REXTRO
SILVER JUBILEE EXHIBITION
FACULTY OF ENGINEERING | UNIVERSITY OF RUHUNA

COSMOTRON

LAUNCH NAVIGATE SUCCEED

VIRTUAL ROVER CHALLENGE 2025

Organized By:

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1. Competition Overview

1.1. Mission Briefing: Project Cosmotron

More than a decade ago, the pioneering rover **Pioneer-1** embarked on a daring mission to the distant, mysterious world of **Xenora**. At that time, advanced technology capable of sending detailed maps or images was still a dream. Instead, **Pioneer-1**'s mission was to forge a physical legacy: to carve a safe passage across **Xenora**'s rugged terrain by planting a network of navigational flags known as the **Pathfinder Array**. These flags would mark the best and safest route toward a predicted asteroid impact site, guiding future explorers when electronic guidance was impossible.

The landscape **Pioneer-1** navigated, a wild expanse called **The Cradle**, was as chemically diverse as it was treacherous. The Green Start Square was rich with copper compounds, malachite, and other copper carbonates, giving the soil a vivid green hue.

Pioneer-1 moved with precision, planting its flags at critical waypoints to guide the safest path through cliffs, jagged rocks, and shifting sands. Its journey culminated at an elevated plateau called the **Verdant Outpost**, where it placed the final Arrival Marker, the decisive flag pointing exactly toward the heart of the anticipated asteroid strike, the **Crimson Impact Site**. This location, richly colored by high concentrations of iron oxides such as hematite and goethite. These iron-rich minerals oxidized in **Xenora**'s deep floor were predicted by advanced machine learning models before **Pioneer-1** even left Earth.

Then, fate intervened. A sudden, violent dust storm engulfed **The Cradle** in a dense, blinding haze of fine particles. Communications with **Pioneer-1** were lost irretrievably as it vanished into the storm's fury. All the valuable data **Pioneer-1** had collected were swallowed by the dust fog, leaving only the physical **Pathfinder Array** silent and steadfast to chart the course ahead.

Now, the torch passes to you and your **Cosmotron-1 Rover**. Though technological advancements have been made, some challenges remain insurmountable: **Cosmotron-1** cannot transmit detailed terrain maps or asteroid samples in real-time. It must rely entirely on the long-established **Pathfinder Array** to navigate the perilous paths laid down long ago.

Your mission is clear: Use the precise alignment of the final Arrival Marker to follow the flagged trail safely through **The Cradle**, carefully avoiding environmental traps while contending with the still-present dust fog that lingers like a ghost, limiting visibility and complicating your journey. At the **Crimson Impact Site**, you must retrieve the rare asteroid sample known as **Argentis,** a cosmic relic held within the iron-rich red soil, preserved as a time capsule for future explorers.

Only through careful guidance, resilience against the chemical-streaked terrain, and unwavering determination can **Cosmotron-1 Rover** fulfill **Pioneer-1**'s legacy, traversing not by streams of data, but by the unyielding path of flags cutting through **Xenora**'s unforgiving wilderness.

Testing Area: Cosmotron Stage 1

2. Competition Structure

Objective:

To design, build, and program a fully autonomous rover within the **Webots R2025a simulation environment.** The rover must navigate a challenging terrain, follow flags, avoid obstacles, locate and retrieve an asteroid object from a specific target zone, and store it safely onboard.

2.1. Stage 1

Competition Phases

1. Navigation of The Cradle: The rover autonomously follows the Pathfinder Array.

2. Arrival at the Crimson Impact Site: The rover uses the final flag to locate and approach the red asteroid stage.

3. Argentis Asteroid Retrieval: The rover must identify the asteroid within the white circle on the stage and perform the retrieval.

4. Secure Storage: The rover places the asteroid into its designated storage compartment

2.2. Stage 2

Finally, after submission, your trained rover will be run in the planet world, which has similar objectives to the sample training world.

3. The Mission Arena: Planet Xenora

The competition will take place in a simulated Webots world representing the surface of Xenora.

3.1. Starting Zone: The "Verdant Outpost"

• **Description:** A green 1.5m × 1.5m square.

• **Terrain:** Borders may be inconsistent, with a step-down to the surrounding terrain of up to 15cm.

• **Initial Placement:** The rover will be placed within this zone, facing the first flag of the Pathfinder Array.

