable during transitions
 - ~5% Assumed labeling error
- Enables
 - Domain Awareness
 - Phase transition prediction



Ground Truth





Prediction



Results





Sensor Parameterization

- What is a sensor?
 - Any device that takes in environment data and produces a new signal
- What is the problem?
 - Measurements are always corrupted by noise
 - Produced states are only as good as the input measurements
- What can we do?
 - Improve sensor hardware; costly and potentially mission prohibitive
 - Calibrate by using external data sources and statistical approaches
- What is the result?
 - Improve precision and accuracy of data without modifying the sensor
 - Appropriately weight disparate data sources
 - Monitor sensors for abnormal behaviors





Sensor Parameterization

Existing Approach

- Constant Systematic/Random Error
- SLR/OO High precision References
- Post sensor site calibration
- Inspect Data
 - Correlated biases
 - Heteroscedastic error

Models

- Physical
 - Time (Clock drift/offsets)
 - Location/Orientation offsets
 - Needs lots of data
- Analytic
 - Linear Regression (w/ transforms)
 - Known correlations
 - Needs some data
- Machine Learning
 - Probabilistic Neural Networks
 - Discovers correlations
 - Needs some to lots of data

Enables

- Sensor theoretical error reduction
- Satellite solution error reduction
- Robust Anomaly detection



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