International Rover Design Challenge

Space Robotics Society

RULE BOOK

INTERNATIONAL ROVER DESIGN CHALLENGE 2022

SEP-OCT 2022

ONLINE WORLDWIDE

WWW.ROVER CHALLENGE.ORG

TRANSFORMING THE WAY YOU INNOVATE

1.0 COMPETITION OVERVIEW

1.1 COMPETITION OBJECTIVE

The Space Robotics Society's International Rover Design Challenge (IRDC) - 2022 is an online space engineering design competition. It challenges university students to conceptualise and design Next-Gen Mars Rovers, which shall be fully equipped and mission ready for future exploration operations on Mars. Teams are supposed to carefully plan each sub-system of the Rover considering various extra-terrestrial parameters in design (Exceptions, if any shall be mentioned). This online research-oriented competition is designed for students to explore their minds and spark the innovative design thinking of individuals, free from constraints on available physical resources. Students are encouraged to be as Imaginative, Creative and Insightful as possible within practical implementable limits for the human race.

The stated guidelines in this Rulebook are intended to give the teams a direction and outline for their designs.

The scenarios and specifics not mentioned in the Rulebook regarding rover capabilities and rover subsystems can be treated as "Open to Interpretation". Teams are allowed to make certain assumptions in such scenarios while providing proper justification for them. This step is taken to promote imagination and creativity in teams, rather than being bound by a higher number of constraints. It should also be stated that there is no "Right Answer" in this competition. We are expecting to see a gamut of approaches and strategies from teams. Teams will be judged primarily on the merit of their System Concept Review (SCR) Package, which includes a written report and a 15 second rendered video submission of the designs.

2.0 GENERAL GUIDELINES

2.1 Competition Format

The IRDC is a completely off-site (online) competition, and no physical inception of designs is mandated to the teams. Graduate and undergraduate students are allowed to participate. IRDC-2022 edition will be a 2-stage competition. Stage 1 will be the submission of the System Concept Review (SCR) Package. In stage 2, the top 10 teams from Stage 1 will be asked to present their ideas to the judges during one-on-one online presentations.

SPROS reserves the right to use and reproduce the information submitted by teams in the competition for educational and promotional purposes through any of its media channels while duly citing the contribution made by respective teams.

2.2 Registration

The registration window for the IRDC-2022 will be open from August 30 to September 15, 2022, and the System Concept Review (SCR) Package submission deadline is 23:59 IST,

October 20, 2022. The top 10 teams will be further asked to present their designs to the judges during 28-30 October, 2022. The submission procedure shall be intimated to the registered teams in the coming weeks.

The registration details and form is available at www.roverchallenge.org/irdc.

2.3 General Official 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. All team members are required to cooperate with and follow all instructions from the officials.

2.4 Queries Regarding the Rules

Any issues not covered by these published rule sets will be addressed on a case-by-case basis by the IRDC Judging Panel on irdc@roverchallenge.org, and all such matters raised by teams shall be posted on the IRDC FAQ section of the competition website. Teams are suggested to view the FAQ section regularly for updates.

The teams are required to formulate a System Concept Review (SCR) Package of their Rovers pertaining to the given mandatory parameters in this document. SCR consists of two components: a written report and 15 seconds rendered video.

3.0 SYSTEM CONCEPT REVIEW

3.1 SCR Report

Page 1 of the SCR Report should bear the Team Logo, Institution Logo, Space Robotics Society (SPROS) Logo, Team Name, Team Lead Name and Contact Information. Document Margins should be 2.54cm from each side. Font Sizes should range between (11pt-16pt) in the document, used appropriately for Headings, Sub-Headings, Text and Annotations.

Font should be uniform across the entire Report. All Images should be annotated. Teams are encouraged to adopt a mission-based approach in the Report. Starting with rover composition and base system information, then explaining each of their additional systems by showing their application in their mission approach. The team's approach to each mission needs to be individually elaborated.

The Teams are required to include one Orthographic/Isometric Image of the entire Rover on Page 2, labelling the primary systems of the Rover (Sample: tinyurl.com/IRDC-image), with

system descriptions not exceeding 15 words per system. A higher number of illustrations, images, CAD models, flowcharts, simulations and representative figures are encouraged.

Teams are required to compulsorily cite any published material that they may use for developing their design at the end of the SDR in an Appendix section. The System Design Review Report shall not exceed a total of 26 Pages (Excluding appendix).

