IMAV2013 General Indoor and Outdoor competition rules v0.1

30-Nov-2012

PRELIMINARY RULES

Introduction

The indoor and outdoor competitions are set up to stimulate the following points:

- high level of autonomy
- multiple MAVs
- operable UAV systems
- custom autopilot design
- high performance platforms

To promote autonomy, RC-only control is no longer part of the competitions. Teams with an innovative RC-only platform can request a demo slot.

Safety and security requirements

For security and safety details see the latest version of the IMAV2013 safety regulations document which is published on the **www.imav2013.org** website. All participants are required to be familiar with the contents of the document and comply with it.
Due to regulation and safety considerations, the maximum weight for all types of MAV is set to **2 kg**.

Location

The outdoor flight competitions will take place at **Muret-Lherm airfield** (Google Maps).

Lat: 43.449546°
Lon: 1.263383°

The indoor flight competitions will take place at **ENAC** (Google Maps).

7 Avenue Édouard Belin
31055 Toulouse Cedex 04
France

Competition slot: preparation time & flight time

Teams are not assigned a preparation time and a flight time but rather a competition slot. In this slot they will set up their equipment, prepare flight, fly the competition, and clear the flight area. Failure to clear the flight area within the flight slot can lead to a penalty or disqualification.
The order of the teams' slots will be randomly decided on the day of the competition before the flights. At any time, before or during the mission, a team can decide once, and only once, to postpone the rest of its mission. In this case, the flight slot of the team is shifted to the end. Therefore, all teams must be ready to fly at any time.
Time slots are 20 minutes for the Indoor mission and 30 minutes for the Outdoor mission.

Scoring

The final score will depend on the success of the mission elements (M = sum of the successful mission elements), the level of autonomy (A), the size of the MAV (S), a presentation made by the team during the mission (P) and a system operation factor (O).
For IMAV2013, it as been decided to put emphasis on two different aspects of the MAVs: autonomy and operation. For this purpose, two scores will be computed based on the same mission elements. The prizes will be awarded according to the two ranking given by the two formulas:

- Autonomy: Total score = $\text{Sum}_{\text{each MAV}}(M \times A \times S) \times P$
- Operation: Total score = $O \times \text{Sum}_{\text{each MAV}}(M \times S) \times P$

In order to facilitate the work of the judges, it is ask to the teams flying multiple MAVs to place a recognizable mark (color, number) on each vehicles.

In addition, two **special jury prizes** will be awarded (see below).

Level of autonomy

Level of autonomy	factor
Video based control: control of the MAV is manual (from complete manua control to attitude-stabilized control)	1
Assisted flight control: the navigation is not completely autonomous but th low-level control is augmented by additional controls (such as collisior avoidance or hovering based on laser scanner or optical-flow)	4
Autonomous flight control: the navigation is completely autonomous but th operator is controlling the mission and the payload, processing perception, an making decision	6
Autonomous target detection: the navigation and is not autonomous but th detection and processing of the targets is automatic	6
Autonomous mission control: not only the navigation but also the detection an decision making is autonomous, without assistance of the operator	12
Using external aids such as visual markers	-2 applied to factor

During the mission, for each MAV in flight, the team will have to demonstrate that without any commands input (RC, joystick, ground station, …) the MAV can sustain flight safely (without leaving the flight area nor crashing) for 30s (outdoor) or 20s (indoor). The team can decide at which time and place this demonstration is performed. During this test, the MAVs can continue their mission if their level of autonomy allows it. The goal is to prove that all the MAV entering the competition can at least achieve a level of autonomy higher than 1.
Failing this test will disqualify the MAV for the final score.

Teams with **innovative design** that are not able to perform this minimum autonomy demonstration can have the opportunity to present a technical demonstration of their MAVs. They will not compete for the mission scores, **but are eligible to the special jury prizes**.

Size factor

The maximum size for the MAV is set to 1 meter:

- wing span for aircraft
- biggest horizontal size including blades for rotary wings

The maximum weight is **2 kg** for all type of MAVs.

Size factor = 1/(size of the MAV)

Presentation factor

The team is rewarded (percentage of the total score) when on of the team member presents to the public the actions currently performed by its team. The goal is to make the demonstration of each team more lively and more readable for the public. A video feedback of the ground station is also possible and is strongly recommended (standard VGA cable or analog video).

