A Local Optimization Technique for Assigning New Targets to the Planned Routes of Unmanned Aerial Vehicles

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Abstract

Using Unmanned Aerial Vehicles (UAVs) are one of the reconnaissance methods gaining popularity recently. Since UAVs are very expensive and scare resources, UAV route planning is vital for increasing their effectiveness in monitoring targets. Route planning can be static or dynamic. In static route planning, routes are constructed according to given UAVs and targets and do not change during the mission. However, in dynamic route planning, number of routes or UAVs can alter which requires the update of existing routes to adopt these changes. For example, some of the UAVs can be lost during the mission or new targets might pop up after the take-off.

This article proposes an iterative local optimization for the distribution of new targets to the existing routes in dynamic route planning. In the proposed solution, it is supposed that all UAVs have the same flight ranges, their initial routes are planned, and they have already visited some of the targets according to these routes. Furthermore, for each UAV, the slack range which is the difference between the flight range and initial route distance is calculated.

Whenever some new targets appear, the proposed iterative insertion algorithm executes as follows. In the first phase of the algorithm, an UAV with the highest slack range is picked and its route is modified by inserting a new target at a time. Adding a new target to an existing route causes an increase in the route distance, which is called update cost. If the update cost is not greater than the slack range, the new target is inserted to the route. After finishing attempts with all new targets, if any of them is left over, insertion process is executed with the UAV having the next highest slack range as described above until either all UAVs or new targets are finished. If there are still uncovered new targets after trying all UAVs, the algorithm proceeds the second phase in which a 2-opt technique is applied to the modified UAV routes for increasing the slack ranges. Then, the first phase of the algorithm is re-run for the remaining uncovered targets. Algorithm will terminate either all the new targets are covered or 2-opt technique does not produce any better slack ranges.

This local optimization technique is implemented using Mason simulation library and tested with various experiments for different parameter settings and TSP data files. The results showed the effectiveness and the success of the proposed iterative insertion algorithm.

In these circumstances, the routes of the UAVs must be re-calculated so that the unassigned targets can be covered by the existing UAVs.