Middle East Technical University

Robotics Society

18. International Robotics Days- 2022

Autonomous Unmanned Aerial Vehicle

Category Rules Part 1-Autopilot

1. AIM

- It is to complete the specified track as soon as possible with the least amount of errors.

2. RUNWAY FEATURES

- The track measures 10 x 10 meters.
- UAVs will take off from a 1x1 meter area from a defined edge point on the track.
- The height of the track is 10 meters.
- There will be gray profiles at the corner points of the track.
- The roof of the track and its surroundings will be covered with nets to prevent the UAVs from going out of the track.
- Cameras can be found at the corners of the walls of the track for shooting.
- Length indications may be found on the sides of the track.

- If UAVs fulfill their mission, they can land on any area within the runway.

3. ROBOT FEATURES

- Competitors must use a controller to start and stop their UAVs, take off manually and switch to autonomous mode. **It is strictly forbidden to control the UAV with a computer or to send commands to the vehicle.** All remaining functions must be performed on the UAV. It is forbidden to touch the controller, to process the data outside of the UAV and to give a remote command to the UAV after the UAV crosses the starting line and before it finishes the track.

- There should be a red bar on the UAV that will show the front of the UAV as shown in ANNEX-1.

- Competitors will pass a verbal test before starting their trial, in which the judges are asked to answer questions about how their autonomous UAV is controlled and communicated. Within the test, the codes of autonomous UAVs should be open to review by the referees. In addition, the referees can ask some questions over the codes. Contestants are required to answer the questions satisfactorily. After the required conditions are fulfilled and the questions are answered clearly, the contestants can start their competition.

- The trial-competition intervals of teams that use a component that emits an amount of electronic noise that may interfere with the flight of other teams may be restricted.

4. COMPETITION RULES

- Each UAV races in turn. The order of competition is determined by drawing lots.

- Competitors are required to use any of the flight control software in PX4 Autopilot v1.9.2 and later versions.

- Competitors can use flight control cards, for example Pixhawk, Navio2, APM Flight Controller, etc., as well as a companion computer, such as Raspberry Pi, ODroid,

Intel Edison, NVidia Jetson TX2, etc. Development should be done with MAVSDK on the Companion computer. Control over the ground control station will not be allowed.

- Competitors will complete the specified task by typing a new flight mode into the Firmware section of the autopilot software. (If they are using MAVSDK, there is no obligation to write a new flight mode) Competitors who do not use a companion computer should add flight mode to the firmware.

- Competitors can switch to the flight mode they have written with a remote control or other external stimulus.

- At this stage, the competitors can use GPS during the flight. (GPS Enabled)

- Competitors will upload the software to be used in the competition to the github page they specified during registration.

- Contestants will give access to the github pages to METU Robotics Community officials.

- Before the start of the competition, all competitors will be given 10 minutes to practice at a part of the course. This period can be changed on the day of the competition depending on the number of competitors.

- It is forbidden to fly a UAV outside the track.

- All UAVs will be collected after the trial period expires and before the competition starts. The UAV, whose turn it is to compete, will be taken to the track by the competitor.

- After the UAVs are collected, before the competition, the competitors will delete the software under the supervision of the referee and reload them from the github pages they specified during registration.

- The competitor has the right to race 3 times with the same UAV. The one with the highest score among these 3 rights will be used in the ranking criteria. The number of rights can be changed when necessary.

- It is forbidden to interfere with the software of the UAVs among the competition rights. Battery replacement and propeller maintenance can be done.

- After the UAV takes off, the UAV is given 150 seconds to complete Mission 1. +90 seconds are gained after completing Mission 1. +90 seconds of time is gained after completing Mission 2. In total, 330 seconds are given to complete all missions.

- The UAV, which is placed at the starting reference point for take-off by the competitor, can start the race with the approval of the referees.

- The competitor UAV is stuck, not moving on, falling, etc. In such cases or at the request of the competitor, the right to compete may be terminated. After informing the referee of this, the UAV will be closed and a safe environment will be created, and the competitor will be allowed to enter the track to take his UAV through the appropriate entrance gate.

