

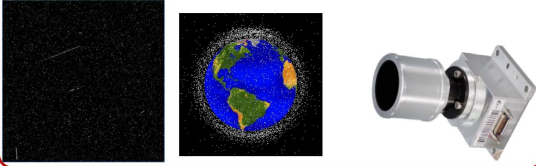
Multi-frame imaging to detect orbital debris

Tim Vrakas

MSEE, Stanford University -- Starlink Bus Avionics, SpaceX

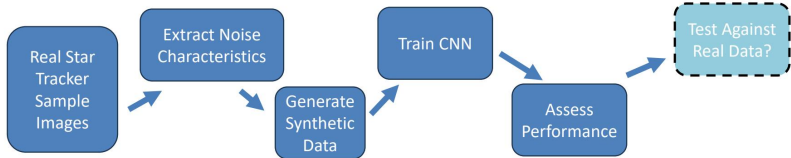
Motivation

- Spacecraft use images of stars to determine their orientation and track debris (RSO)
- Imagers are noisy, and spot detection algorithms cannot detect faint moving objects



New Technique

- Instead of stacking many frames and then finding objects, we propose detecting moving objects directly from the image sequence data
- First, we generate a large synthetic dataset of star imaging sequences
- Then, we train a CNN to highlight moving signals

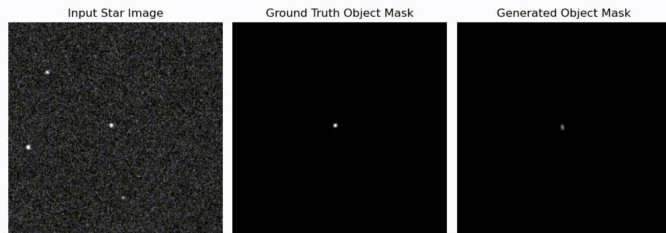


Related Work

- Badura (2020) applied CNN to detect tumbling of RSO based on their reflectance over time
- Dave (2022) demonstrates this approach on with validation using real space image data
- Shah (2023) demonstrates the utility of data from thousands of Starlink Satellites

Experimental Results

- Able to generate synthetic data that accurately represents sample images
 - Integrate Poisson and Gaussian noise profiles
- Achieved loss of $8.2e-6$ on validation dataset



References

- [1] Badura G, Valents C, Gunter B, "Convolutional Neural Networks for Inference of Space Object Attitude Status", AMOS 2020
- [2] Dave S, Clark R, Lee RSK. "RSOnet: An Image-Processing Framework for a Dual-Purpose Star Tracker as an Opportunistic Space Surveillance Sensor", Sensors (Basel), 2022
- [3] Hamil S, Russell V. "Global Ionizing Radiation Environment Mapping Using Starlink Satellite Data" IEEE Transactions on Nuclear Science, 2023