

UAV Route Planning For Maximum Target Coverage

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Abstract

The importance and the impact of using Unmanned Aerial Vehicles (UAVs) in military and civil operations are increasing. One of the challenges in effectively tasking these expensive vehicles is planning the flight routes to monitor the targets. This problem is related with the Multiple Travelling Salesman Problem (mTSP) and the Vehicle Routing Problem (VRP). In these well-defined problems, it is mostly assumed that travelling salesmen or vehicles should visit all the targets and the target function is defined as to find a minimum-distant route. Even, in the constraint versions of the mTSP and VRP, some other restrictions (visiting time windows, number of depots, etc.) are included; it is still assumed that there exists enough number of travelling salesmen or vehicles to cover all the given locations.

However, in reality the number and flight range of UAVs might be insufficient to cover all the targets. As a result, the maximization of the number of targets covered by the limited number of UAVs can be defined as a new problem. Thus, this article presents a solution for this practical optimization problem by modifying the Max-Min Ant System (MMAS) algorithm along with the local optimization technique accordingly.

In the proposed solution, each ant constructs routes for the given number of UAVs using pheromone and heuristic information. These routes are locally optimized using a modified 2-opt technique. After each iteration, the solution which covers more targets with less route distance is selected as the iteration-best solution and the pheromone values of the edges on that route are increased. According to the termination condition, the algorithm stops and outputs the best route found so far as the result. To evaluate the success of the proposed method, another approach, based on the Nearest Neighbor (NN) heuristic, is developed as well. Both solutions are implemented using MASON simulation library and compared by extensive experiments with different parameters and standard TSP data files. The results showed the success of the proposed MMAS method by increasing the number of covered targets up to %18 compared to the solution based on the NN heuristic.