



IMAV 2018 Competition Rules Indoor & Outdoor Events

V1.0

* Note that rules are subject to minor revisions and updates

Introduction

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

- Aircraft efficiency and innovative designs
- Light and small MAVs
- Autonomy and image processing
- Stability in turbulence
- Multi-MAV cooperation

General

Australian Media and Communication Authority (ACMA) allows use of the following frequency bands:

Frequency Band	Power Limit	Notes
915 - 928 MHz		RFD900 Radio Modems are highly recommended.
2.4 - 2.4835 GHz		There may be signal interference due to a nearby tower.
5.15 - 5.25 GHz		
5.25 - 5.35 GHz		
5.470 - 5.60 GHz		
5.65 - 5.725 GHz		
5.725 - 5.850 GHz		

433 MHz is not permitted for use in Australia.

Failure to abide by the boundaries and frequencies can lead to a penalty or disqualification.

Safety

To comply with Australian Drone regulations:

- Please see this link for more details. www.casa.gov.au/modelaircraft
- The maximum take-off weight of any MAVs must not exceed 2 kg
- Maximum flight altitude is 400 ft (approx. 120m) Above Ground Level (AGL), however the ceiling maybe be reduced to comply with competition rules (TBA)
- All MAVs should stay inside the designated flight areas. If a MAV strays outside the designated flight area, it should either land or turn back immediately inside the flight area.
- No-fly zones will be published at a later date.
- Please ensure safe working practice while working on MAVs.

Location

The event is held from the 17th - 23rd November in Bundoora, VIC, Australia. This will consist of 3 competition days, 2 practise days, and 2 conference days.

Indoor Event

The indoor event will be held at the RMIT Bundoora East Campus, approximately 20km from Melbourne city centre. Please note that RMIT Bundoora has both an East and West Campus.

Address:

RMIT Bundoora East Campus,
Plenty Road,
Bundoora VIC

Map:



Outdoor Event

The outdoor event will be held at Greensborough Model Aircraft Club (GMAC), approximately 20 minutes drive from RMIT Bundoora East Campus.

Address:

Greensborough Model Aircraft Club,
Yan Yean Rd,
Yarrambat VIC

Map:

Scoring

The final score will depend on the success of each mission element (E = mission element score), the level of autonomy for each mission element (A), the mass factor (M), the power factor (W), the “in-a-row” factor (I), and a presentation made by the team during the mission (P).

Awards will be determined using the following formula:

$$Total\ Score = P \times \Sigma(MAV\ Score)$$

Where,

$$MAV\ Score = E \times I \times A \times M \times W$$

Where,

P = Presentation (from 1 to 1.1)

E = Element score¹

I = In-a-row Factor

A = Autonomy Level

M = Mass Factor

W = Power Factor

¹Note that Element scoring is defined under the specific event information.

Presentation factor (P)

The team is rewarded when a team member presents the tasks and actions currently performed. The goal is to make the demonstration of each team more lively and accessible for the public. A video feedback of the ground station is also possible and is strongly recommended (standard VGA cable or analog video).

The presentation factor will be determined according to the description of:

- The MAV system and its design
- The initial plan to perform the mission elements
- The tasks actually performed
- The level of autonomy of each task / MAV
- Presentation factor = Is an additional 10% of the final score (P from 1 to 1.1)

In-a-Row Factor (I)

The in-a-row factor allows a multiplier for a single MAV that is able to complete multiple elements in succession (one after another). The multiplier starts counting after the first mission element is completed (take-off and landing are not included).

