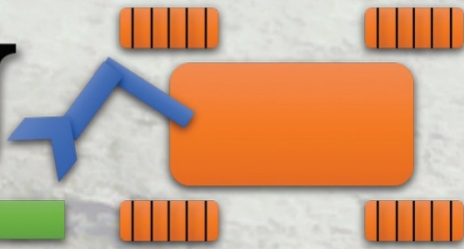


URSC



IRoC-U



ISRO Robotics Challenge - URSC 2024

Let's build a space robot



ARENA & TASK DETAILS V1.0

November 2023

U R Rao Satellite Centre



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1. About the Round

Details of the arena and task enumerated under section 4 of the prelims rule book V 1.1 are provided in this document.

The arena size as mentioned in the prelim rule book V 1.1 is 10 m x 5 m. It is to be noted that the working area shall be 10 m x 4 m as detailed below.

2. The Arena

2.1 3D Model

Model of the arena is available in parasolid format (Arena.x_t) on the challenge website for download.

2.2 Arena Views

The isometric view of the arena is presented in Figure 1. Pragyan rover is depicted for illustrative purpose. The top and side views of the arena are presented in Figure 2 and Figure 3 respectively.

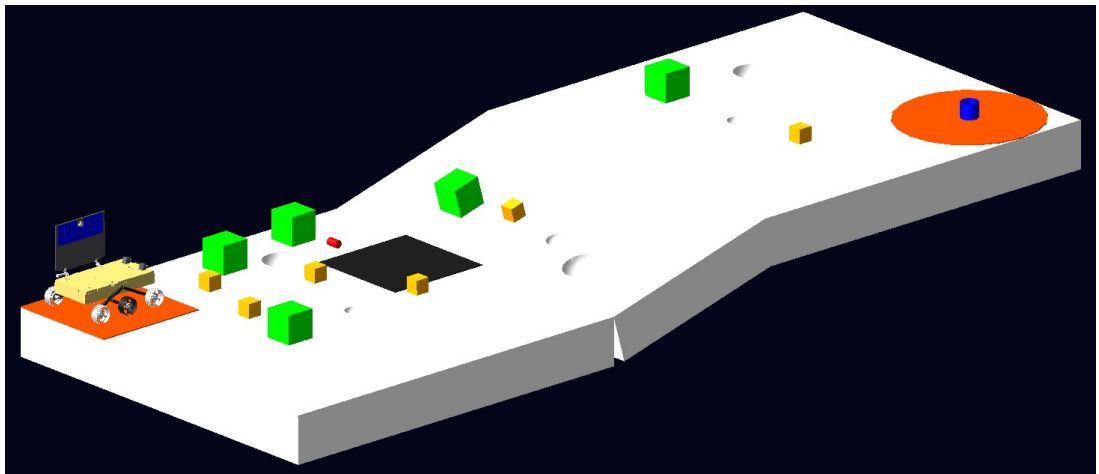


Figure 1: Isometric View of Arena

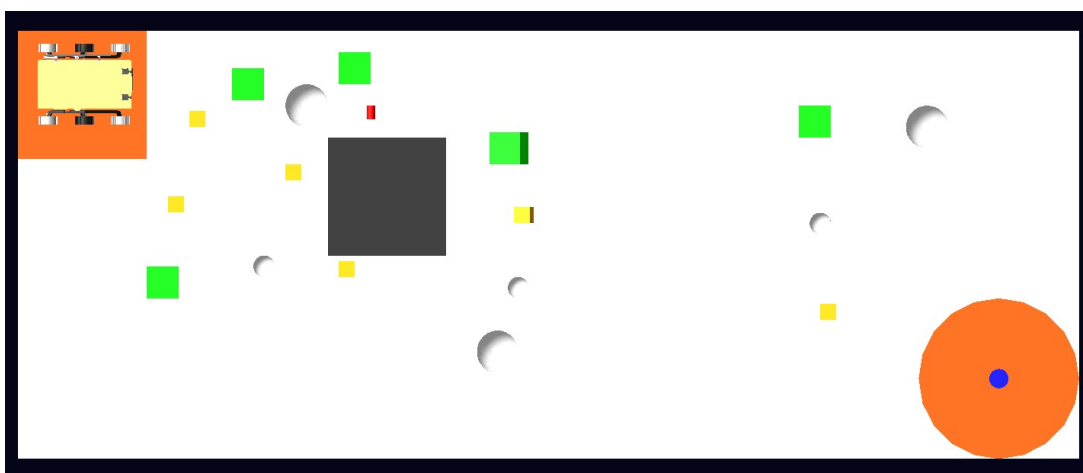


Figure 2: Top View of Arena

