Description of indoor competitions

Introduction

The Summer-IMAV2011 indoor competitions are the *Exploration Challenge* and the *Pylon Challenge*. The rules have been created to stimulate a higher level of autonomy compared to previous years. The main bottleneck for indoor autonomy is reliable indoor positioning. To help teams solve their positioning problem, they are allowed to use *external aids* in both mission environments at the cost of autonomy points (factor A_n). Examples of external aids are visual references, radio positioning beacons, etc.

Additionally, a distinction is made between autonomous flight control and autonomous mission control without any user intervention. The latter type of control will result in a higher score. See Table 1 for more details.
For "Video based" participation, the MAV pilot/operator does not have a direct line of sight with the MAV.

! 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.

Security requirements and safety

For security and safety details see the latest version of the IMAV2011 safety regulations document which is published on the www.imav2011.org website. All participants are required to be familiar with the contents of the document and comply with it.

Scoring for both challenges

The total score for each indoor mission is given by:

$$S_{total} = \sum_{n=1}^{N} \left(\left(A_n - e_n \right) \cdot M_n \right) \cdot \left(2 - \frac{L}{L_{\max}} \right)^k$$

Where:
A_n is the autonomy level of the MAV when attempting mission element n,
e_n equals 0, or 2 when using external aids during mission element n,
M_n is the number of points scored for mission element n,
L is the largest dimension of the MAV,
L_{max} is the maximum allowed dimension, and
k is the exponent of the size part of the equation.

The maximum allowed dimensions for the indoor missions are:
Rotary wing: L_{max} = 70 cm
Flapping wing: L_{max} = 70 cm
Fixed wing: L_{max} = 80 cm
k = 3

For both missions:
The level of autonomy is taken into account per mission element. Thus teams are not penalized for the entire mission if they cannot perform all mission elements at the autonomy level they were aiming for. Teams have to announce the intended autonomy level for each mission element before their flight and state the actual autonomy level during the flight. The autonomy factor (A_n) is shown in Table 1.

Table 1: Autonomy factor

Levels of autonomy:	A_n
Video based, and beyond line of sight	1
Autonomous flight control: Flight is controlled autonomously but the operator is still controlling mission aspects, e.g., commanding transitions between control modes, control of payload, processing perception, and decision making.	6
Autonomous mission control: All aspects of the flight and mission are automated including detection and decision making. Typically, the operator does not touch the controls: hands off control.	12
Using external aids (visual markers, etc.)	-2

Teams have to announce before their flight at what level of autonomy they will attempt each mission element. During their flight they will report to the jury what they are doing so the jury can establish the actual level of autonomy during the mission elements and award the appropriate points. Teams need approval for using their external aids.

Competition slot: preparation time & flight time

Teams are not allocated a preparation time and a flight time but rather **time slots**: A challenge must be completed in a **15 minute** time slot. When a team participates in both the pylon and the exploration challenges, the two 15 minute time slots for each challenge will be scheduled **consecutively**. The teams may then choose in which order they will perform the two challenges. Teams are not allowed to prepare for the second challenge while performing the first challenge. During each time slot, the team will set up their equipment and possibly their external aids for the challenge, prepare the flight and fly the challenge. Teams have to clear the flight area before the end of the last allocated time slot. Failure to clear the flight area on time can lead to a penalty or disqualification.

Pylon Challenge

Slot time: 15 minutes.
Max flight time per attempt: 3 minutes.

The Pylon Challenge is a test for the MAV's ability to maneuver quickly and accurately. Autonomous execution of the task puts the emphasis on quick reactions and robust perception, instead of complex navigation skills. Teams have to fly their MAV in figure 8's around two poles that are 10m apart. Each completed figure 8 will be awarded 1 mission point (M_n). Points will not be awarded for a lap when the MAV flies above pole height (4 m).

Each attempt starts with a team's announcement to the jury of a new attempt. At that time the MAV is located at the start marker (either on the ground or held in hand). The flight starts with takeoff. The achieved level of autonomy (A_n) applies to the entire flight, from takeoff to the expiration of the 3 minutes. A crash ends the attempt. After a crash the team can reposition the MAV at the start marker and start a new attempt. The team can try as many attempts as their time slot allows. The attempt that scores the most points counts for the competition outcome.

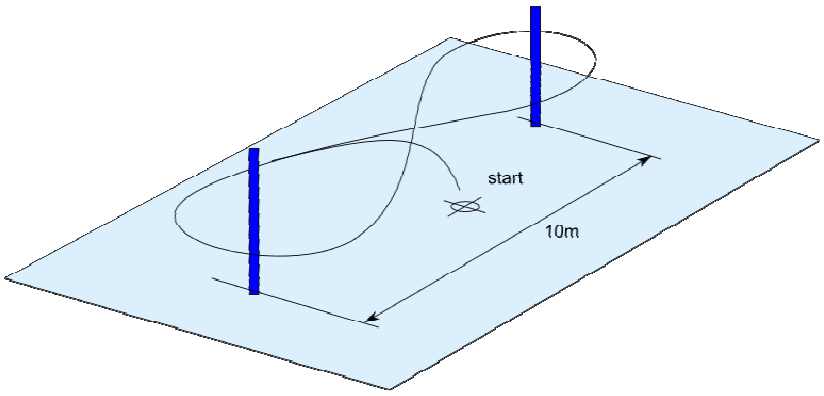

Figure 1: Indoor Pylon Challenge

Exploration challenge

Slot time: 15 minutes.

