I-RIM Challenges

Robotics competitions provide a valuable platform for evaluating the accomplishments of worldwide teams in shared challenge scenarios. They foster discussions, facilitate knowledge exchange, and enhance research.
In the upcoming I-RIM 2024, participants can engage in 2 thrilling robotics Challenges.

Opening: 1st July 2024

Closing: 2nd August 2024

Challenges	
1. Robotic Dog Race	**2. Robotics in Agriculture**

Industrial sponsors & Call for Participants

EagleProjects

Pal Robotics

Enrolment

Enrolments will be accepted until a maximum number of teams (max. 5) for each challenge will be reached. Each team can be composed of a maximum of 6 people. **All interested teams can register for the competition by sending an email to irim2024.challenges@gmail.com**. General requests shall be addressed to **Prof. Michele Focchi (michele.focchi@unitn.it), Dr Clemente Lauretti (c.lauretti@unicampus.it) and Dr Andrea Pupa (andrea.pupa@unimore.it).**

Prizes

The winning team of each competition will receive a prize of **XX Euros**.

Organizers and Points of Contacts

Prof. Michele Focchi
michele.focchi@unitn.it

Dr. Clemente Lauretti
c.lauretti@unicampus.it

Dr. Andrea Pupa
andrea.pupa@unimore.it

1 Robotic Dog Race

The Robotic Dog Race Challenge (RDRC) is a competition supported by the company ***EagleProjects***. Following the ICRA 2023 Challenge, the RDRC will propose traversing a challenging environment composed of obstacles of different difficulties that require heterogeneous locomotion capabilities. The tasks are designed to challenge and stimulate some core skills required by robotics engineers. Participants will have to use solid problem-solving skills, concentration, strategic planning, mental flexibility, and creativity to complete the task.

Description

The Dog challenge is about *Locomotion*: the robot should race from point A to point B in the shortest time overcoming different obstacles (ramps, debris), possibly minimizing the collisions of the body with the environment; the robot can be teleoperated.

Teams will be provided with an open-source map of the environment. For the preparation of the race, the simulation environment, for the training or design of the locomotion framework, we provide a **Git repository** based on **Gazebo (3D robotic simulator)**. In order to create and test features and behaviors the teams will have to implement their own controller and test it before the competition inside the Gazebo simulator. There it will be possible to reproduce the behavior of the installed sensors (e.g. Lidar, RGB camera, Depth camera) using C++ or Python. The developed code will be then uploaded on the robotic hardware of the team or on a **Go1 EDU** quadruped provided by EagleProjects (if needed).

Rules of the game

The aim of this challenge is to test the robot's ability to navigate various obstacles from a point A to point B along a designated path in the shortest time possible.

- The arena is enclosed by walls, preventing the robot from exiting.
- Participants are provided with a 3D map of the arena when they enroll in the challenge.
- There is a predefined path to follow that involves overcoming obstacles of different levels of difficulty.
- Some obstacles like stepping stones, debris, and pieces of furniture, are strategically distributed to challenge the robot's ability to navigate.

- Other obstacles include stairs, ramps with different slopes, tunnels, slippery terrain, and soft terrain (such as foam). Some obstacles require specific abilities, such as crawling under a low bar or jumping over a high step.
- A score is associated to each obstacle (see obstacle scores)
- The judging committee will evaluate the percentage of completion of each task (0% up to full score)
- The scores of the overcome obstacles will be accumulated; if an obstacle is skipped the team receive 0 score.

- If the robot falls there is no penalty if it is able to self-right itself. If the robot is not able to self-right itself, it needs to restart from the beginning of the obstacle.
- Everytime the robot touches the walls, a penalty of 1 point is given (can be changed).
- The judging committee reserves the right to stop any team's attempt if considered dangerous or not following the guidelines.

Note: In this challenge the robot is meant to be tele-operated. However, if the robot successfully completes the challenge in a fully autonomous manner, a X2 score multiplication factor will be applied. The score for each obstacle is determined based on its objective difficulty. The time to accomplish the task will also be an evaluation factor.

