19 - Open-Source Hardware Artificial Intelligence Robotic Racing Drone for Future AI Competitions

In recent years, drone racing has garnered increasing public interest. So too have drone races where the drone is not controlled by a human but by Artifical Intelligence (AI). Races such as the IROS Autonomous Drone Racing pose teams with the challenge of flying through a series of gates in the shortest timespan. To make the quality of AI the deciding factor, all teams were supplied with the same drone. However, this poses challenges to both the organisation who need to supply these drones, and to the teams that could not acquire such a drone and as such could not test their algorithms.

Mission Objective

In order to overcome the issues of previous years' competitions and to support the development and advancement of AIs, Group 19 of the 2020 Spring DSE will design open-source hardware for future AI drone races. Furthermore, the group will also develop software for the drone, serving both to demonstrate the drone's capabilities and serving as a basis for future teams to develop their own programs on.

System Design

In order to design the drone, the group is split into six divisions, each of which works on a specific aspect of the drone.

Propulsion selects the batteries, engines and propellers. This is done by building databases of components, selecting components that can work together and after this the configurations are verified and the best configuration is chosen and validated.

The Electronics division is responsible for determining the system architecture and all other electrical components, such as computers, the camera and wiring. Off-the-shelf components were chosen by means of a trade-off, while the carrier board was custom designed to optimise weight.

Structures is the division responsible for ensuring the structural rigidity and protection against impact of all other components. A frame configuration has been determined in the midterm phase. Then, loads were calculated to determine the materials and manufacturing techniques of the various structural components.

The software has been written by three divisions; Machine Vision & State Estimation determines the location, velocity and orientation of the drone relative to the gate using the images from the camera. Navigation uses this information to determine where the drone shall move. For this purpose, a variety of methods of varying complexity from different fields have been demonstrated, including machine learning and deep reinforcement learning. Control & Stability provides software that, based on the waypoints determined by Navigation and measurements from instruments, is able to generate commands that are outputted to the Betaflight flight controller firmware, which then directly controls the drone state. Finally, a simulation program has been developed to test the aforementioned programs.