Control System Design for an Unmanned Helicopter to Track a Ground Target

XIN Zhekui[1], FANG Yongchun[2, *]

1 Beijing Aerospace Automatic Control Institute, Beijing 100854, China

2 Institute of Robotics and Information Automatic System, Nankai University, Tianjin 300071, China

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Abstract: Due to potential wide applications, the problem of utilizing an unmanned helicopter to track a ground target has become one of the most active research directions in related areas. However, in most cases, it is possible for a dynamic target to implement evasive actions with strong maneuverability, such as a sudden turn during high-speed movement, to flee from the tracker, which then brings much difficulty for the design of tracking control systems. Currently, most research on this field focuses on utilizing a ground mobile robot to track a high-speed target. Unfortunately, it is very difficult to extend those developed methods to airborne applications due to much more complex dynamices of UAV-target relative motion. This study investiages thoroughly for the problem of using an unmanned helicopter to track a ground target, with particular emphasis on the avoidance of tracking failure caused by the evasive maneuvers of dynamic targets. Specifically, a novel control scheme, which consists of an innovative target tracking controller and a classical flight controller, is proposed for the helicopter-target tracking problem. Wherein, the tracking controller, whose design is the focus of the paper, aims to utilize the motion information of the helicopter and the dynamic target to construct a suitable trajectory for the helicopter, so that when it flies along this trajectory, the relative pose between the helicopter and the dynamic target will be kept consant. When designing the target tracking controller, a novel coordinate transformation is firstly introduced to convert the tracking system into a more compact form convenient for control law design, the desired velocities for the helicopter is then proposed with consideration of the dynamic constraint. The stability of the closed-loop system are finally analyzed by Lyapunov techniques. Based on Matlab/Simulink environment, two groups of simulation are conducted for the helicopter-target tracking control system where the target moves along a linear path and takes a sudden turn during high-speed movement, respectively. As shown by the simulation results, both the distance error and the pointing error are bounded during the tracking process, and they are convergent to zero when the target moves straightly. Moreover, the tracking performance can be adjusted properly to avoid tracking failure due to evasive maneuvers of the target, so that to guarantee superior tracking performance for all kinds of dynamic targets.

Key words: unmanned helicopter, trajectory plan, target tracking

*Corresponding author. E-mail: yfang@robot.nankai.edu.cn

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