Space Robotics Society

SPACE ROBOTICS SOCIETY (SPROS)

INTERNATIONAL SPACE DRONE CHALLENGE

An Event of International Space Robotics Week (SPROS Week)

RULEBOOK

31 Jan - 2 Feb
2025

Goa
India

roverchallenge.org

spaceroboticssociety.org

1.0 COMPETITION OVERVIEW

1.1 COMPETITION OBJECTIVE

SPROS International Space Drone Challenge (ISDC) is a space robotics engineering competition. It challenges university students to conceptualise, design, develop and operate an astronaut-assistive next-generation drone (aerial vehicle) and perform specific missions in Mars simulated conditions. Space drones provide multiple advantages over surface robots, such as better reach and range. It is easier for drones to reach places off-limit to the rovers. In addition to solo exploration, the drones can act as wings to the rover and explore together.

The objective of the competition is to provide students with a real-world interdisciplinary engineering experience, combining practical engineering skills with soft skills, including business planning and project management.

1.2 COMPETITION PROCEDURE AND SCHEDULE

The competition is divided into two stages:

- Review Stage (Online)
- Finals (On-site)

MISSIONS/SUB MISSIONS	POINTS
Review Stage(Online)	
System Design and Development Review	200
Finals(on-site)	
Navigation Mission	200
Science Mission	200
Project Implementation & Management Assessment (PIMA)	100

Figure 1.2 Points Distribution

1.2.1 Team Selection Criteria

The teams that successfully submit a System Design and Development Review (SDDR) and have a working drone will be invited to compete in the on-site Finals. Specific details for each deadline (including deliverable format, submission requirements, and judges' expectations) will

be posted to the SPROS website (www.spaceroboticssociety.org) and the ISDC website (www.roverchallenge.org/isdc). Additionally, officials may respond to teams with follow-up questions or requests for clarification at any of these milestones.

1.2.2 Registration

All teams have to declare an intent to compete. The registration form will be available online on the ISDC website (www.roverchallenge.org/isdc) from September 25 to October 25, 2024. No significant deliverables are required for this deadline, aside from team details requested via the ISDC website. The maximum number of students a team may have for the competition is unrestricted.

If a team registers for both International Rover Challenge (IRC) and ISDC, they will not have to pay the participation fee for the ISDC Finals. Moreover, if a team applies for joint ISDC and IRC registration with another rover team from their university/institute campus, the IRC Finals participation fee will be waived in such a case.

Figure 1.2.3 BITS PILANI GOA, ISDC - 2025 Venue

1.2.3 Awards and Honours

- Grand Awards - These are presented to the ISDC's top three teams, i.e., the Champion, First Runner Up, and Second Runner Up.

- Mission Awards: These honours will be given to teams for their creative thinking in a specific subsystem and outstanding performance in any of the ISDC Finals missions. This category also includes the PIMA awards.

- Depending on the judges' verdict, further types of awards might possibly be given out.

1.2.4 System Design and Development Review (SDDR)

Teams must submit a System Design and Development Review (SDDR) package before November 10, 2024. The SDDR package will focus on both technical and project management aspects of drone development and has written a report of 10 pages. In the Project Management aspects, teams shall include the organisational structure of the team, resources management, project planning, a PERT chart showing the project timeline, initial budget, fundraising plans, sponsorships, team recruitment process, and educational and public outreach. In the technical aspects, teams shall include the current state of the drone development and prototypes, overall system design, and the team's prototype testing strategy. The top 12 teams will advance to the on-site Finals based on their SDDR scores. All the teams qualified for the ISDC Finals will have to confirm their participation by December 5, 2024. If a qualified team is unable to participate in the Finals due to a particular reason, then its spot will be transferred to the highest-ranked reserve team.

Competition Dates - ISDC Finals will be held from January 31 – February 02, 2025, at BITS Pilani K K Birla Goa Campus, Goa, India.

The fee details will be available on the website and do not cover the cost of travel or accommodation. The participating teams must make their own arrangements and cover these expenses. Teams should arrange accommodation and transportation promptly upon receiving the SDDR result, as Goa is a popular tourist destination and February is peak season.

Note: Any changes in the dates or rules due to any reason shall be communicated to the teams. The decision solely rests at the discretion of the organising team.

