RoboCup Brasil

FLYING ROBOT LEAGUE

Proposal from:

RoboCup Brasil

Realization:

RoboCup

INTRODUCTION

The **Flying Robot League (FRL)** proposed by RoboCup Brazil aims to stimulate the study and development of autonomous and intelligent flying robots for different tasks applied to the industrial and logistics sector. The Challenge is a reduced and playful model that tries to emulate logistical problems in an arena with two suspended bases for landings and takeoffs, a takeoff base, and three mobile land bases.

Among the research challenges still existing on autonomous and intelligent robots, the **Flying Robot League** aims to stimulate the development of aerial robotic systems and robust flight controllers (trajectory, altitude, and pose) with embedded, precise, and independent camera tracking and localization systems; high-capacity embedded processing; and devices for manipulating and loading objects.

THE FLYING ROBOT

Each team may bring to the **RoboCup FRL** competition several flying robots (here called Drones or UAVs) with vertical takeoff and landing, provided they meet the prerequisites stipulated in this rule. The Drones that will participate in the competition phases must meet the following requirements that will be verified during the inspection phase:

- The Drone cannot use GPS or RTK-GPS systems to locate itself in the arena;
- No aid system external to the arena (e.g., beacons) may be used to locate the Drone;
- During the challenge phases, the Drones must act autonomously, that is, without any external control or human intervention that will result in the completion of the attempt of the phase being executed, except in emergencies;
- Only drones propelled by electric motors and energy through batteries incorporated in the robot will be allowed. The use of helicopters and vehicles with combustion engines or gas balloons is prohibited;
- Drones weighing over 200 grams must have a button (kill switch) that arms or disarms the motors and must be located on the drone;
- The Drone must be able to maintain a fixed position (hover) on the ground at a minimum height of one (1) meter;
- The use of any type of control and detection hardware built into the Drone is permitted as long as they do not pose a risk to participants or the public due to the emission of radiation or another level of signal considered unsafe for humans;
- During challenges, the use of wires, cables, and/or umbilical cords, whether for control, communication, or any other purpose, is prohibited;
- Although the Drone must act autonomously during the challenges, the team must constantly maintain remote supervision of the flying robot following current legislation, ensuring the resumption of control of the flying robot due to any technical problems and/or instability.
- For PHASES 1 and 2 the Drones **must** have a maximum weight of 4 kilograms **(without battery)** and a maximum distance between the propeller axes of 500 mm (see figure below);

- For PHASES 3 and 4 the Drones **must** have a maximum weight of 1.5 kilograms **(without battery)** and a maximum distance between the propeller axes of 330 mm (see figure below);

- The emergency pilot or the captain of the team and all Drones over 200 grams must be registered in the Country's Aerial Vehicles Regulator[1]

NOTE 1: If the drone is not approved in the inspection phase because it does not meet any of the requirements described above, the team will not be able to use it in the competition. If none of the team's drones meet the inspection phase requirements, the team will be disqualified.

NOTE 2: Although each team can bring several drones to the competition, only 1 (one) drone can be used during each phase run, even if it is one drone for each phase.

The team must be able to start or stop the Drone via the remote control at the referee's whistle signal. **It is important to note that the UAVs must demonstrate the ability to adapt to conditions in the real world, such as the lack of ideal lighting conditions and people moving around the arenas, among other sound and visual noises.**

These characteristics are conditions for participation in the Challenge, and the judges will check them before the competition starts.

[1]In Brazil it is ANAC SISANT system: https://santosdumont.anac.gov.br/menu/f?p=133

THE TEAMS

An arbitrary number of members can form teams for this challenge at any level of education. The minimum age allowed for this competition is 18 years old for the team members. Each team will have a captain who will be responsible for interacting with the judge and giving the signal to initialize the code. To enter the arena, the team member must have the appropriate personal protective equipment (PPE). **It is the responsibility of the teams to bring their protective equipment.** The mandatory list of PPE is:

- Protective goggles;
- Helmet;
- Anti-cut glove;
- Fluorescent signaling vest.

NOTE: The team members entering the arena MUST also wear long pants, long shirts, and boots.

Each team will have a work area consisting of a table, chairs, and a power outlet.

It is important to note that the responsibility for operating flying robots meets all legal requirements, particularly ANAC (Brazil Commercial Aviation Regulation Agency) resolutions.

Teams will also have Internet access at their desktops. During the waiting time between competition phases, teams can work freely on their flying robots within the designated area for each group (namely their desk).

No UAV will be allowed to fly outside the arena.

THE ARENA

The **64m2 RoboCup FRL** arena will be built on a site that features a takeoff base, two overhead bases, and three mobile land bases. Figure 1 shows a simulated representation of the arena to give an overview.

- The takeoff base is where the flying robot must leave and return from its tasks, defined in each phase of the challenge.
- The landing bases represent the drones' bases during service/task performance.
- The arena has a competition banner located near the takeoff base.

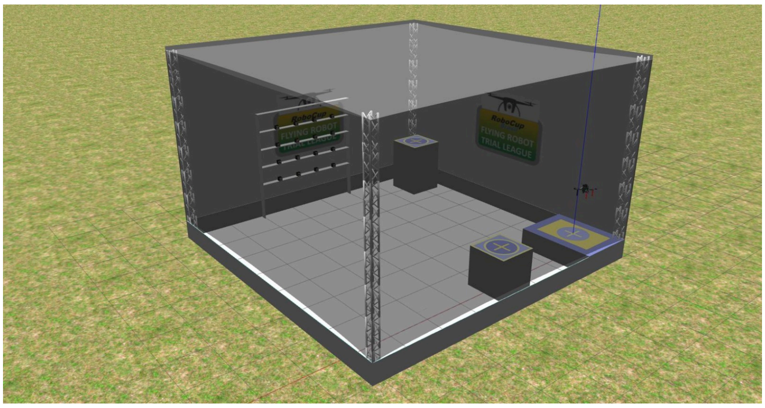


Figure 1 – Overview of the 2024 **RoboCup FRL arena.**

The dimensions of the arena and bases for construction are shown in Figures 3 and 4 below:

