

Multi-UAV Cooperative Ground Target Tracking Based on an Improved Artificial Potential Field Method

Dongsheng Wang¹, Chang Liu¹, Bo Ma², Tianjiao Liang² and Bin Xu^{1,*}

¹School of Automation, Northwestern Polytechnical University, Xi'an 710072, P. R. China

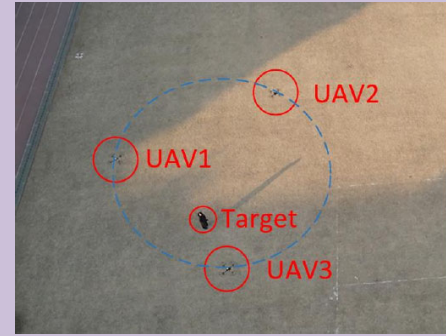
²Chengdu Aircraft Design & Research, Institute of AVIC, Chengdu 610065, P. R. China

*Corresponding author: smileface.binxu@gmail.com

Introduction

In this paper, we investigate the multi unmanned aerial vehicle (UAV) cooperative ground target tracking based on vision and communication information. Firstly, the UAV platform is established as the basis for the verification of target tracking tasks. Each UAV has a camera to observe the target and a processor to implement a deep learning algorithm to recognize and estimate the target position. In addition, the multi-UAV formation control method based on the combination of artificial potential field (APF) and virtual navigator is proposed. This method avoids collisions with obstacles and neighbors while obtaining a larger observation range. Finally, the real flight experiment results show that the target tracking algorithm realizes a reasonable position estimation and the formation control algorithm achieves continuous tracking of the target by the UAV formation.

Figure



The multi-UAV formation control method was tested in three UAVs target tracking experiments. During the actual flight experiment, multi UAVs must keep a safe distance to avoid collisions with obstacles and neighbors.

Mathematical Formulas

$$\mathbf{u}_i = - \sum_{j \neq i}^n \frac{\partial V_I(r_{ij})}{\partial \mathbf{r}_i} - \sum_{k=0}^{m-1} \frac{\partial V_h(h_{ik})}{\partial \mathbf{r}_i} + \mathbf{f}_{v_i} =$$

$$- \sum_{j \neq i}^n \frac{f_I(r_{ij})}{r_{ij}} \mathbf{r}_{ij} - \sum_{k=0}^{m-1} \frac{f_h(h_{ik})}{h_{ik}} \mathbf{h}_{ik} + \mathbf{f}_{v_i}.$$

The control law is shown above, and it can be modified by the artificial potential field of different virtual pilots as needed.

Conclusion

The multi-UAV formation control method based on the combination of APF and virtual navigator is proposed. Based on the establishment of a multi-UAV platform, the formation control law is tested in real flight experiment. Finally, the real flight experiment results show that the target tracking algorithm realizes a reasonable position estimation and the formation control algorithm achieves continuous tracking of the target by the UAV formation.