1.3 ADMINISTRATIVE REGULATIONS

1.3.1 Competition Information

The competition-specific rules and relevant information are defined in this Rulebook, and the specific guidelines issued separately for various submissions/missions will be available on the competition website. All the questions in the FAQ section on the ISDC website will also be considered part of the rules and guidelines. In addition, any official announcement shall also be considered part of these rules. Any issues not covered by these published rule sets will be addressed on a case-by-case basis by the IRC officials. If there is a discrepancy, the Rulebook (this document) will take precedence over FAQs. The rules are designed to be as clear and specific as possible, but there may still be occasional errors or ambiguities. In these cases, the spirit of the rules takes precedence over the exact wording. The key terms "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as specified in RFC 2119, regardless of capitalisation.

1.3.2 Queries regarding the Rules

Queries concerning any rules or guidelines should be directed to the officials via email at irc@roverchallenge.org. The frequently asked questions (FAQ) section on the competition website must be checked before submitting a question. The officials will only answer questions that are not already answered in the rules or FAQs or that require new or novel interpretations. No response will be provided to email addresses other than the designated contact point, as these emails will be considered as spam. The official language of the competition is English.

All communications will be sent only to the official team or team leader's email address. Please check your contact email regularly to ensure you do not miss any important updates or communications from the organiser.

1.3.3 General Officials Authority

The officials reserve the right to revise the schedule of the competition and/or interpret or modify the competition rules at any time and in any manner that is, in their sole judgment, required for safe, fair, and efficient operation. Therefore, all team members are required to cooperate with and follow all instructions from the officials.

1.3.4 Official Instructions

Failure of a team member to follow an instruction or command explicitly directed to that team and/or member will result in a 20-point penalty, which will be deducted from their overall score.

1.3.5 Conduct with Officials

Arguments with or disobedience to any official will result in the team being eliminated from the competition.

1.3.6 Unethical Conduct

In case of unethical conduct by a team member, a 20-point penalty will be deducted from the team's overall score. A second violation will result in the expulsion of that member and his/her team from the competition.

1.3.7 Protests

If a team has a question about scoring, judging, policies, or any official action, in that case, it must be brought to the officials' attention for an informal initial review before an official protest can be filed. A team may protest any rule interpretation, score, or officials' action which they feel has caused some actual, non-trivial harm to their team or has had a substantive effect on their score. If a resolution cannot be found through the initial review, a protest must be filed in writing and presented to the officials by the Team Leader. The decision of the officials regarding any protest will be in a written form and will be final, and no further protests will be considered on that same topic.

1.4 GENERAL REQUIREMENTS FOR TEAMS & PARTICIPANTS

1.4.1 Teams per University

There is no limit to the number of teams a university can send to the competition. Teams that are formed with members from two or more universities are treated as a single team. It is up to the members to decide if they want to represent one university or compete independently. Representing more than one university is not allowed.

1.4.2 Team Members

A person can be a part of only one team. Each team must have one team member identified as their team leader/captain. The team leader/captain is the main point of contact for the officials during the registration process and competition.

1.4.3 Student Status

Team members must be enrolled as degree-seeking undergraduate or graduate students in any university. Team members who have graduated before the competition are ineligible to participate.

Students seeking a PhD degree/PhD students or equivalent are not allowed to participate.

1.4.4 Age

Team members must be at least 18 years of age. Written permission from the official guardian should be provided for members below the age of 18 years on the date of January 1 of the year of the Finals.

1.5 FINANCES

The maximum allowable cash budget that a team can spend on the project is 500,000 INR (6,000 USD). It shall include components for the drone, drone module, drone power source, Drone communication equipment, and Drone base station equipment. Teams are encouraged to get financial and in-kind sponsorships and donations for their project. Teams should mention the sponsorship amount and donations in their SDDR.

1.6 DOCUMENTATION & SUBMISSION DEADLINES

1.6.1 Submission

Submitted documents may only be viewed by members of the submitting team, authorised judges, and officials. The official website of the competition will be used for all online submissions. By submitting documents via the competition website, the team agrees that these documents may be reproduced and distributed by the officials, in both complete and edited versions, for educational and marketing purposes. Teams should check the competition website regularly to keep track of the submission deadlines.

1.7 GENERAL RULES

1.7.1 Forfeit for Non-Appearance

It is the responsibility of each team to be present at the competition site with their Drone at their scheduled timeslot, which will be communicated to them beforehand by the organisers. If a team is not present and ready to compete at the scheduled time, it forfeits its attempt at that mission/task.

1.7.2 Team Briefing

All team leaders/captains must attend the team briefing for that day. If any specific doubts are there regarding the mission, they can be cleared during the briefing. No doubts or clarifications will be entertained once the mission time has begun.

