ICUAS '25 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'25 UAV Competition is organized by:

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Supported by:

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

Table of Contents

Table of Contents **2**
Introduction **3**
Eligibility criteria and team composition **3**
Competition scenario: UAV teams for search and identification of CBRNe incidents in urban environments **4**
Benchmark 1: Threat localization and identification 5
Benchmark 2: Connectivity 5
Benchmark 3: Time 5
Competition run 5
Competition platform 5
Code and data structures **6**
Competition timeline **6**
Phase 1: Qualifiers **6**
Scoring scheme 6
Total team score 7
Disqualifying and penalised behaviours 7
Evaluation procedure 7

Introduction

ICUAS'25 UAV competition is here, again! This year, we are going from one to multiple UAVs! The competition is organized by LARICS from the University of Zagreb through the CBRNe-HERO and AeroSTREAM projects. 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/icuas25_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/icuas25_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 '25 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: UAV teams for search and identification of CBRNe incidents in urban environments

The team of UAVs is deployed in an urban environment to locate and identify possible CBRNe threats (chemical, biological, radiological, nuclear, explosive). The team deploys from the base and needs to find and identify several targets in a known environment. Since some of the threats may interfere with communication links between agents, the team is required to keep a constant communication between the base and all agents in the system. The connection between neighbouring agents in the system is maintained by keeping line of sight (as shown in Fig. 1.) and limiting the distance between agents. The team is considered to be in a valid configuration if the underlying graph is connected.

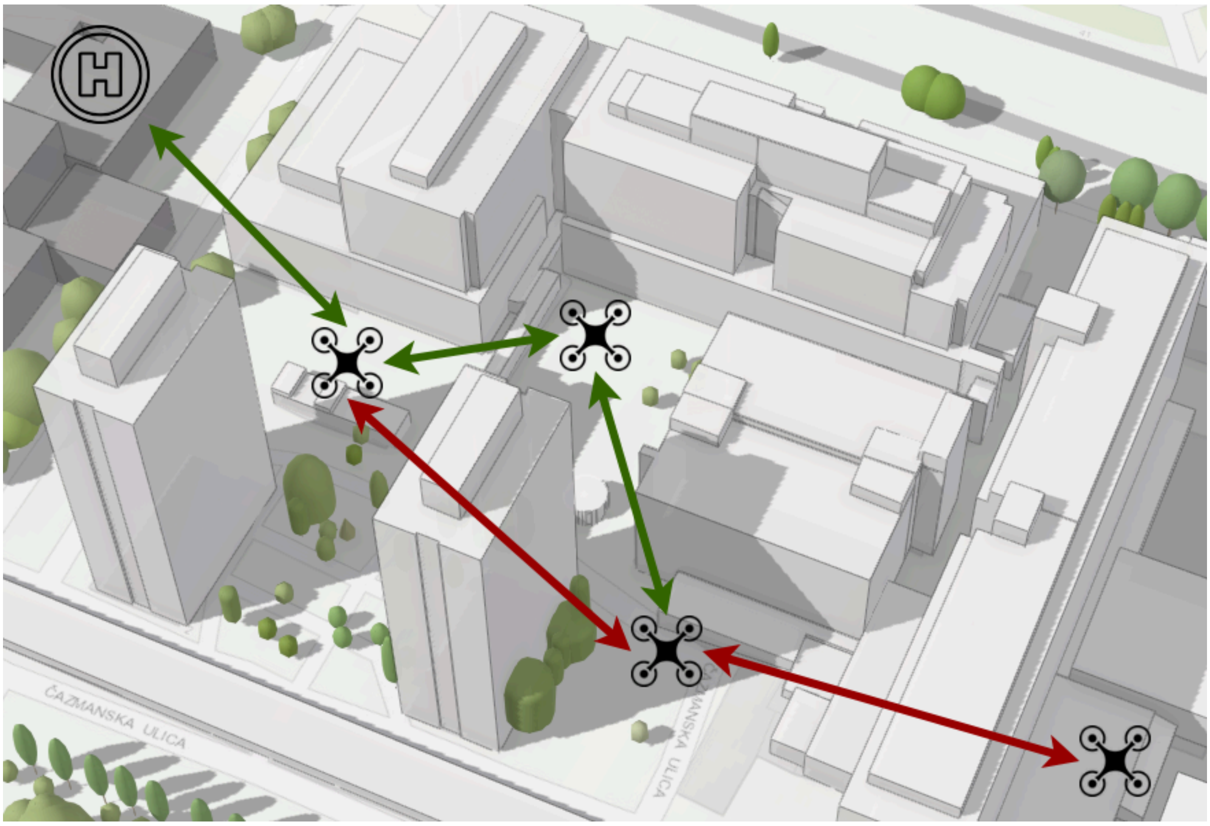

Fig. 1: Multi-UAV team for search and identification in urban environment

The team of UAVs is required to locate and identify an unknown number of targets, which are simulated with ArUco markers, and report the location of the threat to the base. While searching, the battery of each UAV is draining and each UAV can go back to base to recharge, but the system needs to remain connected even with one or more UAVs charging. The team needs to make the decision to end the mission autonomously.

To evaluate the performance of the team of UAVs in such scenario, three benchmarks will be used in ICUAS'25 UAV Competition:

- Benchmark 1: Threat localization and identification - The ability of the UAV to correctly identify all existing threats in the environment and report their location accurately.
- Benchmark 2: Connectivity - The ability of the team to remain connected throughout the mission.
- Benchmark 3: Time - The ability of the team to minimize the time required to locate all threats.

Benchmark 1: Threat localization and identification

- This benchmark focuses on the ability of the UAV team to autonomously navigate the known environment to find and identify all ArUco markers in the arena. Since the number of markers is not known in advance, the UAV team needs to devise a strategy to find as many as possible, taking into account the number of UAVs and the known environment. Once targets are found, the location of each identified threat needs to be reported to the base station.

Benchmark 2: Connectivity

- The benchmark focuses on coordination between agents in a team. The teams need to devise a strategy to cover as much area as possible while maintaining a line of sight between neighbouring agents to ensure that the system is connected, taking into account battery states and the UAVs that may be or need charging. At all times, there needs to be a communication link (via other agents or directly) between each agent and the base.

Benchmark 3: Time

- The benchmark focuses on speed and battery optimization. While the simulation does not take into account actions of the UAV to simulate battery drain, the teams will need to take it into account in the finals. Additionally, the teams need to devise a strategy that will allow their UAV system to reach a decision to end the mission when the number of targets is unknown. The mission ends when all UAVs return to base.

Competition run

All benchmarks will be evaluated on a single run. The run starts with all UAVs in base, and ends when all UAVs return to base (or when the time limit is reached).

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 '25 UAV Competition, the supported versions, and also the versions that the solutions will be evaluated on, are Gazebo Garden and ROS 2 Humble, running on Linux Ubuntu 22.04 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 UAVs to be used are Bitcraze Crazyflies, running through SITL within CrazySim. General information about Crazyflies can be found here.

Code and data structures

For the first phase of the ICUAS'25 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 16th, 2024	Initial draft of the rulebook published
January 25th, 2025	Initial submission - team registration closed
February 20th, 2025	Debug submission
February 28th, 2025	Deadline to upload solutions
March 3rd, 2025	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 following the intermediate submission.

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;
- Any UAV crashes at any point during the run;
- Any UAV battery drops below 20%;
- Any UAV flies out of bounds;
- 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 intermediate submission.

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. Within a single evaluation window, the benchmarks will be the same for all teams. If multiple runs are evaluated, the team’s final ranking will be based on the average of best runs from the evaluation period.