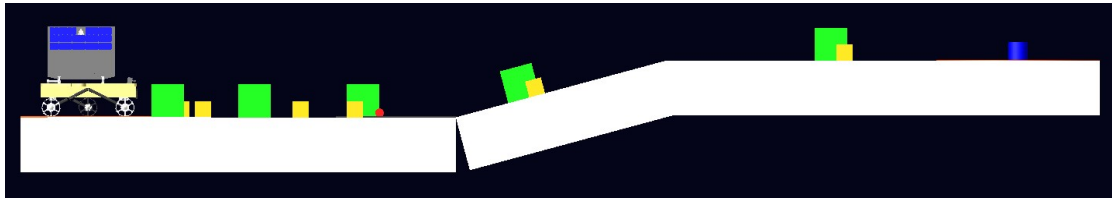


Figure 3: Side View of Arena

2.3 Coordinate System

The measurements are referred to the local coordinate system located at the top left corner of the arena as depicted in Figure 4. The X-axis is along the length of the arena, Y-axis is along the width and the Z-axis is along the height of the arena.

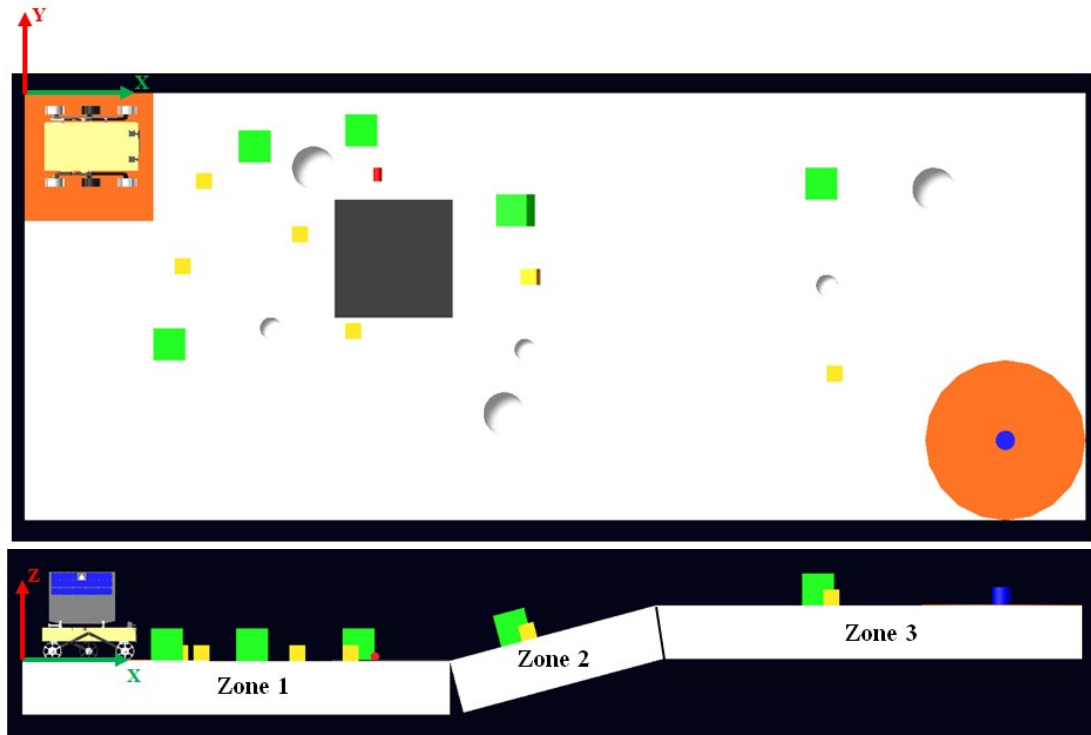


Figure 4: Coordinate System

2.4 Salient Features of Arena

The arena comprises of three zones as depicted below,

Table 1: Overall Arena

| Zone | Length | Width | Slope |
|------|----------|----------|------------|
| 1 | 4 meters | 4 meters | 0 degree |
| 2 | 2 meters | 4 meters | 15 degrees |
| 3 | 4 meters | 4 meters | 0 degree |

The entire terrain is covered with M-sand and obstacles (boulders and Craters) are distributed on the arena along with a sample tube and sample container. Following is the list of all objects on the arena,

1. Obstacles
 - a. Cubes
 - b. Craters

2. Sample Tube
3. Sample Container

The details are discussed in the next section.

