ICUAS ‘24 UAV COMPETITION

RULEBOOK

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This document is subject to change, refinement and development. Changes from the previous version are shown in red.

ICUAS’24 UAV Competition is organized by:

UNIVERSITY OF ZAGREB
Faculty of Electrical Engineering and Computing

larics.fer.hr github.com/larics fer.unizg.hr

Supported by:

https://aerostream.fer.hr/ https://icuas.com/

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Introduction

ICUAS'24 UAV competition is here! The competition is organized by LARICS from University of Zagreb through Aerostream project. Inspired by the scenario of robots in agriculture, the competition will take place in two stages. In the qualifiers stage, teams will develop their solution in ROS-Gazebo environment, and top teams will qualify for the finals stage.

IMPORTANT:
Rules for the competition and scenario details are subject to change! Make sure to check the official repo for any updates:
https://github.com/larics/icuas24_competition
and this rulebook regularly. All clarifications and FAQs will be publicly announced. All communication regarding clarifications on scenario descriptions, rules and scoring must be via the official competition e-mail:
uav-competition@uasconferences.com
or via Github discussions:
https://github.com/larics/icuas24_competition/discussions.

The final scoring scheme, including time limits and penalties, for the simulation phase will be announced after the first evaluation runs.
The scenario and scoring scheme for the finals will be announced by the end of the simulation phase.

Eligibility criteria and team composition

The competition is open to any full-time BSc, MSc and PhD students and others of similar proficiency level. There is no fee to participate in the qualifier phase of the ICUAS '23 UAV Competition.

There is no limit for the number of team members for the simulation phase. The number of team members to participate in the finals will be limited for in-person attendance, but other registered team members will be allowed to support the on-site team remotely.

Each team must elect a Team Leader (TL) who will be responsible for communication with the organising committee and referees. Given the dynamic nature of robotics competitions, which usually evolve with participant feedback, teams will be allowed time to find the optimal group of people to tackle the challenges.

Teams are required to register via the Google form.

Competition scenario: UAVs for indoor agriculture

In an indoor farm, there are several raised garden beds. Each bed contains one of the three species of plants. The goal of the UAV is to count fruits of selected plant variety. These capabilities will be tested in an arena similar to the one shown in Fig. 1.

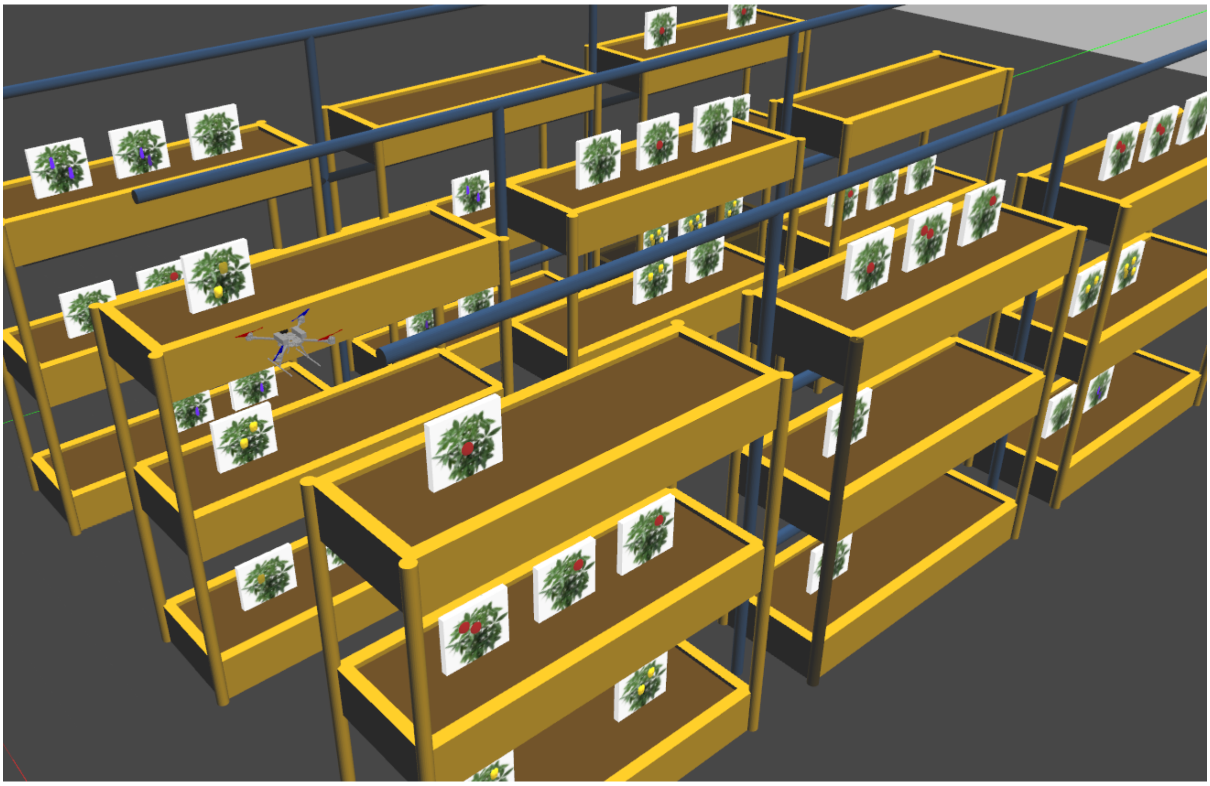

Fig. 1: Competition arena in Gazebo simulation environment

In this virtual greenhouse, the UAVs are used to monitor three plant varieties, with fruits of different shapes and colours.