Software/Code Availability

We provide a locomotion framework (Wolf) for the simulation of the challenge.
For the locomotion track, the teams are expected to develop their own framework.
The code is available at the following link (github code)

Q&A sessions

Every two weeks, the challenge organizers will gather for a question-and-answer session to further refine baseline codes (if needed) and assess queries from the participants.
Requests related to this specific challenge shall be addressed to

· **Prof. Michele Focchi (michele.focchi@unitn.it)**
· **Dr. Andrea Pupa (andrea.pupa@unimore.it)**

2 Robotics in Agriculture

The Tomato Harvesting Challenge (THC) is a competition supported by [Pal Robotics SL](), which will provide the [Tiago robot]() equipped with a 7-DoF robotic arm and parallel gripper. The competition has the ambition to advance the field of agricultural robotics by encouraging the development of innovative solutions for fruit harvesting. Achieving accurate selective harvesting requires overcoming many challenges including the ability to i) detect fruits to be harvested ii) assess their ripeness stage, and iii) plan the robot motion while managing the variability of the agricultural environment. Tomatoes are among the most consumed fruits worldwide and are generally harvested at various ripeness stages to satisfy different consumption requirements. This poses unique challenges in accurately identifying their optimal harvesting time for growers. The competition has great potential to push the boundaries of what is possible in the field of agricultural automation and drive innovation in precision agriculture, benefiting growers and consumers.

Description

The objective of the competition is to program the Tiago robot to harvest ripe tomatoes automatically. Teams will be expected to i) acquire images from the Tiago RGB-D camera, ii) detect ripe tomatoes, iii) reach them through the 7 DoF robotic arm, iv) grasp and detach them from the plant without causing damage and v) place them into a basket.

Participants will have access to a Gazebo simulation environment and a dedicated Robot Operating System (ROS version 1) workspace for training and testing their solutions. The developed code will be then deployed on the Tiago robot provided by PAL Robotics during the conference.

The baseline code for the challenge will be available through a GitHub repository. Instructions for ROS installation can be found on the official website. The simulation environment has been developed internally by the Campus Bio-Medico University of Rome and the University of Modena and Reggio Emilia using the Gazebo simulation engine.

Rules of the game

The arena will consist of a realistic environment with plants and attached mock-up tomatoes. Tomatoes will have predefined positions (which will be set before the competition and will be the same for each group) and different ripeness stages (e.g. green, light red (orange), and red ripe). The Tiago base will remain in a fixed position during the competition in front of the tomato plants.

By leveraging the capabilities of the Tiago robot participants are tasked with designing and implementing systems that can accurately and efficiently perform the following tasks:

Detecting Fruits: Participants are expected to develop robust algorithms to detect tomatoes dealing with occlusions and the natural variability in the appearance of the plants and fruits. The Tiago camera could be moved to facilitate tomato detection.

Assessing Ripeness: Participants need to develop methods to evaluate the ripeness of tomatoes accurately based on color information. This requires distinguishing between different stages of ripeness to ensure that tomatoes are harvested at their optimal stage (e.g. red ripe).

Planning Robot Motion: This involves developing advanced path planning and manipulation strategies that allow the robotic arm to i) safely reach the detected tomatoes, ii) grasp and detach them from the plant and iii) place them into a basket. Teams are expected to fine-control the arm movement while managing collisions with the environment (i.e. plants and basket) and adapt the parallel gripper exerted force on the tomato in order not to damage plants and fruits.

Scoring and Penalties

- Each team will have 2 attempts (subject to change), with each attempt lasting a maximum of 10 minutes (subject to change). All attempts must begin from a starting position and stop after the time limit. The team final score will be determined by the best attempt.
- In case of technical issues, manual system restarts are permitted. The timer will remain unchanged; however, the arm must be returned to a safe home position with the gripper open before proceeding. Any tomatoes that have not been placed will be discarded.
- The score will be computed based on the number of tomatoes harvested within the specified time frame. Tomatoes that are harder to reach or detect will provide higher scores. The score for each tomato harvested, which will be assigned based on its position and the difficulty of detection, will be defined before the competition.
- Penalties will apply i) if an unripe tomato is picked (i.e. green, light red), ii) if a tomato is damaged or dropped, or iii) if the arm collides with the plants and basket. In these cases, the the session may be stopped. Penalty points to be assigned will be defined before the competition.
- The final score achieved by the teams is calculated by subtracting the penalty points from the total number of ripe tomatoes collected into the basket. This score could also reach negative values.
- In the event of a tie, the team with the most reliable performance will be determined by the score achieved in the second attempt.

The competition rules may be subject to changes or integrations. Please refer to the GitHub repository for updates at the following link.

Software/Code Availability

The simulation environment, where each team can train and test the developed solutions, and the Tiago baseline code will be available after challenge registration at the following link. Setup instructions will be provided with the simulation package. Please check the readme page on the repository for the provided ROS packages description. For the implementation of i) fruit detection module, ii) ripeness assessment algorithms and iii) robot motion planning, the teams are expected to develop their own framework.

Q&A sessions

Every two weeks, the challenge organizers will hold a question-and-answer session to further refine baseline codes (if necessary) and address participant queries.

Requests shall be addressed to**:**

- **Dr. Clemente Lauretti (c.lauretti@unicampus.it)**
- **Dr. Andrea Pupa (andrea.pupa@unimore.it)**