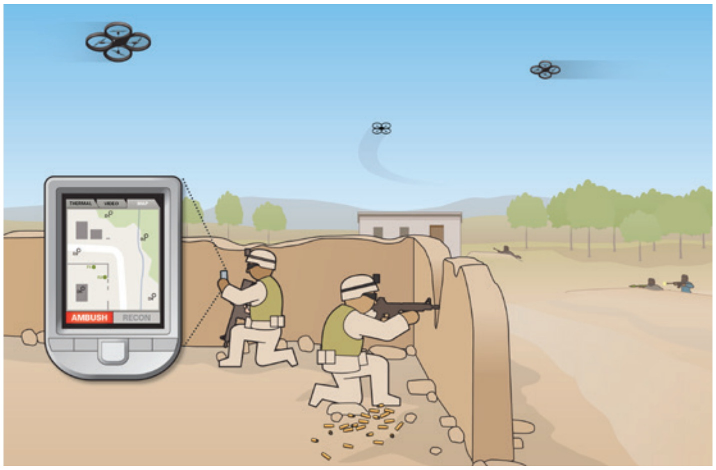
Group Autonomy for Mobile Systems



Project Lead: Dr. James Edmondson,
Software Engineering Institute (FFRDC) at Carnegie Mellon University

Accurate and reliable information gathering can save money, missions, and lives in a wide range of mission-critical scenarios: from search and rescue to active reconnaissance and ambush extraction. Recent advances in the commercialization of remote video, acoustic, motion, infrared (IR), and electromagnetic sensors offer the opportunity to improve information gathering, dissemination, and contextual reasoning of small squads in hostile, challenging environments at low costs. Due to these reduced costs and the robustness of existing platforms, we expect such remote sensors to become ubiquitous in future combat and disaster environments. However, deploying such sensors manually during important missions can be difficult, hazardous, and error-prone. Additionally, the sensors by themselves provide raw data that may be difficult for human operators to properly utilize without automated aids to help determine what information is useful to the mission context.

The Group Autonomy for Mobile Systems (GAMS) initiative aims to create middleware, user interfaces, and toolsets that provide powerful capabilities to human operators for controlling and understanding swarms of sensors, robots, unmanned aerial vehicles (UAVs) and other unmanned autonomous systems (UAS). In the field, a single user can efficiently define the mission for each UAS, and deploy them with little time and effort. Additionally, the GAMS systems integrate sensor information into the control interface, so one user can see what the sensors have detected to better respond to the situation.

For example, a swarm of small UAVs equipped with visual and IR sensors can be used to search a debris field for survivors. The user can define the search region simply by drawing a polygon on a map on his or her mobile device. Given this mission, thermal-sensor-equipped UAS will automatically partition the search region and collaboratively plan and execute a systematic search, showing possible survivors on the map as thermal hits.

Similarly for a reconnaissance mission, the UAVs can again scan a designated area, but this time using a random search pattern to make their movements unpredictable, thereby thwarting insurgent attempts to destroy them. Other search techniques, such as scanning a large area but concentrating on priority regions within that area—such as buildings, known hazardous regions, etc.--are also included within the interface and are available to operators in the same straightforward, easy-to-use manner.

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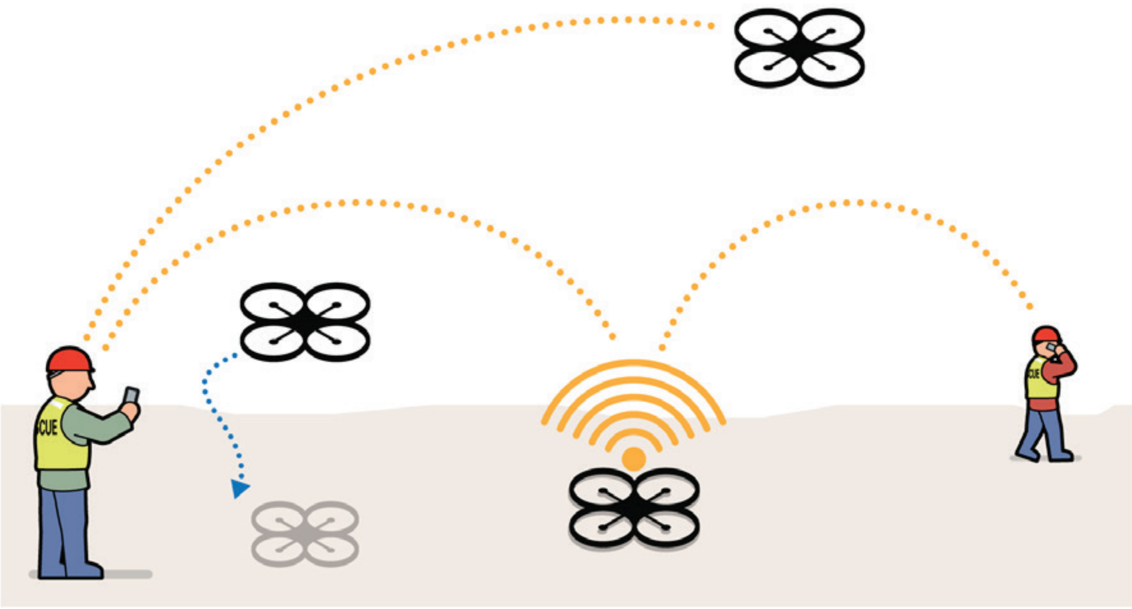

UAS may also be used to enhance communications networks, extending network range by “bridging” between devices, operators, or other UAS. This bridging functionality works in a similarly intuitive manner as searching. An operator creates two regions that must be connected on the interface, and the available UAS determine the resources needed to connect the regions, collaborate to establish a communication path, and move to their appropriate locations.

To accomplish our research objectives, we are creating new user interfaces and middleware that serves as a distributed operating system for swarm operations, is delay and fault tolerant, scales robustly in wireless networks, and is able to complement existing robotic software like the Robot Operating System (ROS).
The GAMS project includes researchers at the SEI and faculty and students from Carnegie Mellon University, with collaborations across Electrical and Computer Engineering, the Robotics Institute, and other departments. All software and hardware maintained by the GAMS team are well documented (over 30% of the code base is documentation, Wikis, and tutorials) and developed as open architectures, with the software released under a BSD license through the Group Autonomy for Mobile Systems (http://gams.googlecode.com), Multi-Agent Distributed Adaptive Resource Allocation (http://madara.googlecode.com), and Drone-RK (http://drone-rk.org) projects. This provides government agencies, contractors, and civilians with the ability to access, modify, and utilize the software using a variety of languages (C++, Java, and Python), architectures, and platforms. Future work for the GAMS team (subject to funding availability) includes: (1) investigations of GPS-denied autonomy using various localization schemes, (2) autonomous, distributed recognition of features, objects, etc. with and without human guidance, (3) large swarm autonomy (e.g. 25+ UAS), and (4) autonomy with reliable meter-accurate platforms such as military-grade GPS systems.

Contact Information

Email: jredmondson@sei.cmu.edu
Phone: 412-268-8905
Fax: 412-268-5758

Mail

James Edmondson
Software Engineering Institute
4500 Fifth Avenue
Pittsburgh, PA 15213-2612