To evaluate the performance of one UAV in such scenario, two benchmarks will be used in ICUAS'24 UAV Competition:

- Benchmark 1: Yield estimation - The ability of the UAV to correctly identify the number of fruits of a given plant variety. The exploration will be evaluated in a ROS-Gazebo simulation environment
- Benchmark 2: Energy - The ability of the UAV to perform the fruit counting task with minimal energy expenditure.

Benchmark 1: Yield estimation

- This benchmark focuses on the ability of the UAV to autonomously navigate the known indoor farm areas and find fruits of a given plant variety. Since some fruits may not be visible from a single row, the teams need to devise flight plans that will enable them to correctly count the number of fruits.

Benchmark 2: Energy

- To contribute to sustainability of ICUAS'24 farm, the teams need to minimise the energy expenditure of the UAV. In the context of the competition, the teams will need to minimise the path and the time taken to count the fruits.

Competition run

Both benchmarks will be evaluated on a single run. One run consists of counting all fruits of a given plant variety. In the beginning of the run, the UAV will receive a list of beds that contain the given plant variety, and needs to plan the path and trajectories to efficiently scan the plants and correctly identify the number of fruits. Each bed may have a different number of plants. Each plant in the bed can have a different number of fruits (including no fruit). The run ends when the UAV returns to the starting area and the UAV reports the fruit count.

Competition platform

The environment for the simulation phase of the competition is the Gazebo simulator (http://gazebosim.org/), in conjunction with Robot Operating System (ROS, https://www.ros.org/). Being realistic and modular, the combination of Gazebo and ROS enables simulations of both actuators and sensors through various plugins. For the ICUAS '24 UAV Competition, the supported versions, and also the versions that the solutions will be evaluated on, are Gazebo 11 and ROS Noetic, running on Linux Ubuntu 20.04 LTS. Teams may opt to use different versions, in which case they assume the risk of their code not running on the evaluation machine. Also, support from the competition organising committee may be limited if other versions are used.

The simulation platform is modelled after a Kopterworx Eagle platform, as a rigid body with 4 arms, equipped with 4 propellers. To simulate the propeller dynamics, the *rotors_simulator* (http://wiki.ros.org/rotors_simulator) package is used. Inertial Measurement Unit (IMU) and odometry plugins are mounted on the vehicle, to provide the UAV attitude and position. To simulate a depth camera, *openni_kinect* plugin is used. The UAV is controlled through Software-in-the-loop paradigm, using https://github.com/larics/uav_ros_stack. The control stack is packaged into a simulation stack available at https://github.com/larics/uav_ros_simulation.

UAV dynamics

Other than Universal Robot Description Format (URDF) files, no additional data on the dynamics of the model will be provided by the organisers. Teams will be allowed to identify mathematical model of the simulation platform if they require such information for the purpose of pose estimation. For the real UAV, if necessary, identification data will be generated by the organising committee and provided to the teams that qualify to the finals.

UAV controllers

The teams are not allowed to develop their own controllers for the UAV. Teams are allowed to develop their trajectory planners that interface with the UAV controllers the same way that the provided trajectory planner does.

Code and data structures

For the first phase of the ICUAS'24 UAV Competition, it is expected that a team's solution will be in the form of one or more ROS nodes. The developed node(s) will interface with the rest of the system via topics and services. List of topics, services and data types will be disseminated to the teams via the technical documentation accompanying the installation files. Subject to feedback from the teams, the organising committee is open to revise these interfaces to streamline the integration of code developed by the teams. Teams are allowed to use ROS messages and services based on built-in ROS message types to communicate between nodes. The solution is to be submitted through Docker containers. Exact details will be communicated through the competition repository.

Competition timeline

December 10th, 2023	Initial draft of the rulebook published
January 15th, 2024	Intermediate submission - team registration closed
February 1st, 2024	Evaluations start (Tentative)
February 15th, 2024	Deadline to upload solutions
March 1st, 2024	Results of simulation phase announced, finalists announced

Phase 1: Qualifiers

Installation files for the first phase of the competition, including the model of the UAV and a model of the competition arena will be released to the registered teams via Github repository.

Scoring scheme

Total scores for the qualifier phase will be the sum of points achieved in each of the benchmarks. For a team to score the points, a run in the simulation needs to be valid.

Total team score

Teams total score will be the sum of the scores for each benchmark. The scoring scheme, along with the point breakdown for benchmarks will be finalised after team feedback.

Disqualifying and penalised behaviours

A run will be disqualified, meaning a team will not receive any points for that run in the following cases:

- The code that the team submitted cannot be run on the evaluation machine;
- The UAV crashes at any point during the run;
- The UAV flies over plants;
- The run exceeds the time limit for a run.

Penalties will be awarded in the form of deduction of points in case the UAV touches any of the obstacles in the arena. Deduction points will be announced after the first evaluation runs. Flying over plants will result in the run being marked as invalid.

A team will be disqualified from the competition if any malicious code or cheating is detected by the organisers during the evaluation.

Evaluation procedure

Following the finalisation of the scoring scheme, the teams will be able to upload their solutions for evaluation. Instructions for the upload will be sent to team leaders via email, and announced in the competition repository. The code/solutions that the team submits will be evaluated by the organisers, and results will be publicly available. The evaluation will be performed weekly, with rankings and points shown on a public website. Within a single evaluation window, the benchmarks will be the same for all teams. Team's final ranking will be based on the average of best runs from the evaluation period.