ROBOFEST 2026

Technical Specifications

Open Category – Autonomous Rover Competition

Organized by:
Faculty of Engineering
Sri Lanka Institute of Information Technology
Malabe, Sri Lanka

FACULTY OF ENGINEERING

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1. Introduction

1.1. EXPLORE. MAP. DOMINATE

The Autonomous Rover Challenge at ROBOFEST 2026 redefines ground robotics by pushing the boundaries of intelligent navigation in complex outdoor environments. In a rugged, dynamic arena, your rover must operate independently, traversing uneven terrain, detecting visual markers, constructing real-time maps, and avoiding unpredictable obstacles. Success is not merely about reaching the destination; it demands robust perception, precise localisation, adaptive path planning, and resilience against environmental uncertainty. This is where autonomy meets endurance, and only the most intelligent machines will prevail.

1.2. About the ROBOFEST Open Category Autonomous Rover Competition

ROBOFEST is an annual robotics competition organised by the Faculty of Engineering, Sri Lanka Institute of Information Technology (SLIIT), where participants demonstrate engineering excellence, creativity, and innovation through the design and deployment of robotic systems.

The **ROBOFEST 2026 Open Category** introduces the **Autonomous Rover Challenge**, a competition focused on real-world robotic autonomy. Teams are required to design, assemble, and program a fully autonomous ground rover that complies with the technical specifications outlined in this document. The challenge integrates perception, navigation, and mapping within an outdoor arena featuring diverse terrain and environmental variability. Performance will be evaluated by an independent panel of judges based on task completion, efficiency, and adherence to competition guidelines.

1.3. The Autonomous Rover Challenge

The objective of this competition is to design and develop an autonomous rover capable of performing intelligent exploration, localisation, and mapping within a structured outdoor environment.

Each rover must:

- Navigate autonomously from a designated start zone
- Detect and localise multiple checkpoints marked using AprilTag 36h11 markers
- Avoid obstacles while traversing uneven terrain
- Generate a live map (2D or 3D) of the environment
- Revisit checkpoints in descending order of marker IDs using the generated map
- Successfully return to the starting position to complete the mission

This challenge emphasises SLAM, perception-driven navigation, and robust autonomous decision-making under uncertain environmental conditions.

1.4. Important Dates

Deadline for registrations	:	**31st July 2026**
Preliminary rounds	:	**28th September 2026**
Final competition	:	**28th September 2026**

2. The Competition

2.1. Contest Eligibility

2.1.1. Team

- Each team can have up to 6 people.
- Since this is the open category, there is no limitation with regard to age or educational level.

2.1.2. Registration

- All entrants to the contest must register their teams before the application deadline on the **31st of July 2026**.
- Each team should register a unique name under which the members will be registered.
- If there are 2 or more teams with the same name, the name will be allocated on a first-come, first-served basis.
- Event organisers may reject a team name during registration if it is deemed inappropriate, and the team would be informed to submit a different name.

2.2. The Rover Challenge Task.

2.2.1. Mission Overview

- Each team must deploy their autonomous rover to complete a navigation and mapping task within the designated arena.
- The mission begins at the designated starting area and concludes when the rover returns to it.
- During the mission, the rover must autonomously navigate to a series of intermediate checkpoints (marked by AprilTag 36h11 markers) while detecting and avoiding obstacles.
- At each checkpoint, the robot must successfully localise itself at a set pose and distance from the marker and register the visit before proceeding to the next target.
- Throughout the run, the rover must generate a live map (2D or 3D) of the terrain and its surroundings.
- After all markers have been identified and the rover localised properly, the robot should revisit the checkpoints using the generated map in order from highest to lowest April Tag 36h11 ID before finishing at the starting area.

2.2.2. Arena Description

- The competition will be held outdoors. Lighting conditions will be natural, and consistency cannot be guaranteed; it is advised to be prepared for varying conditions.
- The arena will feature varying surfaces (e.g., asphalt, concrete, stone pavement, grass, sand)
- The terrain will be uneven, containing ramps, bumps, and inclined platforms that the rover must traverse. It is advised to design the rover with sufficient ground clearance and torque to handle inclines and surface irregularities.
- The arena will be an open space and the boundaries will be marked by April Tag markers with ID: 0.