- If the UAVs are dropped, the right to race fails and the next right to race, if any, is passed.

- While calculating the center of the UAV, the intersection point of the imaginary lines connecting the opposing engines is taken as reference.

- There must be a command or a command that enables the propellers of the UAVs to stop remotely. Security must be ensured while the UAVs are taken from the track.

- Damages that may occur to the UAVs during the trial and competition are within the responsibility of the competitor.

- In case of a technical problem in the course conditions, the referees may terminate the current trial and interrupt the competition.

- In order for the UAV to be deemed to have landed, the propellers must stop after landing.

5. FLIGHT MODE FEATURES and SCORING

Task-1

Purpose of the Mission:

- The vehicle scans the edges of an imaginary cube with dimensions of 5x5x5 on the x, y and z axis. (Axes are included in ANNEX-3.)

- Each edge of the imaginary cube should be crossed at least once. Each scanned edge earns **2 points**. Scanned edges can be scanned again, but do not bring extra points.

- The time given for Task-1 is 3 minutes. After the mission is completed, it should give a minimum 3 seconds pause in the air without switching to Mission-2.

Task-2

Purpose of the Mission:

- To ensure that the UAV makes the maximum number of tours around the equilateral triangle in accordance with the rules within the specified time and returns to the landing point from the point where it started the tour.

- The UAV will take off from the take-off point and navigate between the corners of an equilateral triangle as in the figure in ANNEX-2.

- During interpolation, the head angle of the UAV will constantly follow the point of interest, which is the midpoint of the equilateral triangle.

- Each successful round completed in accordance with the rules earns 4 points.

- The task duration is 2 minutes. Within the specified time, the UAV must have landed and stopped its engines.

- The UAV that gets the most points in accordance with the rules and successfully completes both missions will be the winner.

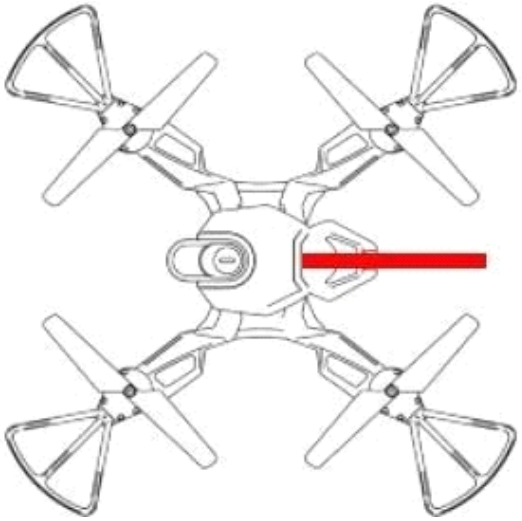
Considering the date and city of the competition, one should be cautious against any weather conditions that may occur.

As in all categories, the general category rules apply in the Autonomous Unmanned Aerial Vehicle-Autopilot Category.

