Reinforcement learning drone control system for obstacle avoidance in forest

Paweł Miera, MSc, Tymoteusz Turlej, PhD

AGH University of Science and Technology, Cracow, Poland

Abstract

Reinforcement learning (RL) is making an increasing contribution to the control of robots. Simulation is a key step in the process of training the policy of the agent. This approach is also increasingly used in the field of drones, as discussed in the review article [1], in which the authors describe the growing interest in using these algorithms to control the speed and altitude of UAVs.

The prepared system was designed for autonomous forward flight and avoidance of trees encountered in the forest, based on readings from a rotating LiDAR sensor. Drone was controlled by setting the desired speed in XY axes. The flight altitude was set to a constant value.

The policy of Proximal Policy Optimization (PPO) agent was trained in a custom 2D simulator written in Python. RL agent was controlling the drone based on a 360-element array containing measurements from LiDAR sensor.

UAV flight control was performed using the Robot Operating System. All prepared scripts were first tested in the Gazebo simulator and then the prepared system was launched on a real drone. The UAV successfully flew through both virtual and real forests.

The results were as follows:

1. Custom simulator: Agents have been tested by completing 100 missions for random tree placements. The best success rate was 91%.
2. Reality: The system was tested 25 times:
   - 13 successful flights without hitting any tree.
   - 7 flights during which the drone hit one tree but continued.
   - 5 failed flights during which drone hit a tree and then fell.

Video abstract, that includes recordings of drone flights, is available at https://youtu.be/3umS0plbOS0.

Image



Figure 1: a) Custom 2D simulator, b) Drone flight in reality.

Recent Publications

1. Jithin Jagannath et al. (2020) Deep Learning and Reinforcement Learning for Autonomous Unmanned Aerial Systems: Roadmap for Theory to Deployment. DOI: 10.48550/ARXIV.2009.03349.
2. Antonio Loquercio et al. (2019) Deep Drone Racing: From Simulation to Reality with Domain Randomization. CoRR abs/1905.09727.
3. Alejandro Rodriguez-Ramos et al. (2019) A Deep Reinforcement Learning Strategy for UAV Autonomous Landing on a Moving Platform. Journal of Intelligent & Robotic Systems 93, 351–366.
4. Yunlong Song et al. (2021) Autonomous Drone Racing with Deep Reinforcement Learning. CoRR abs/2103.08624.
5. Antonio Loquercio et al. (2021) Learning High-Speed Flight in the Wild. CoRR abs/2110.05113.

Photograph



Biography

Paweł Miera is a graduate of Automation and Robotics at AGH University of Science and Technology in Cracow. During his studies, he attended the AGH Drone Engineering science club, where he researched drones and their control. Nowadays, he is working on drone-related projects.

Email: miera@student.agh.edu.pl

Notes/Comments: