IMAV 2016

International Micro Air Vehicle Competition Rules v2.3

October 17th – 21st, 2016

Beijing

Changelog

12 May 2016 – v1

- Competition rules first drafted

1 Aug 2016 – v2

- Added different weight category for indoor objects
- Added 1 extra marker design for UAV landing on both indoor and outdoor mission
- Added contact detail of IMAV 2016 competition committee

19 Sept 2016 – v2.1

- Added color of wall in indoor competition
- Include unit of L in formula 2.
- Update on 5.2.2, 5.2.3, and 5.2.4 (changes in scoring system)
- Added link to competition arena photos

21 Sept 2016 – v2.2

- Update definition of Autonomous factor
- Update Autonomous factor penalty for mission 5.2.3

10 Oct 2016 – v2.3

- Updated table and landing platform height for indoor missions
- Updated lifebuoy dimension and weight category for outdoor mission

Contents

1. Introduction

The aim of IMAV2016 competition is explore the applications of micro air vehicles (MAVs) in civil applications, such as disaster response theme and firefighting scenario. The main theme of IMAV2016 is 'search and rescue' on an off-shore oil rig. The competition simulates an accident happened in the rig, causing fire to the platform and result in people falling into the water. A team of MAV experts is to perform search and rescue missions based on the above scenarios.

Outdoor Competition: equipped with multiple MAVs, the search and rescue team approaches the accident site. The team needs to perform the following missions in one or multiple trials:

1. Take off from a moving and rocking platform.
2. Do a fast mapping of the accident area to evaluate the whole situation and then find designated targets, such as the location of the people in the water.
3. Deliver lifebuoy to the person's vicinity.
4. Sample water around the oil rig and then release the water into a specified water container.
5. Landing on the same moving and rocking platform.

Indoor Competition: the team needs to enter a building in the drilling platform to move some important objects to safe locations. The main mission elements are designed as follows:

1. Taking off from a moving platform
2. Entering the building via different entrance: doorway, chimney or window.
3. Pickup objects and release them to the correct locations.
4. Exiting the building.
5. Landing on the moving platform.
6. Mapping of the indoor environments.

The details of the mission elements are covered in the outdoor and indoor competition section respectively.

2. Schedule

To be determined

3. Safety and security requirements

The details of safety and security is listed in the other document 'IMAV2016 Safety Rules'. Please read the file and take corresponding action. Teams failing to comply with the safety rules will be disqualified of the competition.

4. Scoring System Design

4.1. Total Score System

The total score of the team competition is calculated using the following equation

$$T = \sum_{i=1}^{N} T_i = \sum_{i=1}^{N} (I_i \cdot M_i \cdot A_i \cdot V_i) \quad (1)$$

where i corresponds to each mission element, N is the total number of mission elements in the indoor and outdoor competition category. The four letters 'I, M, A, V' correspond to:

- I is the In-a-row factor
- M is the Mission score for each mission element
- A is the Autonomous factor
- V is the Vehicle factor

I: In-a-row factor encourages participants to complete as many mission elements as possible using a single MAV in a single trial (trial ends when MAV lands or crashes). The more mission elements completed in a single trial, the higher is the In-a-row factor. There are different scores for In-a-row factor in outdoor and indoor competition, as shown in Table 4-1 and Table 4-2 respectively.

Table 4-1: outdoor competition In-a-row factor

Number of mission elements completed in a single trial	In-a-row factor (I_i)
1	1.0
2	1.2
3	1.4
4	1.7
5 (Max)	2.0

Table 4-2: Indoor competition In-a-row factor

Number of mission elements completed in a single trial	In-a-row factor (I_i)
1	1.0
2	1.1
3	1.2
4	1.4
5	1.6
6	1.8
7 (Max)	2.0

Special note:

1. For outdoor competition, takeoff and landing will only be considered in the In-a-row factor if the takeoff and landing are performed on the moving platform AND at least

one mission element has been scored (mapping, deliver lifebuoy or water sampling). MAVs doing only landing or takeoff will not be considered as valid In-a-row factor.

2. For indoor competition, mission number 1 (takeoff), 8 (landing), and 9 (mapping) will NOT be considered in the In-a-row factor.

M: Mission score is calculated based on how well the mission is executed and completed. Details of the outdoor competition are covered in Section 5 and details of the indoor mission score are discussed in Section 6.

A: Autonomous factor encourages participants to tackle the mission elements autonomously. **Autonomous factor will be calculated individually for each mission element.**[1] For outdoor completion, first person view (FPV) flight is not allowed.

Table 4-3: Outdoor autonomy definition

Autonomy Level	Autonomous factor (A_i)
First Person View (FPV)	0
Semi-Autonomous	6
Full-Autonomous	12
External aids • Using customized maker (Except those provided by IMAV2016 organizers) • Placing static electronics (such as router, Wi-Fi booster, and beacon) outside of Operating Zone.	-2 (will be subtracted from the total)

For the indoor competition, A is computed as in Table 4-4:

Table 4-4: Indoor autonomy definition

Autonomy Level	Autonomous factor (A_i)
First Person View (FPV)	1
Semi-Autonomous	6
Full-Autonomous	12
External aids • Using customized maker (Except those provided by IMAV2016 organizers) • Placing static electronics (such as router, Wi-Fi booster, and beacon) outside of Operating Zone.	-2 (will be subtracted from the total)

The definition of the three autonomy levels are as follows:

- **FPV**: the drone is flied via first-person-view goggle and the mission element decisions are made by the operating pilot.
- **Semi-autonomous**: the drone flies autonomously, but human operation is needed for some decisions related to missions (i.e switch of servo).

[1] Updated 21 Sept 2016 (v2.2)

- **Full autonomous**: the drone flies autonomous and mission element is achieved without human help. Human pilot is only for safety monitoring. Pilot or GCS operator cannot issue any command during the mission element.

V: Vehicle factor encourages participants to utilize small size MAVs to complete the mission elements. Vehicle factor is calculated based on the following equation:

$$V_i = \left(2 - \frac{L}{100}\right)^2 \quad (2)$$

where L is the largest size of the drone, the diagonal tip-to-tip size, including blades, in cm[2].

Note: If a team completed any mission elements more than once in the given competition time, the highest total score (T_i) obtained for that mission will be considered in the final score. This is to ensure that each mission element is counted only once in the total score, avoiding stacking the scores from multiple landing and takeoff or any other mission.

4.2. Competition Time and Multiple MAVs Operation

Competition Time Setup

- Each team is given 30 minutes duration for the whole competition run. A 5 minutes set up time is reserved for each team prior to the start of the competition. After 5 minutes set up time, or when the team is ready to start, a 30 minutes count down timer will start and be displayed in a big screen.
- In the 30 minutes competition time, each team is given ONE chance to pause the timer and abort the current trial. The team will be able to continue the trial with the remaining time at a later time (will be queued up at the end of the list).
- Indoor and outdoor competition happen on different days. Each team will have 30 minutes for the corresponding competition category.

Multiple MAV Operation

- Only up to 2 MAVs are allowed to fly at any given time
- Each flying MAV must be accompanied by a safety pilot (for FPV) and an observer (for Semi-autonomous or Full-autonomous) at all time.
- Crashed MAVs must be retrieved and powered-off before starting a new trial.
- The team can use any number of MAVs in the competition, but only a maximum of 2 MAVs are allowed to fly at the same time. They can be used in either the same or different missions. The score of each MAV for each mission will be calculated individually based on the MAV's vehicle factor, autonomy level, mission score, and

[2] Updated 7 Sept 2016 (v2.1)

In-a-row factor. Do note that only the highest score for each mission element will be considered in the final score.