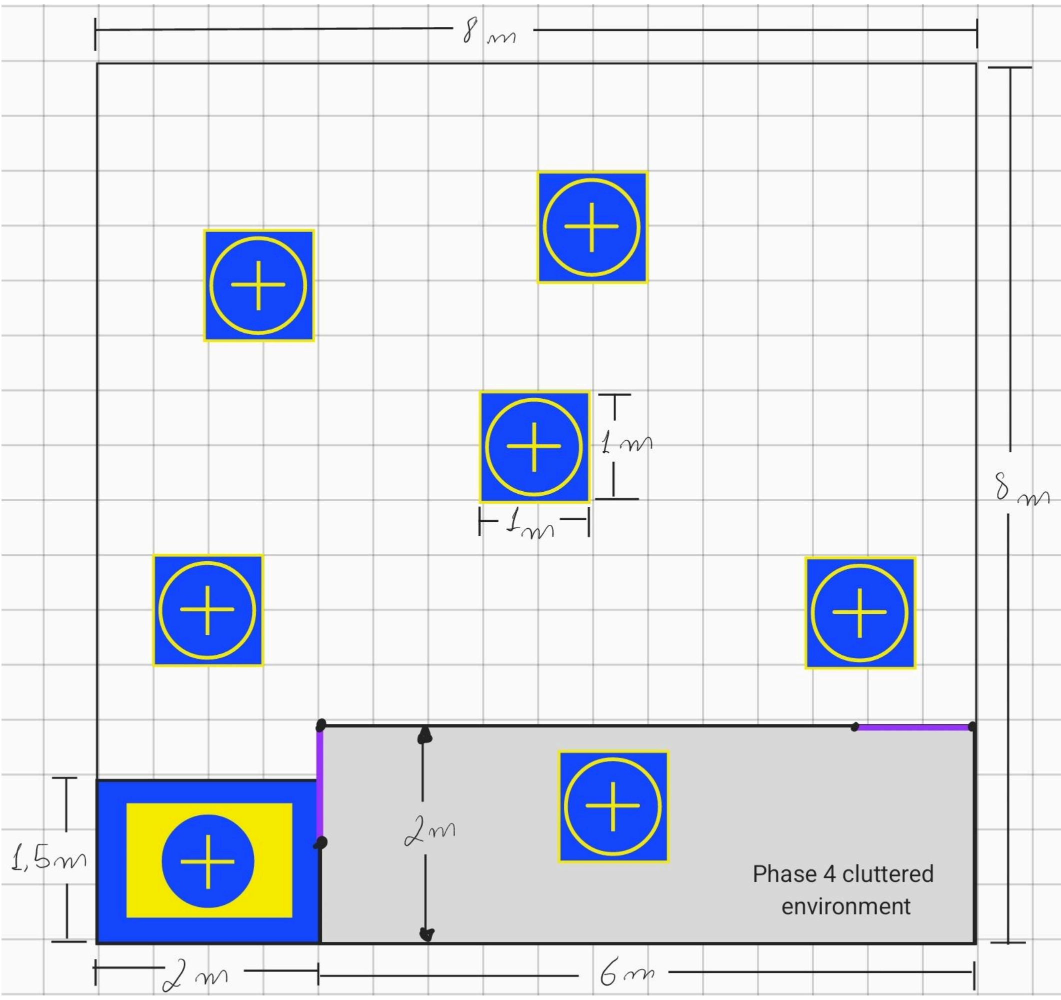


Figure 3 – Dimensions of the **RoboCup FRL** arena. The Gray area (2 x 6 x 1.5 m) is the cluttered environment of Phase 4.

All landing bases must be at least 9 mm thick. Figures 3 and 4 present an overview of the world and its bases.

Takeoff Base	Landing Bases (The width of Yellow lines = 5cm)

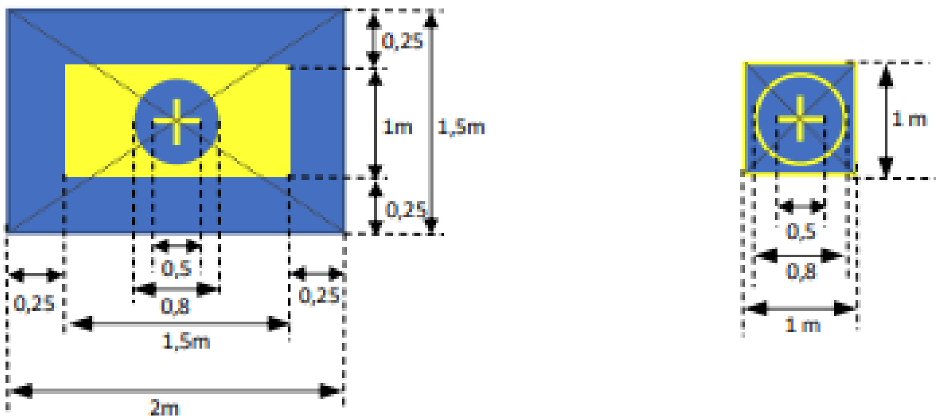


Figure 4 – Dimensions of the takeoff, suspended, and mobile bases.

The grey area in Figure 3 is used for the cluttered environment used on the challenge of Phase 4.