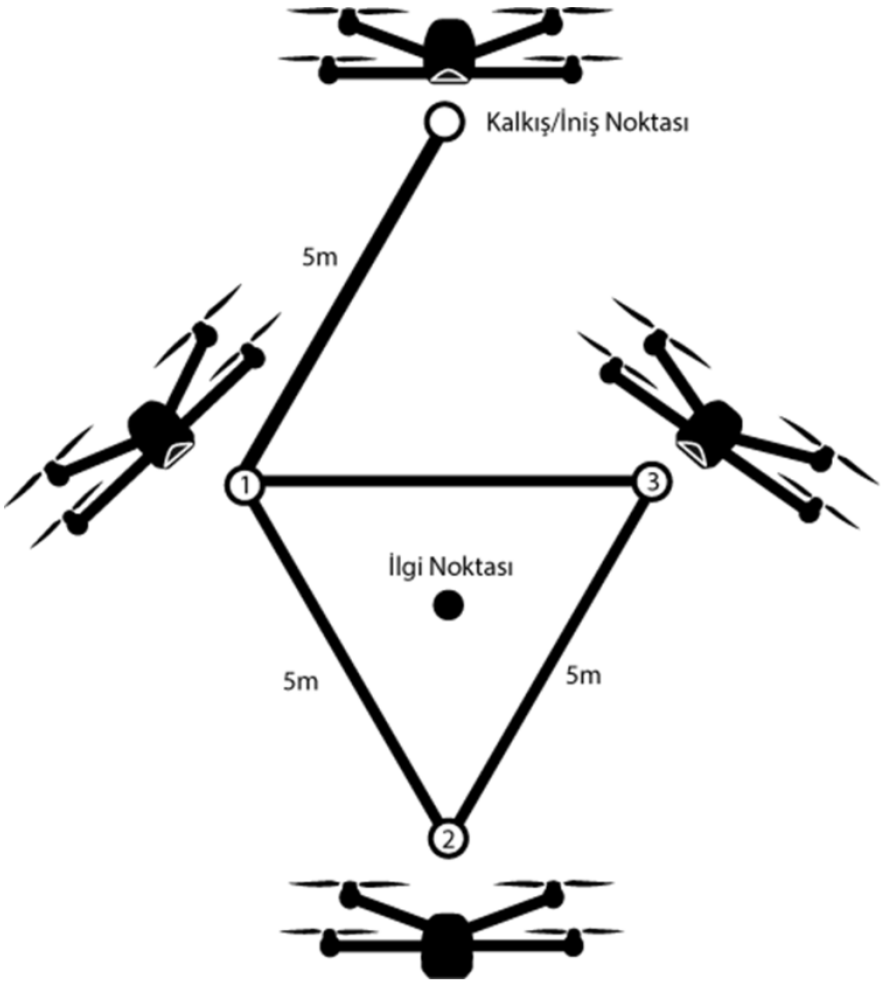
METU Robotics Society reserves the right to make changes in the rules if deemed necessary.

The software used by the competitors in the competition will be shared with the public as open source code after the end of the competition.