5. Outdoor Competition

5.1. Introduction

5.1.1. Competition mission elements

The following tasks are required for the outdoor competition:

1. Autonomous takeoff
    - Take off from a moving platform.
    - The moving platform will move in the area 'A' illustrated in Figure 5-1.
    - Visual markers will be placed on the moving platform.
2. Fast mapping of the accident area
    - MAVs are to fly to the area 'B' to create a stitched map of that area.
    - People fallen into the water has to be identified by the stitched image.
    - Real-time stitched image will score bonus points; offline stitched image has to be submitted within 20 minutes after landing of the MAVs.
3. Sampling of water from the accident area
    - MAV has to fly to area 'C' to collect water samples.
    - Water samples have to be released into a water container located in 'A'.
4. Deliver lifebuoy to the victims in the water
    - Release a lifebuoy to the detected person.
    - If the person's coordinate is autonomously detected during the fast mapping process, extra points will be granted provided the lifebuoy is released into the correct zone.
5. Landing on the moving and rocking platform
    - The landing area is also designed in area 'A' in Figure 5-1.
    - Successful landing on the moving platform or static platform will score different points.

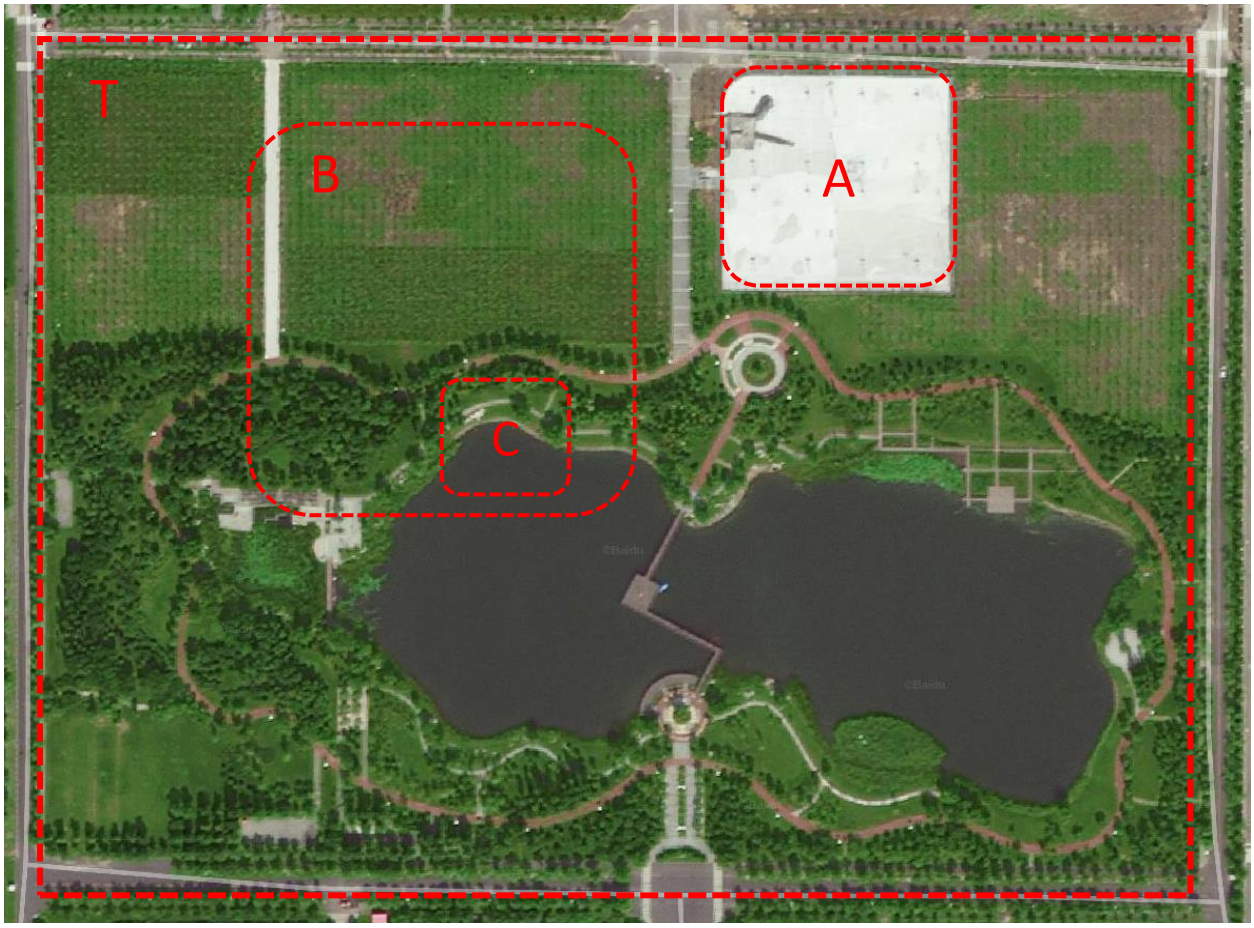

Figure 5-1: Planned outdoor competition site. 'A' is for takeoff and landing on a moving platform. 'B' is for fast mapping. 'C' is for water sampling and lifebuoy delivery.

5.1.2. Competition site selection

The outdoor competition venue is located in the Beihu Lake of Liangxiang campus of Beijing Institute of Technology as shown in Figure 5-1.

- In Figure 5-1, the total area 'T' is 300 m × 400 m.
- The size of the area 'A' is 75 m× 75 m. The size of the area 'B' is 130 m × 130 m, and the size of the area 'C' is 35 m × 35 m.
- The map overview of the competition site can be accessed at : http://j.map.baidu.com/Uwwy7
- The official overview of the site is : http://english.bit.edu.cn/AboutBIT/VisitingBIT/campusIchnography/index.htm
- Photos of Competition area : http://www.imavs.org/2016/competition_area.html

5.2. Outdoor Mission elements and Mission scores (M_i)

5.2.1. Mission element 1: Takeoff

Each MAV is to take off at the area 'A' in Figure 5-1 to score points in this mission element.

Mission score for this element will be calculated as follows:

Table 5-1: Outdoor takeoff mission

Takeoff method	Mission score (M_1)
Taking off from the moving and rocking platform	5
Taking off from the moving platform	3
Taking off from the static platform	1

The takeoff mission scores will be counted only when at least one of the mission 2, 3, 4 has been attempted. Takeoff without completing any of the mission will be considered as invalid.

Takeoff will only be considered in the In-a-row factor if it satisfies BOTH of the following two conditions:

1. If the takeoff is conducted on the moving platform, $M_1 \geq 3$;
2. At least one mission element has been scored: mapping, deliver lifebuoy or water sampling. MAVs doing only landing or takeoff will not considered in the in-a-row factor.

For example, an MAV took-off from the moving platform and scored some points in the Mapping mission, but did not land on the moving platform. Only the takeoff and mapping will be considered as valid In-a-row mission. The In-a-row factor will be 1.2 according to Table 4-1.

5.2.2. Mission element 2: Mapping

This mission is to deploy an MAV carrying a camera to quickly survey the accident area, create an overview map of the area and locate interested targets. The survey area is labeled as 'B' in Figure 5-1 with an estimated size of $120\text{m} \times 120\text{m}$. The scoring of this mission is illustrated in Table 5-2.

Table 5-2: Outdoor mapping mission

Mapping method	Mission score (M_2)
Real time mapping: stitched map is performed in real time (onboard or ground station) and mapping result is shown on the ground station in real time[3].	2

[3] Updated 19 Sept 2016

Offline Mapping: provide a map within 20 minutes after the MAV lands.	1
Find each target in the map (6 in total)	+0.5 each

The map creation process may have three autonomy levels:

Table 5-3: Outdoor map creation autonomy level

Mapping method	Autonomy level
Full autonomous: the map is created autonomously without any human intervention after loading the images.	12
Semi-autonomous: human operation is needed besides loading images in the software.	6
Manual: the images are manually stitched or pasted together	1

The autonomy level of the mapping mission is the lower factor among the flight autonomy level and the map creation autonomy level. For example, a team flies an MAV with semi-autonomous mode (6 for flight) and creates map fully autonomous (12 for map creation), the overall autonomy level for the mapping will be 6.

