Biography

Dr. Hung (Jim) La is the director of the Advanced Robotics and Automation (ARA) Laboratory and an associate professor of the Department of Computer Science and Engineering, University of Nevada, Reno.

Dr. La is an expert in Robotics and Control Systems. He has authored/co-authored 2 patents, 1 software copyright, and **160 papers** in major journals and international conferences. **12** of his papers have won best conference paper awards and best paper finalists in the top-ranked conferences (AHFE2024, ACIIDS2024, IROS2022, SII2022, IROS2019, SSRR2018, ICRA2017, ISARC2015, etc.) He was a key member of the CAIT team (Rutgers University) who successfully developed the Robotic Assisted Bridge Inspection Tool (RABIT) for the Federal Highway Administration in 2013. He has managed 28 Federal and Industry funded projects (NSF, NASA, US-DOT, Industry) as the role of PI, Co-PI, and SP. Dr. La received prestigious awards including the 2023 UNR's Established Innovator Award, the 2019 NSF CAREER, the 2014 ASCE's Charles Pankow for Innovation, and the 2017 and 2019 Best CSE Researcher Awards.

Project title: RFA-078: Multi-altitude Guidance and Control System

Project Summary

Background: Robotic platforms (e.g., Superpresure Balloon by Jet Propulsion Laboratory (JPL), Air Ballast Balloon by Google Loon, Hybrid Airship by Northrop Grumman, and Japan's Venus climate orbiter Akatsuki, etc.) need multi-altitude guidance and control systems to allow them to work optimally to explore and collect data in Venus's atmosphere. However, there are currently few research and development efforts related to the guidance and control of Venus's aerial platforms [2]. Without these measures in place, the Venus aerial platforms are not able to operate efficiently or collect data.

Objectives and Methods: This project's five SMART objectives and five associated deliverables will lead to the creation, testing, and validation of two algorithms. These algorithms will address the challenges NASA faces when navigating Venus's atmosphere and enable precise aerial platform positioning, ensuring optimal altitude and path finding within the planet's middle atmosphere. To achieve these SMART objectives and deliverables, first, we will develop a localization algorithm, called the maximum correntropy criterion-extended Kalman filter (MCC-EKF), to allow the aerial platform to locate itself in Venus's middle atmosphere. Second, we will develop a vertical and lateral control algorithm that considers the localization outcomes and supports the aerial platform to find an optimal altitude and lateral path. The vertical control will be constructed based on the artificial potential field approach, and the lateral control will be done via the *belief*-based online partial observable Markovian decision process (POMDP). These algorithm developments will allow us to understand the aerial platform localization and navigation needed to explore Venus's atmosphere.

Plan and Collaboration: This work will be performed by the Science PI, Dr. Hung (Jim) La, and

his Ph.D. student in collaboration with NASA JPL scientist Dr. James Cutts. He will support Dr. La's team by facilitating access to and interpretation of Venus data to train and validate the developed algorithms (see the letter of support). Dr. La will have the opportunity to collaborate with Dr. Cutts to work on Venus's aerial platforms, even validating the proposed algorithms on the newly developed Venus Variable-Altitude Aerobot (VVA) simulation and prototype [3]. With the support of Dr. Cutts and his team, Dr. La can focus on atmospheric modeling and navigation for this VVA platform. Additionally, JPL will provide insight into their data to help Dr. La's team analyze and interpret it to feed the localization and navigation algorithms. The insights from JPL scientists are critical for this project since the analyzed radar and SAR data will lay the foundation for the next objective: creating a vertical and lateral navigation control algorithm. The project fits NASA's focus area (RFA-078) "Aerial Platforms for Missions to Measure Atmospheric Chemical and Physical Properties."

Expected outcomes: The major outcomes created as part of this project are the localization algorithm and the control and navigation algorithm. Since JPL is currently lacking efficient guidance and control mechanisms for Venus's aerial platforms, it is difficult for NASA to launch Venus's exploration mission. Thus, these two algorithms will advance science and meet NASA's research needs. The new development of the MCC-EKF-based localization and the *belief*-based online-POMDP for lateral motion planning will help mankind explore our sister planet.