A Modular Swarm Optimization Framework Enabling Multi-Vehicle Coordinated Path Planning, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

The advancement of Unmanned Aerial Systems (UAS) with computing power and communications hardware has enabled an increased capability set for multi-vehicle collaborative operations. By cooperatively allocating unmanned resources, vehicle tasking, and planning the subsequent vehicle paths, the efficiency of UAS operations can be maximized. Heron Systems proposes to develop the Multi-Agent Cooperative Engagement (MACE) framework into a mature prototype that enables collaborative resource allocation, task allocation, and path planning for unmanned systems operating in dynamic environments subject to diverse communication conditions. This Phase 2 work will focus on refining the path planning portion of MACE as well as maturing the resource and task allocation library developed during Phase 1. The path planning architecture will define key modules to plan paths to a global objective, assess potential obstacles, and avoid collisions while maintaining progress towards the global objective. The framework will be constructed in a modular fashion to allow a plug-and-play capability for the resource/task allocation as well as the various components of the path planning pipeline, giving end users the flexibility to explore other methods for UAS collaboration. At the conclusion of Phase 2, the MACE framework will be demonstrated using Heron Systems' HWIL simulation/stimulation environment. Once verified via the HWIL environment, the MACE framework will be deployed onboard several aerial assets and tested against scenarios specifically tailored towards precision agriculture applications.

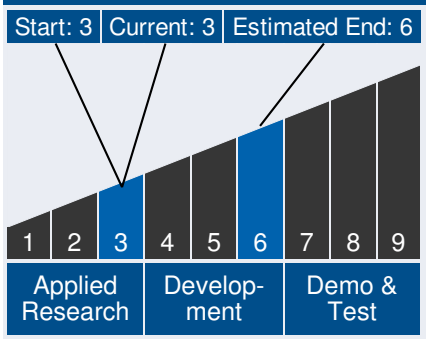
ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: Collaborative unmanned operations can offer NASA significant new capabilities in the areas of airborne science, weather monitoring and the ongoing study of UAS integration into the National Air

Table of Contents

Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

Space (NAS). We have identified the ongoing Unmanned Traffic Management (UTM) program and related studies being conducted at NASA Langley and NASA Ames. Collaborative capabilities can support several ongoing initiatives either directly or by offering capabilities that empower further opportunities. Methods for determining suitable paths in the presence of both compliant and non-compliant aircraft are vital for safe integration. Additionally, MACE can provide NASA with a framework for enabling safe terminal area operations where collaborative control can be used to guide entering and exiting UAS into safe and predictable flight patterns. A secondary NASA customer set will be the Aeronautical Earth Sciences programs operated by NASA Langley. MACE can empower enhanced data collection through the deployment of multiple sensors and increased coverage areas. Further, the flexible resource allocation capability can allow scientists to maximize their data collection time to focus on targets of opportunity that may not be fully understood prior to launching the mission. A third opportunity is insertion into the ongoing storm monitoring and prediction activities jointly conducted by NASA and NOAA. MACE can be used to supplement ongoing GlobalHawk flights to gather high fidelity data.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Commercially, MACE promises to dramatically improve the efficiency of operations of many envisioned UAS applications. Of particular interest are those in the areas of precision agriculture and aerial surveying. Heron Systems will build a service delivery model tailored for precision agriculture supporting rapid surveying of fields and follow-on tasking based on real-time findings. Similarly, a second product line will tailor to the needs of civil engineers supporting inspection requirements. Heron Systems is principally targeting the commercial market.

Management Team *(cont.)*

Principal Investigator:

