

IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Interactive Presentations - IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (IP)

Author: Mr. Nijanthan Vasudevan
Drexel University, United States

Ms. Cassandra Paoli
United States

Mr. Oudayl Massat
Space Generation Advisory Council (SGAC), United States

Mr. Arjuna Karthikeyan Senthilvel Kavitha
Drexel University, United States

CASSINI: ADVANCING ASTROBIOLOGY WITH INTEGRATIVE ROBOTICS & ARTIFICIAL
INTELLIGENCE

Abstract

The pursuit of understanding life's potential in the universe motivates our development of advanced systems integrating robotics and artificial intelligence (AI) for enhanced astrobiological exploration. We aim to overcome the challenges of vast and unpredictable space environments, enabling more precise and efficient investigations across extraterrestrial bodies.

Our methodology centers on autonomous robotic explorers equipped with AI-driven tools for in-situ analysis of extraterrestrial samples (soils, atmospheres, and bodies of water). Machine learning algorithms drive the identification, classification, and detailed analysis of astrobiological materials – a process greatly enhanced by our CASSINI (Cognitive Astrobiology Surveyor with Sample Identification Navigation Intelligence) tool.

We've developed a novel AI framework enabling real-time decision-making, adaptive learning, and autonomous navigation – critical for conducting complex scientific missions in space. This framework supports biosignature searches, planetary habitability assessments, and comprehensive investigations of planetary geology and chemistry.

The effectiveness of these integrative systems has been validated through comprehensive simulation and field tests in Earth-based analog environments. Results underscore the systems' enhanced operational autonomy, superior data acquisition, and analytical precision. These advancements not only expand operational capabilities but also offer potential benefits for safe and effective extravehicular activities (EVA).

In conclusion, the integration of robotics and AI represents a transformative approach to astrobiological exploration. This synergy significantly broadens the research scope and efficiency while propelling the interdisciplinary field of space life sciences. Our study emphasizes the pivotal role of these technologies in expanding our knowledge of life's distribution, potentially leading to the groundbreaking discovery of extraterrestrial life.

Keywords: Astrobiology, Robotics, Artificial Intelligence, Space Exploration, Autonomous Systems, Biosignatures, Planetary Habitability, EVA