3. Description of Objects

3.1 Type, Shape and Dimensions

Table 2: Dimensions of Obstacles and Sample

| Type | Description | Size | Colour Code |
|------|------------------|--|-------------|
| A1 | Obstacle-1 | Cube of side 150 mm | Yellow |
| A2 | Obstacle-2 | Cube of side 300 mm | Green |
| B1 | Obstacle-3 | Crater of diameter 200 mm | - |
| B2 | Obstacle-4 | Crater of diameter 400 mm | - |
| T | Sample Tube | Cylinder of diameter 80 mm and Length 125 mm Mass = 200±10 grams | Red |
| C | Sample Container | Cylinder of Inner diameter 150 mm and Length 150 mm | Blue |

3.2 Marking

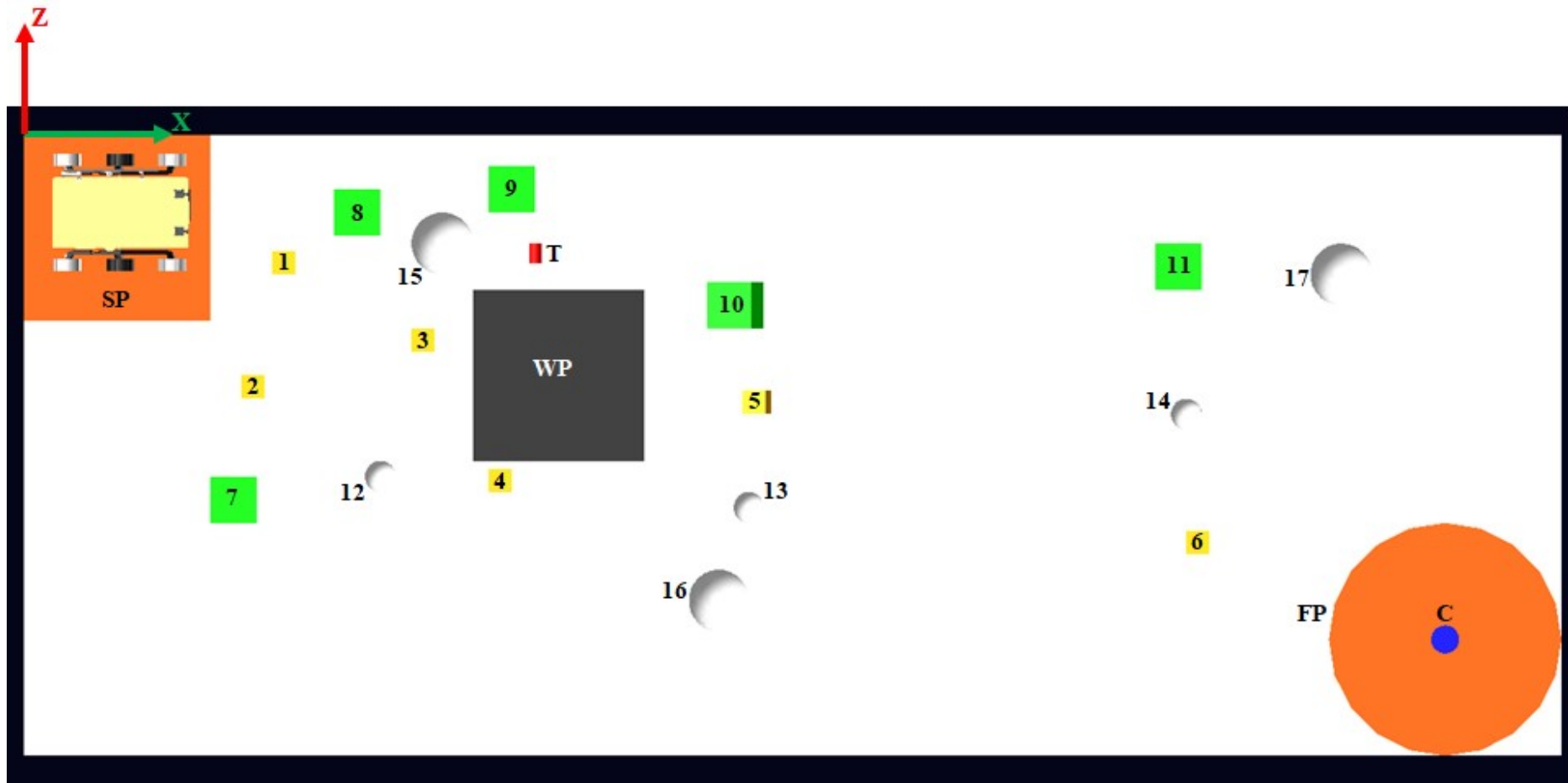


Figure 5: Obstacle Identification

3.3 Position Coordinates

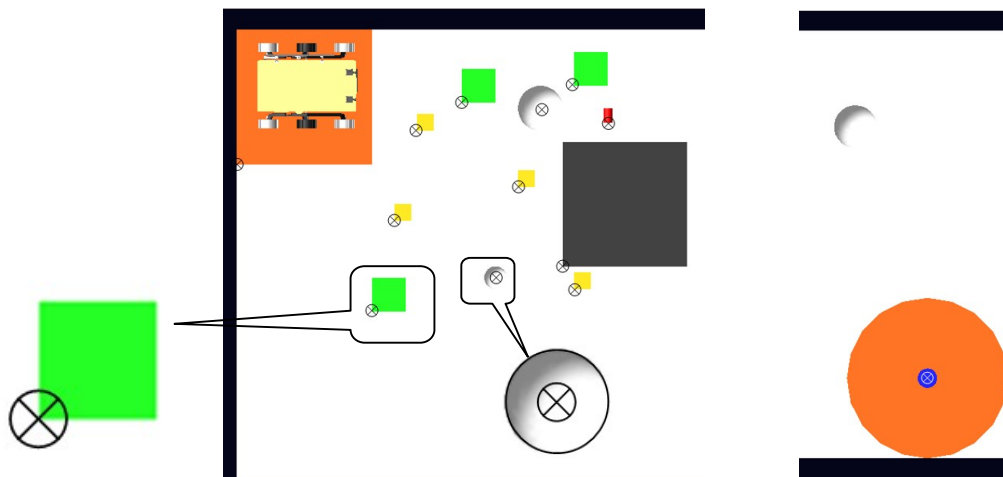


Figure 6: Reference points for coordinate - top view

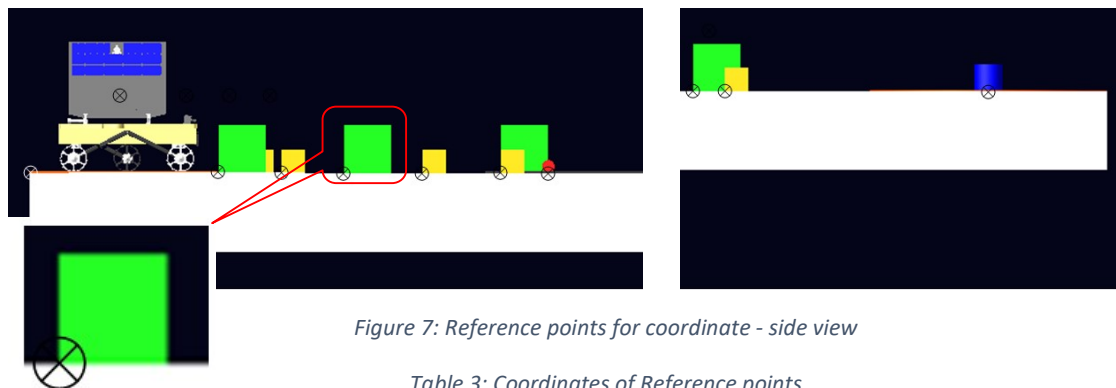


Figure 7: Reference points for coordinate - side view

Table 3: Coordinates of Reference points

| ID | Type | X,Y,Z (meters) |
|--------|-----------------------------------|----------------|
| 1 | A1 | 1.6, -0.9, 0.0 |
| 2 | A1 | 1.4, -1.7, 0.0 |
| 3 | A1 | 2.5, -1.4, 0.0 |
| 4 | A1 | 3.0, -2.3, 0.0 |
| 5 | A1 | 4.7, -1.8, 0.2 |
| 6 | A1 | 7.5, -2.7, 0.5 |
| 7 | A2 | 1.2, -2.5, 0.0 |
| 8 | A2 | 2.0, -0.6, 0.0 |
| 9 | A2 | 3.0, -0.5, 0.0 |
| 10 | A2 | 4.5, -1.2, 0.1 |
| 11 | A2 | 7.3, -1.0, 0.5 |
| 12 | B1 | 2.3, -2.2, 0.0 |
| 13 | B1 | 4.7, -2.4, 0.2 |
| 14 | B1 | 7.5, -1.8, 0.5 |
| 15 | B2 | 2.7, -0.7, 0.0 |
| 16 | B2 | 4.5, -3.0, 0.1 |
| 17 | B2 | 8.5, -0.9, 0.5 |
| SP | Start Position | 0,-1.2,0 |
| T | Sample Tube | 3.3,-0.825,0 |
| WP | Way Point | 2.9,-2.1,0 |
| C & FP | Sample Container & Final Position | 9.17,-3.25,0.5 |

4. Starting Position, Waypoints and Final Position

4.1 Starting Position

Rover will be positioned within the 'SP'. 'SP' is 1200mm x 1200mm square with coordinates mentioned in the Table 3.

