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Multi-UAV Persistent Surveillance With Communication Constraints and Health Management

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This paper presents an extended formulation of the persistent surveillance problem first proposed in [1]. The extended formulation incorporates new communication constraints and a stochastic sensor failure model, in addition to modeling stochastic fuel flow dynamics and the basic constraints of providing surveillance coverage using a team of unmanned vehicles. Using a parallel, distributed implementation of an approximate dynamic programming algorithm, an approximate policy for the persistent surveillance problem can be quickly computed. Simulation analysis of this policy indicates that it correctly coordinates the actions of the team of UAVs to simultaneously provide reliable surveillance coverage and communications over the course of the mission, and appropriately retasks UAVs to maintain these services in the event of sensor failures.

I. Introduction

Unmanned aerial vehicles (UAVs) are becoming increasingly sophisticated in terms of hardware capabilities. Advances in sensor systems, onboard computational platforms, energy storage, and other enabling technologies have made it possible to build a wide variety of UAVs for a range of different mission scenarios[2,3]. Many of the mission scenarios of interest, such as persistent surveillance, are inherently long-duration and require coordination of multiple cooperating UAVs in order to achieve the mission objectives. In these types of missions, a high level of autonomy is desired due to the logistical complexity and expense of direct human control of each individual vehicle. Currently, autonomous mission planning and control for multi-agent systems is an active area of research[4–8]. These mission planning problems are especially challenging because the UAVs may be subject to unpredictable failures, such as loss of a critical sensor, damage sustained during flight, etc. Occurrence of failures may have a large negative impact on the overall mission performance, so it is important that the autonomous mission system account for the possibility of failures when

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