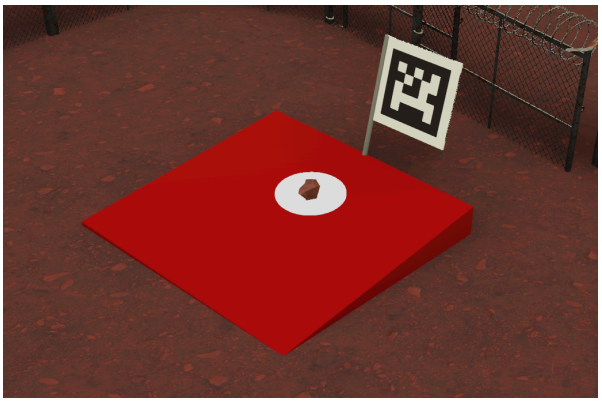
3.2. Asteroid Stage: The "Crimson Impact Site"

• **Description:** A red 1.5m × 1.5m square stage, structurally similar to the Verdant Outpost. It is located near the final navigation flag (ID=0).

• **Target Zone:** A white circle is located centrally on this red square.

• **Placement:** After detecting the ID=0 flag, locate the "asteroid" object. The asteroid is located within the white circle on the red 1.5m x 1.5m stage.

Its center will always lie on the perpendicular line extending from the center of the ID=0 flag's surface. Use a robotic arm to grasp it.



Crimson Impact Site in Webots World

3.3. General Terrain: "The Cradle"

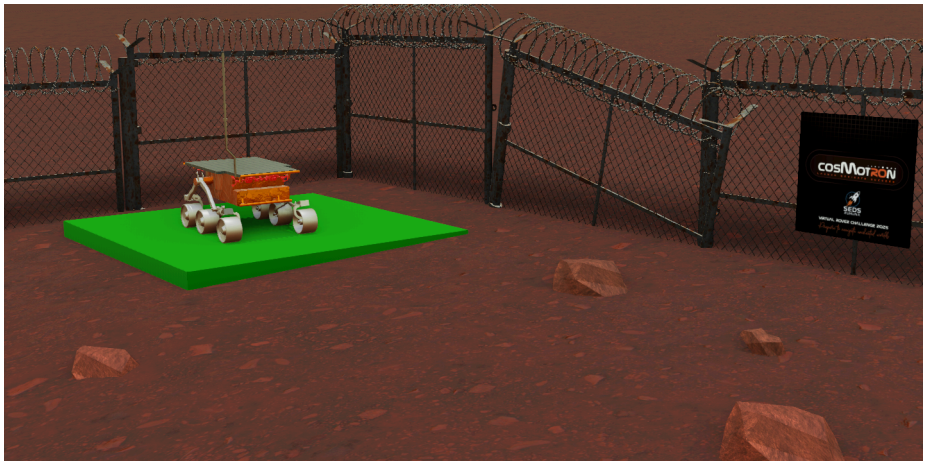
• **Uneven Floor:** The arena floor is not flat.

• **Obstacles:** The terrain is littered with rocks and debris. The types and sizes of these objects will be consistent with the sample environment, but their quantity, density, coordinates, and rotations will be changed in the final competition.

3.4. Environmental Challenges on Xenora

• **Fog:** A persistent Xenoran fog will reduce visibility.

• **Variable Lighting:** Lighting conditions may change



Verdant Outpost with Sample Rover Placement

Rocks and debris

4. Task Summary

Primary Objective: Program a simulated autonomous rover to navigate an obstacle course, interpret navigational markers, and perform a precise object manipulation task.

Required Task Sequence

1. Initialization: *Start within the 1.5m × 1.5m green square.*

2. Flag-Based Navigation:

• Detect and navigate towards flags marked with AprilTags (25H9 family).

• If ID=1, turn right. If ID=2, turn left. If ID=0, stop and proceed to the final task.

• An extra flag is added to train the rover to navigate in both left and right directions.

3. Navigate through debris: Continuously navigate on static obstacles and uneven terrain.

4. Object Retrieval: After detecting the ID=0 flag, locate the specified "asteroid" object. The asteroid is located within the white circle that is on the red 1.5m x 1.5m square stage. Use a robotic arm to grasp and lift the object.

5. Object Storage: Place the asteroid securely within a designated compartment on the rover.

5. Rover Design Constraints

5.1. Simulation Platform

This competition is held exclusively within the Webots robotics simulator.