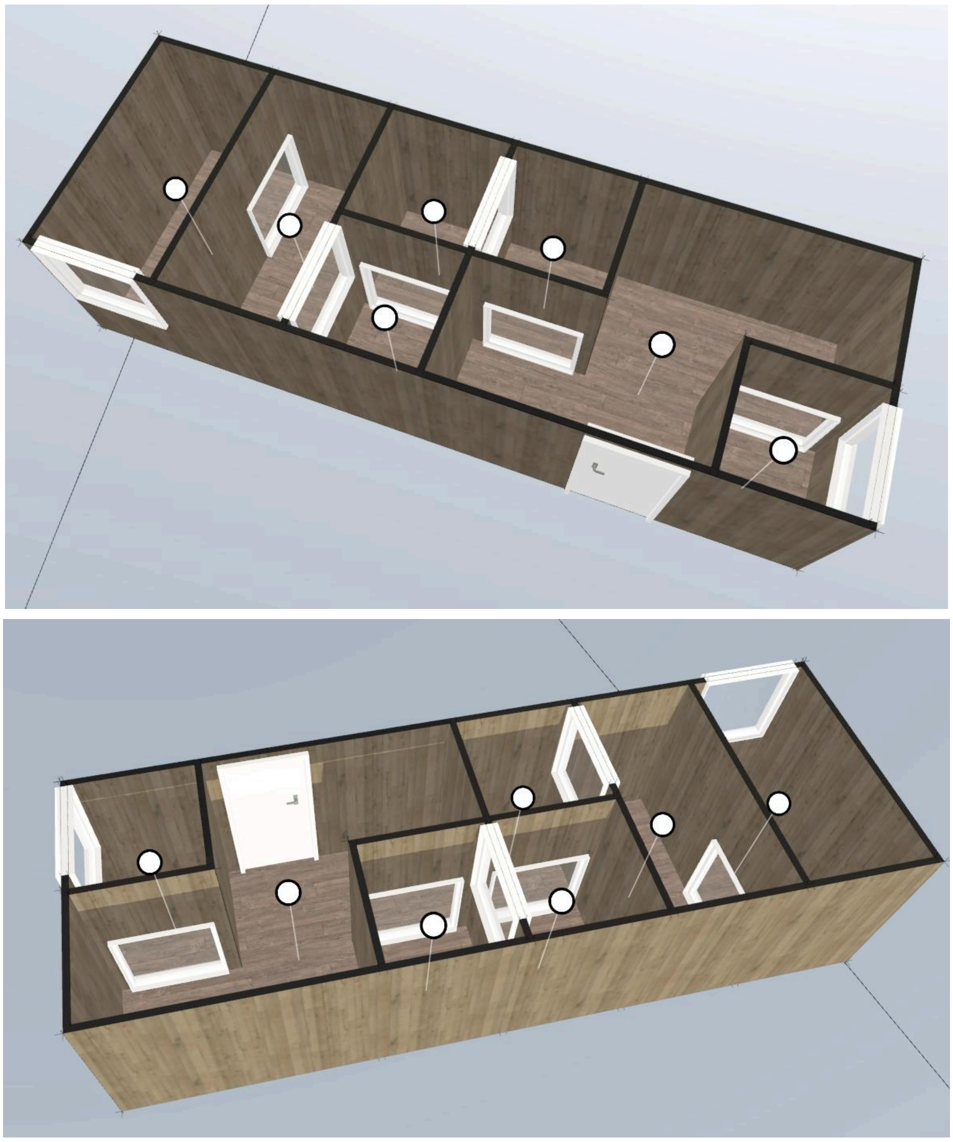


Figure 5 – Area layout for Phase 4.

The dimensions of the Phase 4 cluttered environment can be seen in Figure 6 below.

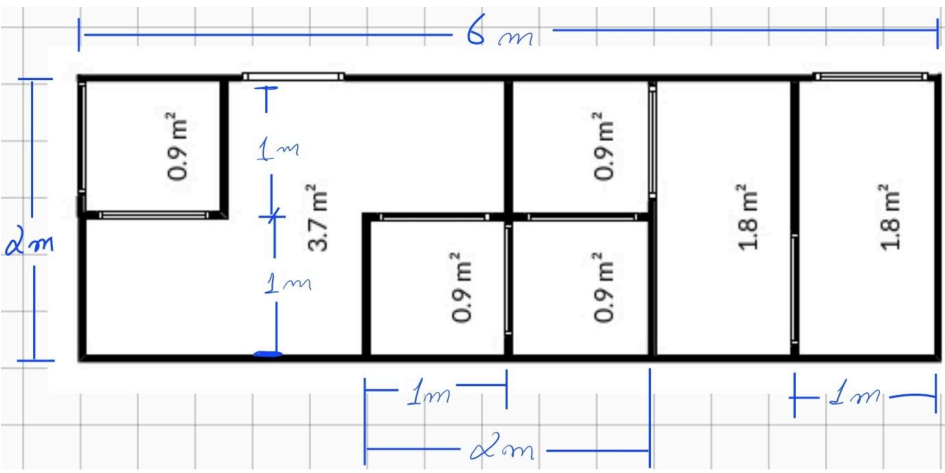


Figure 6 – Dimensions of the Area Layout for Phase 4.

The cluttered environment of Phase 4 will have a total of 1.5m height, 2m length, and 6m width. The windows where the UAV must pass are 0.8mx0.8m (width x height). This area will have a door in the middle for cases when the operator must enter to collect the UAV. This door must be 0.8x1.5m (width x height) in size.

The arena can be built directly on the ground or an 8mx8m covering of MDF (any color) with a 12 mm thickness.

NOTE 1: The arena floor will be smooth (homogeneous) and without features. Depending on the paint used on the floor or on the base paint, it may have some degree of reflection.

The entire arena will be lined with protective netting of a 5 cm hole. There will be one opening in the net in the corner of the arena so that team members can enter the arena. Two sides of the arena (the one facing the takeoff base and the one on the right side of the arena) will not have a net but a large banner. The banner facing the takeoff base will have the RoboCup logo within a drawing art. The banner on the right side will be empty and pure white with no features.

NOTE 2: The landing bases can be placed at a random height, with a minimum of 0 meters and a maximum of 1.5 meters above the ground.

NOTE 3: The landing bases can be placed anywhere within the arena, including on the top of the cluttered environment of Phase 4, as long as it is 0.5m from the walls.

The takeoff base and the side walls surrounding the arena will be approximately 0.5 meters high.

NOTE 4: The arena assembly location may suffer from variable external light (sunlight through windows that causes non-uniform lighting), and it may be assembled close to walls. Competition drones must be robust to these variations.

NOTE 5: NO changes to the arena by teams will be allowed.

NOTE 6: Each team will have a time defined by draw to use the arena during warmup and during each phase.

THE CHALLENGE

The **RoboCup FRL** has 4 phases. Each phase deals with a problem that must be faced by the Drone autonomously.

The team does not need to complete all phases. However, the final score will be the simple sum of the scores obtained by the team in all sequential phases.

During the competition phases, each team will have 30 minutes to make up to 3 attempts to complete the tasks of the respective phase.

NOTE 1: The team will be able to carry out tests and change the source code within 30 minutes until they make their first attempt. After the first attempt, the team will no longer be able to open the source code or script or make any changes to the code or parameters.

NOTE 2: When executing the code in the terminal, the only way to change strategy is to use a flag that calls another script. However, once the code has started, the operator can no longer touch the computer until the attempt is completed.

NOTE. 3: During task execution, at least one member of another team must be available to observe and supervise the competing team.

NOTE. 4: The teams participating in this phase must save the log of all data from the drone (or rosbags) and the log of the task's activities (base locked, QRcode read, etc.) for cases in

which the judge requests them. These records are necessary for a deeper analysis of the robot's movement.

The competition days will be configured as follows: warm-up and competitions. The inspection phase of the participating teams' drones will be carried out during the last run of the warm-up phase.

The day and time for each team to conduct the warm-up and the competition order will be defined by drawing lots, and the timetable will be provided one week before the competition.

When registering, each team must submit the TDP along with the necessary information and send a copy to tiagopn@ci.ufpb.br. As soon as registration is finalized, a Whatsapp group will be created for real-time communication between the chair and the leaders of each team.

