2024 DTRG Indoor Drone Competition Rules

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1. Introduction

This year's Competition is based on the IMAV 2024 indoor drone competition. Teams must accurately fly a drone around a circuit, collecting points via a sequence of tasks: precision landing, aerial manipulation, and obstacle avoidance. The aerial manipulation task, involving the collection and deposit of an object from the ground, has the most points associated with it. This task requires teams to design, build, and operate a sample collection device.

All drone equipment is provided by DTRG and flying will be overseen by senior members of DTRG. No prior knowledge or drone pilot experience is required.

The Competition will take place within the flying arena (Figure 1), an 8 x 8 x 3 m netted volume within the Motion Capture Laboratory, room 405.836E. The date of the competition day and weekly training sessions will be posted on DTRG.org.

Prizes will be awarded to successful teams from a prize pool worth a total of more than $500 in drone equipment, including: radio transmitter gear, flight control hardware, and frame parts.

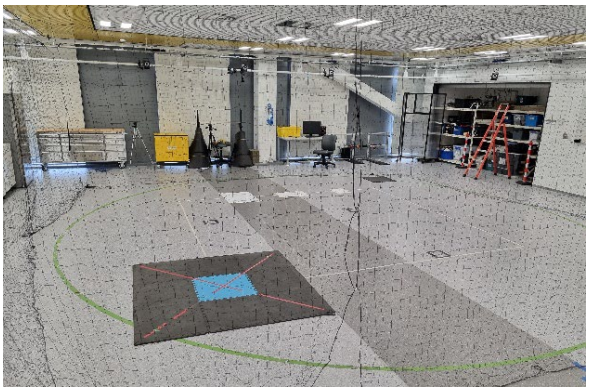


Figure 1: Flying arena. Not all competition elements are shown.

2. Competition Slots

Each team will be assigned a 15-minute time slot to set up in the pilots' area, practice if needed, complete a 10-minute competition run, and clear the area. The order of the teams' slots will be drawn by lot at the start of the competition day. The 10-minute competition run will be timed via a countdown timer by the DTRG operation team. The timer is started when the competition team is ready but no later than 4 minutes into the time slot and is paused for events outside the control of the team, such as battery replacements.

Each team will be given 10 minutes immediately before their time slot to attach their sample collection system on a standby drone. All teams and team members must follow all health and safety instructions by the DTRG operation team.

3. Drone Description and Operation

The drone is a GEPRC Crown Cinewhoop (Figure 2), a quadrotor drone with a mass of approximately 500 grams and 250 mm motor-to-motor diameter. It includes a downward facing camera with video radio transmitter, capable of flying in first person view (FPV). The video feed will be displayed on a monitor and FPV goggles for use by the competing team.

Figure 2: Competition drone

One of the competition tasks involves the collection and deposit of a small object. A separate radio receiver can be used by the competition team if they wish to control a small servo (provided) and attach this to the bottom of the drone. Teams will need to design and construct their sample collection system in their own time. The UoA Maker Space in B402 is the recommended space for this activity. The Maker Space contains 3D printers, a laser cutter, hand tools, and some materials.

During the competition, a designated DTRG member, referred to as the *Pilot Director*, will operate the primary radio transmitter. They will be responsible for starting/stopping motors and always regulating height. A member of the competing team, referred to as the *Pilot Competitor*, will hold a second radio transmitter and be responsible for lateral position and heading control (always forwards). At any time, the *Pilot Director*, can take control of all axes of the drone for safety reasons and repositioning. The *Pilot Competitor* is to verbally direct the *Pilot Director* to control height using only three commands:

- “climb” or “take off”
- “descend” or “land”
- “hold”

The *Pilot Competitor* may also nominate heights (e.g. knee height, waist height, head height) for the *Pilot Director* to fly during one or more of the Tasks.

Battery management is the responsibility of the DTRG operation team. Battery replacement will occur every 2 circuits during the competition.

4. Competition Details

There is a circuit to be flown around in which there are several tasks to be performed, each of which will generate points for the team, Figure 3. The centreline of the circuit is a 4 x 4 m square, marked out by blue tape on the floor. The borders of no-fly zones are 1 m laterally from the centreline, marked out by red tape on the floor. The *Pilot Director* will take full control of the drone and fly it to the nearest point overhead the centreline before returning lateral control to the *Pilot Competitor* if:

- the centre of the drone enters a no-fly zone, or
- the heading of the drone is more than 45 degrees from forwards, or
- they deem that the drone is flown in an unsafe manner.

The Tasks within the circuit are as follows:

- Task 1: Take-off from the start zone, fly the circuit in a clockwise direction and land on a choice of three different circular pads.
- Task 2: Collect an object and deposit this in the adjacent collection box.
- Task 3: Return and land in the start zone, either returning directly or while avoiding obstacles.

Teams may choose to pass on any tasks that they are unable or choose not to complete.