Mission Elements Done In-a-Row	I Multiplier
1	1.0
2	1.2
3	1.4
4 (max. available)	1.6

Level of Autonomy

Level of Autonomy	Factor
Video based control: control of the MAV through an FPV system.	1
Autonomous flight control: the navigation is completely autonomous, however the operator is controlling the mission and payload	5
Autonomous target detection: the navigation is manual, however the detection and processing of targets is automatic	5
Fully autonomous control of both the navigation and target detection.	10
Using external aids, such as visual markers	-2 applied to factor

Mass Factor (M)

This year there will be a mass factor allocated to each MAV, rather than a size factor, defined as follows:

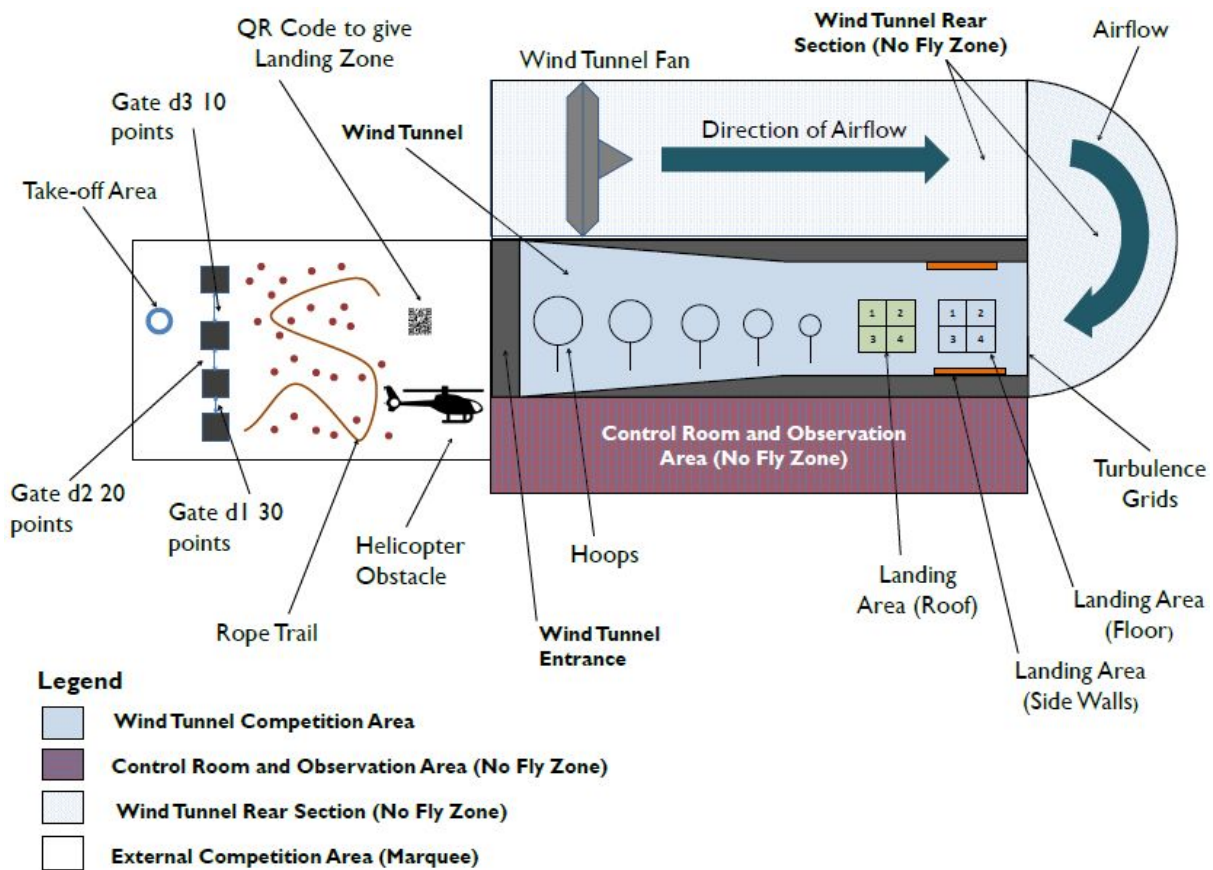
$$M = \frac{1000}{MAV \text{ mass (grams)}}$$

Power Factor (W)

A power factor will also be applied to each competing MAV, to encourage alternative energy sources and lower capacity batteries.

$$W = \frac{10}{Total \text{ Battery Capacity (W.h)}}$$

Indoor Course



Mission Brief

Teams are allocated 15 minutes to attempt the course, with the option to “pause” their time once by using their “Wild Card”.

