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Planning Multiple UAVs to Visit Points of Interest Considering Flight Range and Service Time Constraints

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Abstract

Unmanned Aerial Vehicles (UAVs) have exhibited their value in both civilian and military applications in the recent years even though they have their own limitations such as limited flight ranges and high operation costs. Applications exploit the mobility of UAVs to service many customers located at Points of Interest (PoIs).One of the important Quality of Service requirements of these applications is to visit the determined PoIs during a given service time period. As the number of UAVs owned by the applications is limited due to the expensive price tag on UAVs, in real life applications, we face with an optimization problem. In this work we define this optimization problem as to minimize the number of used UAVs to service all the given PoIs during the given service time windows. Moreover we also aim to minimize the total traveled distance by all UAVs. The main constraints in the problem are UAV flight range and PoI time windows. We name this problem the Covering Maximum PoI by Multiple UAVs Problem (CMP/MUP.) As CMP/MUP can be classified as a combinatorial optimization problem, we use a greedy approach to reach a reasonable solution in an acceptable time period. Thus, we design a heuristic based solution called NN for Maximum PoI/ Multiple UAV (NN-MP/MU). In generic NN heuristic, one selects the nearest PoI as the next one unless it cannot return to base. However, in this case, another optimization problem appears which are related with the delays spent among the PoIs. Therefore, we adopted the NN method into the CMP/MUP such that NN-MP/MU first selects three nearest PoIs and the PoI causing the least delay is picked up within that set. The critical point is that selected PoI might not be the nearest, but the one from the closest three while satisfying all other constraints. The results of extensive simulation tests show the effectiveness of the proposed heuristic for different flight ranges, PoI topologies, and time windows.

Keywords: Unmanned Aerial Vehicles, Route planning, Genetic Algorithm, Optimization, Simulation

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