TEAM DESCRIPTION PAPER (TDP)

Sending TDPs to the competition is mandatory and has an eliminatory character. Only teams that submit the TDP describing their technology and how they solved the TDP challenge, along with a video demonstrating the drone's execution of the TDP challenge, will be able to pay the registration fee and participate in the event.

NOTE: In 2025, the top three places of the 2024 Robocup Brasil Flying Robot League and the hosting team are already classified to participate in the Robocup FRL 2025. They only need to submit the TDP (no video is needed, nor is the execution of the TDP challenge). For the following years, only the top three places of the Robocup FRL will be excused from the video and the TDP challenge.

The TDP needs to be done using the Springer Lecture Notes in Computer Science template[2], with a minimum of 6 and a maximum of 8 pages containing the following information:

- **Title:** must be the name of the team;
- **Authors:** must be the names of the team members (full name);
- **Affiliation:**
  - University where the team comes from;
  - Link to the team, group, or lab's webpage;
  - Phone number of 2 contacts for Whatsapp Group;
  - The e-mail of the captain of the team;
- **Just below the Keywords, there should be a link to the execution of the TDP challenge performed by the team's UAV**;
- **As for the article itself, the TDP must contain:**
  - 0.5 page maximum for the title, author's names, affiliation, abstract, keywords, and video link.
  - 1.5 pages maximum describing the used UAV (mechanics, electronics, sensors, etc);
  - 2 pages maximum describing with details the Navigation System (software, with open git-hub);
  - 3 pages describing how the team solved the TDP task, describing the proposed architecture and development, as well as presenting the obtained results and discussing them;

[2] See the link for the template at overleaf: https://www.overleaf.com/latex/templates/springer-lecture-notes-in-computer-science/kzwwpvhwnvfj

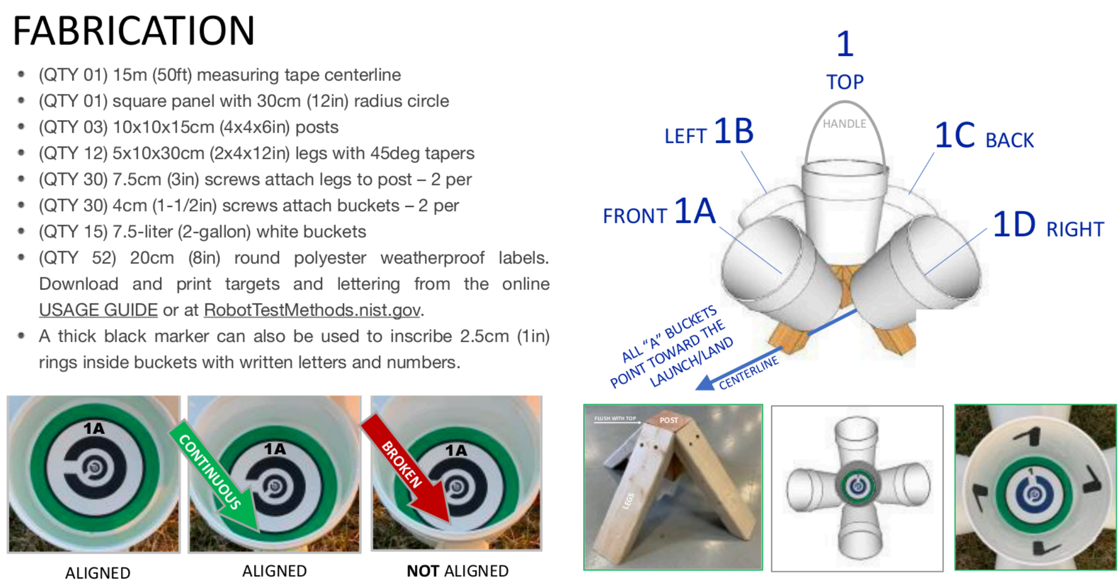
- 1 page maximum for References.

The TDP Challenge[3]

To be classified to participate in the RoboCup Flying Robot League, the team must perform a TDP challenge and submit the video of the drone performing the desired task along with the written TDP.

The task consists of one flying robot performing 2 (two) different plight paths (Position and Transverse) autonomously around a desired target.

The target fabrication follows the standard below:

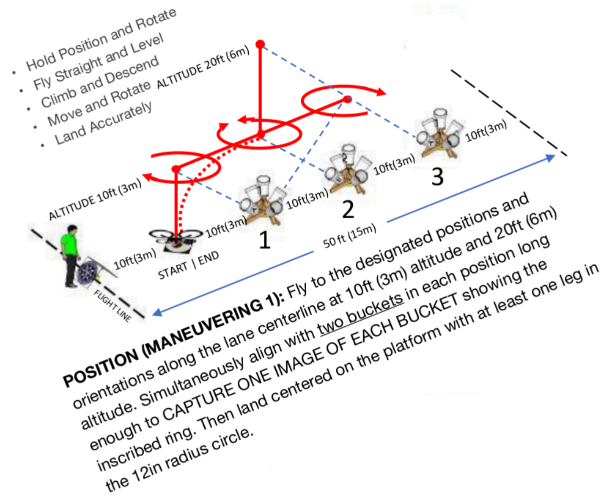


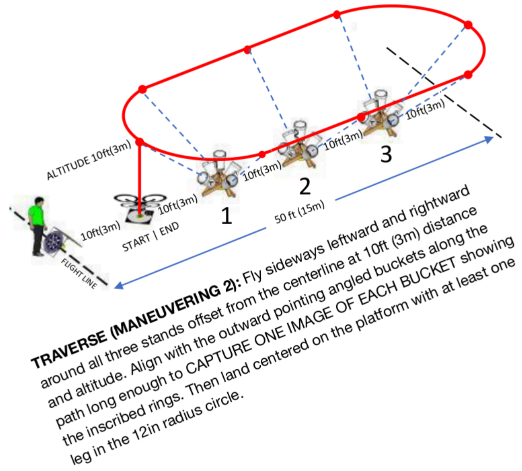
The aircraft flies the designated flight paths to align with one or more white buckets. Each alignment requires a single image of the inscribed brewen ring inside the bottom of the buckets. The team must perform all 40 alignments and accurate landings. Visual acuity targets evaluate camera pointing and zooming capabilities.

NOTE: The team will only be classified if it successfully completes both paths.

