HIGH PERFORMANCE COMPUTING MODERNIZATION PROGRAM

RESEARCH PROJECT #: HPCMP-FIX-24-034-F

Automated Data Fusion Techniques for Improved Tracking and Characterization of Near Space Objects

About: Maui High Performance Computing Center (MHPCC) DoD Supercomputing Resource Center

The Maui High Performance Computing Center (MHPCC) DoD Supercomputing Resource Center (DSRC), established in 1993, is an Air Force research Laboratory (AFRL) Center managed by the University of Hawaii under contract to the Air Force Research Laboratory's Directed Energy Directorate at Kirtland Air Force Base, New Mexico. The MHPCC DSRC operates as one of the five DoD Supercomputing Resource Centers in the DoD's High Performance Computing Modernization Program (HPCMP).

RESEARCH LOCATION: Kihei, HI

PROJECT DESCRIPTION:

Multiple sources of data exist for many satellites and objects in near earth orbit, including telescopes of various wavelengths and locations, radars, and laser ranging devices. Unfortunately, coordinating and making effective use of these different data sources has been challenging because of limitations in the timely dissemination of data, computational resources, and registration and alignment of images and data of different modalities. Modern high performance computers and machine learning techniques offer a potential solution to this dilemma by enabling automated data fusion in a near real time context.

Demonstrating the ability to track one resident space object can be done on a laptop at a trade show, but to simulate the tracks of 7,000+ satellites and 36,500 pieces of debris requires a supercomputer. These satellite's orbits are uncertain due to natural changes or human based maneuvers. This adds to the computational complexity of the task. This is a unique opportunity to for synergy between two national assets in the Pacific Theater MHPCC and MSSC.

This project will concentrate on data fusion, machine learning, and image enhancement techniques that can be applied across multiple sets of images taken at different times and even perhaps at different locations and/or of different portions of the electromagnetic spectrum. The goal is to seek automated techniques that can enhance, segment, and characterize an object in space more precisely from multiple sets of images and imaging modality than could be accomplished from each alone.

The successful faculty member will have great latitude to explore different approaches to accomplish this but will also be expected to be a self-starter who can deliver working software to our team by the conclusion of this internship.

Under the guidance of mentors, the faculty member will participate in software algorithm development in the areas of machine learning, AI, image processing, and data fusion. Specifically, the faculty member will apply modern high performance computing resources and techniques to space situational awareness in order to combine multiple sources of data into a single integrated product of higher fidelity than its constituent sources.

The faculty member will have access to cutting edge computational resources and imagery, with the opportunity to pioneer new techniques to leverage the two to great benefit to our nation and other peaceful users of space. The faculty member will develop and test their ideas in a fast paced co-located R&D environment in Maui, Hawaii.

Weeks 1-2: Learn about the research at Maui High Performance Computing Center. Meet the team. Take required training and receive proper access to coding environments, datasets, and required documentation. Talk through potential solutions for the prompt.

Week 3-4: Familiarize yourself with different kinds of modern machine learning architecture: supervised learning, unsupervised learning, and reinforcement learning. Conduct a literature review on the state of the art relating to the project. Conduct an analysis of alternatives for different approaches.

Weeks 5-8: Demonstrate a baseline model with one of the approaches. Continue the process of hyper-parameter tuning and incorporate more training data. Optimize the model through cross validation and regularization. Repeat with another model depending on results and feasibility.

Week 9: Develop a presentation of the faculty member's accomplishments and provide the faculty member feedback on their project.

Week 10: Presentation and out processing.

ANTICIPATED START DATE:

June 2024 – Exact start dates will be determined at the time of selection and in coordination with the selected candidate.

QUALIFICATIONS:

The ideal candidate must be full-time faculty from an accredited U.S. pre-college, college, or university with a background in Data Science, Image Processing, Data Fusion, Machine Learning, Artificial Intelligence, and preferably Space Situational Awareness too. A successful candidate would be able to research on site at the Maui High Performance Computing Center in Kihei, Hawaii. Adjunct or visiting faculty are ineligible.

ACADEMIC LEVEL:

Degree:

- Doctoral

DISCIPLINE NEEDED:

- Computer, Information, and Data Sciences
- Engineering
- Physics
- Science & Engineering-related