The points to emphasis are:

- the system and its design
- the initial plan to perform the mission elements
- the currently performed tasks
- the level of autonomy of each task / MAV

Presentation factor = 0 to 10 %

System operation factor

The system operation factor reflects the ease to operate a MAV system. It takes into account the number of MAV operated during the mission (the one that actually scored mission elements) and the number of people to operate them. All team members entering the flight area to take part of the mission (ground station operators, video operators, antennas holders, MAV launchers and retrievers) are counted as counted as mission operators. Only the safety pilots (one for each MAV) are not counted except if they launch or retrieve their MAV and the “presentation” members if they are not taking part of the mission.

Operation factor = mumber of MAV / number of mission operators

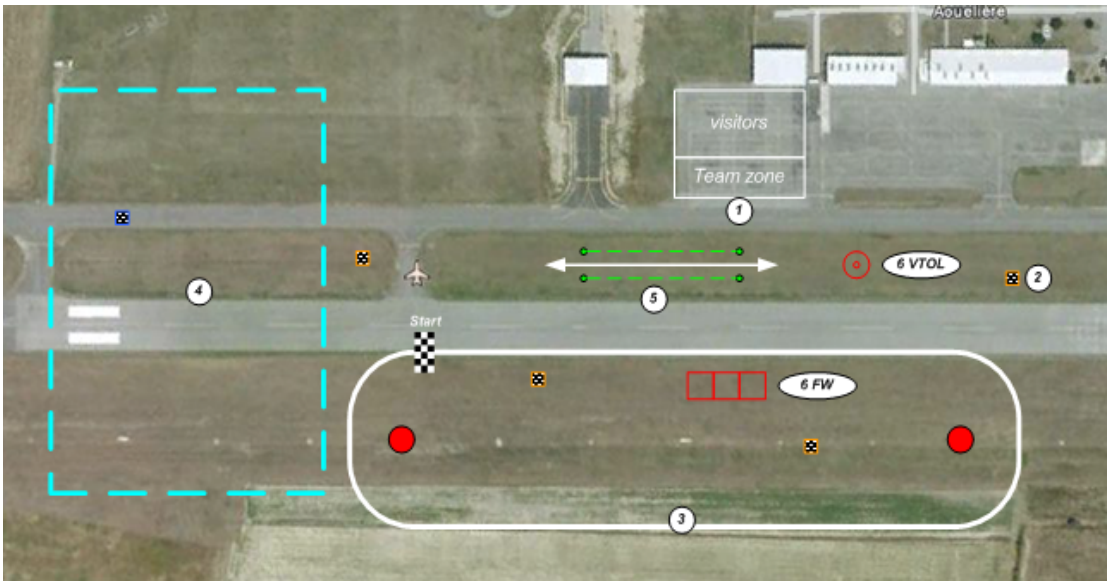
Mission elements

The mission is made of multiple small elements that can be done in any order, by one or more MAV, at the same time or in sequence.
For each mission element, a score is awarded to the MAV that realize the element depending on your performances.
A MAV can try several times the same mission elements, only the best score will be taken into account for the final scoring.

Outdoor mission

1. Automatic take-off
    a. a take-off is automatic if the safety pilot doesn't give any commands (except mission start signal)
    b. the MAV can be hand-launched.
    c. points are awarded for every MAV that performs at least one other mission element during its flight, except precision landing (taking off and landing is not enough to count as a valid mission flight)
2. Drop zones
    a. four drop zones are scattered around the flight area
    b. the center of a drop zone is marked with a QRCode
    c. the score depend on the distance of the dropped ball to the center (less than 5 meters or less 10 meters)
    d. the gps coordinates of the centers will be given before the flight
    e. all coordinates are exact except for one for which the real position can be up to 20 meters again from the gps coordinates (vision is thus needed for accurate drop)
    f. when all drop zones are filled during the mission, extra points are awarded
3. Flight performances
    a. fly as many laps as possible in the compition slot around 2 poles
    b. the count of the laps begin when crossing the "start" line; a lap is completed each time the line is crossed
    c. the MAV as to land before the end of the mission slot to be valid
    d. flight altitude is only limited by the boundaries of the flight area
4. Target detection and recognition
    a. search and read a landmark within the flight area
    b. 2 signs will be shown: a human readable number and a QRCode (only on-line decoding is considered as fully autonomous detection, extraction from a recorded picture is not)
5. Urban corridor
    a. fly between 2 aligned arches without going out of the track