For target detection in the map, it will be performed by judges on the competition site. The competition teams do not need to perform target detection autonomously.

The 6 targets scattering in the area 'B' will have different shapes with a maximum size of 1 meter in both horizontal and vertical directions. Illustrations of the targets are shown in Figure 5-2, which are referred to as T1-T6. Identification of the 6 targets will be carried out by the judges and only the markers with clear shapes are considered valid. **GPS coordinates of the markers need NOT to be determined.**[4] Please note that the red T6 target represents a person who has fallen into the water. A lifebuoy should be delivered to T6's vicinity in mission 3, which is to be covered in Section 5.2.3.

Three white square-shape markers will also be placed in the area 'B', whose GPS coordinates will be given **prior to the competition**[5]. These three markers can be used as reference GPS markers for teams who want to locate the position of T6 using their own stitched maps.

[4] Updated 19 Sept 2016
[5] Updated 19 Sept 2016

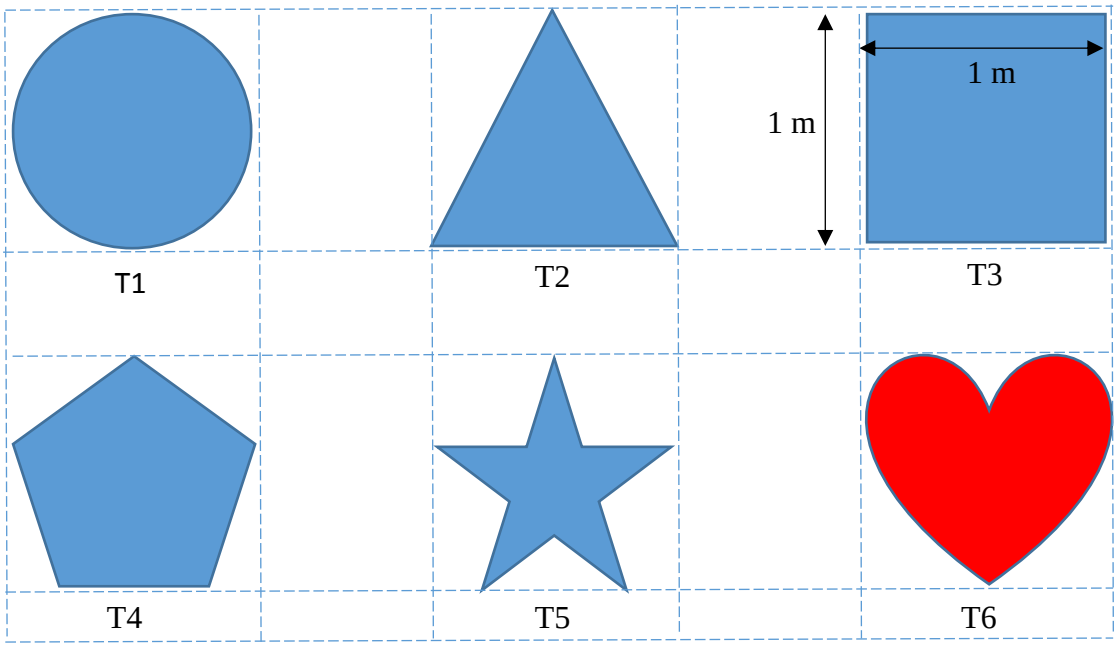

Figure 5-2: Shapes of the 6 targets

5.2.3. Mission element 3: Lifebuoy Delivery

This mission requires the team to deliver a lifebuoy to the place where a person has fallen to the water (marker T6). **Note that the teams can choose to identify the location of the marker by themselves (either manually or autonomously), or to get the official GPS coordinate of the marker prior to the competition (with a penalty of -2 in Autonomous factor, A_3).**[6]

The score of this mission is measured by the accuracy of the delivery as defined in Table 5-4.

Table 5-4: Outdoor lifebuoy delivery mission

Lifebuoy delivery zone	Mission score (M_3)
Release the lifebuoy to the 1 m zone	5
Release the lifebuoy to the 2 m zone	4
Release the lifebuoy to the 3 m zone	3
Release the lifebuoy to the 5 m zone	1
Release the lifebuoy outside of the 5 m zone	0

The targeted area of delivery is shown in Figure 5-3, which is located in 'C' in Figure 5-1.

[6] Updated 21 Sept 2016

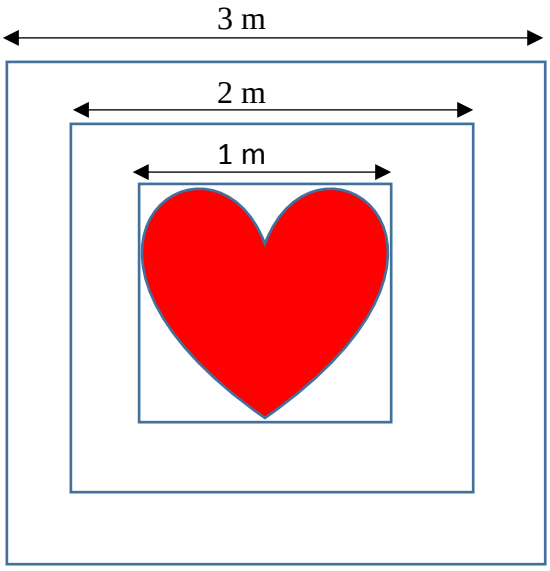

Figure 5-3: Release zone illustration, the maximum valid release zone is 5 m

The weight of the lifebuoy is adjustable in order to encourage teams to use smaller MAVs for the lifebuoy delivery. Team can choose a desired lifebuoy with the weight and dimension as according to Table 5-5.[7]

Table 5-5: Weight assignment for lifebuoy

Lifebuoy Weight (gram)	Lifebuoy Dimension (diameter in cm)[8]
20	18
50	18 or 28
100	18 or 28
150	28 or 38
200	28 or 38

The lifebuoy can be attached before take-off.

[7] Updated 10 Oct 2016 – v2.3
[8] Updated 10 Oct 2016 – v2.3

5.2.4. Mission element 4: Water Sampling

The water sampling area is in 'C' and the water container will be placed in 'A' in Figure 5-1.

The scoring of this mission is defined in Table 5-6.

Table 5-6: Outdoor water sampling mission

Water Sampling	Mission score (M_4)
Collect water and release water into container	5
Collect water only	2.5
Release water into container only, minimum 20 grams of water needs to be in the container.	2.5

This mission is assessed in two main sub missions: water collecting and water releasing. Teams are allowed to do either one of the two or both.

The 'water collecting' sub-mission will be scored only when the MAV navigates above the sampling area and then descends to collect water. External operation is allowed while collecting water, but the autonomy level will be affected.

The 'water releasing' sub mission will be scored only when the water is released into the container. The minimum amount of water collected in the container is **20 grams**.

Attaching a bottle of water to the MAV before takeoff is not allowed for 'water collecting', but it can be used for teams trying the 'water releasing' sub-mission.

The coordinate of the water container will be given before on the practice day. Teams are also allowed to measure its location use their own GPS receiver on the practice day. **External markers can be placed near the container with a penalty of -2 points in Autonomous factor.**[9]

The water container top maximum opening is 1.5m×1.5m.

[9] Updated 19 Sept 2016

5.2.5. Mission element 5: Landing

Each MAV is to land on the same moving platform as the takeoff in the area 'A' in Figure 5-1 to score points in this mission element.