4.2 Waypoint

Rover shall mandatorily traverse obstacles '2', '12' and '4' and navigate to waypoint 'WP' as indicated in Figure 5.

Waypoint is 1100mm x 1100mm square with coordinates mentioned in Table 3.

4.3 Sample Pick-Up Position

Sample Tube 'T' is located at the location mentioned in Table 3.

4.4 Sample Drop Position

Sample Tube 'T' has to be dropped in to Sample Container 'C'. Coordinates of the 'C' is mentioned in the Table 3.

4.5 Final Position

After dropping the sample the rover has to be positioned near to Final Position 'FP' circle of diameter 1500 mm. The coordinate of the 'FP' is mentioned in the Table 3.

The rover should not be within the 'FP' and it should near to 'FP'.

5. Task Details

5.1 Segment 1: Commanded Waypoint Navigation

Rover should move from starting position to waypoint 'WP' in a commanded manner and must navigate obstacles '2', '12' and '4'. The path planning can be done offline and rover can be commanded with exact path for this segment. Failure to traverse any obstacle mentioned earlier will attract penalty points.

Objectives of this segment include demonstration of rover capability to

1. navigate obstacles
2. follow commanded path

5.2 Segment 2: Autonomous Sample Pick Up

After arriving at the waypoint, rover must autonomously

1. Identify the sample
2. Approach the sample
3. Pick the sample

All these tasks must be accomplished autonomously without intervention of the team members (physical or otherwise). In case of contingency or failure of autonomous mode, commanded mode can be exercised and this will attract penalty points.

5.3 Segment 3: Autonomous Navigation

Picked-up sample must be transported to the sample drop position while navigating the obstacles autonomously. All obstacles (cubes and craters) must be identified by the onboard sensors and appropriately avoided by rover mobility system to plan optimal path.