2.2.3. Checkpoint Markers

- The competition will use April Tag markers from the 36h11 family.

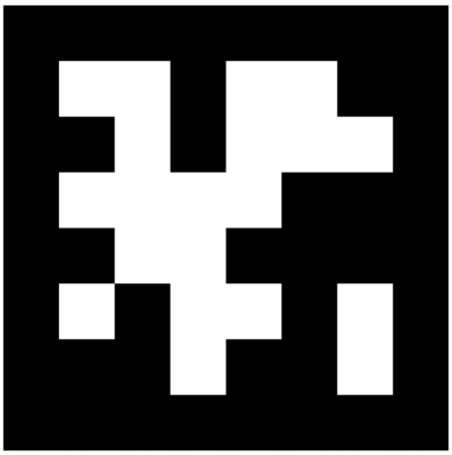

Figure 1: April Tag marker (ID - 1)

- Checkpoint markers will be numbered sequentially, starting from ID : 1, with a total number of markers being 7 (the total checkpoint number may vary).
- Each marker will be a square with a total size of 200mm, with a tag size of 160mm.
- Markers will be mounted vertically on obstacles, walls, or dedicated stands at varying heights and orientations.
- The height from the floor to the centre of the marker will range from 150mm to 500mm.
- Markers may be placed on uneven terrain or near obstacles, requiring the rover to navigate close enough for successful detection.
- The rover must detect the marker ID and autonomously log it as visited. The rover must stop momentarily in front of the marker to indicate detection before moving.
- Markers will be illuminated by the arena's ambient lighting. Teams should be prepared for potential glare or shadows depending on the rover's angle of approach.

2.2.4. Arena Boundaries

- The outer limits of the arena are defined by physical walls or marked by April Tag markers with ID: 0.
- Any attempt to cross the boundary or to forcefully impact the walls or obstacles will result in penalties or disqualification.
- Rovers must use their sensors to map these boundaries and obstacles and stay within the designated play area.

2.3. Specifications of the Rover.

2.3.1. Autonomous Navigation

- All rovers must operate fully autonomously once the run begins. Which includes:
    - Exploration with obstacle detection and avoidance.
    - SLAM and navigating to the pre-determined checkpoints marked by April Tag markers.
    - Avoid leaving the competition arena.
    - Autonomously revisit the checkpoints in the order of the markers' ID from highest to lowest before returning to the starting position.

- Judges may inspect the system to verify the declared autonomy level.
- Rovers may use teleoperation if the robot is stuck, with the judges' prior approval.

2.3.2. Localisation and Mapping

- The rover must generate a map of its surroundings while traversing the arena and localise itself within the predefined checkpoint areas marked by April Tag markers.
- A vision perception system is required for detecting April Tag markers.
- The rover must generate a map of the arena; a 3D map is preferred, as the terrain and elevations will vary.
- Rovers can use any combination of the following for localisation and mapping (but are not limited to)
    - RGB-D (RGB + depth) cameras or a stereo camera setup.
    - Encoders, magnetometer, IMU, GPS and sensor fusion for localisation.

2.3.3. Teleoperation

- All rovers must have teleoperation capabilities and abide by the following regulations,
    - Teleoperation must be used to set the robot to the starting position and to leave the arena after the run.
    - Manual teleoperation is prohibited during the autonomous navigation run.
    - The teleoperation interface should provide live information on the robot's power consumption, battery availability, live-generated map and other data.
    - Teleoperation can be used with permission during a run from an official if the robot is stuck, with a penalty on the final score.
- Only a single computer can be used for robot teleoperation.