Mission score for this element will be calculated as follows:

Table 5-7: Outdoor landing mission

Landing method	Mission score (M_5)
Land on the moving and rocking platform	5
Land on the moving platform	4
Land on the static platform	2
Land on ground, in 3 meter radius from the platform	0.5
Crashes or land outside of 3 meter radius from the platform	0

The landing mission will be counted only when at least one of the mission 2, 3, 4 has been attempted. Takeoff and landing without any of the mission will be considered as invalid.

For the In-a-row factor, landing will only be considered in the In-a-row factor if the trial satisfied BOTH of the following two conditions:

1. If the landing is performed on the moving platform, $M_5 \geq 2.5$
2. At least one mission element has been scored: mapping, deliver lifebuoy or water sampling. MAVs doing only landing will not be considered as valid In-a-row factor.

For example, an MAV took off from the moving platform and scored in the Mapping mission, and then landed on the moving platform. The takeoff, mapping, and landing will be considered as valid continuous mission. The In-a-row factor will be 1.4 according to Table 4-1.

Vision markers visualized in Figure 5-4 or Figure 5-5 will be placed on the moving platform for those teams who want to perform vision-guided landing. **Teams can choose either one of the official markers for this mission element.**[10] Use of any other markers will be considered as external marker and will have a -2 penalty in the autonomy level.

Teams are also allowed to place external beacons on the moving platform, which will also influence the autonomy level by a -2 penalty.

[10] Updated 1 Aug 2016 (v2)

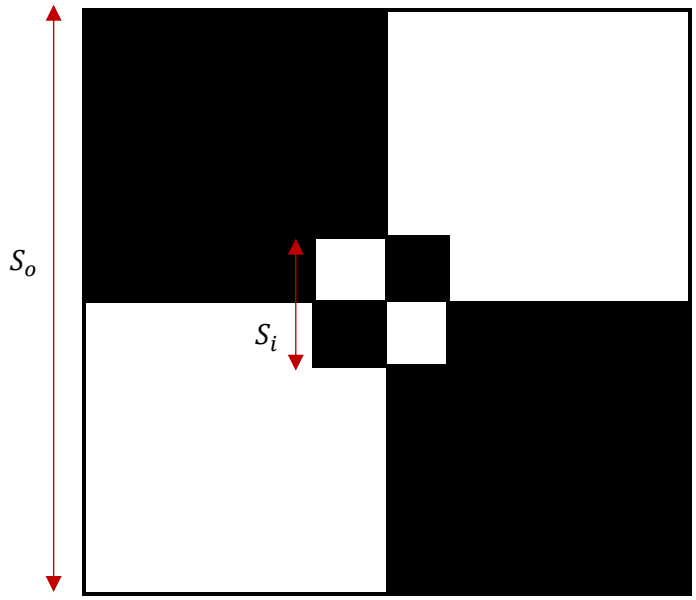

Figure 5-4: design of pattern on the moving platform. The pattern consists of two quad-squares. The outer square is used for vision-based pose estimation in larger distances while the inner square is used for pose estimation in close range. The sizes are $S_o = 1m$ and $S_i = 0.1m$.

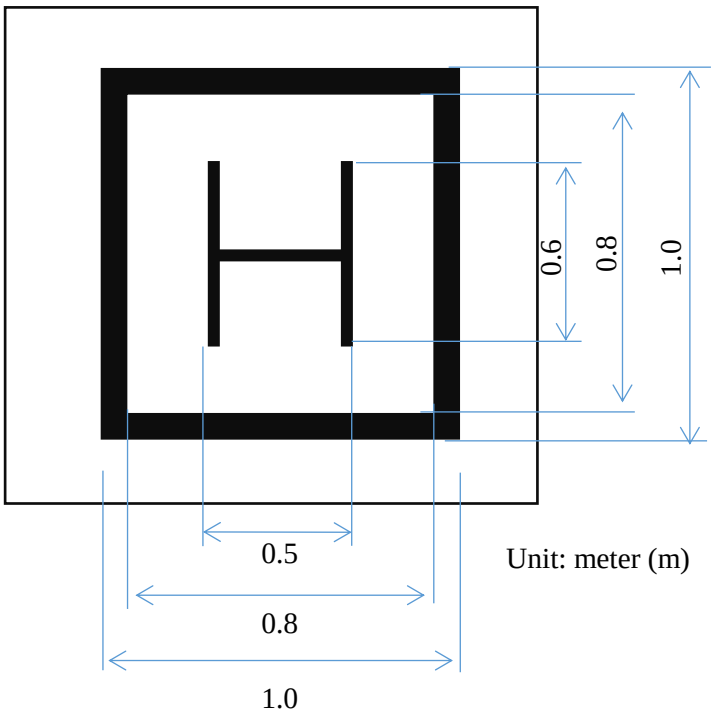

Figure 5-5: alternate design of pattern on the moving platform

6. Indoor Competition

6.1. Introduction

6.1.1. Competition mission elements

There will be a total of 9 mission elements including taking-off and landing in this indoor challenge as shown in the Table 6-1.

Table 6-1: Indoor competition mission design

Element Number	Mission
1	Take off at Operating Zone (2 possible ways): a) From a moving platform b) From ground
2	Enter building (3 possible entrances): a) Chimney b) Windows c) Doorway
3	Search and pick Item A
4	Search and drop Item A
5	Search and pick Item B
6	Search and drop Item B
7	Exit building (2 possible exits): a) Windows b) Doorway
8	Landing at Operating Zone (2 possible ways): a) On a moving platform b) On ground
9	Provide building interior map (2 possible configurations) a) 3-Dimensional map b) 2-Dimensional map

Mission elements should be carried out in the following sequence:

- MAV to take off outside the building, then enter the building via one of the few selected entrance point (Mission element 1 and 2)
- MAV is then to carry out targets searching, picking, and dropping in different rooms of the building, in any order (Mission element 3, 4, 5 and 6)
- At the end of the mission, MAV is to fly out of the building back to the takeoff zone to land (Mission element 7 and 8).
- Map of the building interior should be generated from the flight (Mission element 9).

6.1.2. Competition Site

The indoor competition venue is located in the gymnasium of Zhong Guan Cun campus of Beijing Institute of Technology. The map overview of the competition site can be accessed at: http://english.bit.edu.cn/AboutBIT/VisitingBIT/campusIchnography/index.htm

6.2. Competition Layout

Netted competition arena is divided into 2 zones as shown in Figure 6-1

- Operating Zone
- Mission Zone

Operating Zone (OZ) is where all participants (except failsafe pilot and/or observer) should be gathered throughout the whole competition turn. All ground control station (including antenna, router, booster etc.) should be set up in this zone. Any additional object/marker set up beyond this zone will have a penalty of -2 each on Autonomy Factor (will be discussed in Section 0) of the respective mission element which benefits from the object/marker. Layout of the OZ is shown in Figure 6-2.

Mission Zone (MZ) is the area enclosed by the building, serving as the main arena for most of the mission elements in the indoor challenge. Layout of the MZ is shown in Figure 6-3.

IMPORTANT: the walls and floors in the indoor setup are with features. They are not pure solid color or featureless. This is to facilitate those teams who would like to explore vision algorithms for navigation.