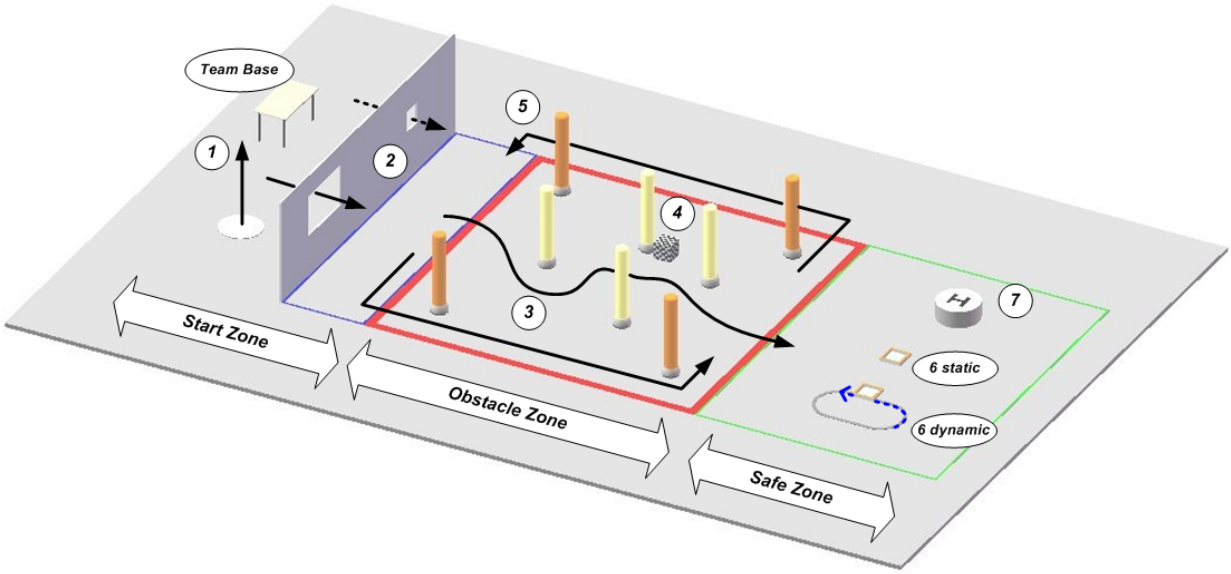
6. Precision landing
    a. a landing is classified as a field landing, a normal landing or a precision landing
    b. the size and place of each landing zone (normal/precision) depends of the type of MAV (fixed-wing, VTOL)
    c. in case of rough landing, the may be asked to demonstrate airworthiness of the vehicle
    d. extra points are awarded if the MAV is able to take-off again after staying still 10 seconds on the ground and without any operator intervention
    e. all MAVs has to be landed within the time slot, otherwise all mission elements since last take-off will be discarded for this MAV



Mission elements	**Mission score**
Automatic take-off	1 per MAV
Drop (close/far/outside)	2, 1, 0 per zone and per MAV +2 if at least one point is scored for each zone
Flight performance	number of laps / 8 (per MAV)
Target detection	1 for clear view of the target 1 for human readable sign 2 for QRCode decoding
Arch	depending of the altitude 1 or 2 per MAV +1 for crossing the 2 arches without going out of the corridor
Landing (precision/normal/field)	2, 1, 0 per MAV +1 if taking off after 10 seconds staying still without any operator assistance