The indoor event consists of several challenges, culminating in a wind-tunnel challenge focusing on stability in turbulence. Teams must attempt to complete as many of these challenges as possible to achieve the maximum number of points.

Take-off

- Take-off from the designated platform.

Window Challenge

- Three different sized windows will be available for teams to choose.
- Points range according to the size of the window (smaller window is worth more points).
- Small window -
 - Square
 - (W)0.5m x (H)0.5m
- Medium window
 - Rectangular
 - (W)1.0m x (H)1.5m
- Large window
 - Rectangular
 - (W)1.5m x (H)1.5m

Pole Navigation and Follow the Rope

- Poles will be arranged in a random pattern whereby the aircraft(s) **MUST** navigate through (cannot go above pole height) . Pole specification :TBA
- Points will be deducted for any obstacle hit.
- A rope will pass through the pole area (high contrast against the floor) representing the a preferred path through the pole area.
- The MAV must follow the rope all the way to the end. Points for following the rope are awarded in sections. The rope is divided into 4 sections.

QR Code Translation

- QR code(s) will be visible at the end of the pole area.
- QR code(s) must be translated to english words.
- One QR code contains information pertaining to the next challenge. Additional points are awarded if the MAV is able to incorporate the information from the QR code to its decision-making for entry to the wind tunnel (see next mission element for details).

Wind Tunnel Entry

- The door to the wind tunnel expansion chamber will be open, with a divider down the middle. The entrance is split into left and right sections. Points are awarded for entering the wind tunnel section through either right or left sections.

- One QR code (in previous mission element) will translate to “left” or “right”. If the MAV is able to use this information to choose the correct side to enter the wind tunnel, additional points are awarded
- For this element, teams may choose 1 of 3 wind speeds:
 - No wind
 - Low wind
 - High wind (**exact speeds TBA**)
- More points are awarded for higher wind speeds. Wind speed may not be changed once the MAV has entered the wind tunnel area (it may be changed before additional attempts).

Turbulent Wind Tunnel Test Section with Hoops

- The wind tunnel test section will contain hoops of 3 different sizes, starting with largest, and getting smaller. The MAV is challenged to fly through each of these hoops, with points awarded for each hoop flown through.
- **Hoop diameters and locations (TBA)**
 - Extra-Large hoop
 - Large hoop
 - Medium hoop
 - Small hoop
 - Extra-small hoop
- Additional points are awarded for the wind speed in the tunnel, with more points awarded for the higher speed.
 - No wind
 - Low wind
 - High wind (**exact speeds TBA**)

Landing/Perching

- Landing takes place in the wind tunnel on a choice of landing pads. The landing pads are situated close to the turbulence grids at the foremost part of the test section (farthest from the MAV entry point).
- Landing pads are half velcro and half perspex (0.5mX0.8m total). Note that the soft side of the velcro will be used in the wind tunnel. Points are awarded according to material.
- The same landing pad will be placed at each landing location. Landing location is either floor, ceiling, or wall, with the most points being awarded for the wall.
- The MAV will finish the course by successfully landing on one of the pads and remaining there for 10 seconds.
- This mission element needs to be conducted at the same speed chosen as the previous wind tunnel element.

Scoring

Mission Element	Description	Points Available
Take-off	Successful take-off from take-off platform	5
Window Challenge	Large window Medium window Small window	10 20 30
Poles Navigation and Follow the Rope	Successfully make it through poles area Points awarded for each section of the rope followed accurately Points deducted for each obstacle hit	+10 +10 -2 (max. 50 pts)
QR Code Reading	Successful QR code translation	+5
Wind Tunnel Entry	Entry to tunnel Correct side of tunnel entered (as named in QR code) <i>Wind speed:</i> No wind in tunnel Low wind in tunnel High wind in tunnel	+2 +5 0 +5 +10 (max. 17 pts)
Hoops	Extra Large Hoop Large hoop Medium Hoop Small hoop Extra Small hoop <i>Wind speed:</i> No wind in tunnel Low wind in tunnel High wind in tunnel	+1 +5 +10 +15 +40 0 +5 +10 (max. 81 pts)
Landing/perching	<i>Location:</i> Floor Side Wall Ceiling <i>Material:</i> Perspex (smooth) Velcro <i>Wind speed:</i> No wind in tunnel Low wind in tunnel High wind in tunnel	+5 +20 +10 +20 +10 0 +5 +10 (max. 50 pts)