2.3.4. Processing and Computation

- Some of the processing and computations can be offloaded to an external computer, which has the live visualisation of the robot running.
- The robot must use only wireless communication, and Wi-Fi is recommended.
- It is advised not to rely solely on the external computer for crucial computations, as communication failures can cause the robot to malfunction.
- Pre-existing ROS and ROS2 packages may be used, but they must be compiled into a single launchable system.

2.3.5. Size and Weight constraints

- The rover must fit inside a cuboid of size,
    - Length – 700mm
    - Width – 500mm
    - Height – 600mm
- The rover should not weigh over 20kg.

2.3.6. Onboard Sensors

- Permitted sensors include (but are not limited to):
    - 2D/3D LiDAR or RGB+D sensors.
    - Monocular or stereo camera.
    - Inertial Measurement Units.
    - IR, ToF, and ultrasonic sensors.

- Magnetic or Optical wheel encoders.
- GPS modules

2.3.7. Power System and Electrical Safety

- Power must be supplied by electric batteries only (LiPO, Li-Ion, etc.).
- The voltage between any two points in the electrical circuit must not exceed 24V.
- All wiring must be properly insulated and securely fastened to the chassis to prevent wear, short circuits, or entanglement with moving parts. Loose wiring that poses a risk will result in a failed inspection.
- Teams must demonstrate safe battery handling practices. Batteries must be securely mounted to the rover to prevent shifting or ejection during movement.
- Charging is allowed only in designated areas outside the competition arena. Teams must bring their own charging equipment.
- The rover must be equipped with a master power switch that isolates the battery from the rest of the system, enabling safe powering down without manually disconnecting connectors.

2.3.8. Safety and Fail-Safe

- The teleoperation system must include a dedicated, immediate "Kill Switch" or E-Stop function that cuts power to the motors and stops all autonomous functions instantly.
- The rover must be equipped with a prominent, easily accessible physical E-Stop button (typically a red mushroom button) on the exterior of the chassis. Pressing this must immediately cut power to the drive motors.
- The mechanical systems of the rovers should follow these regulations,
    - All drive chains, gears, and high-speed moving parts must be enclosed or guarded to prevent injury to personnel or damage to the arena.
    - The rover must not have any sharp, protruding, or hazardous elements that could damage personnel or the arena.
- In the case of unsafe operations (i.e., the rover exhibits uncontrolled behaviour), referees reserve the right to halt a run or disqualify a team.
- A functionality check of both the physical and wireless E-Stop systems will be conducted during the initial inspection. Rovers failing this test will not be allowed to compete.

2.4. Specification of the Arena.

2.4.1. Arena Layout and Dimensions

Figure 2: Top view of the rover arena (Red arrows denote the exploration run and the green arrows denote the return)

- The arena comprises an asphalt road and concrete brick pavement.
- The arena area will be approximately 413 m^2 and will have the layout shown in Figure 2 above with the orange lines.
- The terrain will have varying elevation changes and a maximum slope at certain locations of approx. 20°.
- The terrain may feature bumps, asphalt, brick pavement, gravel, grass and concrete floor.
- The borders of the area will be marked using April Tags with ID: 0, walls, white tape, wire fences and pavement curbs.

2.4.2. Start Zone and Checkpoints

- The starting zone is near the top right corner of the map (refer Figure 2) and will have a designated rectangular area marked by white lines.
- The robot should start the run within this zone and end it by returning to the start zone.
- The exact location of the checkpoint is to be marked by the rover during the initial exploration phase. The checkpoint is to be noted within a zone defined by a 1.5m-radius semi-circle centred on the base of the marker, in the direction the marker faces, as shown in Figure 3 below.
- The locations of the checkpoints may vary between runs to prevent prior memorisation.