The flight paths are seen below:

[3] This challenge is a task taken from a broader set of tasks from the "Drone Tests and Scoprable Scenarios for Evaluating Systems Capabilities and Remote Pilot Proficiency in Open, Obstructed, and Confined Environments (Levers 1-5)" document from the National Institute of Standards and Technology from the U.S. Department of Commerce. Available at: https://www.nist.gov/system/files/documents/2023/04/19/NIST%20Drone%20Tests%20-%20Levels%20of%20Proficiency%20Brochure%20%28v2023A%20PAGE%20SIZE%29.pdf





PHASE 1 - LOCATION AND MAPPING

The heterogeneity of drone landing sites in nature is quite varied. Landing often needs to occur suddenly, and the drone needs to find a suitable landing site. This mapping is essential for an autonomous task to be performed safely. Thus, PHASE 1 will require the team's robots to recognize the arena, detect landing bases (randomly allocated before the start of the phase), and land and take off at each detected base.

THE TASK

In PHASE 1, the drone must leave the takeoff base and travel around the arena while detecting the 6 (six) landing bases. The Drone must detect each existing base and land 1 (one) time on each of the detected bases. After that, the Drone must return to the takeoff base and land.

MAIN OBJECTIVE

The task aims to overcome the following challenges:

- ☐ Landing base recognition using vision;
- ☐ Optimized routing problem;
- ☐ Precise landing and takeoff;

CONDITIONS

All landing bases are mobile and can be placed anywhere within the arena, including on the top of the cluttered environment of Phase 4, as long as it is 0.5m from the walls.

<u>The landing bases can be placed at a random height, with a minimum of 0 meters and a maximum of 1.5 meters above the ground.</u>

On each team's turn, the landing bases will have their positions visually known only when the task is carried out. They will be placed randomly in the arena.

NOTE: The teams are NOT allowed to perform any measurement of the arena.

A time will be defined for each team to carry out PHASE 1. Each team will have 30 consecutive minutes to carry out up to 3 attempts to complete the tasks. The score obtained in the best of the 3 (three) attempts will be considered, the others being discarded. Each attempt can take up to 10 minutes.

CONCEPT: Attempt is the act of trying to execute a certain phase, starting with the drone's takeoff and ending when the drone lands automatically (either outside the landing base or upon returning to the takeoff base), when the pilot resumes control of the drone, or when the team captain states that the attempt is over.

Interaction with the Human: in this PHASE 1, the robot can return to the takeoff base with a command given by a human (team member via remote control) or return autonomously. Upon returning to the takeoff base, the attempt ends.

SCORE

This phase has a maximum score of 240 points.

For each base visited for the first time, the team will receive 20 points for each landing base visited. It will be considered that the robot has visited the base only if the drone lands on the base (noticeable in the touch of all the landing gear of the drone on the base).

CONCEPT: Visiting = Visiting a base is the act of the drone identifying (by vision) AND landing on a specific landing base.

With each repeated visit (landing) in a base, the team loses 5 points.

If the robot autonomously returns to the takeoff base and successfully lands on it, the score on this Phase **doubles (2x)** if the score is positive. If the score is negative, the team does not score the attempt. If the robot does not return to the takeoff base, the team may choose to stop the attempt, without penalty, at any time or when the 10 minutes of the attempt expire.

If the team decides to stop the robot at any point during an attempt, the score will count until the moment of interruption. All three attempts must be made with the robot starting from the takeoff base.

PHASE 2 - PACKAGE TRANSPORTATION

Nowadays, Drones can quickly transport equipment, materials, and packages between landing/takeoff stations. This is especially useful in search-and-rescue situations, where injured personnel must be searched for and first aid kits must be delivered. In urban centers, there are also situations such as traffic accidents where packages, such as medical equipment, must be urgently delivered between hospitals or between hospitals and the accident. Thus, PHASE 2 aims to demonstrate cargo transport technology using autonomous Drones.

NOTE: This phase is in alignment with the tasks of the RoboCupRescue League.

THE TASK

In PHASE 2, the robots will have to transport 3 (three) first aid kits from (1) one landing base where the kit is placed to another landing base where there is no first aid kit. When the team completes the transport of all first aid kits to their respective bases correctly, the robot can return to the takeoff base, finishing the phase or attempt.

Realization:

MAIN OBJECTIVE

The task aims to overcome the following challenges:

- ☐ Optimized routing problem;
- ☐ Precise landing and takeoff;
- ☐ Aerial Manipulation;

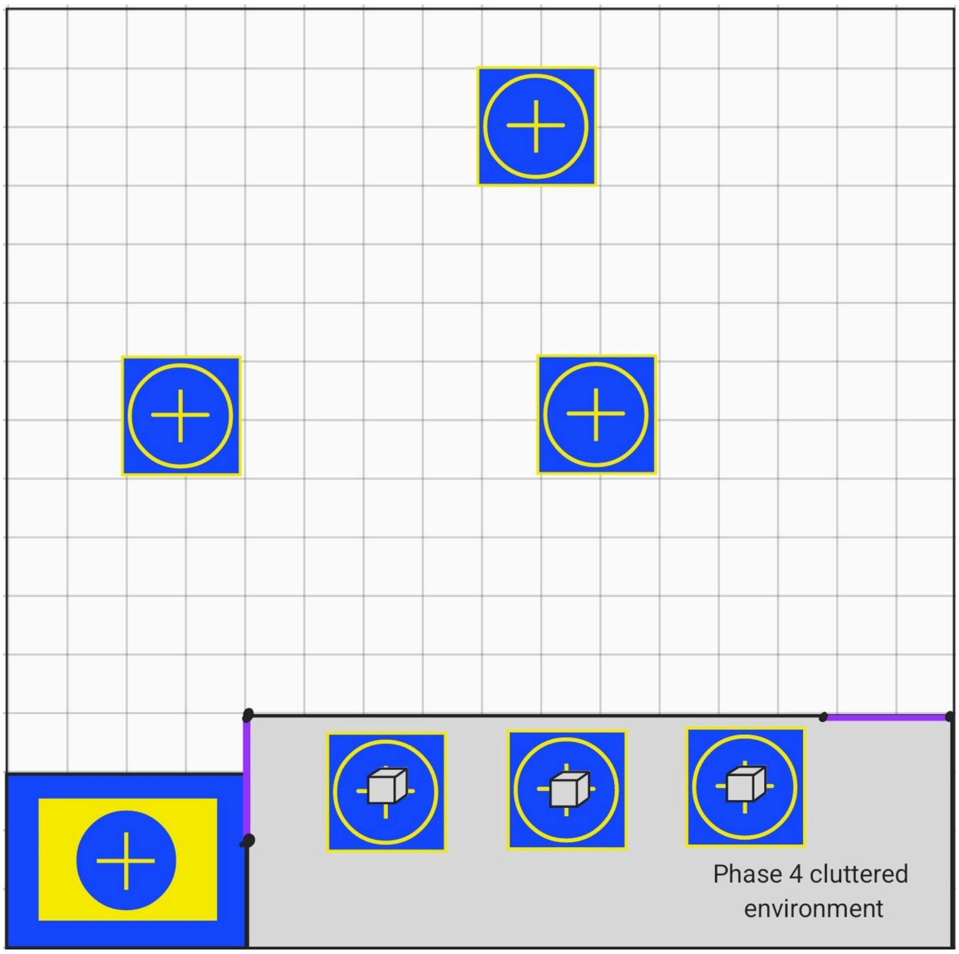


Figure 7 – Layout for Phase 2.

