



Resource Allocation and Path Planning for Multi-Vehicle Autonomous Source Localization and Mapping

Samuel Kemp

Advisors: Jonathan Rogers

Georgia Institute of Technology

skemp32@gatech.edu

Abstract:

Low-cost autonomous vehicles provide advantageous radiation sensing platforms for source localization and radiation mapping. Significant investment has been made in recent years to develop teams of unmanned aerial vehicles (UAVs) and unmanned ground vehicles (UGVs) that can perform these missions rapidly and autonomously. Such systems oftentimes leverage “swarm” control algorithms, which allocate vehicles to search or map particular spatial areas of the environment and compute vehicle trajectories that yield minimum-time solutions to the mapping or search problem. Several key challenges remain in the development of effective swarm control algorithms for radiation sensing and mapping, to include real-time mapping of unknown environments, communications limitations, and synthesis of measurements from multiple vehicles. When compared to other multi-agent planning problems, one unique feature of radiological search and mapping that makes this problem uniquely difficult, particularly when using UAVs, arises from the inverse square law governing radiation intensity. In most source localization and mapping problems, UAVs must fly at very low altitudes to obtain useful measurements. This requirement for low-altitude flight greatly complicates the problem of rapid search and mapping because oftentimes the locations of obstacles which impede the paths of the vehicles are not known a priori. Flight through obstacle-dense regions is inherently slower than through obstacle-free regions, prolonging sensing and traversal times. This work presents the development of a new multi-vehicle control algorithm for radiological search and mapping that seeks to discover obstacle density online. The algorithm then allocates resources to different geographic regions by balancing information-driven search with the objective of a minimum-time solution. A variety of path planning techniques can be coupled with this resource allocation approach, resulting in a comprehensive multi-agent control scheme applicable to heterogeneous vehicle teams. Basic simulation results will be presenting highlighting the promise of this new multi-objective control technique to radiological search and mapping problems.