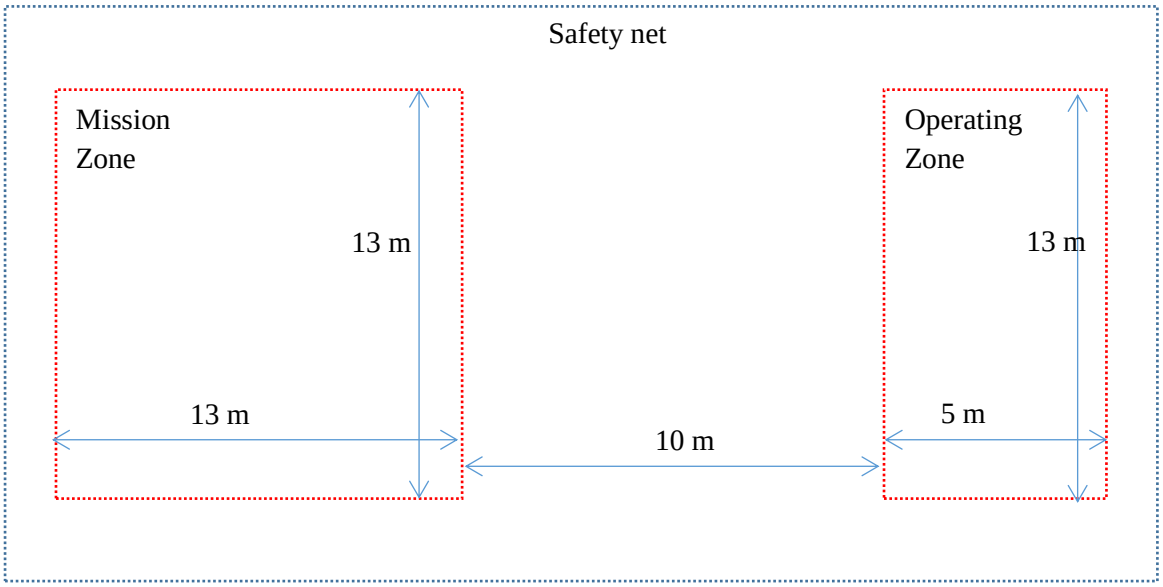

Figure 6-1: Competition Layout

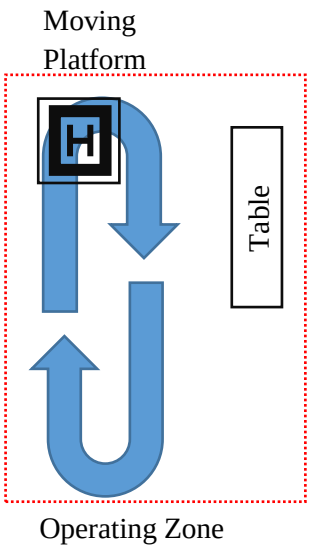

Figure 6-2: Operating Zone Layout[11]

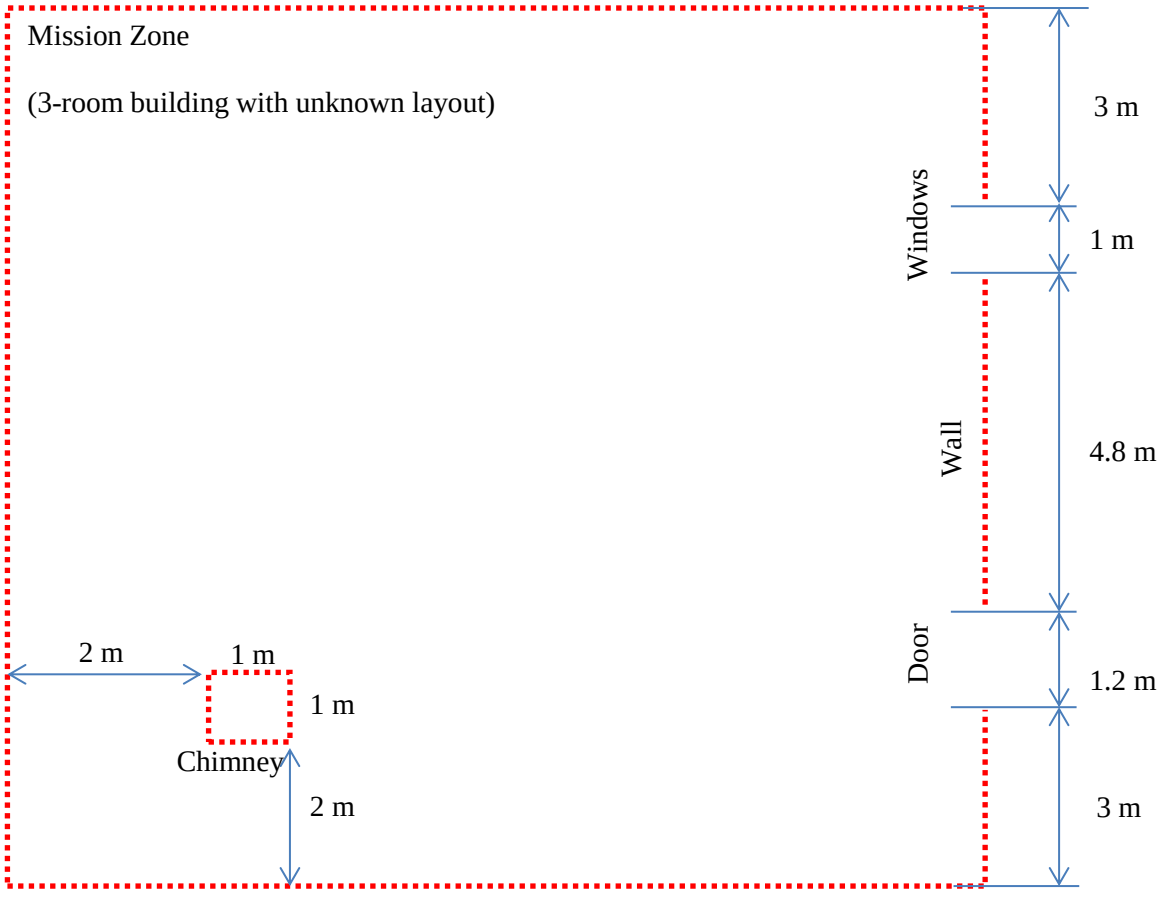

Figure 6-3: Mission Zone Layout

[11] Updated 10 Oct 2016 – v2.3

6.3. Mission elements and Mission scores (M_i)

6.3.1. Mission element 1: Takeoff

Each MAV is to takeoff at the Operating Zone (OZ) to score points in this mission element.

Mission score for this element will only be considered if the MAV completed at least 1 mission elements among mission element 2 to 7 after the takeoff.

There will be NO In-a-row factor ($I_1 = 1$) in this mission element.

Mission score for this element will be calculated as follows:

Table 6-2: Indoor takeoff mission

Takeoff method	Mission score (M_1)
Taking-off from the moving platform in OZ. Dimension of the moving platform can be obtained in Figure 5.3 and 5.4. Moving platform will move in a constant speed not more than 2 m/s.	2
Taking-off from ground within OZ	1
Taking-off outside OZ	0

6.3.2. Mission element 2: Enter building

The MAV is required to navigate into the building via 3 entrances

- Chimney
- Windows
- Doorway

Detail dimensions of the entrances can be viewed Figure 6-4, Figure 6-4, and Figure 6-5. Note that color of the wall will be slightly grey[12].

