Mechanical Planning Under Uncertainty for Unmanned Aerial Vehicles

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Abstract

Unmanned aerial vehicle (UAV) technology has grown out of traditional military and research applications and has flooded the commercial and consumer markets, showing the ability to perform a spectrum of autonomous functions. This technology has the capability of saving lives in search and rescue, fighting wildfires in environmental monitoring, and delivering time dependent medicine in package delivery. These examples demonstrate the potential impact this technology will have on our society. However, it is evident how sensitive UAVs are to the uncertainty of the physical world. In order to properly achieve the full potential of UAVs in these markets, robust efficient planning algorithms are needed. This presentation will address the challenge of planning under uncertainty for UAVs. We develop a suite of algorithms that are robust to changes in the environment and build on the key areas of research needed for utilizing UAVs in a commercial setting. Throughout this research three main components emerged: monitoring targets in dynamic environments, exploration with unreliable communication, and risk aware path planning.

Robust algorithms for managing the uncertainty of the physical world will be presented with results in both simulation and hardware experiments. FARSITE, a realistic wildfire simulation, is used for testing persistent monitoring of dynamic environments. Coordinated exploration is managed under the challenge of uncertain communication indoors. Teams of up to 8 simulated UAVs and 2 real UAVs are shown performing better when compared to a frontier-based method. We developed a novel probabilistic graph search algorithm, risk-aware graph search (RAGS), that minimizes the likelihood of executing high-cost paths. The algorithm shows improvements over traditional search algorithms like A* and D* over graphs with stochastic edge costs.

High level planning algorithms have been challenged in dynamic conditions where the environment is not modeled perfectly. In developing planners for uncertainty we ensure UAVs will be able to operate in conditions that they were unable to previously. We address the need for robustness in robotic monitoring, coordination, and path planning tasks.

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