Indoor mission

1. Take-off and hover
    a. a take-off is performed from the starting zone
    b. after taking-off, the MAV must other for at least 5 seconds within the take-off area (circle of 2 meters diameter)
    c. points are awarded for every MAV that performs at least one other mission element during its flight, except precision landing (taking off and landing is not enough to count as a valid mission flight)
2. Flying through the window
    a. two windows are opened through a wall (one big, one small), the scores depends on the window that is passed by the MAV
3. Flying through the “obstacle” zone
    a. several poles are placed in the flying area and the MAV as to cross the area to reach a “safe” zone at the other side
    b. four fixed poles are marking the corner of the “obstacle” zone, the four others have unknown positions
4. Target detection and recognition
    a. a target is placed in the “obstacle” zone near a pole
    b. mission task is to find the target and read the sign on the pole close to it
    c. 2 signs are placed on each pole: a human readable number and a QRCode (only on-line decoding is considered as fully autonomous detection, extraction from a recorded picture is not)
5. Follow a path
    a. The path is laid out around the four fixed poles which mark the obstacle zone
    b. the score depends on the number of laps done flying over the path
6. Drop zones
    a. a static drop zone and a moving drop zone are placed in the “safe” zone
    b. each zone are marked with a QRCode
    c. the static zone can be scored only once, but the moving zone can be scored as much as possible (only one ball can be drop at a time; a ball is dropped when it touches the ground)
7. Precision landing
    a. the MAV can perform a precision landing on a small platform
    b. in case of rough landing, the may be asked to demonstrate airworthiness of the vehicle
    c. extra points are awarded if the MAV is able to take-off again after staying still 10 seconds on the ground and without any operator intervention



Mission elements	**Mission score**
Take-off	1 per MAV
Fly through window (small, big, none)	2, 1, 0 per MAV
Fly through obstacle zone	1 per MAV
Target detection	1 for a clear view of the target 1 for reading the human readable sign 2 for QRCode decoding
Path following	number of laps (per MAV)
Drop zone	1 for the static drop zone (per MAV) 2 for each drop in the moving zone
Landing (precision)	1 per MAV +1 if taking off after 10 seconds staying still without any operator assistance

Special jury prizes

The IMAV jury members, beside of judging the success of the mission elements, will be asked to award two special prizes:

- System prize: this prize is awarding the team that will present the best innovation on MAV system elements such as autopilot hardware or software design, Human-Machine Interface, payload control...
- MAV Design prize: this prize is awarding the best innovation on aerodynamics or mechanical solutions

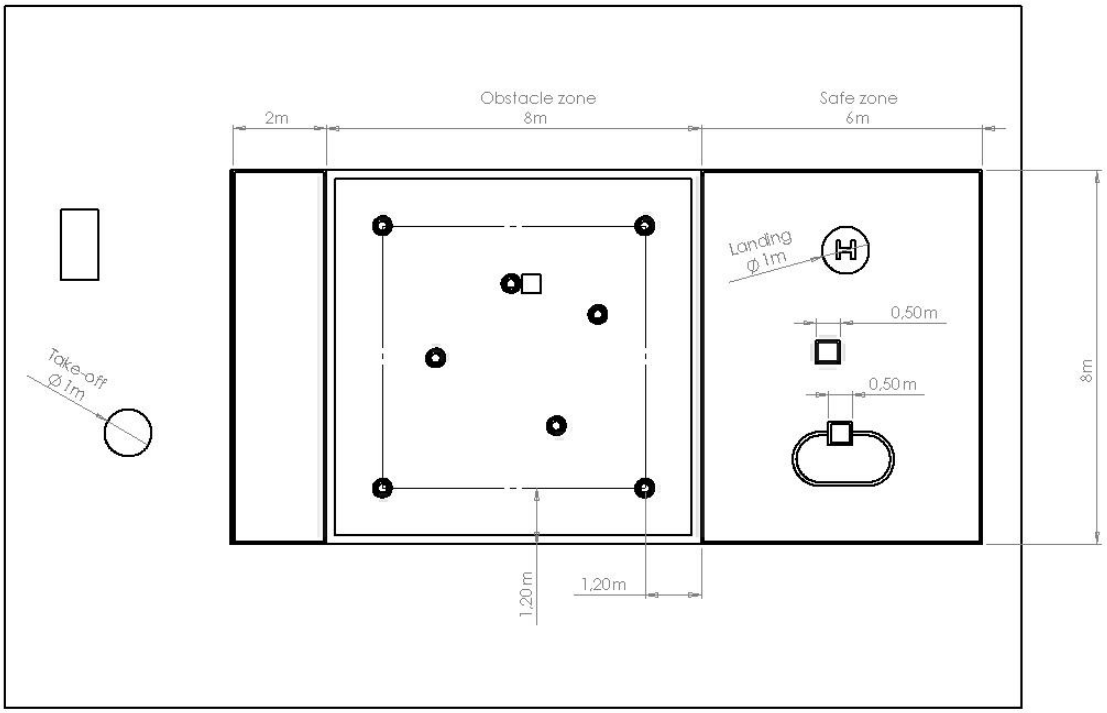
Size and shapes

All dimensions presented here are preliminary and might be updated.

