3D Trajectory Optimization for UAV-Aided IoT Data Collection in 3D Terrain with Heterogeneous Data Demand

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이종 데이터 수요가 있는 3차원 지형에서의 UAV-Aid IoT 데이터 수집을 위한 3차원 궤적 최적화

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Abstract

UAVs have been becoming more and more important tools in the wireless communication field due to their non-terrestrial mobility. In this paper, we present a model with respect to design the 3D smooth trajectory of UAV for the data collection in 3D terrain. To get smoother trajectory, we introduce the Bezier curve. Moreover, since the problem is non-convex, we use the matrix-based differential evolution to optimize the proposed model.

Ⅰ. Introduction

Unmanned aerial vehicle (UAV) has become a more and more important role due to its dynamics and swift mobility characteristic, utilizing in many fields, such as search & rescue wildfire detection and especially wireless communication. In this paper, we focus on studying the rotary-wing UAV. The key point of UAV-enabled wireless communications is to plan a position where the UAV hovers or a flying trajectory to let the UAV finish the communication mission.

The proposed model has four main parts: trajectory representation, terrain representation, communication channel, and energy consumption model. We use Bezier curve to denote the trajectory that reduces the number of decision variables and let the trajectory be smoother [1]. To generate the terrain, Gaussian functions are employed in our model to represent the terrain. The communication channel is the air-to-ground channel [2]. We refine the energy model from [2] to a 3D energy model. The problem obviously is non-convex. Thus, we use a heuristic method, matrix-based differential evolution (MDE) to optimize it.

Ⅱ. Numerical Result

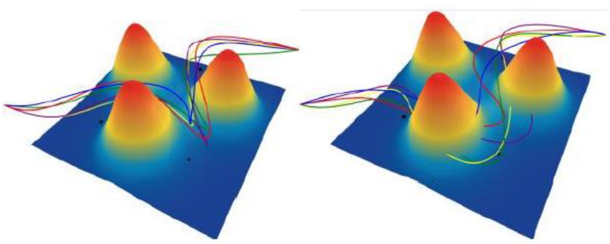

Fig. 1. The comparison of two scenarios with terrain and without terrain shown in 3D viewing angle.

Fig. 1 illustrates the optimization results of the trajectory in two scenarios with and without terrain under different date size requirement. We can see that all trajectories are smooth and in terrain scenarios the trajectories can avoid the obstacles.

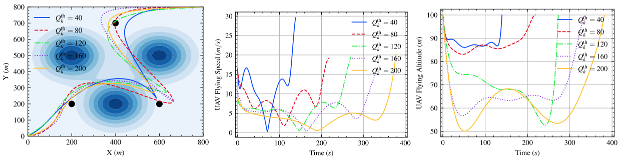

Fig. 2. The trajectory dynamics information, UAV 2D trajectory, UAV speed, and UAV altitude versus time.

Fig. 2 shows the trajectories' 2D trajectory, speed, and UAV altitude versus time. All the dynamics information curves in Fig. 2 are smooth enough.

Ⅲ. Conclusion

In this paper, we propose a UAV trajectory generating model considering terrain factors for data collection. To satisfy the requirement of smooth, we use Bezier curve to represent the trajectory. In the simulation, we use MDE to optimize the model. The Numerical results suggest that our model can generate the smooth trajectory and meet the data collection requirement effectively.

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