RCAP 2020

Preface

The applications of unmanned aerial vehicles (UAVs) are extensively increasing across a range of diverse practices for agricultural, search and rescue, delivery and disaster response. The UAV competition aims to explore potential usage of UAVs in a disaster response theme in earthquake scenario. The competition simulates an earthquake damaged building in the aftermath of an earthquake disaster. Teams of UAV experts must perform search and rescue missions based on above scenarios.

The main areas of competition:

- Autonomous navigation and control
- Localization and perception
- Obstacle detection and avoidance
- Reliability and robustness of algorithms

Safety

- All UAVs should stay inside the designated flight areas. If a UAV strays outside the designated flight area, it should either land or turn back immediately inside the flight area.
- Please ensure safe working practice while working on UAVs
- **Radio Frequency: only 2.4GHz(Wi-Fi, Bluetooh, ZigBee,,,etc)**
  In Japan, can not use 5.7/5.8Ghz video transmitter, and 433/915MHz telemetory tx/rx. (Only those who have Japanese national qualifications can use 5.7/5.8GHz vtx.)

League Rules

Location:

Aichi International Exhibition Center “Aichi Sky Expo”,

Conference Room L1.

Address:

5-10-1 Centrair, Tokoname, Aichi, Japan.

The competition conceptual plan is illustrated Below (Fig 1):