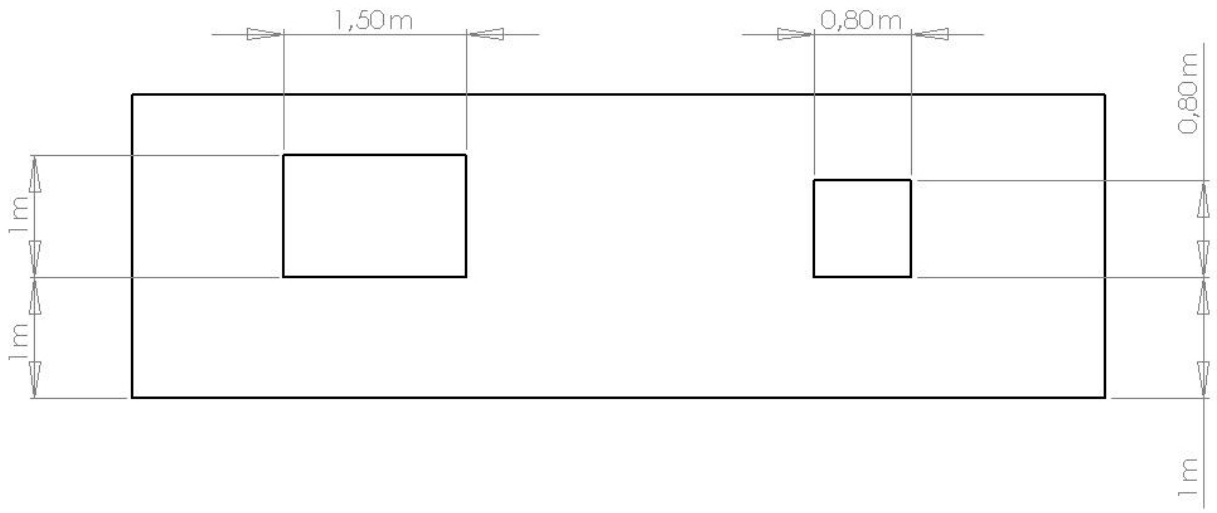
Outdoor flight area

TODO: arches

Indoor flight area



Windows for indoor mission



QRCode

QRCode are two-dimensional bar codes that can be easily decoded using software libraries such as ZBAR.
The size of the QRCode for the outdoor mission zone will be 1x1 m, and 15x15 cm for the indoor mission (printed black over a white background)

Scoring examples

A team with 5 members, 1 presentation and 2 MAVs for the outdoor mission:

- a 50 cm fixed wing aircraft performing an automatic take-off, 20 fully autonomous laps and a normal automatic landing (no action of the operator between the mission elements)
- a 40 cm VTOL MAV performing an autonomous take-off, 2 close drops and 1 far (autonomous navigation with visual validation), finding and reading the human-readable target (assisted navigation), flying the corridor (video-based, not low altitude) and making an autonomous precision landing

The two scores are:

- operation: (2/5)*((1/0.5)*(1+(20/8)+1)+(1/0.4)*(5+2+3+2))*1.1 = 17.16
- autonomy: ((1/0.5)*(1+(20/8)+1)*12+(1/0.4)*(5*6+2*4+3*1+2*6))*1.1 = 264.55

A team with 3 members, 1 presentation and 1 MAV for the indoor mission:

- a 60 cm MAV performing an autonomous take-off, flying through the big window in assisted mode, crossing the obstacle zone with autonomous navigation, finding the target in assisted mode, reading automatically the QRCode, droping 1 ball in the static zone (assisted mode) and doing a precision landing (assisted mode)

The two scores are:

- operation: (1/3)*(1/0.6)*(1+1+1+1+2+1+1)*1.1 = 4.88
- autonomy: (1/0.6)*(1*6+1*4+1*6+1*4+2*6+1*4+1*4)*1.1 = 73.3333