Yrithu Thulaseedharan Pillay, PhD
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Biography:

Dr. Yrithu Thulaseedharan Pillay is an Assistant Professor in the Department of Mechanical and Aerospace Engineering at Western Michigan University (USA). His research interests include astronautics and orbital mechanics, aircraft and spacecraft dynamics, artificial intelligence and machine learning-based guidance, navigation, and control (GNC) for spacecraft and UAVs. He has taught courses in Orbital Mechanics, Neural Network-based techniques for Aerospace Engineering (graduate level), and Control Systems at various levels.

Dr. Pillay earned his PhD in Electrical Engineering and Computer Science from Wichita State University (USA) in 2024, where his dissertation focused on applying Artificial Neural Network-based machine learning to cislunar estimation, prediction, and control. He also holds a Master's and Bachelor's in Aerospace Engineering. He has published research at AIAA SciTech and AAS/AIAA Astrodynamics Specialist conferences, and is a recipient of the Dwane and Velma Wallace Graduate Teaching Assistant Award for excellence in teaching.

Intelligent control techniques for spacecraft GNC

The renewed interest in lunar missions and the push toward Solar Electric Propulsion (SEP) brings new challenges. SEP delivers propulsion at high efficiency but with very low thrust, resulting in mission durations of weeks or months. Throughout these long transfers, the spacecraft traverse cislunar space under the combined gravitational influence of the Earth and Moon, requiring the three-body problem to be solved for trajectory analysis. Even minor errors in trajectory planning, arising from unmodelled effects such as solar radiation pressure, lunar ephemeris errors, and high-order gravity terms, can lead to significant deviations. This concern is far more pronounced for low-thrust missions than for impulsive maneuver-based missions like Artemis II. To address this, AI and Machine Learning techniques were applied to improve state estimation in the presence of unmodelled dynamics, demonstrating significant reductions in estimation error under worst-case conditions. Building on this, ML was used to learn and predict environmental dynamics, and the estimation scheme was integrated with a real-time controller to provide closed-loop feedback control.

This work naturally extends into two related directions. The first is to explore the use of AI/ML techniques in satellite swarms, which are groups of satellites operating together to achieve a shared goal. This work focuses on intelligent, adaptive control for swarm formation, obstacle avoidance, and swarm healing in the event of member failures. The second explores broader AI/ML approaches for spacecraft and UAV navigation, leveraging the foundation established in the cislunar work. Both directions represent active and growing research programs, with the long-term goal of developing robust, intelligent autonomy for spacecraft and UAV operating in complex and unpredictable environments.