Cooperative control of small and micro air vehicles

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Abstract

The focus of this talk will be cooperative control techniques for small and micro air vehicles. There are numerous potential applications of this technology including aerial reconnaissance, border patrol, monitoring forest fires, oil fields, and pipelines, and tracking wildlife. This talk will present a general approach to cooperative control problems which can be summarized in four steps. The first step is to identify the coordination variables which are the minimal information needed to effect cooperation. The second step is to quantify the cooperation constraint and cooperation objective in terms of the coordinate variables. The third step is to develop a centralized cooperation strategy that acts upon the instantaneous values of the coordination variables to achieve the objectives. Finally, the fourth step is to use information consensus schemes to transform the centralized strategy into a decentralized algorithm. The consensus algorithms allow a team of vehicles to agree upon the instantaneous value of the coordination variables while connected through a noisy, intermittent, time-varying communication network.

We will also show several applications of our approach in the context of small unmanned air vehicles (UAVs). The first application will be to the problem of cooperative rendezvous. There are numerous military scenarios where it is desirable to have a team of UAVs converges simultaneously to a region of interest. However, pop-up threats, wind, and an unreliable communication environment make this problem extremely challenging for small UAVs. The second application will be distributed fire perimeter monitoring where a team of UAVs is tasked to monitor the border of a forest fire. The nature of the environment only allows communication when the UAVs are in close vicinity of each other. Therefore, cooperation must be achieved with only infrequent communication. The third application will be that of cooperatively tracking and targeting a moving ground target when sensor occlusions are probable.