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Abstract

This paper presents a robust satisficing decision-making method for Unmanned Aerial Vehicles (UAVs) executing complex missions in an uncertain environment. Motivated by the info-gap decision theory, we formulate this problem as a novel robust satisficing optimization problem, of which the objective is to maximize the robustness while satisfying some desired mission requirements. Specifically, a new info-gap based Markov Decision Process (IMDP) is constructed to abstract the uncertain UAV system and specify the complex mission requirements with the Linear Temporal Logic (LTL). A robust satisficing policy is obtained to maximize the robustness to the uncertain IMDP while ensuring a desired probability of satisfying the LTL specifications. To this end, we propose a two-stage robust satisficing solution strategy which consists of the construction of a product IMDP and the generation of a robust satisficing policy. In the first stage, a product IMDP is constructed by combining the IMDP with an automaton representing the LTL specifications. In the second, an algorithm based on robust dynamic programming is proposed to generate a robust satisficing policy, while an associated robustness evaluation algorithm is presented to evaluate the robustness. Finally, through Monte Carlo simulation, the effectiveness of our algorithms is demonstrated on an UAV search mission under severe uncertainty so that the resulting policy can maximize the robustness while reaching the desired performance level. Furthermore, by comparing the proposed method with other robust decision-making methods, it can be concluded that our policy can tolerate higher uncertainty so that the desired performance level can be guaranteed, which indicates that the proposed method is much more effective in real applications.