3.2 SCR Video

Teams have to make a rendered video of their Rover performing any of the given mission objectives. The video should not be of more than 10 seconds and should be in MP4 format. The SCR will be judged on the basis of:

1. Compliance of Rovers to the given parameters and effectiveness on mentioned tasks.
2. Depth of extra-terrestrial conditions and parameters considered in systems.
3. The depth of justification and reasoning provided in the SDR on each design decision.
4. The novelty, innovation and imaginativeness of the design.
5. System Sophistication and effectiveness of the presentation.

4.0 COMPETITION MISSIONS

Numerous robotic missions have successfully explored Mars during the past 50 years. These missions have greatly increased our understanding of the Martian environment, its geology and prospects for habitability. The polar regions of Mars have remained less explored. Both the north and south poles of Mars have polar caps. These caps consist of a year-round visible permanent or residual cap and a temporary cap that appears in winter and disappears in summer. While the permanent cap in the south is primarily carbon dioxide ice with a small amount of water, it is made of water ice in the north. The seasonal cap of the south is bigger than that of the north because the southern winter occurs when Mars is farthest from the Sun in its orbit.

Both poles exhibit indications of an unusual layered topography, in which the alternating bands of colour may include various combinations of ice and dust. These layered geological bands, which resemble the growth rings of trees, may help solve the puzzle of previous climate change on Mars and establish whether it was caused by a catastrophic event or merely a steady evolution in the planet's environment.

A precursor robotic mission to further explore and investigate the polar regions of Mars would be an excellent option to reveal the characteristics of these structures.

4.1 Theme

A robotic mission to explore and investigate soil-ice boundary region near **Planum Australe** (tinyurl.com/IRDC-2022), the southern plains of Mars.

4.2 Mission

Conceptualise and design a Mars Rover(s) to explore and characterise the frigid soil-ice boundary region of Planum Australe.
During the mission, the primary objectives of the Rover would be to:

- Explore unique region of Mars near the border of the southern polar cap at a latitude of about 74 to 77 degrees south.

- Conduct a visual reconnaissance of the region by navigate and traverse successfully through the different terrains of this region.

- Conduct various scientific experiments (biological, geological etc.) and analysis, including in-situ analysis with the Rover for signs of microbial life, habitability and characteristics.

- Collect and analyse regolith samples from the soil-ice boundary, surface and sub-surface environments. Assess the biological potential of the soil-ice boundary and sub-surface environments.

- Characterise surface and subsurface physical properties and mineralogical composition of the layered landscape.

- Characterise the climate and local weather of the landing site, and conduct aerobiology investigation.

Note: The above-mentioned list of objectives is not exhaustive. They have been provided just to give the teams a direction about the Rover's capabilities. Exploration of Mars is a complex task, and there are a lot of other objectives and aspects which the teams might find more suitable for their Rover exploration mission.

For this mission, teams have to make the following assumptions:

- The Rover has already been transported to exploration location.

- The mission length is 20 hours.

- The rover is placed onto the layered terrain near the south pole but located on bare soil, not the seasonal carbon dioxide frost. The longitude chosen is the area where the south pole's layered terrain extends the farthest north.

- An astronaut base station with all the necessary resources is situated at a distance of 20 km from the rover.

4.3 Rover Sub-System Guidelines

Teams are encouraged to design the maximum proportion of the rover indigenously. Teams are, however, allowed to use readily available products/parts in the market. In such cases, the reasoning of the component selection will be judged rather than the actual design of such market-ready components.

1. Mechanical Design- All the mechanical systems, including but not limited to wheels, motors, drive/actuation mechanisms, robotic arm and science module, should be readily operable on Mars.

2. Electronics Design- The focus is to design and conceptualise a reliable electronics system. The judges understand that the onboard electronics are mainly Silicon Based on Earth which may not be able to function properly on Mars. Teams may treat this as an exception

and are not required to look at Material (Semiconductor Level) aspects of electronic components. All other parameters are to be considered for Martian operation.

3. Scientific Experiments and Analysis (Science) Package - All Martian parameters must be considered while developing instruments and equipment for scientific analysis.

4. Power and Communication System Design - Teams should consider the challenges presented by frigid conditions near the poles, the rover must overcome various difficulties.