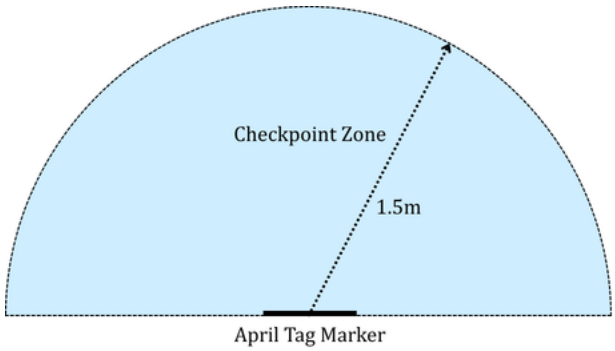

Figure 3: Checkpoint zone

2.4.3. Obstacles

- Obstacles will be randomly arranged on the day of the competition and may vary between runs to prevent prior mapping or memorisation.
- The obstacle field will include a combination of:
    - Cardboard structures (boxes, walls, partitions).
    - Styrofoam boards (lightweight barriers, panels).
    - Existing arena elements such as walls, fences, and fixed structures.
    - Natural terrain features such as grass patches, sand/gravel patches, and uneven ground.
- Obstacle sizes will vary and may range from 300mm to 1000mm.
- Checkpoint markers will be placed on obstacles as well.
- The layout will ensure that at least one valid path exists connecting all checkpoints and though obstacles.

2.4.4. Visual and Environmental Conditions

- Lighting conditions may vary throughout the day; no assumptions should be made about illumination.
- The environment may contain strong shadows cast by objects, high contrast regions and glare.
- Vision systems must be robust to overexposure and underexposure with sudden brightness changes.

2.4.5. Safety Protocol

- The arena will be cleared of people during each rover's run attempt.
- Referees may halt a run at any time if the rover exhibits unsafe or uncontrolled behaviour.
- Rovers without a demonstrated fail-safe mechanism will not be allowed into the rover arena.

2.5. Rules of the Elimination Rounds

2.5.1. Initial Inspection

- Each rover must undergo an inspection by the judging panel before being allowed to participate in the elimination round.
- The inspection will verify,
    - Compliance with size, weight limit and other rules

    - Functionality of the failsafe mechanisms
    - Declaration of any manual teleoperation and communication with the external computer.
    - Visual inspection of onboard sensors.
- Rovers that fail the inspection will not be allowed to compete until the issue is rectified.

2.5.2. Rover Calibration and Software Changes

- Calibrations of the rovers can be done inside the arena before the final arena configuration is completed.
- The time given for calibration will be decided by the judges during the competition.
- Software changes can also be made before the arena configuration is completed, but this needs to be done with the approval of judges.

2.5.3. Run Attempt Format

- Each team will be allocated a defined run duration, during which they may perform up to 3 official attempts.
- Only one rover may do an arena run at a time.
- Between attempts, teams are allowed to perform minor repairs, battery replacements, sensor recalibrations, and software adjustments, subject to prior approval from the judges.

2.5.4. Time Allocation

- Each team will be given a maximum of 1 hour (T_{max})for all attempts combined.
    - While 1 hour is the stated time, the exact time will be announced at the start of the competition.
    - Depending on the number of participating teams, judges may decide to shorten this time as well.
- Time will be measured from the moment the wheels of the rover completely leave the starting zone to the time the rover's wheels are completely within the starting zone at the end of the run.
- The best valid attempt within this time will be used for qualification.

2.5.5. Completion Criteria

- The run is considered complete when the rover,
    - The rover starts the run from the starting zone
    - Successfully explore the arena, avoiding obstacles and localise at the checkpoints marked by April Tag markers (ID > 0) within the specified zone.
    - After all the markers are found, complete the return run by returning to each and every checkpoint in the descending order of April Tag markers.
    - Finish the run by fully returning to the starting zone.
    - Avoid moving out of the arena boundaries.
- Skipped checkpoints, collisions with obstacles and leaving the boundaries will result in penalties.
- Major collisions will result in the invalidation of the run.

2.5.6. Disqualification of Teams

- The team will be disqualified if,
    - Manual teleoperation occurs during the autonomous run without prior approval from the judges.
    - The rover fails to operate autonomously as declared.
    - The rover continuously leaves the arena boundaries (this will be at the discretion of the judging panel).
    - The rover shows erratic behaviour.
    - The rover continuously collides with the obstacles (this will be at the discretion of the judging panel).

