Aerospace Europe Conference 2023
Joint 10th EUCASS – 9th CEAS Conference

Abstract #XXX *(to be filled by the organizers)*
Preferred Topics: FDGNCAV / UAVFUT
Corresponding author: AYDINLI Sevket Utku
e-mail of corresponding author: uaydinli@aselsan.com.tr
Type: Oral
Status of corresponding author: Student

Title

Performance Comparison of Deep Reinforcement Learning-Based Quadcopter Guidance Algorithms

Authors

Sevket Utku AYDINLI [1], Ali Turker KUTAY [2]*

** Corresponding author*
[1] ASELSAN Research Center, Ankara, Turkey
[1,2] Department of Aerospace Engineering, Middle East Technical University, Ankara, Turkey
Email: uaydinli@aselsan.com.tr[1], kutay@metu.edu.tr[2]

Abstract

Reinforcement learning has been applied to quadcopter guidance [1, 2] in recent years. Acceleration-based closed-loop deep reinforcement learning guidance strategy is developed for quadrotor guidance with dynamics delays in [1]. Hovell et al. [2] proposed deep reinforcement learning to learn a closed loop multiagent real-time quadrotor guidance strategy for debris and damage inspections of aircraft runways.

This paper aims to compare the performance of reinforcement learning-based guidance strategies with classical closed-form guidance laws and model-based computational guidance algorithm for the quadcopter guidance problem. The engagement scenario of the quadcopter and the target in the vertical plane is formulated in RL framework by constructing an MDP with a reward function that aims to intercept the target with high precision in the shortest time. The relative kinematics between the quadcopter and the target are selected as environmental states and guidance command is defined as the agent action. Four different strategies of reinforcement learning-based guidance are proposed: 1) directly learning the complete guidance command, 2) learning the guidance coefficient of classical guidance algorithms, 3) learning the biased command which is applied by summing with the guidance command produced by the classical guidance algorithms, and 4) learning both the guidance coefficient and the biased command. Numerical simulations are performed to compare the performance of the proposed reinforcement learning-based guidance strategies with the Pure Proportional Navigation (PPN), True Proportional Navigation (TPN), Effective Pure Proportional Navigation (EPPN) and Model Predictive Control (MPC) algorithms.

The main contributions of this paper are threefold. Firstly, a novel reinforcement learning-based guidance strategy which learns both the guidance coefficient and the biased command have been proposed. Second, three guidance strategies have been proposed in which reinforcement learning-based guidance methods are used dependently, independently, and together with classical guidance algorithms in addition to the novel reinforcement learning-based guidance strategy. Third, the proposed reinforcement learning-based guidance strategies are compared with classical guidance methods and model-based computational guidance algorithm.

References

[1] Hovell, Kirk, Steve Ulrich, and Murat Bronz. "Acceleration-based Quadrotor Guidance Under Time Delays Using Deep Reinforcement Learning." *AIAA Scitech 2021 Forum*. 2021.

[2] Hovell, Kirk, Steve Ulrich, and Murat Bronz. "Learned Multiagent Real-Time Guidance with Applications to Quadrotor Runway Inspection." (2022).