Scenario: your team is asked by law enforcement agencies to secure evidence held in a private building on a guarded compound. Your team's MAV is small enough to slip past the guards and enter the building. Based on intelligence information you must first confirm that you have entered the right building by visual recognition of known features in the building. Then, your team will proceed to pick up a piece of evidence from the desk and bring it outside the building. A retreat through the opening in the roof is advised to escape detection. Once outside the building the evidence must be placed in a designated zone where it will be picked up by an agent. While the evidence is analyzed the MAV is required to land and wait for further instructions at a predefined spot. As the sun rises the MAV will quickly heat up and you are advised to anticipate this change. After a short waiting period, your MAV will be instructed to fly again and end the mission.

The Exploration challenge is depicted in Figure 2. It consists of the following mission elements:

Take off: The MAV will take off in the start zone behind the wall and score 1 mission point.
Fly over wall: when starting in zone 1, the MAV has to fly over the wall to score 1 point.
Enter Building: The MAV can enter the building through the door (1 point), through the window (2 points) or through the chimney (3 points).
Identify coarse pattern: The coarse pattern has to be identified (1 point). See table 4 for specification of the patterns.
Identify fine pattern: The second pattern to be identified is a photograph of a face (2 points).
Pick up object: The challenge is to pick up an object inside the building that needs to be transported outside the building. 1 point is scored when the pick up object is successfully transported outside.
Exit building: The MAV can exit the building through the door or window (0 points) or the chimney (2 points).
Release object: 1 point is scored when the MAV drops the pick-up object in the object release zone.
Precision landing: Finally the MAV can demonstrate its precision landing capabilities on a small platform (1 point).
Heat resistance: Next to the landing platform a heat lamp is positioned simulating the sun. The MAV is required to stay 20 seconds on the platform and then successfully take off again (1 point).

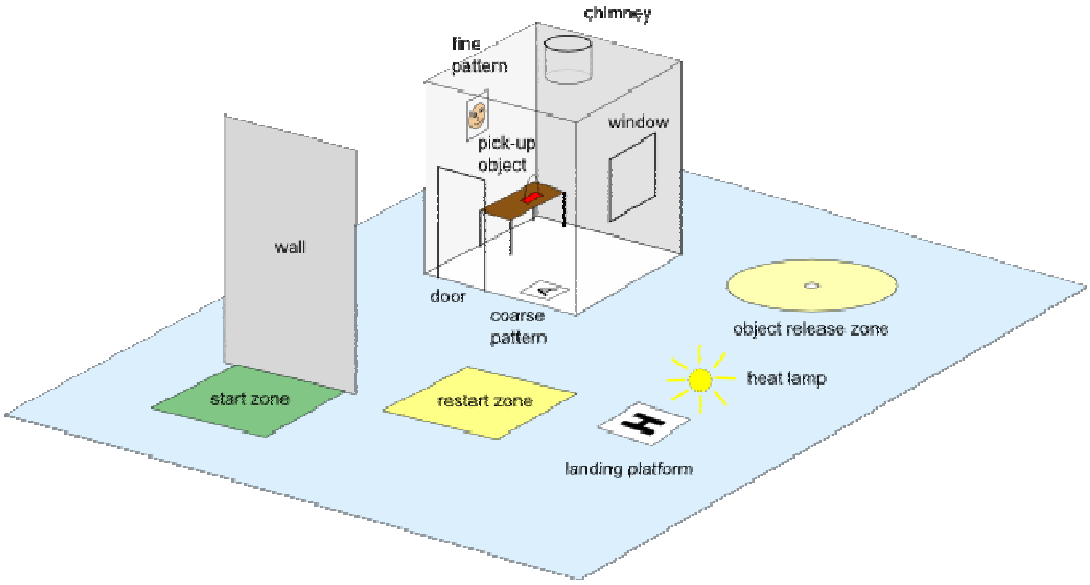

Figure 2: Indoor Exploration Challenge

Pilots / operators may not leave their start zone while flying but they are allowed to leave the start zone to pick up the MAV and start again when they are inside the start zone again. The MAV should be placed in the restart zone.

One mission element involves the picking up of a physical object with the MAV. Teams have to supply their own pickup object. Teams are free to choose the pickup object including attachment and release mechanism. The only constraint is that the pickup object must be big enough to contain a 5x5cm square. Figure 3 shows an example pickup object.

