Reinforcement Learning Final Project: Vision Based Quadrotor Obstacle Avoidance

Objective:

The goal of this project is to implement the findings from the research paper titled "End-to-End Motion Planning of Quadrotors Using Deep Reinforcement Learning" by E. Camci, et al, 2019.

The paper introduces a novel approach to quadrotor motion planning, emphasizing the use of raw depth images for reinforcement learning.

It is mandatory for teams to implement their project using Microsoft AirSim. Any other environments are not acceptable for this implementation. This requirement ensures a standardized evaluation and comparison of results across all student projects.

Overview of the environment:

For this project we are using Airsim Blocks environment. This environment is available pre-built for Window and Linux. If you are using a Linux distribution that have compatibility issues with Airsim the easiest way is to install a new Linux on an external SSD drive from scratch. Instructions to do so are available here.

The project consists of three tiers, progressively introducing complexity (The RL algorithm selection is at the discretion of the team, allowing for the use of custom algorithms or pre-existing stable baselines)

Project Tiers:

1. **No Obstacle Setting:**
    - Objective: Quadrotor follows a global path from the current position to the goal without encountering obstacles. We define the *global path* as the straight line that connect a start position to the goal location. In this tier we do not incorporate any vision.
    - Emphasis: Establishing the quadrotor's ability to navigate the global path.
2. **One Obstacle setting:**
    - Objective: Quadrotor navigates the global path while avoiding a single obstacle.
    - depth images from the onboard camera is used to sense obstacles during the obstacle avoidance process.
    - After successfully navigating around the obstacle, the agent is required to rejoin the global path.
3. **Multiple Obstacles setting:**

- Objective: Extend the agent's capability to navigate the global path amid multiple obstacles and rejoining the global path after avoiding each obstacle.

Team Collaboration:

- Teams of two can collaborate on the project.

Final Deliverables:

- 10-minute presentation highlighting architecture, challenges, and results.
- Submission of presentation slides, a presentation video, and well-documented, organized code.

Evaluation Criteria:

- Grades are based on the fidelity of the implementation to the paper's methodology, presentation quality, and achieved results.
- The speed at which the quadrotor successfully avoids obstacles is a crucial factor in the final evaluation. Teams should prioritize the efficiency and agility of their reinforcement learning agent in navigating around obstacles within the specified environment.

Final Note:

This project provides students with a focused implementation of a state-of-the-art approach to quadrotor motion planning using raw depth images. The chosen paper serves as a guide for the project's architecture and methodology, offering a structured and targeted exploration of deep reinforcement learning for this specific application.

Students are not only encouraged to implement the methodology outlined in the selected paper but are also given the opportunity to modify and enhance the algorithm. If a team successfully modifies the algorithm and achieves superior results compared to the referenced paper, it qualifies for consideration as a *conference paper*. This provides an additional incentive for students to explore innovative enhancements and contribute new insights to the field of deep reinforcement learning for quadrotor motion planning using raw depth images.

Best of luck with your implementation and potential contributions to the field!