CONDITIONS

Three bases will be placed on top of the environment of Phase 4 at a height of 1.5 m. In each landing base, 1 (one) first aid kit will be placed.

Each of the first aid kits must be delivered to 3 (three) other landing bases spread throughout the arena. The landing bases may be located anywhere in the arena at any height. However, the positions of the landing bases are known in advance.

The drone must pick up one kit at a time and take it to one of the empty landing bases, regardless of the order.

The kits can be placed in any pose within the yellow circle of the landing base for pickup and in any position at the base for delivery.

The drone does not need to be with all parts of the landing gear inside the landing base area to pick up and deliver the first aid kits.

There will be no marker (barcode, QRcode, Apriltags, etc.) to recognize the first aid kits. The boxes cannot be delivered to bases that already have boxes (the ones on top of the environment of Phase 4), and the kits cannot be delivered to landing bases that already contain another kit.

Furthermore, a suspended cable may not be used to collect the boxes. In addition, there will be no magnetic plate on the kits to collect them.

The first aid kits will be similar to the one in Figure 8, with similar dimensions.

Figure 8 – First aid kit for Phase 2.

The kits will weigh a minimum of approximately **160g, and** the team can choose the maximum weight.

In this phase, each team will have 30 minutes and up to 3 attempts. Each attempt can last a maximum of 10 minutes, and the highest score obtained in one attempt will count.

Interaction with Humans: in this PHASE 2, the robot can return to the takeoff base with a command given by a human (team member via remote control) or return autonomously. Upon returning to the takeoff base, the attempt ends.

SCORE

This phase has a maximum score of 360 points.

For each first aid kit, the robot correctly identifies, grabs, and lifts the detected kit, the team will receive 40 points. The team will receive an additional 20 points for each first aid kit delivered to the correct landing base. When left on the correct base, the package will be considered delivered and will no longer count points. Subsequently, it will not suffer any penalties (e.g., if it is dropped, detected, or lifted again). After correctly transporting all 3 (three) packages (first aid kits), the robot should return to the takeoff base autonomously.

If the drone drops the package after being removed from its home base anywhere other than the correct base, the team will lose 5 points, and the package will be invalid for any subsequent scoring or penalty.

If the robot returns to the takeoff base autonomously (without human intervention) after having transported at least 1 (one) of the packages correctly, and if the drone lands at the base successfully, the team will have its score on this Phase **doubled (2x)** if the score is positive. The score will be doubled if, and only if, the robot has transported at least 1 (one) package correctly. If the score is negative, if the robot returns to the takeoff base, the team does not score the attempt. If the robot does not return to the takeoff base, the team can choose to stop the attempt, without penalty, at any time or when the 10 minutes of each attempt are up.

If the team decides to stop the robot at any time in an attempt, the score will be valid until the moment of interruption. All 3 (three) attempts must be made with the robot starting from the takeoff base.

PHASE 3 - HUMAN-SWARM INTERACTION

Commercial aircraft inspectors play an indispensable role on the runway, serving as a visual bridge between pilots and ground crew by using signal portable illuminated beacons to communicate vital instructions to pilots. This visual signage can also be used by survivors in the wild to be rescued. This scenario summarizes the potential of harnessing human body movements as command inputs within systems, laying the foundation for advanced Human-Robot Interaction (HRI). An extension of this paradigm is Human-Swarm Interaction (HSI). Therefore, PHASE 3 will require the teams' robots to reach landing platforms based on a human's visual command.

THE TASK

In PHASE 3, the aerial robots will have to land on all 6 (six) landing bases, guided only by visual commands performed by a human operator using human-robot interaction techniques. After landing on all bases, the robot must return to the takeoff base autonomously.

MAIN OBJECTIVE

The task aims to overcome the following challenges:

- ☐ Human-Robot Interaction;
- ☐ Multi-robot systems;

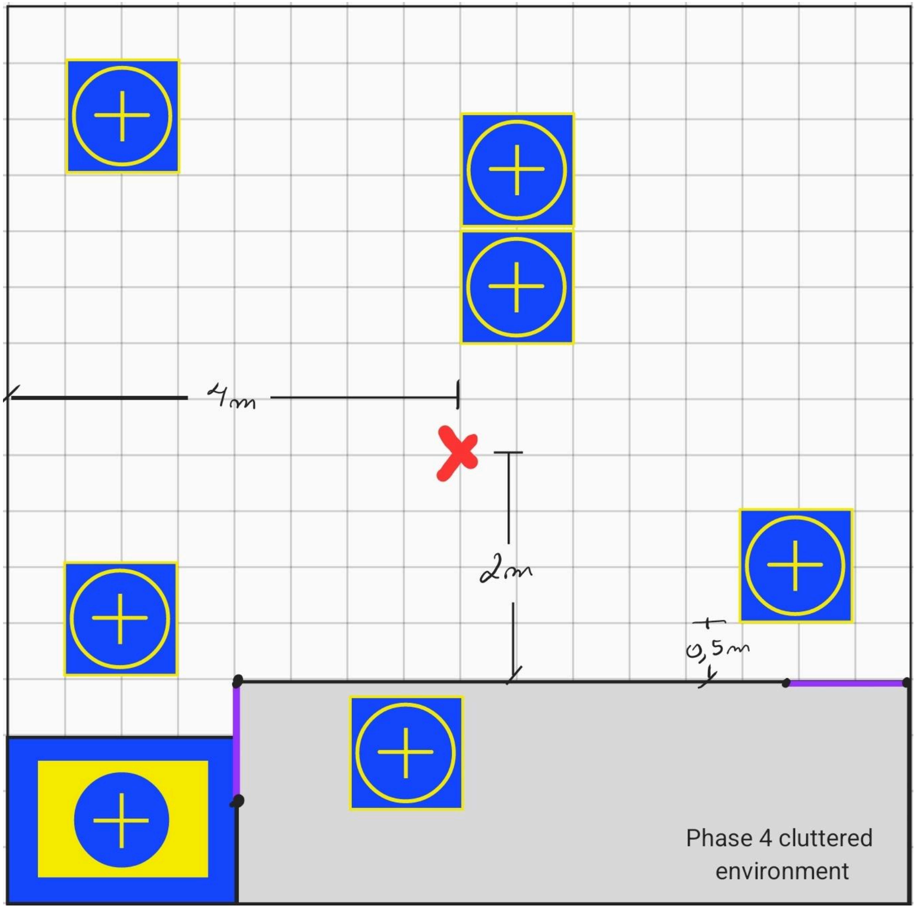


Figure 9 – Layout for Phase 3.