Version: Webots R2025a Webots R2025a Download

5.2. Physical Constraints

• Size Limit: The rover must fit within a 1.1m × 1.1m × 1.1m cube in its initial starting configuration. Deployable mechanisms like robotic arms are permitted to extend beyond these dimensions after the simulation starts.

• Autonomy: The rover must operate fully autonomously.
• Boundary Compliance: The rover must remain within the arena's boundaries. A penalty will be applied for any violation.

5.3. Required Components & Systems

Your rover design must include the following components:

1. Camera: For detecting AprilTags and potentially the asteroid.
2. Robotic Arm: A manipulator capable of retrieving the asteroid.
3. Storage Compartment: A clearly defined area on the rover's chassis.
4. No Limitations for your Hardware Design

5.4. Design Philosophy: Custom vs. Pre-built Rovers

The use of pre-built rovers is permitted but highly discouraged. A significant portion of the final score (40%) is dedicated to innovation and engineering design. Teams are expected to demonstrate substantial custom engineering.

*Custom designs built from base nodes score significantly higher.

6. Mission Protocol Specifications

6.1. Navigation System: The Pathfinder Array.

The flags use AprilTags (**25H9** family).

- **ID=1: Right Turn Directive**
- **ID=2: Left Turn Directive**
- **ID=0: Arrival Marker**

(ID = 0 Indicates the rover has reached the Crimson Impact Site)

The final path will consist of a maximum of 5 flags.

6.2. Object Manipulation:

The Argentis Asteroid, The rover must identify the Argentis asteroid, retrieve it from the white circle on the Crimson Impact Site, and place it securely in its onboard storage

7. Rules and Regulations

All participants must adhere to the following rules to ensure a fair and competitive event. Violation of these regulations may lead to penalties or disqualification at the discretion of the organizing committee.

1. **Team Composition**

   Each team may consist of up to 4 members, including the team leader. The team leader will serve as the official representative of the team and is the only member permitted to raise queries, objections, or appeals to the organizing committee.

2. **Eligibility**

   Every participant must be officially registered under their respective educational institution. Participants must provide valid institutional identification or verification upon request.

3. **Robot Submission**

   Each team is permitted to submit only one Webots rover model for the competition. Backup projects or alternate robot files are not allowed. However, modifications or repairs may be done between rounds, if permitted by the organizers.

4. **Software and Simulation Environment**

   The competition will be conducted using the Webots simulation platform. Teams must ensure their simulation environment, version, and configuration match the official competition setup. Any external libraries, plugins, or scripts must be pre-approved by the organizers before use.

5. **Team Responsibility**

   Teams are fully responsible for developing, testing, debugging, and operating their rover within the Webots environment. The organizers will not provide coding, design, or simulation assistance during the event.

6. **Fair Play**

   Collaboration, code sharing, or model exchange between teams to gain an unfair advantage is strictly prohibited. Violations will result in the immediate disqualification of all involved teams.

7. **Schedule and Instructions**

   Teams must follow the official event schedule and organizer instructions precisely. Failure to comply may result in penalties, disqualification, or forfeiture of an attempt.

8. **Evaluation**

Performance will be assessed based on task completion, efficiency, and adherence to competition rules. The judges' decision is final and binding, except in cases of confirmed procedural error.

8. Final Round and Cash Prizes

The **Final Round** will be evaluated live via **Zoom** after the submission deadline has passed. Teams will be notified of the exact schedule and meeting details well in advance.

Cash Prizes

Position	***Cash Prize***
1st Place(Championship)	*Rs. 30,000*
2nd Place	*Rs. 20,000*
3rd Place	*Rs. 10,000*

9. Marking Criteria

Category	Points	Total
Innovation & Design	**30**	Engineering creativity, robustness of the custom rover design, manipulator effectiveness, and overall technical presentation.
Asteroid Retrieval	**15**	Successful identification, grasping, lifting, and storing of the Argentis asteroid.
Navigation Accuracy	**15**	Precision in following the Pathfinder Array to the Crimson Impact Site.
Custom Rover Development	**15**	Marks awarded for designing and developing a fully custom rover.
Final Flag Recognition	**15**	Correctly detecting all Pathfinder flags until the Final Flag and executing the appropriate commands.
Adherence to Constraints	**10**	Compliance with starting size limits and staying within arena boundaries.

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