*Wind tunnel speed cannot be changed with a MAV in the tunnel

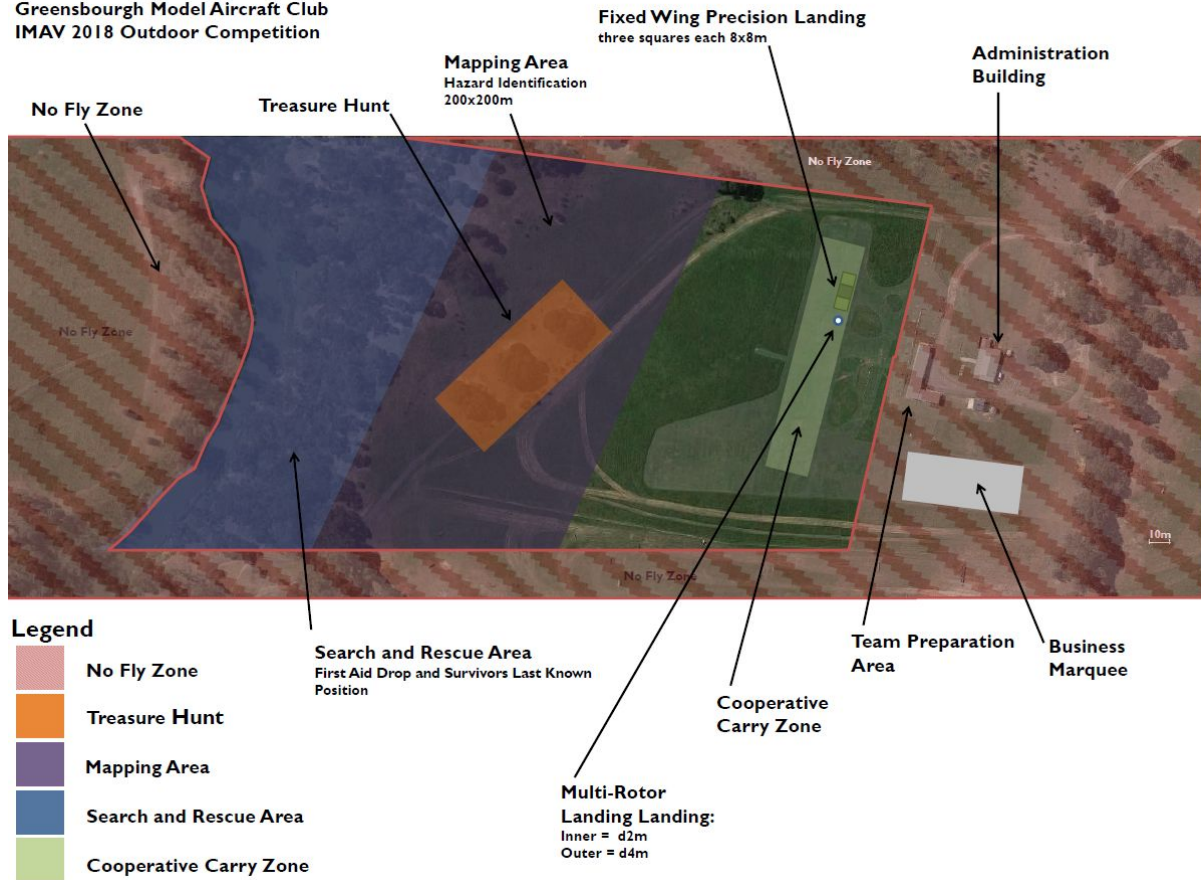
Rules

- 1-pilot per craft in flight area at a time
- All flying aircraft need to stay within the designated flight area
- All aircraft will be checked before flight and must be airworthy
- Pilot must maintain visual line-of-sight contact with their MAV
- Only competing team may have their radio equipment on during the competition
- Only competing team may fly their MAV during their competition slot
- All teams shall present each of their crafts for scrutineering
- All batteries must have a means of monitoring the voltage to prevent cells dropping too low and becoming a hazard. They must also have appropriate storage when not in use, or charging (eg. LiPo safe bags).
- The team is always responsible for the safety of its MAVs and is liable for any accidents caused by their MAVs.
- The main ground station screen has to be shared via a VGA output (to a projector or screen delivered by the organisation)
- If an MAV relies on means of navigation other than GPS (e.g., the video system under video based flight), the loss of this navigation system must be taken into account. In such a case the MAV should immediately perform a safety landing as described below. The team must convince the jury that the MAV can be retrieved upon loss.
- A human safety pilot must be able to take over the MAV at all times in case of an emergency by means of a reliable data link which will result in an immediate action of the MAV imposed by the safety pilot over this reliable link, especially near the launch zone and spectators.
- Instructions given by the field marshalls shall be followed without argument.
- The Wild Card may only be used to pause the competition time slot once. When all other teams have competed, remaining time from the first attempt may be used to complete the course (time permitting).

Failure to adhere to these rules may result in penalty or disqualification.

Outdoor Course

Greensborough Model Aircraft Club
IMAV 2018 Outdoor Competition



****Designated areas are subject to changes**

Mission Brief

Teams are allocated a 20 min time slot. As well as 5 mins for unpack and pack up time. The mission elements for the outdoor event are as follows:

Take-off

Max points are awarded for auto-takeoff. Manual takeoff will result in lower points.

