UAVRP with Moving Targets

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Our study is concerned with the optimization of the trajectory for an unmanned aerial vehicle (UAV) tasked with intercepting a designated array of n linearly moving targets within the d-dimensional Euclid ean space, where $d \in \{2, 3\}$ in practical scenarios. This problem presents a natural extension of the Unmanned Aerial Vehicle Routing Problem (UAVRP) with Dynamic Depots, as outlined in [1]. Its practical application finds pertinence in military strategy, particularly in orchestrating the routing of drones to engage adversary assets during transit.

The problem under consideration is classified as NP-hard due to its reduction to the Traveling Salesman Problem (TSP) in instances involving zero target velocities. Notably, the problem's complexity is compounded by a nonlocal cost function, where reordering targets can significantly alter temporal arrival sequences and interpoint distances. Consequently, conventional local optimization heuristics, such as the widely employed 2-opt method detailed in [2], are ill-suited for this problem domain.

Theorem. For all $n > \Gamma^{-1}(2d)$ (which holds for all instances of practical interest), there exists a combination of $n!$ real values such that there does not exist a problem instance with such route lengths. Here Γ^{-1} is the inverse of the gamma function, a commonly used extension of the factorial function.

Therefore, UAVRP with moving targets is not completely devoid of structure. In particular, we explore the insights provided by [3], which investigated the function expressing the distance to a rendezvous point with a single mobile target over time. Through our analysis of the compositional nature of these functions and their inherent properties, we outline promising avenues for future research endeavors.

References

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