Sandia National Laboratories

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SOHBRIT: Autonomous COTS System for Satellite Characterization

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ABSTRACT

As technology continues to improve, driving down the cost of commercial astronomical products while increasing their capabilities, manpower to run observations has become the limiting factor in acquiring continuous and repeatable space situational awareness data. Sandia National Laboratories set out to automate a testbed comprised entirely of commercial off-the-shelf (COTS) hardware for space object characterization (SOC) focusing on satellites in geosynchronous orbit. Using an entirely autonomous system allows collection parameters such as target illumination and nightly overlap to be accounted for habitually; this enables repeatable development of target light curves to establish patterns of life in a variety of spectral bands.

PROJECT DESCRIPTION

The Sohbrit system is responsible for autonomously creating an optimized schedule, checking the weather, opening the observatory dome, aligning and focusing the telescope, executing the schedule by slewing to each target and imaging it in a number of spectral bands (e.g., B, V, R, I, wide-open) via a filter wheel, closing the dome at the end of observations, processing the data, and storing/disseminating the data for exploitation via the web. Sohbrit must handle various situations without human interaction such as outages due to weather, focus changes due to temperature shifts, and optical seeing variations. Sohbrit can collect large volumes of data nightly due to its high level of automation.

Sohbrit is the first COTS system we are aware of to fully automate the process of multispectral geosynchronous characterization from scheduling all the way to processed, disseminated data. In this presentation, we will discuss design decisions, issues encountered and overcome during implementation, and results produced by Sohbrit.

Use Case

The Sohbrit system has recently been used to search for anomalies in satellite orbits and record images of those anomalous satellites. Initially, the system takes images of the geosynchronous belt with a wide-angle camera. Sandia software automatically differentiates satellites from stars and uses a satellite TLE (two-line element) catalog to correlate the in-view satellites with the catalog's ground truth. A task for the narrow-field-of-view Sohbrit telescope is created and Sohbrit will image the anomalous satellites for closer inspection. Imaging, analyzing, correlating, scheduling, tasking, and final imaging can all done without a human in the loop.

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Figure 1 Sohbrit Facility

From left to right and top to bottom:

M42 - Orion Nebula, Iridium 96 (satellite streak), Telescope & Cameras, wide-angle telescope image.

Biographies

Kai Anderson has an M.S. in Computer Science with an emphasis in Human Computer Interaction from Utah State University as well as a B.S. in Computer Science. He is currently developing software at Sandia National Laboratories within the Space Mission Architectures and Concepts group. At Sandia he has worked on several projects including user interface efforts, developing prototype systems, as well as data collection & processing projects such as Sohbrit.

Nathanael Brown has an M.S. in Electrical Engineering with an emphasis on Digital Signal Processing from Purdue University and a B.S. in Electrical Engineering from the University of New Mexico. He has been a software/electrical engineer at Sandia National Laboratories for the last 15 years after working for 10 years in industry. Nathanael focus has been on developing advanced software algorithms including metaheuristic optimization, social network analysis and anomaly detection. He has applied these techniques to domains including transportation, satellite range scheduling and other national security applications.

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