Nano-copter AI challenge

There is a surge of interest in the artificial intelligence (AI) of tiny drones. Because of their light weight these drones are safe and thanks to their small size they can navigate in very narrow spaces. However, their small size and light weight also pose an extreme challenge for autonomous flight, since the drones can only carry very few sensors and very little processing power and memory onboard.

IMAV 2022 envisages to advance the state-of-the-art in vision-based autonomous flight of tiny drones by organizing the "Nano-copter AI challenge".

Goal:

In the competition a nano-copter, Bitcraze's Crazyflie, will have to fly as fast as possible through an obstacle zone with the help of a single camera and a small neural network processor (Bitcraze's AI deck).

The score is mainly determined by the distance covered inside the arena within the allotted time, but the drone can gain extra points by passing through orange gates that are present inside the arena. The locations of gates and obstacles, and the exact types of obstacles are a priori unknown. Moreover, obstacles can be moved during the competition run (but never in front of the drone, so that it does not have to deal yet with dynamic obstacles).

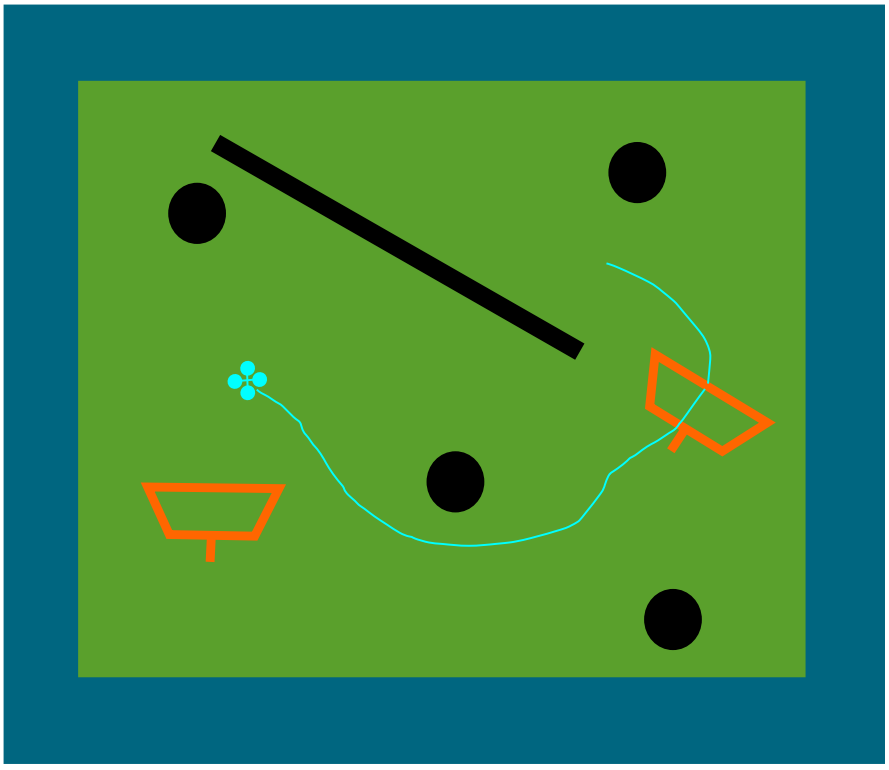

Illustration of the competition. The tiny blue drone needs to avoid obstacles and fly as fast as possible to cover as much distance as possible within the arena (green area). It can gain extra points by passing through orange gates. We are currently planning to fly in a 10 x 10 m arena, where the drone should stay in an inner 8 x 8 m area. The video shows the arena, the "Cyberzoo".

Score

Monocular obstacle avoidance is already challenging on larger drones with more processing power. This is the reason for the addition of the orange gates, as the detection of these gates can be performed with more well-known methods. Teams can tune the difficulty of the task to what they think to achieve, which is compensated for in the scoring. Specifically, teams can choose not to have any obstacles. In that case, their score is multiplied with the lowest scoring factor. Adding obstacles substantially increases the scoring factor, and allowing for obstacles to be displaced even further increases the factor:

- Only gates: env_factor = 1
- Gates and obstacles: env_ factor = 5
- Gates and dynamic obstacles: env_ factor = 10

The score is then determined as follows:

Score = (Distance x env_factor + gates passed x gate_scale x env_factor) x processing_factor

The gate_scale will be 10, i.e., passing through one gate counts as covering an additional 10 meters during the run. There will be 2 gates.

Finally, teams can either process transmitted images offboard or use the onboard processing for computer vision. It is more challenging (but also rewarding) to process all images onboard. Hence, the processing_factor is 1 if processing offboard, and 5 if processing onboard.

The obstacles can be of almost any type, although we will not use mirrors or transparent surfaces.

Rules

The score will be determined based on two 5-minute runs. The best run counts. A time slot will be 10 minutes: 2.5 minutes to set up, 5 minutes to fly, and 2.5 minutes to evacuate the area for the next team. We will accommodate for a practice opportunity for the teams.

Environment

The current video, simulator and graphics are based on the Cyberzoo flight arena at the TU Delft. However, the competition may take place elsewhere. Later versions of the rules will specify the competition environment in more detail.