2.5.7. Penalties

- Time-adjusted penalties carry different weights under the following conditions,
    - Missed checkpoints (exploration phase): each penalty carries 0.1 weight (W_E).
    - Obstacle contact: each penalty carries 0.05 weight (W_O).
    - Missed checkpoints (return phase): each penalty carries 0.1 weight (W_R).
    - Localising outside the checkpoint zone: each penalty carries 0.025 (W_L).
    - Using teleoperation during the autonomous run: each penalty carries 0.1 x Time (W_T).
    - Manually moving a stuck rover: each penalty carries 0.25 (W_M).
    - Leaving the arena boundaries: each penalty carries 0.25 (W_B).
- These penalties are added to the raw time for ranking purposes.

2.5.8. Ranking and Qualification

- Teams will be ranked based on task completion, navigation time (T_{nav}), and received penalties.
    - Navigation time is the time it takes to start from the start zone and return to it.
    - Navigation time is calculated even if checkpoints are missed.
- Teams that complete the task (i.e., run) will be ranked based on navigation time, with shorter times resulting in higher rankings.
- Teams that don't complete the task will be given a score, and regardless of their navigation/completion time, they will be ranked below the teams that complete the task.
- The top five (5) teams from the elimination round will advance to the final round, as determined by the number of available finalist slots.

2.5.9. Score Calculation

$$Score = \frac{n_E}{N} + \frac{n_R}{N} + \frac{1}{T_{nav}\,(1 + \sum W_i\, P_i)}$$

$$W_i \in \{W_E, W_O, W_R, W_L, W_T, W_M, W_B\}$$

- In this equation, n_E refers to the number of checkpoints that the rover has successfully explored, detected, and correctly localised at, meeting the required pose and distance criteria defined for a valid checkpoint visit.

- n_R refers to the number of checkpoints that the rover has successfully returned in the correct order.
    - If there are seven checkpoints, the correct return order is April Tag Markers 7654321, and if a participating team returns in the order 7564231, then n_E will be 3 since only 7, 4 and 1 are correctly visited checkpoints.
- N refers to the number of all checkpoints in the rover arena.
- In the score equation, wi refers to the i-type weight category, and the pi refers to the number of penalties incurred for the i-type weight category.
- If navigation is not complete (i.e., the rover doesn't return to the start position), then T_{max} is used as the T_{nav}.
- This score is also called the penalty-adjusted score.

Any violation or incident not addressed in the technical specifications will be decided at the judge's discretion. Therefore, the judges' decision will be final in such scenarios.

2.6. Rules for the Final Round

2.6.1. Pre Final Verification

- All rovers qualifying for the final round will be subjected to a second inspection to ensure:
    - No unauthorised modifications were made after the elimination rounds.
    - Safety mechanisms and declared autonomy level remain unchanged.
    - Battery and structural integrity are intact.
- Rovers must be placed in the isolation zone post-inspection until their run slot.

2.6.2. Competition Format

- The final round will follow the same task as in the elimination round,
    - Start the run from the starting zone.
    - Successfully explore the arena, avoiding obstacles and localise at the checkpoints marked by April Tag markers (ID > 0) within the specified zone.
    - After all the markers are found, complete the return run by returning to each and every checkpoint in the descending order of April Tag markers.
    - Finish the run by fully returning to the starting zone.
    - Avoid moving out of the arena boundaries.
- There may be more or fewer checkpoints than in the elimination round.
- The complexity of checkpoint and obstacle placement may be higher.
- Each team will be given only one (1) official attempt in the final round.

2.6.3. Time Limits

- Each team will be given a maximum of 45 minutes (T_{max}) to complete their attempt.
- Timing begins upon leaving the starting zone and ends when the rover returns to the starting zone, and all wheels are inside the zone.
- Judges will keep official time and calculate the ranking.

