

Title: Markov Decision Process based Trajectory Planning for UAVs under Uncertain Wind Conditions.

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In this paper we propose a Markov Decision Process (MDP) algorithm for path-planning of Unmanned Aviation Vehicles (UAVs) under varying wind conditions. Solutions to path-planning for UAVs are becoming increasingly necessary as autonomous UAVs continue to enter commercial and government spaces. Path-planning is inherently challenging, as UAVs need to account for dynamically changing flying conditions such as weather, obstacle or no-fly zones, degraded vehicle health and off-nominal battery power consumption. Machine learning methods such as Markov Decision Process (MDPs) have the potential to revolutionize how vehicles navigate in such uncertain environments. Previous papers have demonstrated the use of MDPs to optimize UAV path-planning for energy consumption under time-varying wind distribution. In this study, UAV trajectories from a pre-determined waypoint to target cell, will be computed on a 7X7 grid environment by optimizing parameters for mission assurance and safety limits in addition to the energy consumption, and operation time. The UAV navigates the grid by taking actions to move in either of the eight cardinal and intercardinal directions, under constant thrust profile. The next state of the UAV is calculated by considering its action, transition probability, obstacle cells and the wind speed magnitude and direction. Both constant and stochastic wind will be considered in this paper, the parameters being extracted from real wind measurements in proximity to an experimental UAV flight. One of the studies to be demonstrated in this paper is that as the unmanned airspace gets more complex with multiple vehicles and environmental uncertainties, trade-offs between energy consumption, operation time, risk tolerance, and mission assurance needs to be made. Further, MDPs are capable of fast computation of UAV trajectories under varying wind, hence making them suitable for in-flight path planners.