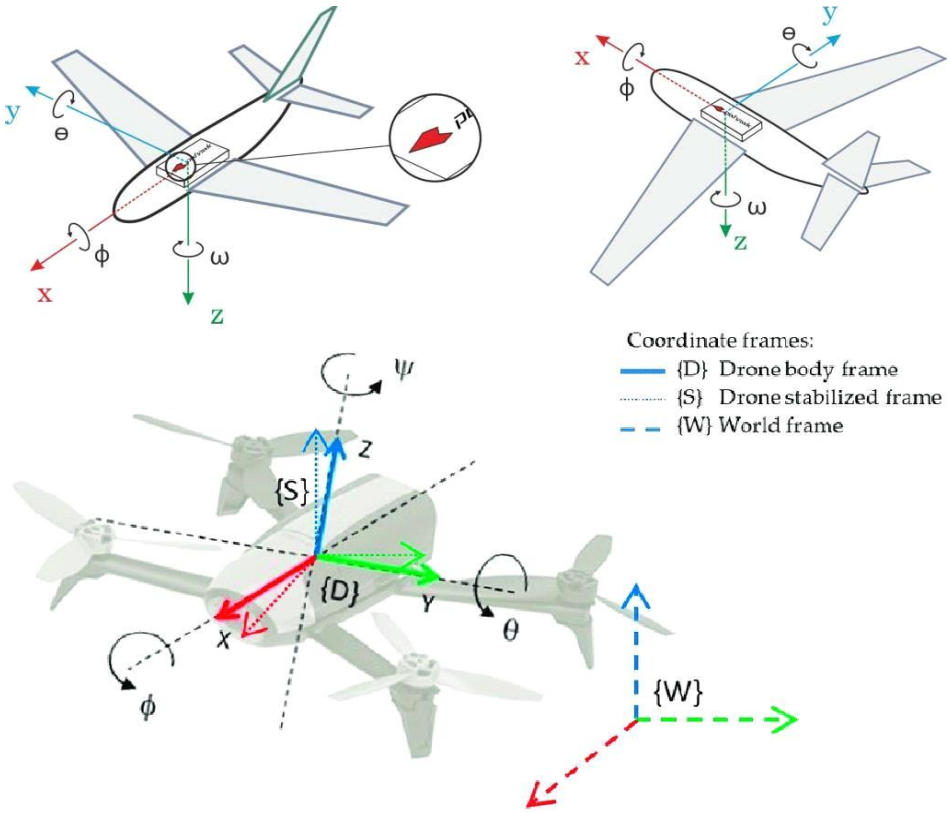
ANNEX-1



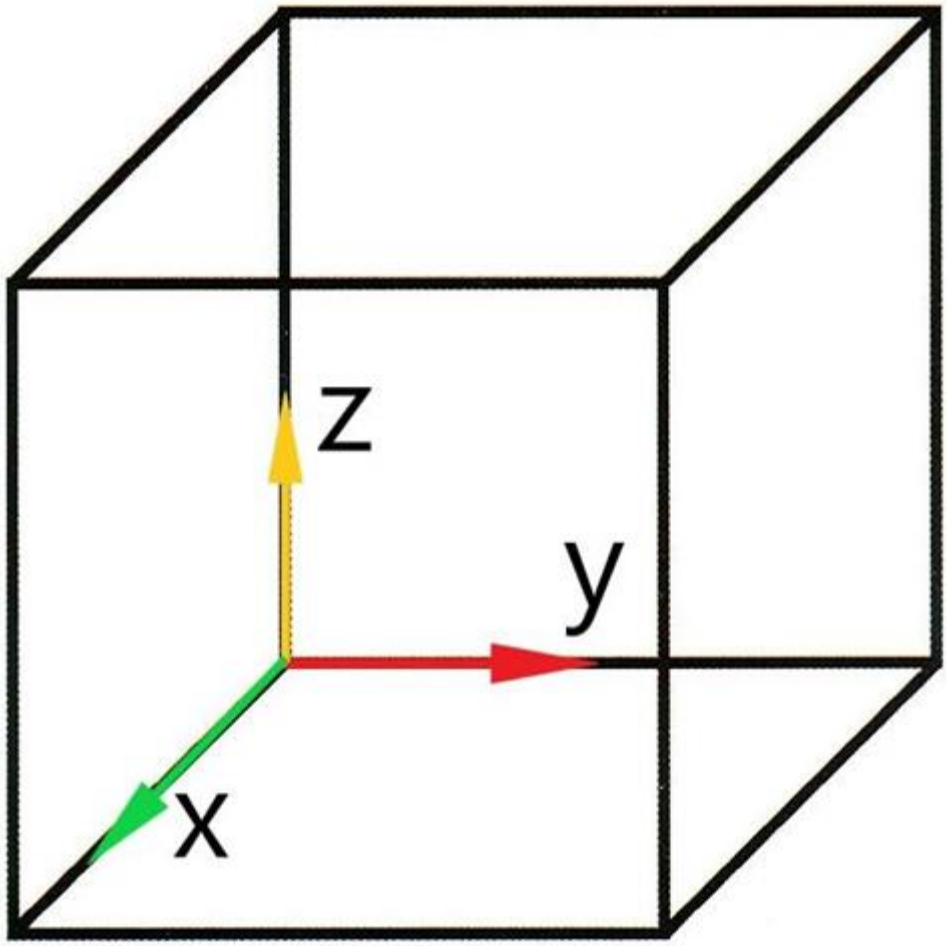
ANNEX-2



ANNEX-3


y
θ
x
ϕ
ω
z
Coordinate frames:
{D} Drone body frame
{S} Drone stabilized frame
{W} World frame
ψ
{S}
{D}
{W}
θ
ϕ

Runway and X, Y, Z coordinates (representation):



The center of the origin is 2 meters away from the specified X and Y lines, and $2\sqrt{2}$ meters away from the intersection of the X, Y and Z lines.