Treasure hunt (metal detection)

- Underground gas pipelines are highly hazardous in Australia, detection and location of a metal pipeline is necessary for safe practice. This mission element challenges teams to detect hidden metal objects. Details:
 - 8 X 8 meter area will home 4 identical metal discs, the objective is to identify the metal discs in the grid which represent a metal pipeline. Points will be awarded for each disc found.

- Metal disc specifications : TBA

Mapping

- Generating a 2D or 3D Map of a specified area .
- Additional points are awarded for:
 - Identifying the location and type of hazards:
 - 3 X 44 gallon drum
 - 1 X crocodiles
 - 44 Gallon Drums specs: TBA
 - Crocodile: TBA

Search and Rescue

- Search for an injured firefighter in the “Forest” and deliver a first aid kit. You are provided with the injured firefighter’s last known location (30 seconds ago). Given the average firefighter moves at 5km/h you should be able to know how far away the firefighter could be from the last known position. You also know the firefighter is in the forest. Points will be allocated for:
 - Navigate through the forest
 - Detecting the firefighter and his location
 - Deliver a first aid kit to within 1m of the firefighter (12cm x 9cm x 2.5cm, 150g) to the firefighter, if you can’t detect the firefighter deliver the first aid kit to the last known location provided. Otherwise demonstrating the payload drop elsewhere for minimum points.



Trafalgar first aid kit mini. 4 shown here for demonstration purposes however only 1 needs to be carried by the aircraft. (12cm x 9cm x 2.5cm, 150 grams)

Communications Relay

- With respect to the previous search and rescue mission element, a live video feed needs to be sent back to the ground control station. Due to the nature of terrain, teams will not have line of sight signal from the take-off and landing area to the river and therefore will require a video feed relay back to the ground control station.
- Note: Pilot will always follow aircraft into the forest to maintain control link line of sight with aircraft but relaying video through the pilot is not allowed.

Landing

- If the aircraft lands in the designated precision landing area max points will be awarded. Less points are awarded for normal landing elsewhere.

