Space Engineering Challenge by UPT

Annex 2: Technical Specification brief
2025/v1.0

Land Rover Edition — Subsurface Exploration Mission (2025)

The Space Engineering Challenge by UPT is an educational robotics competition inviting students to develop robotic systems inspired by real space exploration missions.
The 2025 edition focuses on subsurface exploration: land rovers navigating and mapping underground or cave-like environments.
Participants will design, build, and program robotic systems capable of traversing complex, uneven terrain, collecting data, and performing other mission objectives

1. Mission Scenario

1.1. Mission Environment:

- Real or simulated **underground / cave-like setting**
- Low, artificial, ambient light
- No fog or haze;
- Uneven, rocky or granular terrain: gravel-like (largest rocks you have to traverse having less than 10cm in height)
- Possible narrow passages and varying ceiling heights: minimum width and height being at most 20% higher than the maximum dimensions of the rover
- Artificial obstacles and exploration targets: mandatory and optional, presented during the Day 1 briefing;
- No running or pooling water, except typical cave moisture;
- Chilli environment: around 10C and high humidity (data to be updated)

1.2 Mission Elements:

1. **Navigation** — traverse designated mission area on a given path while navigating the obstacles; Remote controlled, with no direct (line of sight) visual contact.

   a. **Passing checkpoints identified by QR codes -** you will get a unique value and you will have to make a HTTP request passing the value, the air temperature and the ambient pressure; we will take care of the required network infrastructure over IEEE 802.11;
2. **Object sampling** — picking a specified object and carrying it to a designated spot. The object will have a maximum mass of 100g (±5%)
3. **Data Transmission / Reporting** — real time/live telemetry, logging and upload mission results to the jury
   a. You will have to measure and transmit real-time data regarding the ambient temperature and relative humidity

2. General Requirements

2.1 Rover Design

- Ground-based robotic platform ("rover")
  - arm(s) and gripper(s) are allowed if needed;
  - No separation of parts during mission is allowed
- Remote controlled operation (see Software section)
- **Size limit:** max 30 cm x 30 cm x 30 cm (including sensors and appendages)
- **Weight target:** 4 kg (±5%) (fully equipped)

2.2 Power Supply

- Battery powered only (no tethered power or external supply)
- Sufficient for minimum **15 minutes continuous operation** per mission run

2.3 Mobility

- Suitable for **rough, uneven, and slippery terrain**
- Ability to handle (overpass) obstacles up to 10 cm in height
- Capable of turning in place or within narrow passages (min turning radius ≤ 50 cm)

3. Functional Requirements

3.1 Navigation

- Remote controlled, with no direct visual contact
- Ability to resume operation after temporary loss of localization/communication
- Operate without reliance on GPS (or similar) or local external positioning
- Local communication will be provided as IEEE802.11 network
  - Internet access is not guaranteed

3.2 Object Detection and Interaction

- Identify predefined objects (e.g. color-coded, fiducial marker, QR code, RFID tag)
- Physical interaction (picking on board)

3.3 Communication

- Wireless data transmission (Wi-Fi 802.11), provided by organisers; personal networks and/or protocols/standards are not accepted;
- Live telemetry: ambient temperature, air pressure + extra data considered relevant for the organizers;
- Data hand-off required after mission run

4. Performance Metrics

Below is the general outline. Details and scoring sheet are going to be presented in the technical briefing of Day 1.

- **Time to complete mission** (shorter = better): quantitative measurement;
  - Time to reach each checkpoint also take into account
- **Object picking and handling**: qualitative and quantitative.
  - Ignoring/missing/failing the picking adds time → you rank lower
- **Robustness** (ability to handle unexpected environment features)
  - Loosing parts of the robot means forfeiting the run

5. Hardware Constraints

- **Maximum hardware budget:** €1,000 (excluding spare parts and any equipment part of the “ground station”)
- Participants must be able to provide a **Bill of Materials** (BoM) for review
- Rovers must be able to connect to a 801.11 WiFi network in the 2.4GHz band
  - SSID and connection data to be provided at least a week before on-site activities
- Rover must feature an accessible **emergency stop** (manual on the rover)

6. Software Requirements

- Any platform, language, or architecture is allowed
- No external computation allowed during mission run (onboard compute only)
- Manual intervention during run penalized or forbidden depending on task: final decision belongs to the jury.
- **Mandatory logging**:
  - Mission start and stop time
  - Robot status telemetry
  - Ambient Temperature and relative humidity

7. Safety Requirements

- No sharp, hot, or dangerous exposed components
- Safe battery system (protected Li-ion or equivalent)
- No pressurised gases, chemicals, liquids, or volatile substances onboard
- No permanent damage to test environment allowed
- Robots will undergo **Go/No-Go safety inspection** prior to participation: Day 1 of the event.