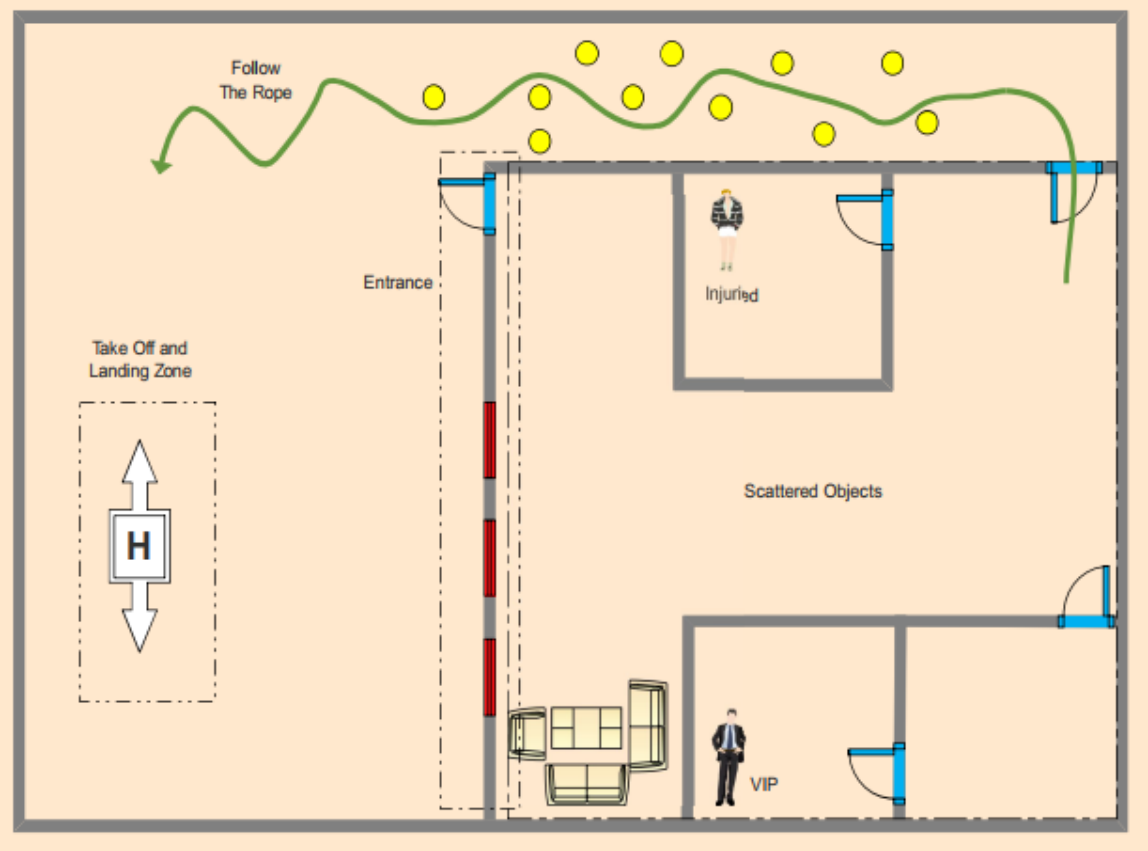

Figure 1: Competition Area

Scoring

The final score will depend on the success of the mission elements (**S** = sum of the successful mission elements), the level of autonomy for each mission element (**Au**), the abundance factor (**A**) and the "in-a-row" factor (**I**).
Awards will be determined using the following formula:

$$Total\ Score = T = (I).(Au)\sum A_n.S_n$$

In-a-row factor (I)

The “in-a-row” factor encourages participant to complete as many mission elements as possible without stopping. The more mission elements completed in a single trial, the higher is the factor.

Number of mission elements completed in a single trial	**Factor**
1	1.0
2	1.1
3	1.2
4	1.3
5(max)	1.4

Level of autonomy (Au)

The level of autonomy describes how a UAV is operated in order to fulfil the mission elements. The factor associated to each autonomy level is then used to compute the final score.

Level of Autonomy	**Factor**
Autonomous flight control: the navigation is completely autonomous but the operator is controlling the mission and the payload	1
Autonomous target detection: the navigation is manual but the detection and processing of the targets is automatic	1
Fully autonomous mission control: the navigation and the decision making are autonomous, without assistance of the operator	2
Using external aids such as visual markers	-0.2 applied to factor per marker

Abundance Factor (A)

This Factor is determined by the number of teams completing certain mission. The formula for calculating the factor is:

$$A = 1 + \frac{|NumOfTeams - SuccessfulTeams|}{NumOfTeams}$$

Mission Brief

Teams are allocated 20 minutes to attempt the course for every round (includes Setup Time). Trial start is considered from take-off platform and whenever UAV touches the ground will be considered trial finished. Teams can perform as many trial runs as they can. Teams must attempt to complete as many of these challenges as possible to achieve the maximum number of points. If Teams run more than one Trial in a Round, only the highest score yielded from a trial will be counted for that round.

Competition will be held in two rounds preliminary and one round in final. In preliminary rounds the highest score of two rounds will be used for ranking teams. Referees will select a number of teams to participate in the Final round. Some missions may not be counted in preliminary round. In the Final round some missions may slightly change.

Take-off

- Take-off from the designated Static or moving platform and hover in place for 5 second.

Entrance Challenge

- There is three similar window for UAVs to enter the building.\
- Dimensions of the window:
    - Square
    - (W)0.5m x (H)0.5m
- Bonus points are awarded to teams that cross the window with a marker that been attached below the window by referees.
    - Marker color will be one of the following colors: Red, Green and Blue.
    - Marker shape will not be uniform or geometric shapes
    - Example of marker is shown in Fig 2, 3.

Figure 2

Figure 3

Mapping

- The UAV must explore the building and make a map of surrounding environment.
- Generated map from all Teams will be compared and the best map in Quality and Completeness will get the highest score.

Find Injured Persons

- Some people have been trapped and injured during the earthquake. The objective is to locate these injured people and show an image of them in real-time.
- Injured people will be positioned in all stances (lying down, standing, sitting, etc.)
- Bonus point is awarded to teams that show location of detected people on the generated map.
- ~~Example image of an injured person:~~

Find and Identify Target Person

- One of the people inside building is selected by referees for teams to identify and find its location.
- Teams will be provided with the face image to identify before match.
- Target person stance will always be standing.
- ~~Example of targets face image:~~

Find and Locate Objects

- There are three objects scattered inside building. Teams should detect and identify the objects.
- Objects consists of:
    - Laptop (Opened)
    - First Aid Kit (With a Red Cross arm)
    - Fire Extinguisher Capsule
- No image will be provided
- Bonus Point is awarded to Teams that show location of objects (with Names) in the generated map.