CONDITIONS

The human operator must position himself in the middle of the arena (marked with a red X on Figure 9) at any orientation. After positioning the human operator, the Drone must take off autonomously (by command from the team's computer). After the take-off, upon the task initialization (by command from the team's computer), the drone must approach the human operation autonomously in order to fit the human operator in a more "suitable" Field-Of-View position of the drone. From there, the drone and human can move freely to complete the phase, in which the aerial robot must land on all the lading bases guided only by the visual commands of a human.

When carrying out the phase, the aerial robot must land on all the landing bases, guided only by a human's visual commands. All landing bases will have their visual markers occluded (or turned upside down). The robot must move only by visual command with the human, that is, by Human-Robot Interaction. Furthermore, the robot must post the names of the visual commands made by the IHR operator on a terminal for the judge to view.

No commands originating from pre-programming or environmental feature detection should be used to detect the base or land on it.

In this task, each team can use up to 2 (two) robots simultaneously or sequentially in each attempt. If the team chooses to use 1 (one) drone only, it must land on the 6 (six) bases of the arena. If the team wishes to use 2 (two) drones, they must each land on 3 (three) different bases. Landing bases cannot be repeated; that is, each drone must land on a different base from the other.

NOTE 1: The drones used cannot be larger than 330 mm.

NOTE 2: Drones used in this phase MUST have propeller protectors.

Each team will have 30 minutes to make up to 3 attempts to complete the tasks. The score obtained in the best of the 3 (three) attempts will be considered, with the others discarded. Each attempt can last up to 20 minutes.

NOTE 3: The human who will control the drones through gesture/action recognition must be inside the arena and must wear all the required personal protective equipment (PPE).

NOTE 4: Human tracking techniques will NOT be allowed (e.g., detect and follow).

Interaction with Humans: in this PHASE 3, all drone movement commands must be made by recognizing gestures or actions from one of the team members inside the arena. Upon returning to the takeoff base, the attempt ends.

SCORE

This phase has a maximum score of 240 points.

At the beginning of the phase, that is, during the take-off of the aerial robot, the human operator must be in the middle of the arena at any orientation.

Before the Drone begins the task of landing on the bases, and after approaching the human operator in the center of the arena, the aerial robot must detect and recognize the human operator, and its recognition/detection must be shown on the team's computer terminal. If the drone does not recognize the human operator, no points will be counted.

All detected movements must be shown on the team's computer terminal (examples: the human's coordinate in the world, the human's skeleton, the image, etc.).

For each base visited for the first time, the team will receive 20 points.

The robot will be considered to have visited the base if the drone lands on the base (i.e., the touch of all the drone's landing gear on the base is noticeable).

The team loses 5 points for each repeated visit (landing) to a base. If the team is using two drones and one of the robots lands in a base where the other robot has already landed, the team loses 10 points.

If the robot returns to the takeoff base autonomously (without human intervention) after landing in at least 1 (one) landing base successfully, the team will have its score on this Phase **doubled (2x)** if the score is positive. If the score is negative, if the robot returns to the takeoff base, the team does not score the attempt. If the robot does not return to the takeoff base, the team can choose to stop the attempt, without penalty, at any time or when the 10 minutes of each attempt are up.

If the team decides to stop the robot at any time in an attempt, the score will be valid until the moment of interruption. All 3 (three) attempts must be made with the robot starting from the takeoff base.

NOTE: If the team is using two drones, for the score to be doubled, both drones must land on the takeoff base successfully at the end of the test.

If the score is negative, if the robot returns to the takeoff base, the team does not score the attempt. If the robot does not return to the takeoff base, the team can choose to stop the attempt, without penalty, at any time or when the 10 minutes of the attempt are up.

PHASE 4 – CLUTTERED ENVIRONMENT NAVIGATION

The ability of UAVs to navigate autonomously is a precondition for performing disaster rescue and logistics deliveries. However, enabling safe flights of UAVs in unknowingly cluttered environments containing a large number of obstacles is mandatory, especially in disaster rescue situations. Therefore, PHASE 4 will require a flying robot to navigate safely through a cluttered and dark environment.

NOTE: This phase is in alignment with the tasks of the RoboCupRescue League.

THE TASK

In PHASE 4, the aerial robot needs to successfully autonomously navigate through a cluttered and dark environment while searching for 5 (five) targets spread within this environment. Upon leaving the labyrinth, the drone must autonomously land on a landing base in the middle of the arena.

MAIN OBJECTIVE

The task aims to overcome the following challenges:

- ☐ Robotic vision;
- ☐ Cluttered environment navigation;
- ☐ UAV Exploration;