Mission score for this element will be calculated as follows:

Table 6-3: Indoor entering building mission

Enter method	Mission score (M_2)
Enter via Chimney. Frame of entrance will be marked with black border for visual aid. See Figure 6-6 .	4
Enter via Windows. Frame of entrance will be marked with blue border for visual aid. See Figure 6-5	2
Enter via Doorway. Frame of entrance will be marked with red border for visual aid. See Figure 6-4	1

[12] Updated 19 Sept 2016 (v2.1)

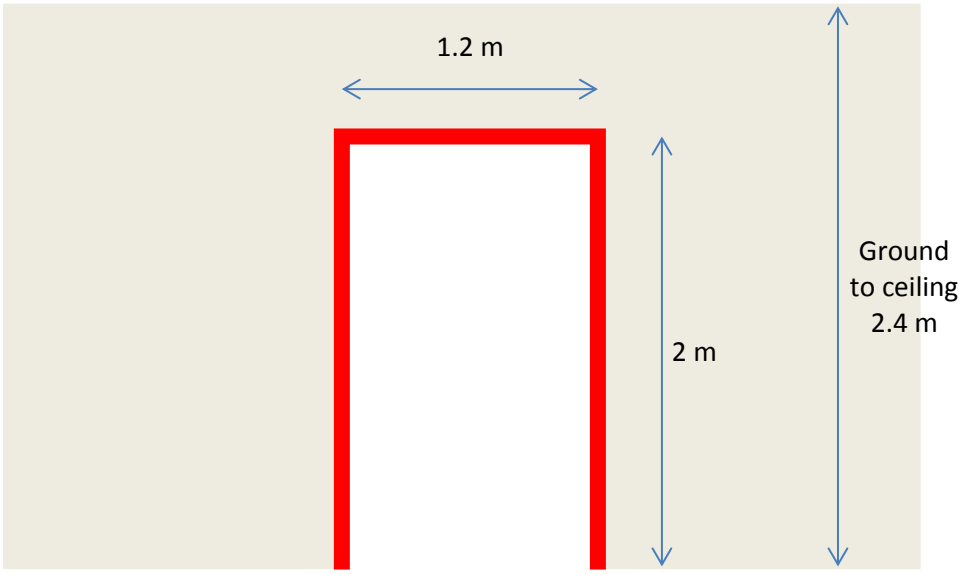

Figure 6-4: Doorway Entrance

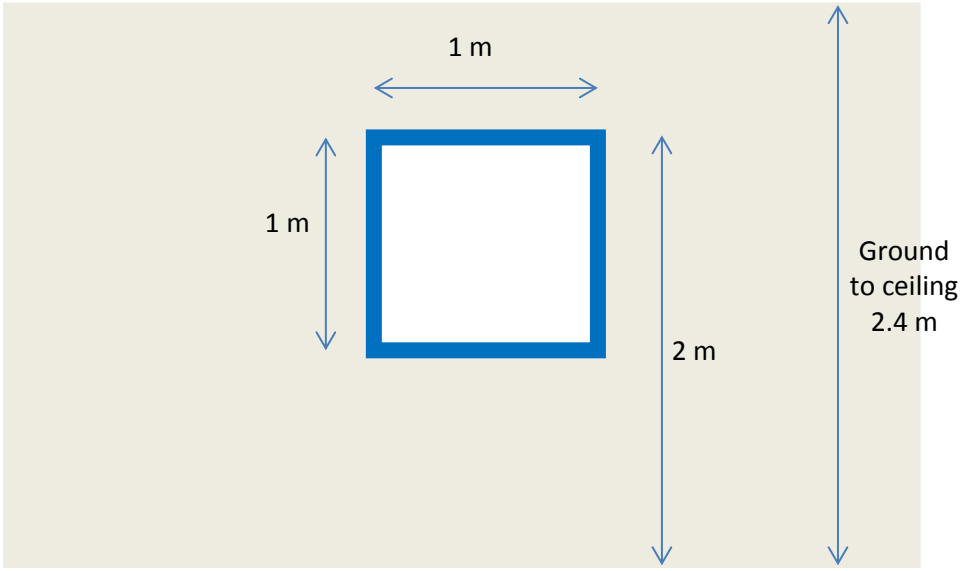

Figure 6-5: Windows Entrance

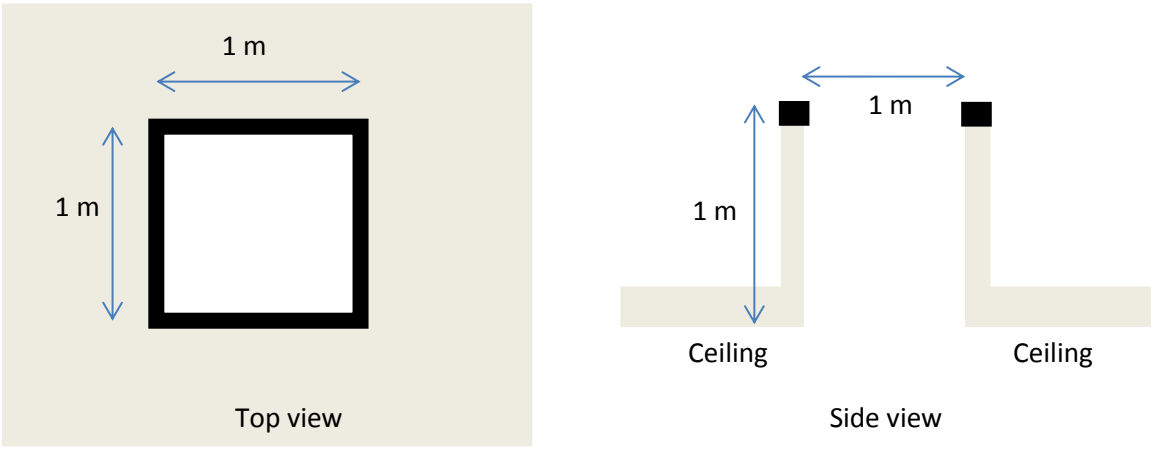

Figure 6-6: Chimney entrance

6.3.3. Mission element 3, 4, 5 and 6: Pick and release items

These 4 mission elements can be conducted in any order. Completion of any element will grant Mission score ($M_3/M_4/M_5/M_6$) to the corresponding mission element.

Mission element 3 requires the MAV to pick-up and fetch on-board a cylindrical object (Label as Item A) from a table in one of the room in the building. **Table height is 1 m**[13]. Item A will be painted red. See Figure 6-7 for visual illustration. Item A will be placed on the table together with three other similar items painted white. MAV is required to identify and pick correctly Item A among the items. See Figure 6-9 for visual illustration.