Follow the Colored Rope and Obstacle Avoidance

- There is a rope on the ground that marks the exit of building. UAVs must follow the rope in order to safely exit building and avoid obstacles.
- The rope starts inside building and after crossing a door there are poles near the rope.
- UAVs must adjust its course in order to avoid the poles by deviating slightly from rope.
- Rope will have a color of Red (Color may change but will be different from the background) and the diameter 3cm.
- Rope will not have the angles below 90 degree and sharp turns.
- Poles will have different diameters and a single color (Yellow).
- This mission can be skipped by flying over the obstacles.
- While doing this mission UAVs cannot go above the height of poles doing that will cause the mission to fail.
- Following the rope will be scored in three parts for each one thirds of the rope.

Landing

- UAV must land on either static or moving platform
- UAVs can land anywhere but they won't get any point from this mission.
- Specification of landmark is shown in Fig 4.

Time

- The objective is to finish missions and round as fast as possible
- The time is measured from the first take-off to last land (end of trial).
- Teams with the best time will be ranked and awarded points.
- In order for team's time to be ranked, teams need to finish at least three missions (beside take-off and land).

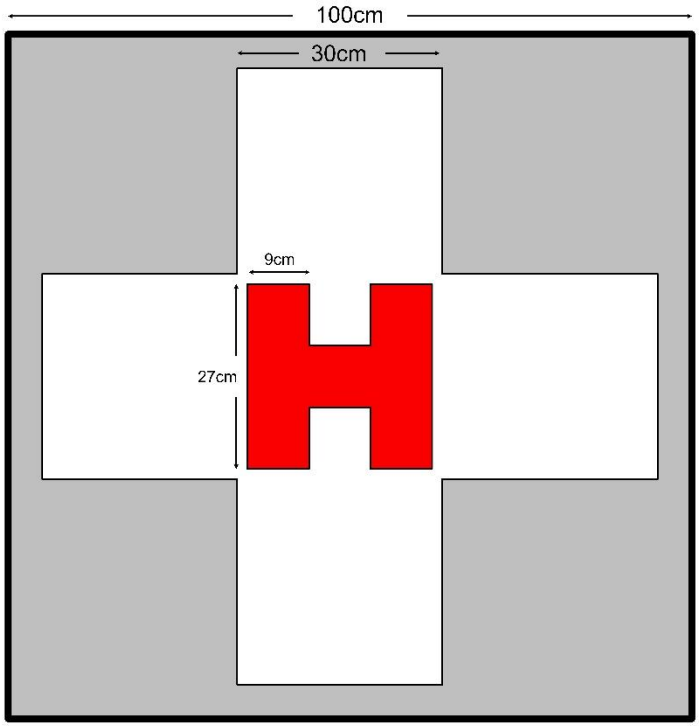

Figure 4: Landing Pad Specification

Scoring

Mission Elements	Mission Detail	Score
Take-Off	Static Platform	**1**
	Moving Platform	**2**
Entrance	Enter non-Marked Window	**2**
	Enter Marked Window	**4**
Find injured Persons	Detect Each Person	**+3**
	Show each Person on Map	**+1**
Find and Identify Target Person	Identify Target	**3**
	Show Target on Map	**+1**
Find and Locate Objects	Detect each Object	**+2**
	Show each Objects on the Map	**+1**
Follow the Rope	Each One Thirds	**+3**
	Each Hit to Obstacles	**-0.5**
Landing	Static Platform	**1**
	Moving Platform	**3**
Mapping	Range for map quality	**1-15**
Time	First Place	**3**
	Second Place	**2**
	Third to Last Place	**1**

Rules

- 1-pilot per UAV in flight area at a time
- All flying robots need to stay within the designated flight area
- Only competing team may fly their drones during their competition slot
- All teams shall present each of their UAV for scrutinizing
- The team is always responsible for the safety of its UAV and is liable for any Accidents caused by their UAV
- A human safety pilot must be able to take over the UAV at all times in case of an emergency by means of a reliable data link, especially near the launch zone and spectators. (safety Pilot can use laptops)
- UAVs must complete a mission beside take-off and land to get points for these missions.
- In-Row Factor will not count for take-off and land missions.