1.8 DRONE OPERATIONS

- Teams will operate their drones from designated base stations. These base stations will be isolated such that the visibility of the course is blocked to the operators. Basic Indian-style power outlets (220V, 50Hz), tables, and chairs will be provided.

- **Drones are expected to travel 400m at most from the command station and the maximum allowed elevation from the ground is 25 feet.** The base station's controller screen must constantly display the drone's elevation from the surface during the final.

- All the competition events will be held in full daylight or under adequate artificial light.

- The GPS coordinates provided shall adhere to the WGS 84 datum standard. The format for the same will be latitude/longitude in decimal degrees.

- Testing will not be allowed at the site during or before ISDC-2025.

2.0 DRONE GUIDELINES

2.1 FACULTY ADVISOR ROLE

- The drone entered into the competition must be entirely designed and built by the student team members without direct involvement from faculty advisors and industry professionals.

- The role of faculty advisor/coordinator/supervisor will be limited to mentorship and guidance. He / She may not make design decisions.

- Students should perform manufacturing and fabrication tasks themselves as much as possible. For cases where in-house manufacturing and fabrication are not possible, teams can approach contractors, but the amount charged will be considered in the team budget.

2.2 SIZE, WEIGHT, AND DESIGN

- The drone shall be a stand-alone, off-the-grid, mobile platform. A single connected platform must leave the designated start line. The drone may be fixed or rotary wings.

- T**he weight of the drone should be less than 5 Kg.**

- There are no restrictions on the dimensions of the drone.

- The drone must use power systems that may be applicable on Mars. Battery-powered systems can only be used for drones. Any potential hazardous material will require proper documentation to be submitted to the organisers before the competition.

2.3 COMMUNICATION EQUIPMENT

- The drone shall be operated remotely using wireless communications with no time delay. The operators will not be able to view the drone or the site directly as they will be operating sitting in their base stations. Teams must power down communications equipment at the event sites while not competing to not interfere with other teams.

- During drone operations, a spotter must maintain visual contact with the drone at all times. The pilot will not have a direct view of the drone, so a designated team member in the field must act as a spotter.

- Both omnidirectional and directional antennae are allowed, but communications equipment must not rely on the team's ability to watch and track the Drone firsthand. Steered directional antennae may use a mechanized antenna mounted outside that is controlled via an electronic signal from the command station. Signal strength, relayed GPS, or other strategies may be used to give feedback on antenna direction, but it is not allowed to mount a camera on top of the antenna for visual feedback.

- Base station antenna height is limited to 3 metres and shall adhere to all applicable regulations. Antenna bases must be located within 3 meters arc of the team's command station.

- Any ropes or wires used for stability purposes only may be anchored within 3 meters of the command station.

- Teams are responsible for ensuring that they comply with the Indian regulations for the frequency band in which they operate.

- Teams should ensure that their communications equipment can automatically or manually switch between frequency bands, should there be any interference from an innocent third party.

- Teams must inform the organisers of IRC about the communications standards they will be using, including frequency bands and channels, by December 1, 2024. Teams will be

allocated a frequency range within their operating frequency band(s) which they must operate within at all times.

- The teams are strongly encouraged to investigate spread spectrum, automatic channel switching, frequency hopping, or other interference-tolerant protocols.

- Communication on the 5.8GHz band is recommended for less interference.

- The Finals will take place in an area which has a high RF (particularly WiFi) environment. Teams should consider this when designing their communications systems, and take steps to avoid foreseeable complications.

3.0 COMPETITION MISSIONS (FINALS)

- The ISDC Finals will have two field missions and one assessment (presentation).

- Teams will get a maximum time of 15 minutes to complete a mission. If a team completes a mission in less than 10 minutes, the team will get 20% bonus points for that mission.

- All the penalties are additive: e.g. penalties of 10% and 20% would result in a score of 70% of the points earned during that particular mission. All the missions are scored independently, and it is not possible to score less than zero in a mission.

- Before the start of the mission, teams will get 10 minutes as the setup time to set up all necessary systems and equipment at the base station. After completing the mission, teams will have to switch off their radio communication equipment immediately, and they will have 5 minutes to disassemble all the equipment and vacate the base station.

- The drone is not required to be in the same configuration during the entire competition. Teams can change the configuration of the drone according to their needs and mission requirements. The drone will be accessible to the teams throughout the competition, and teams can make modifications and repairs between the missions.

