WARA Robotics Mobile Manipulation Challenge

The primary objective of the WARA Robotics challenge is to invigorate research activities in robotics among partner sites at WASP universities. Focused on the intricate domain of mobile manipulation, the challenge poses a compelling task that necessitates innovative solutions. By formulating a specific challenge, we aim to inspire research teams to devise ingenious and novel approaches to address the complexities associated with mobile manipulation. The challenge encompasses diverse sub-tasks, including mobility aspects such as navigation, mapping, and localization, alongside manipulation challenges like grasping and contact-rich insertion of pieces. Furthermore, it extends to perception aspects, involving object detection and pose estimation, as well as full-body control. Through this comprehensive approach, the WARA Robotics challenge aims to foster advancements in the fields of mobility, manipulation, and perception within the WASP research ecosystem.

Overall domain description

The envisioned scenario for the WARA Robotics challenge is grounded in the realm of lab automation, motivated by the challenges prevalent in scientific research, particularly within various biomedical domains. Despite advancements in research methodologies, many bio-medical tasks continue to rely heavily on manual labor. The challenge addresses a specific but essential sub-task persistently performed by lab assistants worldwide: washing glassware. While crucial for ensuring an adequate supply of clean equipment, this task does not demand specialized knowledge, yet consumes valuable time of highly-qualified research personnel.

Thus, the challenge we pose to the WASP community involves the development of a mobile manipulation system capable of partially automating this process. The system must autonomously navigate safely in a human-populated lab environment, localize carts loaded with glassware that needs washing, transport these carts to a designated dishwasher room, and manipulate the glassware for loading into an industrial dishwasher. Successful solutions to this challenge hold the potential to significantly alleviate the labor-intensive nature of lab work, allowing researchers to allocate their expertise to more complex scientific endeavors.

Challenge Tasks

The WARA Robotics challenge is composed of the following sub-tasks:

1. *Carting glassware that needs washing.*
   The first sub-task (see Figure below) concerns a mobile robot navigation and manipulation setup. In this task, the robot is to navigate an environment to a pre-set goal location where a cart full of glassware has been positioned. The robot is to then move the cart and navigate again to a second marked location in a room where a dishwasher is set up. It is assumed that there will be no closed doors that the robot needs to manipulate along the way. For this task, the robot has only onboard sensors available which can include for instance lidars and cameras. WARA Robotics will provide a 2D occupancy map of the environment as prior and allow teams to run a (teleoperated) mapping session prior to addressing the challenge, if desired. The task is considered successfully completed if the robot is able to move the cart from

the start to the goal location. It is also expected that the path the cart needs to take will include at least one left and at least one right turn.

2. *Manipulating glassware and dishwasher.*
   The second sub-task (see Figure below) assumes the robot is already at the dishwasher location and is presented with a table-top scenario. A box full of plastic beakers or similar plastic bottles is provided at one end of the table, and a rack to mockup an industrial dishwasher is set-up at the other end. Both of these are placed roughly within predefined workspace zones. The task of the robot is then to select items from the box, pick them up, and insert them onto the pins sticking out from the dishwasher rack. Different levels of difficulty are envisioned in this task, ranging from very easy (small workspace feasible for a fixed-base robot, homogeneous non-transparent items tagged with QR codes) to very hard (large workspace that requires a mobile base, heterogeneous transparent plastic objects).

Figure: A cart (top left) is used to transport glassware that needs washing (top right) to a dishwashing area. The glassware is to be loaded onto a dishwashing rack (bottom left) and into an industrial dishwasher (bottom right).

Challenge Timeline

WARA Robotics aims at running the challenge final on-site in Västerås in November 2025. Here is the envisioned timeline (this is temporary and can be adjusted to the teams requirements):

May 2nd:	This document outlining the challenge is published
June 2nd:	Deadline for expression of interest (see below)
June 13th:	Digital twin of the system sent to qualified teams
August 8th:	Sample challenge kits sent to qualified teams
August 29th:	Deadline for simulation code submission (see below)
September 19th:	Deadline for simulation solution presentation (see below)
November 27th:	Challenge Day

Conditions

1. *Robotic Platform*

All teams will use an ABB Mobile YuMi Research Platform. It comprises an ABB Dual-Arm YuMi robot mounted on a telescopic pillar fixed on a custom-made omnidirectional base. The robotic base uses four independently steerable and drivable wheels to achieve almost-instantaneous arbitrary change in planar velocity, i.e. directional and rotational. The mobile base is equipped with two 2D lidar sensors (front and back) for mapping and localization. The manipulator is a dual-arm ABB YuMi robot. Each arm has 7-DoF with a payload of 500g. An Azure Kinect RGB-D camera, mounted atop the robot, provides visual and depth information required for perception tasks.

2. *Simulation Environment*

A digital twin of the Mobile YuMi and the lab automation items will be provided in AGX Dynamics from Algoryx. The digital twin presents similar ROS2 interfaces to control the robot to those available in the physical system.

3. *Code Repositories*

The teams have the possibility to share the code of their working solution for additional points. A repository will be created in the WARA Robotics organization where the teams can push their solution in dedicated branches.

4. *Evaluation Metrics*

A working solution of the challenge should feature cart maneuverability, robust bin picking, and correct plasticware insertion. Moreover, it is expected that the teams will have a working solution in simulation before transferring the results to the real platform. The following points will be assigned to evaluate the approaches:

- 5 points for cart identification and correct grasping
- 5 points for cart steering (at least one right and one left turn)
- 5 points for identification and grasping of the plasticware in the bin
- 5 points for correct item placement in the rack (2 for beaker, 3 for bottle).

Additional points will be assigned for:

- best solution in simulation: 5 points
- code sharing: 1 point for using someone else's code, 2 points for the team whose code is used

Finally, the evaluation will also consider:

- generalizability to variation in item placement (cart, bin, rack)
- fault tolerance in real-time to failures in detection, grasping, and placing
- general robustness of the solution
- seamless transition from subtask 1 to subtask 2
- execution time

5. *Challenge Day and Results*

During the challenge day, the teams will prepare a presentation to explain their approach and then show the resulting demo. A jury composed by members of AstraZeneca, Algoryx, and ABB will evaluate the teams' performances and name a winner. The WASP Program Office will attend the challenge and collect multimedia material for advertisement (see this video from the 2024 challenge). Finally, it is expected that the participating teams will contribute to collect and formalize their approaches and results in a scientific paper.

Expression of Interest

In order to facilitate organization and set up the number of kits we need to prepare, we ask that teams register for the challenge by June 2nd. To register, send via e-mail to matteo.iovino@se.abb.com a 1 page pdf with the following information: main contact person of the team and expected team composition.

Prize

The prize is a 50.000 SEK contribution for the winning team to the participation of the 2026 Hannover Messe, a major international trade show, primarily focused on industrial technology and the manufacturing industry.

Contact

Matteo Iovino: matteo.iovino@se.abb.com