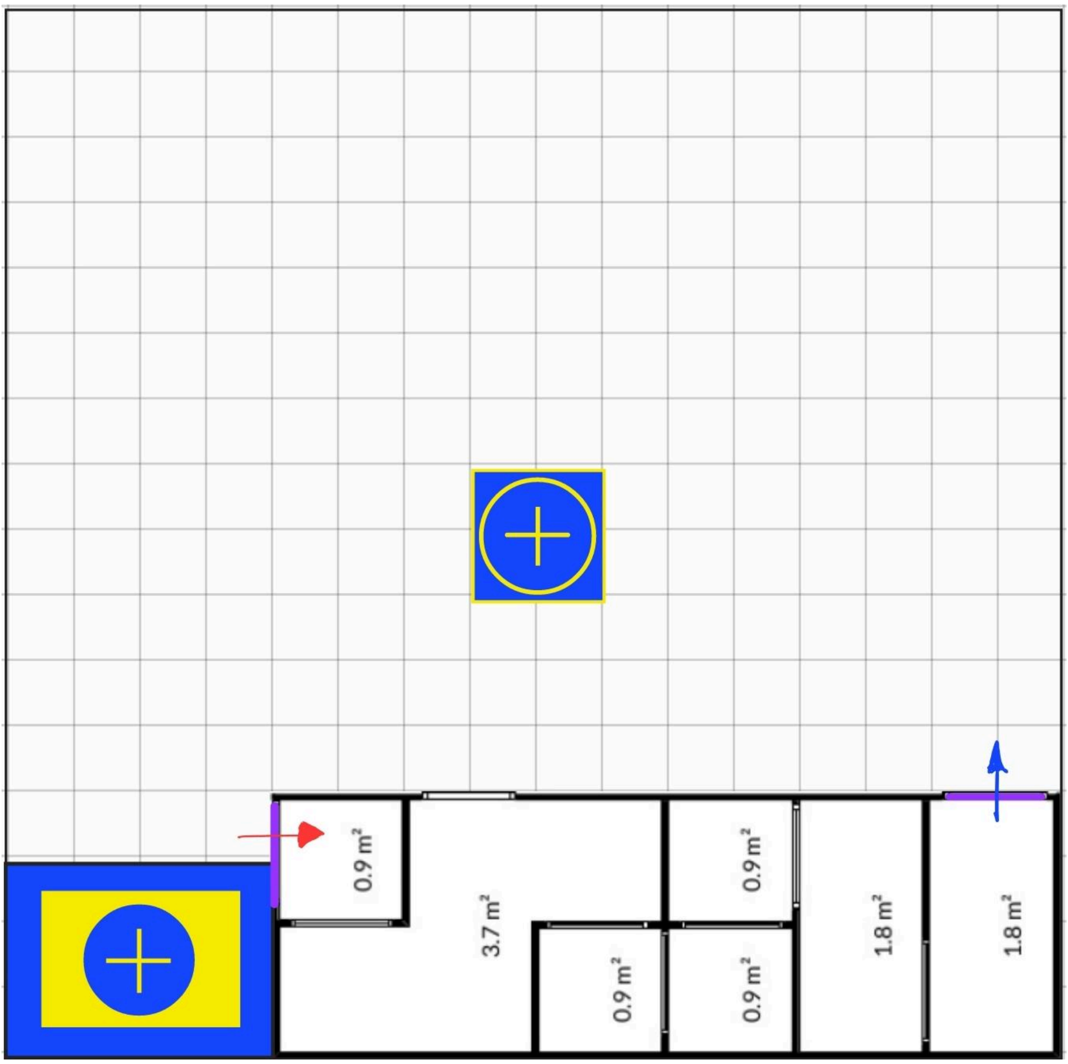


Figure 10 – Layout for Phase 4.

CONDITIONS

The drone must take off autonomously from the takeoff base and enter the cluttered environment of Phase 4 through the entrance indicated by the red arrow (see Fig 10). The robot must fly within the maze while searching for five QRCodes spread throughout the maze. The QRCodes will be placed at any position and can be placed at any wall within the maze. The QRCodes will NOT be placed on the floor or the ceiling of the cluttered environment. The QRCodes will be identified by letters (A, B, C, D, and E). The QRCodes are 10 cm on each side. Examples of QRCode to be used can be seen below:

A B C D E

Figure 11 – QRCodes used in Phase 4.

After reading the QRCodes and navigating through the maze (cluttered environment), the flying robot must leave the area through the window indicated by the blue arrow. Upon leaving the cluttered environment, the UAV must autonomously land on the landing platform in the middle of the arena.

NOTE 1: The drones used cannot be larger than 330 mm.

NOTE 2: Drones used in this phase MUST have propeller protectors.

Each team will have 30 minutes to make up to 3 attempts to complete the tasks. The score obtained in the best of the 3 (three) attempts will be considered, with the others discarded. Each attempt can last up to 10 minutes.

Interaction with Humans: in this PHASE 4, the robot can return to the takeoff base with a command given by a human (team member via remote control) or return autonomously. Upon returning to the takeoff base, the attempt ends.

SCORE

This phase has a maximum score of 300 points.

In this phase, the team will receive 50 points for successfully navigating the maze (i.e., entering the maze through the space indicated by the red arrow and leaving it through the space indicated by the blue arrow). The robot will not lose points if it hits a wall. However, the attempt will be finished if it lands in any area except the landing base.

For each different QRCode detected for the first time, the team will receive 20 points.

If the robot successfully lands on the landing base after leaving the cluttered environment through its exit (space indicated by the blue arrow) autonomously (without human intervention) and reading at least 1 (one) QRCode successfully, the team's score on this Phase will be **doubled (2x)**. If the robot does not land on the desired landing base, the team can choose to stop the attempt, without penalty, at any time or when the 10 minutes of each attempt are up.

If the team decides to stop the robot at any time in an attempt, the score will be valid until the moment of interruption. All 3 (three) attempts must be made with the robot starting from the takeoff base.

THE WINNER

The winning team will be the one with the highest number of points combined. In case of a tie, the following conditions will be adopted for the tiebreaker, in this order:

1. The tiebreaker will be in favor of the team that scored in the most different phases;
2. If the tie persists, the team that scores the most in PHASE 4 will be the winner;
3. If the tie persists, the team that scores the most in PHASE 3 will be the winner;
4. If the tie persists, the team that scores the most in PHASE 2 will be the winner;
5. If the tie persists, the team that scores the most in PHASE 1 will be the winner;
6. If, after all the above criteria, the tie persists, the tied teams will be declared winners in the same place.

NOTE 1: The team that obtains ZERO points in all phases will be automatically disqualified from the competition.

NOTE 2: The team that decides not to fly will lose by W.O., and you will automatically get ZERO points in the respective phase.

Note 3: Only teams that scored points in at least one phase can be in first, second, or third place in the competition, even if the lack of points means there is no winner.

AWARDS

The teams placed in the top three positions will receive champion, runner-up, and third-place trophies.

OMISSIONS

Situations not foreseen in the rules (and/or issues related to the interpretation of these rules) will be clarified and/or decided by the organizing committee and the judges. Their decision on the matter shall be final.

FAIR PLAY

The characterization of a lack of Fair Play by a team and/or one of its members at any time will imply the adoption of sanctions that may include (but are not limited to) warning, loss of points, round elimination, elimination of the competition, banning from the current and subsequent events. The penalty adopted by the Organizing Committee will take into account the seriousness of the transgression.

FINAL CONSIDERATIONS

We hope everyone has a great experience this year. Given the increasing use of flying robots, we also hope this becomes a major league in the following years of RoboCup. If you have any questions, do not hesitate to contact the league chair or the general chairs.

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