- During drone operations, a spotter must maintain visual contact with the drone at all times. The pilot will not have a direct view of the drone, so a designated team member in the field must act as a spotter.

- In the event of an emergency, the spotter will use radio communication with the pilot to prevent the unsafe behaviour of the drone. In a dual-pilot setup, the spotter may take direct control of the drone if necessary. The spotter's intervention is limited to potential safety issues and should not otherwise participate in the mission.

- The spotter's primary responsibility is to ensure the safe flight of the drone and maintain a safe distance from people and structures. If the spotter intervenes with the drone, judges may consider it as a "kill switch." In this case, the drone will not be allowed to continue the mission.

3.1 INTERVENTIONS

An intervention can be called when a critical error hinders regular drone operation during a mission. Teams are allowed to take not more than one intervention during a mission. A 30% penalty for the total points scored in that particular mission will be imposed.

A request for intervention can only be called by the team members present at the base station. It must be relayed through the judges at the base station. Teams may designate any number of team members who may repair or retrieve the Drone (hereafter referred to as “runners”). Spectating team members may be asked to act as runners, and also drone operators may leave the base station and become runners, but those members who leave the base station will not be allowed to re-enter the base station.

3.1.1 SPROSCAPE

- The ISDC 2025 Finals will be performed within a specially designed simulated landscape called Sproscape.

- It will be the world’s largest arena of its kind. It will incorporate numerous Mars-like topographical elements, such as craters, mounts, rocky gardens, rifts, quarry fines, etc. On the outer edges of the Sproscape, base stations for controlling the drone will be present.

Figure 3.1.1 Sproscape, International Rover Challenge – 2023 (For Reference)

3.2 SCIENCE MISSION (SM)

During this mission, the drone will use its onboard sensors and instruments to gather atmospheric data and images from three separate locations. The goal is to locate and gather basic information about certain areas for future scientific research by astronauts. The teams

will be provided with the approximate GPS Coordinates or markers of those locations before the start of the mission.

- The drone should conduct a minimum of two of the following analyses of the atmosphere: temperature, humidity and atmospheric pressure, etc. The teams can do other analyses depending on their choice. While collecting the atmospheric data, the drone's elevation from the ground should be different for each location, with the first location's elevation being 10 feet, the second's being 15 feet, and the third being 20 feet. The drone controller's computer in the base station should constantly display the drone's elevation reading.

- The drone should take photographs of the three locations in as much detail as possible.

- After completing the mission time, teams will have to prepare for a 10-minute presentation for the judges, based on the data collected. The presentation is mandatory for the teams, even if they are unable to collect data during the mission.

- The presentation to the judges should include:
- Results of on-board drone tests performed, including data and images.

- A comparison of the drone-collected atmospheric information and images with the atmosphere and surface of Mars.

- Teams are expected to have basic knowledge about the Mars atmosphere, astrobiology, and features.

3.3 NAVIGATION MISSION (NM)

To make future expeditions more effective, the drone is tasked to direct a fictitious rover as it travels across the surface of Mars. The rover's optimal paths to various locations on Mars must be discovered by the drone. The pathways should be chosen so that the rover faces the fewest obstacles possible by avoiding challenging terrain characteristics including craters, rifts, rocks, and loose soil, among others.
The drone will be required to move no more than 400 metres away from the base station while on the mission in order to find particular markers/GPS coordinates. Three markers will be dispersed over the field. The markings will be orange colour cones (the sample image for the cones will be provided on the website). For at least one marker, approximate GPS coordinates will also be given. On the map that was given to the teams at the base station, the teams should mark the allocated markers and the best path to get to them. Locating markers and figuring out the best routes to those markers will earn you points.

3.6 PROJECT IMPLEMENTATION AND MANAGEMENT ASSESSMENT (PIMA)

The objective of the PIMA is the assessment and review of the project and final drone design. PIMA will have one-to-one interaction between the teams and the judges. The teams will have to give a presentation to the judges about their drone development. This presentation will cover the lessons learned during the whole life cycle of developing a drone. It will include mostly system engineering and management aspects of the project, from the project plan to manufacturing and testing the drone. Teams may also include spin-offs that have emerged from their drone project. Furthermore, this presentation offers the opportunity for the judges to ask some specific questions.

3.6.1 Project Implementation and Management Assessment Procedure

- More details about the format of PIMA will be provided separately in October.
- The details that are not covered in this rulebook will be shared in the form of separate guidelines and the FAQs section on the website.
- For any query related to the rulebook contact us at contact@roverchallenge.org