- Kenneth Kroeger

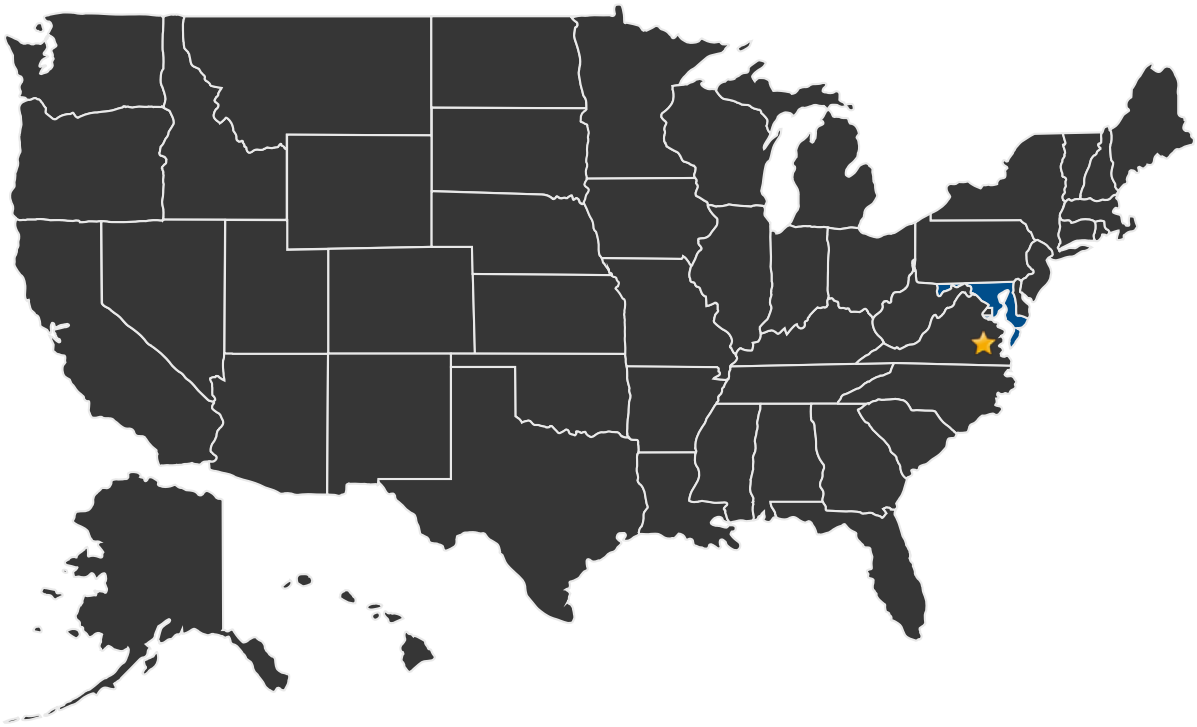
Technology Areas

Primary Technology Area:
Modeling, Simulation, Information Technology and Processing (TA 11)
└ Simulation (TA 11.3)
  └ Simulation-Based Training and Decision Support Systems (TA 11.3.4)

A Modular Swarm Optimization Framework Enabling Multi-Vehicle Coordinated Path Planning, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Langley Research Center

Other Organizations Performing Work:

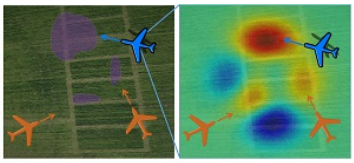
- Heron Systems, Inc. (Lexington Park, MD)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23163)

IMAGE GALLERY



A Modular Swarm Optimization Framework Enabling Multi-Vehicle Coordinated Path Planning, Phase II

DETAILS FOR TECHNOLOGY 1

Technology Title

A Modular Swarm Optimization Framework Enabling Multi-Vehicle Coordinated Path Planning, Phase II

Potential Applications

Collaborative unmanned operations can offer NASA significant new capabilities in the areas of airborne science, weather monitoring and the ongoing study of UAS integration into the National Air Space (NAS). We have identified the ongoing Unmanned Traffic Management (UTM) program and related studies being conducted at NASA Langley and NASA Ames. Collaborative capabilities can support several ongoing initiatives either directly or by offering capabilities that empower further opportunities. Methods for determining suitable paths in the presence of both compliant and non-compliant aircraft are vital for safe integration. Additionally, MACE can provide NASA with a framework for enabling safe terminal area operations where collaborative control can be used to guide entering and exiting UAS into safe and predictable flight patterns. A secondary NASA customer set will be the Aeronautical Earth Sciences programs operated by NASA Langley. MACE can empower enhanced data collection through the deployment of multiple sensors and increased coverage areas. Further, the flexible resource allocation capability can allow scientists to maximize their data collection time to focus on targets of opportunity that may not be fully understood prior to launching the mission. A third opportunity is insertion into the ongoing storm monitoring and prediction activities jointly conducted by NASA and NOAA. MACE can be used to supplement ongoing GlobalHawk flights to gather high fidelity data.