2.6.4. Penalty System

- The same penalties apply as in the elimination round.
- If no team completes the task, final rankings will be based entirely on the score value.

- Higher team wins, and the same score equation will be used as in the elimination round.

2.6.5. Disqualification Infractions

- The run will be invalidated if,
  - Manual teleoperation occurs during the autonomous run without prior approval from the judges.
  - The rover fails to operate autonomously as declared.
  - The rover continuously leaves the arena boundaries (this will be at the discretion of the judging panel).
  - The rover shows erratic behaviour.
  - The rover continuously collides with the obstacles (this will be at the discretion of the judging panel).

2.6.6. Tie-Breaking Rules

- If the same ranking or score is given to more than one team, the judges will decide the ranking.

2.6.7. Awards and Final Results

- The award will be given to the team that completes the task (refer 2.5.5.) and ranks highest based on final rankings.

Any violation or incident not addressed in the technical specifications will be decided at the judge's discretion. Therefore, the judges' decision will be final in such scenarios.

Note: Registered teams are encouraged to check this specification document periodically, as it may be subject to minor revisions.

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3. Additional Information

Any amendments to the rules will be posted on the ROBOFEST website at www.robofest.lk. Please do not hesitate to contact us if further information or clarification is required. You may contact the ROBOFEST organisers through email at robofest@sliit.lk or contact the Open Category Coordinator.

Open Category Coordinator
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Registration link: https://forms.cloud.microsoft/r/QLcqb9N0VU

4. Appendix

Video Link: [Robofest Rover Track]

Figure 4: Top view 1 of the arena

Figure 5: Top view 2 of the arena

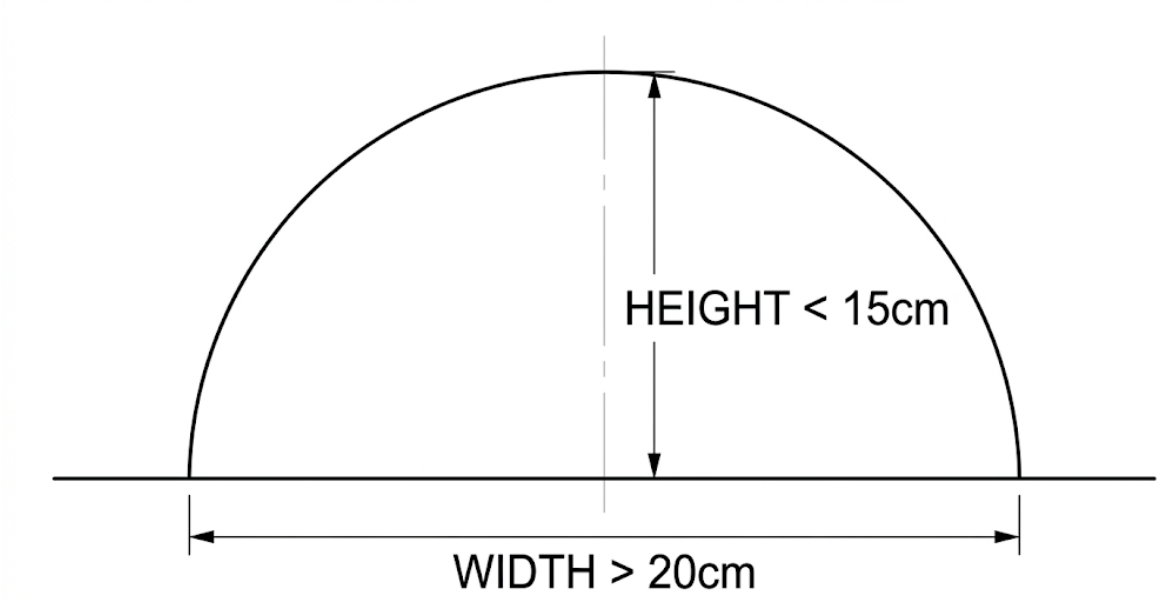

Figure 6: Side profile of track bumps (the geometry may vary)