Table 2 shows the mission points per mission element. In the case of multiple attempts for the same mission element, the best score counts. The pickup object may not be manually manipulated during the mission.

Table 2: Indoor exploration challenge mission points

Mission element:	*Score M_n*
Take off	1
Fly over wall	1
Enter building through door / window / chimney	1 / 2 / 3
Recognition of course pattern	1
Recognition of fine pattern	2
Bring pick-up object outside building	1
Exit through chimney	2
Drop object in zone	1
Land on small platform	1
Heat resistance	1

Table 3: Dimensions of exploration mission structures

Drop zone	1m diameter
Landing zone	1m x 1m
Building: LxBxH	3m x 4m x 3m
Chimney	1m diameter, 1m high
Door	1m x 2m

Window	1m x 1m
Pick up object minimal size	5cm x 5cm
Wall (height x width)	230 x 200 cm

Table 4: Definition of patterns

Coarse pattern	A roman alphabet letter ~20cm high with font Arial, printed black on white A4 size paper.
Fine pattern	Color photograph printed on white A4 paper: the teams need to identify a photograph of a possible five different faces. The 5 pictures will be sent to the registered teams, and can be downloaded from the website (under competitions).
Texture inside the "building"	Figure 5 shows an example of the wall texture. A to-be-defined texture will be used for the ground inside the "building", which will be published on www.IMAV2011.org

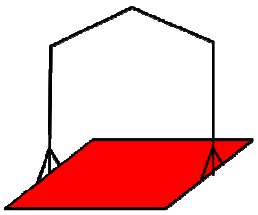

Figure 3: Example of the pick-up object

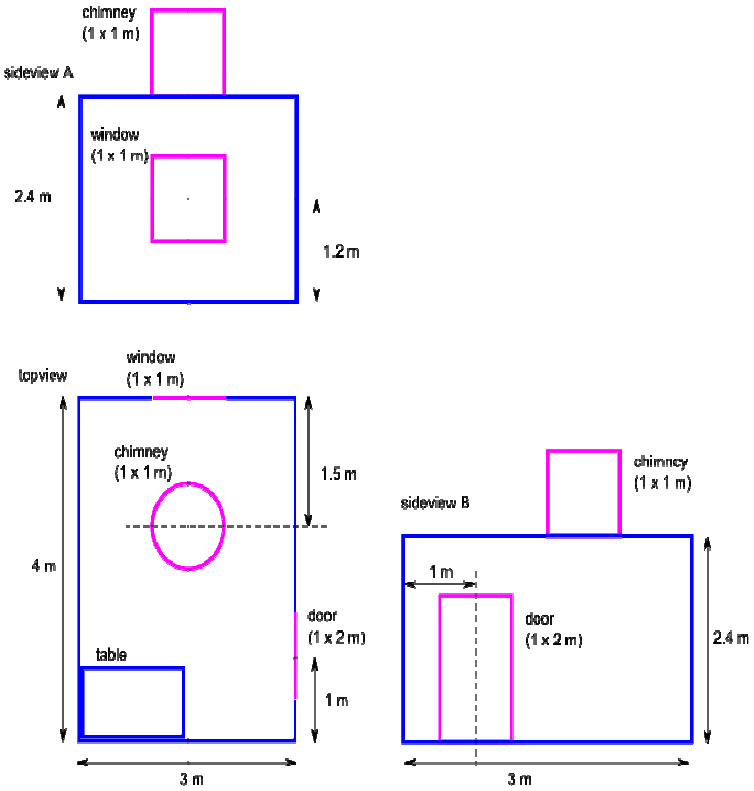

Figure 4: Building dimensions

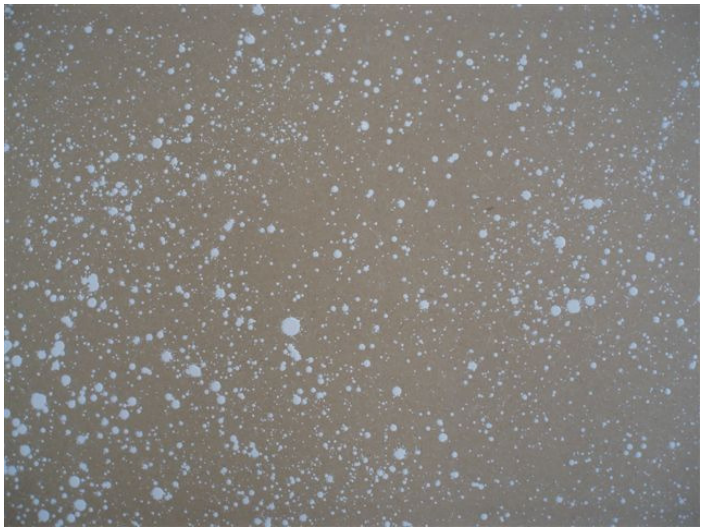

Figure 5: wall texture inside building