Rules

- 1-pilot per craft in flight area at a time
- All flying aircraft need to stay within the designated flight area
- All aircraft will be checked before flight and must be airworthy
- Pilot must maintain visual line-of-sight contact with their MAV
- Only competing team may have their radio equipment on during the competition
- Only competing team may fly their MAV during their competition slot
- All teams shall present each of their crafts for scrutineering
- All batteries must have a means of monitoring the voltage to prevent cells dropping too low and becoming a hazard. They must also have appropriate storage when not in use, or charging (eg. LiPo safe bags).
- The team is always responsible for the safety of its MAVs and is liable for any accidents caused by their MAVs.
- The main ground station screen has to be shared via a VGA output (to a projector or screen delivered by the organisation)
- If an MAV relies on means of navigation other than GPS (e.g., the video system under video based flight), the loss of this navigation system must be taken into account. In such a case the MAV should immediately perform a safety landing as described below. The team must convince the jury that the MAV can be retrieved upon loss.
- A human safety pilot must be able to take over the MAV at all times in case of an emergency by means of a reliable data link which will result in an immediate action of the MAV imposed by the safety pilot over this reliable link, especially near the launch zone and spectators.
- Instructions given by the field marshalls shall be followed without argument.
- If you wish to leave pilot zone you must be with a marshal for safety purposes. The area is prone to snakes and other dangerous wildlife.

Failure to adhere to these rules may result in penalty or disqualification.

Scoring

For outdoor competition we're using a mass and power scaling factor instead of a size factor because

- We want to encourage use of alternate power sources
- We want to encourage the use of unusual/novel configurations
- We do not want to penalise the use of fixed wings in the outdoor competition simply due to their size
- Encourages good engineering design principles and optimisation of the craft for the specific task
- Encourages adequate design procedures/simulation
- Forces competitors to consider aerodynamic efficiency of the aircraft

The scoring of each element is as follows:

Mission Element	Description	Points Available
Take-off	Successful take-off from take-off platform	+5
Treasure hunt (metal detection)	Correct location found of each disc Bonus points for all disks located	+2 +2 (max. 10 pts)
Mapping	Map created Identify each hazard Location of each hazard	+10 +5 +5 (max. 50 pts)
Search and Rescue	Navigating through the forest Detect Firefighter Detect firefighter's location <i>Payload Drop:</i> Deliver the first aid kit to the firefighter Deliver the first aid kit to last-known location Successful payload drop demonstration	+10 +5 +10 10 3 1 (max. 35 pts)
Landing	Precision landing in specified fixed wing or multi-rotor areas. Controlled landing in specified fixed wing or multi-rotor areas. Controlled landing outside all landing areas	10 5 1
Video Relay	Video from MAV relayed to ground station for viewing by spectators	+10

Novelty Events

Co-operative Carry

- The co-operative carry will require teams to carry a standard bucket (**pictures and dimensions TBA**) filled with water. The bucket is half filled with water and has cutouts to encourage spilling of the water unless the MAVs are very stable. Points will be deducted for the amount of water spilled out.
- The objective of this event is to deliver water from one location to a drop off point located 24m away.
- Teams may choose how to attach MAVs and bucket. For this event we want to encourage more, smaller MAVs, the scoring is representative of this.
- The scoring for this event uses the same equation except the In-a-Row Factor is replaced by a Number-of-MAVs Factor (e.g. 2 MAVs is 2.0 multiplier, 4 MAVs is 4.0 multiplier)

Silent MAV Contest

- The silent MAV contest requires the MAV to carry a 1 kg payload for 5 minutes. (**Exact payload TBA**)
- Challenge will occur indoors.
- The MAV will have the average Sound Pressure Level (SPL) measured over the course of 30 seconds, taken during the final minute of the hover challenge .
- The entrant with the lowest average SPL wins the challenge.
- Max aircraft dimension allowed is 1000mm (e.g. measured prop-tip to prop-tip.)

Scoring

Novelty Events	Description	Points Available
Cooperative Carry	Multiplier for Number-of-MAVs used to carry bucket	*N-MAVs
	Take-off safely and hover while carrying bucket	+10
	Travelling towards drop off location while carrying bucket	+ 5 per meter
	Successful landing of MAVs and bucket at designated location	+10
	Spilling out 250 grams of water	-10
Silent MAV	The entrant with the lowest average sound pressure level wins the challenge.	-