Rover is allowed to traverse the 150mm cube (yellow obstacles) without any penalty on score, however any physical interaction with 300mm cube (green obstacles) will attract penalty points.

Similarly, rover is allowed to traverse the 200mm diameter craters without any penalty on score; however any physical interaction with 400mm diameter craters will attract penalty points.

5.4 Segment 4: Autonomous Sample Drop

Picked-up sample must be transported to the sample drop position while navigating the obstacles autonomously. Rover must identify the container and required orientation of sample tube for placement. The sample can be transferred autonomously into the container.

Switching to commanded mode during any part of this segment will attract penalty points.

5.5 Segment 5: Autonomous Final Positioning

After dropping the sample, rover must come out of 'FP' and positioned nearer to 'FP'

Switching to commanded mode during autonomous final positioning will attract penalty points.

6. General/Additional Rules

1. Rover must be stable while traversing obstacles. If rover falls/topples the team will be disqualified from the participating in further segments.
2. Physical interaction of any team member with the rover after rover starts movement is strictly prohibited.
3. Command may be issued to the rover to switch from commanded to autonomous mode or vice versa. No other commands are allowed.
4. The coordinates for the sample drop and final parking positions must not be hard-coded for path planning. Rover should identify the sample container and place the sample in the container in the appropriate orientation.
5. Use of joysticks and human-in-loop to control the rover is not permitted.
6. It may be noted that the rover operation is planned to be conducted during day time on well lit arena.