Distributed Optimization for Cooperative Missions in Uncertain Environments

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Abstract

A cooperative mission involves the coordination of multiple controllable agents that share a common objective, often in an uncertain environment, with possible limitations imposed on cross-agent communication. In a multi-traveling-salesman type of problem, a ''mission'' is the process of controlling the movement of the agents to identify and ultimately visit (alone or in synchronized groups) ''target points'' with associated ''rewards'' so as to maximize the total collected reward.

In this work, we will show how to formulate and solve a receding horizon optimization problem adopting a ''hedge-and-react'' as opposed to an ''estimate-and-plan'' approach, thus bypassing the combinatorial and stochastic complexity of explicitly assigning vehicles to target points. We will present a key stability property and illustrate this approach through applications to a laboratory setting involving small autonomous robots with wireless communication capabilities. In a ''coverage control'' mission, agents with sensing capabilities are tasked with the problem of cooperatively discovering target points. We will discuss a distributed optimization approach aimed at (locally) maximizing the joint detection probabilities of random target points and illustrate its operation through an interactive software demonstration for environments that include multiple polygonal obstacles.