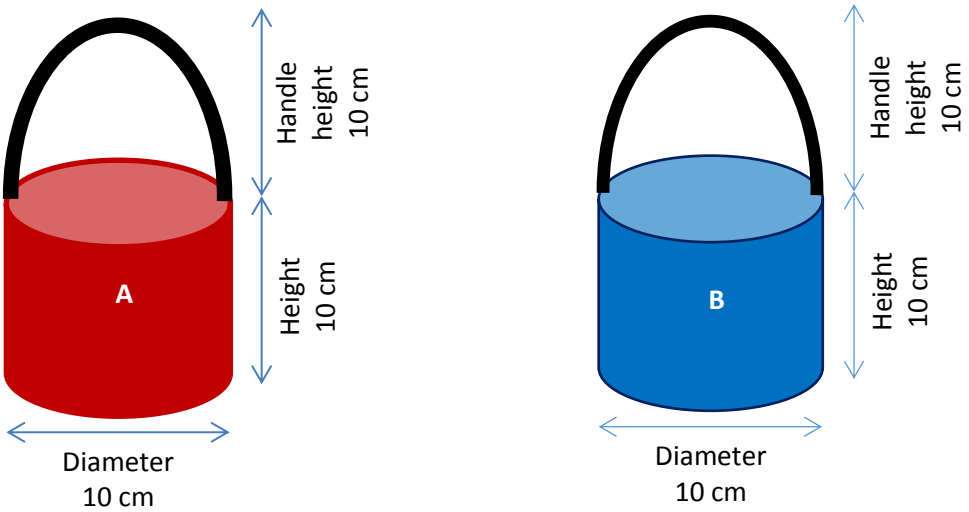

Figure 6-7: Cylindrical objects

[13] Updated 10 Oct 2016 – v2.3

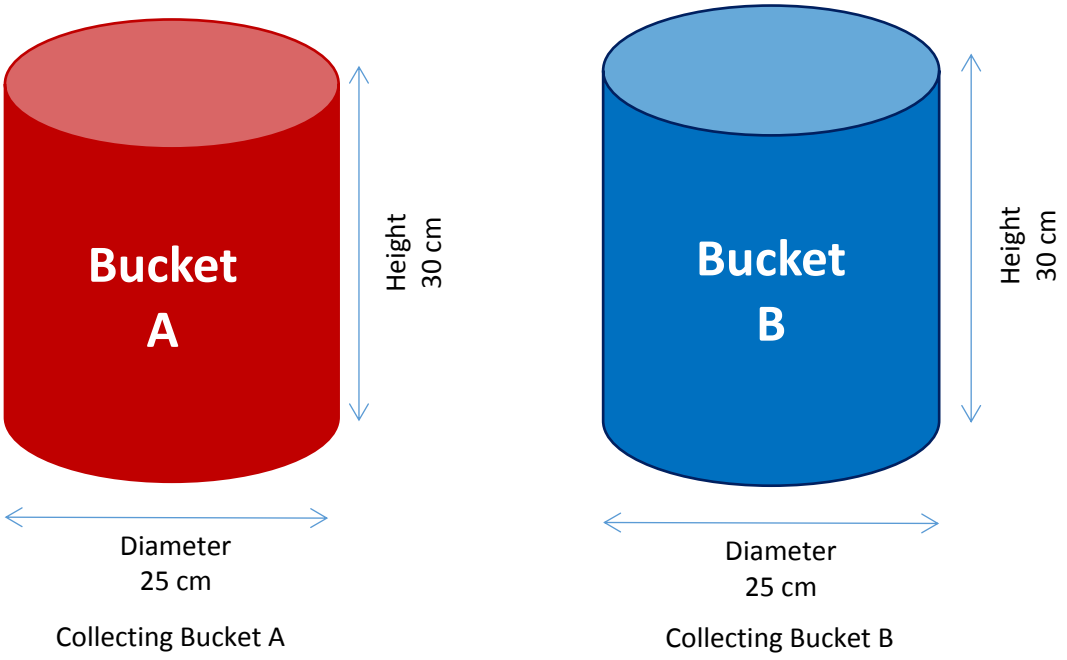

Figure 6-8: Buckets collecting items

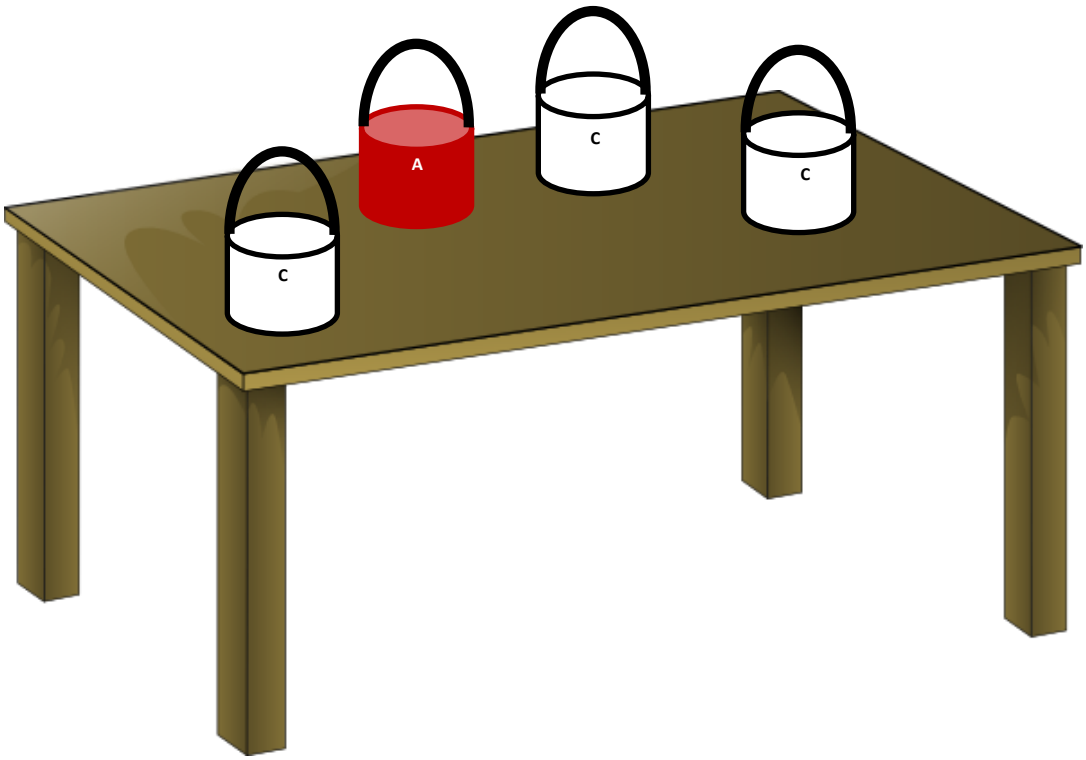

Figure 6-9: Item A to be identified

Mission element 4 requires the MAV to drop item A into a collecting Bucket A in one of the room in the building. See Figure 6-8 for visual illustration of Bucket A.

Mission element 5 is similar to element 3, except that now the MAV is required to pick-up and fetch on-board a blue cylindrical object (Label as Item B) from a table in one of the

room in the building. Item B will be painted blue. See Figure 6-8 and Figure 6-10 for visual illustration.

Mission element 6 requires the MAV to drop item B into a collecting Bucket B in one of the room in the building. See Figure 6-8 for visual illustration of Bucket B.

Note that the location of Bucket A for mission element 4 is in the same room as the location of Bucket B for mission element 6. Teams are required to identify the correct collecting bucket for dropping the right items.

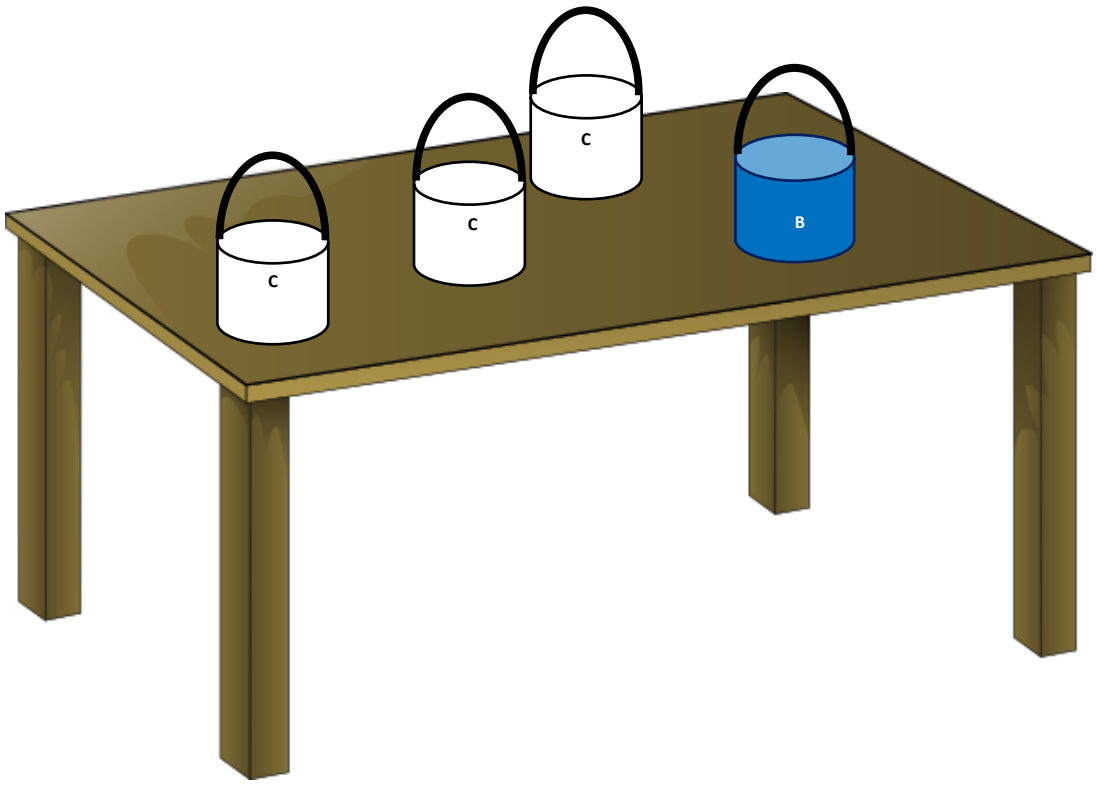

Figure 6-10: Item B to be identified

The weight of item A and B are variable according to the weight of the MAV as Table 6-4.

