MBZIRC
Mohamed Bin Zayed International Robotics Challenge
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MBZIRC
Maritime Grand Challenge

White Paper
Submission Requirement

MBZIRC Maritime Grand Challenge

This highly complex, multi-layered task involves autonomous aerial and surface vehicles working together in a GNSS-denied environment off the coast of Abu Dhabi, to detect unfriendly vessels and offload goods from them in the shortest possible time.

MBZIRC Maritime Grand Challenge teams will use a heterogenous unmanned system comprising:

- **1 autonomous unmanned surface vehicle (USV)** base station with a manipulation arm.
- **A swarm of 5-20 unmanned aerial vehicles (UAV)**. UAVs may land on, take off from and recharge on the USV.

The USV Base Station and manipulation arm will be provided to each team by ASPIRE. The UAVs are to be provided by each competing team. No other device or equipment is allowed besides the USV+UAV swarm system.

Communication

- The whole USV + UAV swarm system must work in a GNSS-denied environment.
- No extra-system communications are allowed (except those provided by the challenge organisers for security and safety purposes).
- Intra-system communication is permitted. The USV could hold a base station (such as a femtocell) to augment the UAV swarm capabilities.

The Tasks

This challenge has two principal tasks: **inspection** and **intervention.**

Inspection Task:

The UAV swarm is used to monitor a large surface area of water to identify vessels which are in motion. Out of the total number of vessels present, there will be a subset of ‘target’ vessels. Once a vessel is found, the UAV swarm deploys to identify whether it is a target or not through a scan of the vessel with the following outcomes to be transmitted to the USV:

- A 3D model of the vessel to match with a reference model.
- In the case of a possible target vessel, a Boolean “suspected”/ “not suspected” signal is transmitted to the rest of the swarm through intra-swarm communication for collective decision making.
- Once a target vessel is confirmed by the operator, the USV+UAV swarm system proceeds to the intervention task.

Intervention Task:

- For the vessels that are potentially classified as target:
  - Video streaming is activated between the UAVs and the USV.
  - The operator watches the video and confirms the nature of the vessel.
  - If the operator does not confirm the suspected target because the UAVs made a wrong collective decision, the team will be penalised by increasing the mission completion time with a pre-defined number of minutes and the swarm will resume searching.

- When a vessel is identified as a target, the operator selects items to be retrieved from that vessel.
    - The items must be picked up from the vessel and transported by the UAVs to the USV either collectively or via individual transport.
    - One of the target vessels will have items that are too large to be collected by the UAVs. The UAVs will collectively attach to those larger objects and move them closer to the edges of the vessel.
    - Once the vessel is close to the USV, the large object will be picked up by the USV directly using its manipulation arm.
    - This will require USV locomotion and manipulation to be performed in a coordinated fashion and considering possible adverse sea conditions. The large objects collected by the manipulation arm are to be deposited on the deck of the USV.
    - After all the items have been collected from the target vessel, the swarm will resume exploring and decide whether all target vessels have been found.
    - The mission is considered completed after a pre-defined finish time or the moment when UAV-USV system has determined that there are no more target vessels in the area and have landed back on the USV, whichever is earlier.

Scoring

Team scoring of the final demonstration will be based on the speed and accuracy of accomplishing the Inspection and Intervention tasks.

Equipment details

1. ASPIRE intends to provide participants with a USV. The exact details of the USV will be finalised at a later date. For the purposes of development of White Papers, please expect the USV to have the following characteristics:
    a. **A payload platform** approximately 3m wide and 5m long.
    b. **Dry weight:** about 500Kg.
    c. **Available load capacity:** about 500Kg.
    d. **Power supply:** 2 high-efficiency 48V 110Ah marine batteries (one battery per engine), each equipped with BMS (Battery Management System) for cell protection and balancing.
2. ASPIRE intends to acquire and provide participants with a robotic arm, to be selected by each participant, with a value up to USD 50,000.

The equipment details are only preliminary and are subject to change.

White Paper Phase

White Paper Format

White Papers must be written in English, and provided in Adobe PostScript (.pdf) format, with a maximum of 15 pages of A4, with at least 2cm margins on all sides. Font sizes must be 12pt minimum.

The paper must contain two sections: Team Information, and Technical Approach. These will be weighted in the scoring by 40% and 60%, respectively. The minimum information to be provided in each is given below.

1. Team Information

- Team Name
- Team members (individuals, universities, entities comprising the team)
- Team main point of contact and one alternative point of contact (name, email, phone number)
- Team roster containing a list of all individual team members, their contact information and their affiliations with sponsors or partners.
- Previous technical challenge competition experience
- Description of technical capabilities:
    - Multi-autonomous vehicle systems
    - Computer vision
    - Unmanned vehicle (UAV and USV) localisation and navigation
    - Autonomous system communication in a GNSS-denied environment
- Optional: Technical awards, patents or related publications
- Optional: Link to one unlisted YouTube or other video (maximum 10 minutes duration) and a short description of the video (maximum 100 words)

2. Technical Approach

- Technical approach to solving the inspection and intervention tasks in GNSS-denied environment, including the following:
  - Description of UAV capabilities and sensors
  - Description of autonomous multi-UAV interaction and coordination methods for search, identification and localisation
  - Description of communication and video streaming methodology between UAV+USV system
  - Approach to mounting and controlling the Robotic Arm on the USV for the marine environment
  - Description of physical interaction and motion coordination between UAVs, USV and the robotic manipulation arm
  - Description of any simulation methodologies used for proof of concept
- Uniqueness of approach and its contribution to the advancement of the state-of-the-art in autonomous robotics
- Risks and Mitigation approach
- Safety considerations to ensure UAV returns to base on command
- Expected commercial and societal impact and applications of the technical solution
- Any additional relevant information not listed above

3. Submission details

- **Only registered participants can submit a white paper.**
- Each team can submit revisions of its white paper (eg. Technical approach revision, updated team information etc.) during the window for white paper submission. The last white paper to be submitted by each team will be considered for judging.
- **Deadline for submission:** 31 January 2022. 6pm GST (Gulf Standard Time). White papers received after this time will not be considered.

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