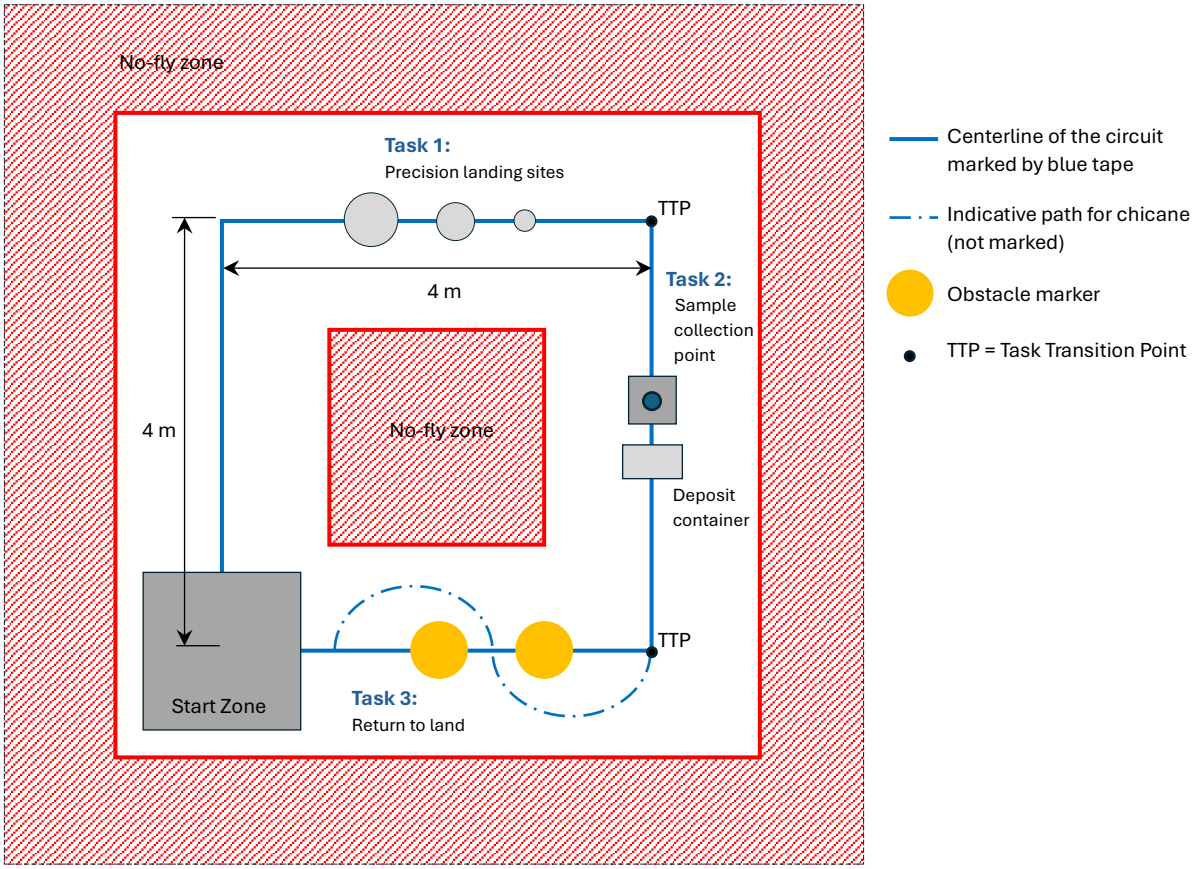


Figure 3: Plan view of the competition circuit

5. Scoring

Total score

During the competition slot, teams will be allowed to have repeated attempts at the circuit, each time attempting the tasks they choose. The team will only be allowed to score points for each task once during each circuit. The score of a team will be the cumulative score from all the circuits carried out within the allotted time. Each circuit must start from the take-off and landing site. The final score for a team will be determined using the following formula:

$$S = \sum (T_1V_1 + T_2V_2 + T_3V_3)$$

Task 1: Precision Landing, T_1

	T_1
No landing	0
Successful landing on the 50 cm diameter pad	1
Successful landing on the 35 cm diameter pad	3
Successful landing on the 20 cm diameter pad	5

- A landing occurs when any part of the drone touches the ground. A landing cannot be reattempted until the next circuit.
- A successful landing occurs when all landing feet of the drone are on or within the border of a landing pad.

Task 2: Sample Collection and Deposit, T_2

	T_2
No collection	0
Successful collection	5
Successful collection and deposit in the container	10

- The sample used for collection is a 3D-printed cone with a steel screw attached to the top, Figure 4(a). It is approximately 45H x 43W mm and 10 grams. The cone was used in the IMAV2023 competition; print files are available here. The sample cannot be modified by the team.
- The sample will be placed at the collection point on the centreline and returned there after completion of each circuit.
- The plastic container, Figure 4(b), is located 1 m from the sample collection point with dimensions 450L x 360W x 250H mm.

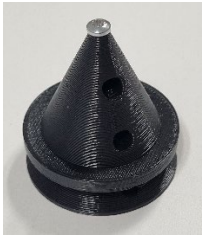
(a)  (b) 

Figure 4. (a) Sample close-up and (b) container with the sample in the background

Task 3: Return and Land in the Start Zone, T_3

	T_3
Return home and land	2
Return while avoiding the obstacles and land	5

- Two obstacles, marked by 50 cm diameter circles on the floor, are located on the centreline of the circuit, with centres spaced 1 m apart.
- To successfully avoid the obstacles, the drone must fly between the obstacles and the drone centre must never overfly the edge of any one of the obstacles.

Viewpoint V_n

	V_n
Line of sight	1
First person view (FPV)	2

- A team can choose to use a different viewpoint for each task.
- To be deemed FPV, the pilot competitor must continuously watch the live video stream from the drone's downward facing camera on either the FPV monitor or FPV goggles.