Table 6-4: Weight assignment for Item A&B

MAV Weight (gram)	Items Weight (gram)
≤500	20
500 ~ 999	50
>999	100

Mission score for these elements will be calculated as follows:

Table 6-5: Indoor item picking and releasing mission

Mission 3	Mission score (M_3)
Identify and pick Item A (red) correctly and fetch on-board.	5
Pick and fetch on-board the wrong item (white).	3
Did not manage to pick any item	0
Mission 4	Mission score (M_4)
Release Item A (red) into Bucket A (red)	2
Release Item A (red) into Bucket B (blue)	1
Did not release Item A	0
Mission 5	Mission score (M_5)
Identify and pick Item B (blue) correctly and fetch on-board.	5
Picked and fetch on-board the wrong item (white).	3
Did not manage to pick any item	0
Mission 6	Mission score (M_6)
Release Item B (blue) into Bucket B (blue)	2
Release Item B (blue) into Bucket A (red)	1
Did not release Item B	0

Teams are allowed to give up on mission element 3 and/or 5 by pre-loading Item A and/or Item B on-board of MAV before takeoff. No mission score will be given to element 3 and/or 5 in this case.

6.3.4. Mission element 7: Exit building

The MAV is required to navigate out of the building via 2 exits

- Windows
- Doorways

The exits are the same course of the entrance in Mission element 2, except that Chimney will not be an exit. See Figure 6-3, Figure 6-4, Figure 6-5, and Figure 6-6 for visual illustration.

Mission score for this element will be calculated as follows:

Table 6-6: Indoor building exit mission

Exit method	Mission score (M_7)
Exit via Windows. Frame of entrance will be marked with blue border for visual aid. See Figure 6-5	2
Exit via Doorway. Frame of entrance will be marked with red border for visual aid. See Figure 6-4.	1

6.3.5. Mission element 8: Land

Each MAV is to land at the Operating Zone (OZ) to score points in this mission element. **Teams can land the UAV on the ground or on the moving platform, with either 1 of the 2 markers shown in Figure 6-11. Teams can choose either one of the official markers for this mission element. Use of any other markers will be considered as external marker and will have a -2 penalty in the autonomy level.** [14]

Mission score for this element will only be considered if the MAV completed at least 1 mission elements among mission element 2 to 7 prior to the landing.

There will be NO In-a-row factor ($I_8 = 1$) in this mission element.

Mission score for this element will be calculated as follows:

Table 6-7: Indoor landing mission

Landing method	Mission score (M_8)
Landing on the moving platform in OZ. Dimension of the moving platform can be obtained in . Figure 6-11 . Moving platform will move in a constant speed not more than 2 m/s.	4
Landing on ground within OZ	1
Landing outside OZ	0

[14] Updated 1 Aug 2016 (v2)

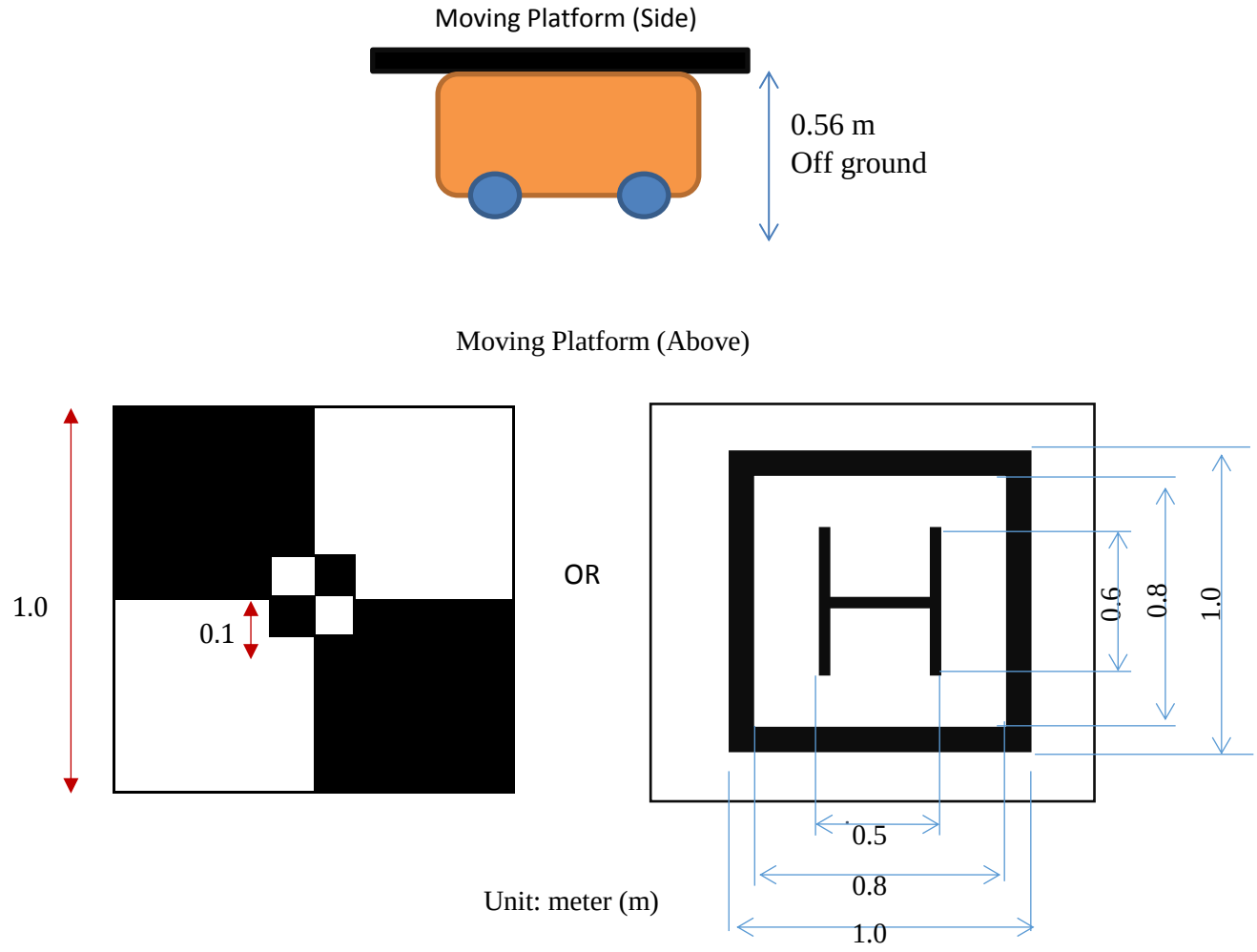

Figure 6-11: Moving platform marker[15]

[15] Updated 10 Oct 2016 – v2.3

6.3.6. Mission element 9: Build Map

Each team is required to submit a map describing the interior of the building and location of obstacles in the building within 15 minutes after the team's turn is over.

There will be NO In-a-row factor ($I_9 = 1$) in this mission element.

Vehicle factor (V_9) of this element will take the factor of the largest MAV flew by the team.

Mission score for this element will be calculated as follows:

Table 6-8: Indoor mapping building mission

Map display	Mission score (M_9)
Display map in 3D visual effect (able to roll and turn the map to view different angles)	2
Display map in 2D visual effect	1
Display of obstacles (e.g.: tables, chairs, sofas) location on map (To a maximum of 4 correctly located obstacles)	+0.5 each (Max +2)

7. Contact Detail

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