AAS AWARDS at the 2021 AMOS CONFERENCE

Cindy Schumacher

The 22nd annual, and first hybrid, Advanced Maui Optical and Space Surveillance Technologies (AMOS) Conference, and EMER-GEN® program for students and young professionals ages 17-35, both presented by Maui Economic Development Board (MEDB), fostered international collaboration on space environmental issues. The three-day conference, devoted to Space Situational Awareness (SSA), Space Domain Awareness (SDA), and Space Traffic Management (STM), offered a cross-section of private sector, government, and academic participation worldwide.

"We thank the American Astronautical Society's (AAS) Space Surveillance Technical Committee for their continued collaboration on the 4th annual AMOS Conference Best Paper and Best Student Paper Awards," said Leslie Wilkins, President and CEO, MEDB. "Also, in collaboration with AAS, select papers presented at this year's conference will be peer-reviewed and published in a special issue of the Journal of Astronautical Sciences. We are grateful to AAS and the Committee for acknowledging the technical merits and state-of-the-art contributions of the AMOS community."

Paul Kervin, AMOS Conference Technical Chair, said, "We have been working closely with AAS for several years. The collaboration has added to the quality of the conference in several ways. One of those ways is the technical award process. We have a rigorous and in-depth review that involves dozens of AAS members, experts in government, academia, and industry, in both the evaluation and the determination of the Best Paper and Best Student Paper Awards."

For more information on the AMOS Conference, visit amostech.com

AAS BEST PAPER AWARD

The AMOS Conference Best Paper Award was presented to C. Channing Chow II, Ph.D., founder and CEO of Cloudstone Innovations LLC, for *Cislunar Orbit Determination Behavior: Processing Observations of Periodic Orbits with Gaussian Mixture Model Estimation Filters.*

Abstract

Orbits of objects in cislunar space are, in general, non-Keplerian due to the influence of the Moon's gravity and cannot be generically parameterized by a simple set of characteristics. Objects are also fainter and move relatively more slowly when viewed from Earth. Detection and tracking are expected to be significantly more difficult and as a consequence, orbit determination becomes more challenging. In this paper we review a subset of possible orbits and their expected astrometric and photometric signatures from the perspective of hypothetical ground-based electro-optical sensors on Earth. Although a multitude of orbits are possible, we focus on special types of orbits that are closed in the synodic frame (i.e. periodic) and emanate from the libration points of the Earth-Moon system. We investigate three separate elemental periodic orbit families that have been differentially corrected in a high-fidelity dynamical system: H1, L1, W4W5. For each family, we set objects at different locations at different epochs and simulate the expected observational features (e.g., right ascension, declination, visual magnitude) based on faceted satellite models. In this study, we show how Gaussian mixture model estimation filters behave when processing different observation sets, specifically varying data cadence, data density, data quality, and data span. Convergence and uncertainty bounds are shown to have a strong dependence on the observational data composition (affecting the accuracy of fitting orbits) and a notable correlation to orbital stability (affecting the ability to predict/correct orbits).

AAS BEST STUDENT PAPER

The AMOS Conference Best Student Paper Award was presented to Shaylah Mutschler, University of Colorado (Boulder), for *Application of SoleiTool for Density Estimation using CubeSat GPS Data.*

Abstract

A key requirement for accurate trajectory prediction and SDA is knowledge of the non-conservative forces affecting space objects. These effects vary temporally and spatially and are primarily driven by the dynamical behavior of space weather. Existing SDA algorithms adjust space environment models based on observations of calibration satellites. Still, lack of sufficient data and mismodeling of non-conservative forces can cause inaccuracies in space object motion prediction. This work aims to improve our modeling of non-conservative forces, specifically atmospheric drag, by leveraging observations of objects not typically utilized for space environment monitoring. Recently, there has been a rise in popularity of LEO CubeSats, with several companies establishing commercial CubeSat constellations for remote sensing and communication applications. Our research takes advantage of the abundance and quality of CubeSat GPS information to infer the space environment affecting their motion. We explore rigorous and practically realizable means to utilize CubeSats as indirect sensors of the space environment. The focus is on atmospheric density for more accurate prediction of LEO object motion. In our previous work, we developed SoleiTool to estimate forcing parameters of a physics-based space environment model using debris tracking data. In this work, we expand SoleiTool's Capabilities to estimate parameters of TIE-GCM using CubeSat GPS information. Precise Orbit Determination (POD) information from nine CubSats over 11 days is used to sense a global density field when historical data shows two geomagnetic storms via elevated Kp values. This paper explores three SoleiTool approaches to estimate atmospheric density, and compares them to the operationally used model, as well as MSIS. We conclude with a suggestion for which approach is recommended moving forward.