ICRA2024
May 13-17, Yokohama, Japan

2024

Robot Sim2Real Challenge

AGILEX SIM2REAL CHALLENGE-RULEBOOK

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Statement

The Organizing Committee encourages and advocates technological innovation and open-source technology, and respects the intellectual property rights of participating teams. All intellectual property developed by the participating teams during the competition belongs to their teams, and the organizing committee will not be involved in disputes over intellectual property among the members of the teams. Participating teams must properly handle all relationships over intellectual property among members of the team from schools, companies and other statuses.

Participating teams shall respect all intellectual property rights of the original products provided by the Organizing Committee and shall not reverse engineer, copy, translate, or engage in any other behaviors detrimental to the intellectual property rights of the owners of the products.

Any damage to the intellectual property rights of the educational products provided by the organizing committee and the organizer will be investigated by the intellectual property rights owner in accordance with the law.

Release Notes

Date	Version	Changes
November 13, 2023	V1.0	First release

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1 Introduction

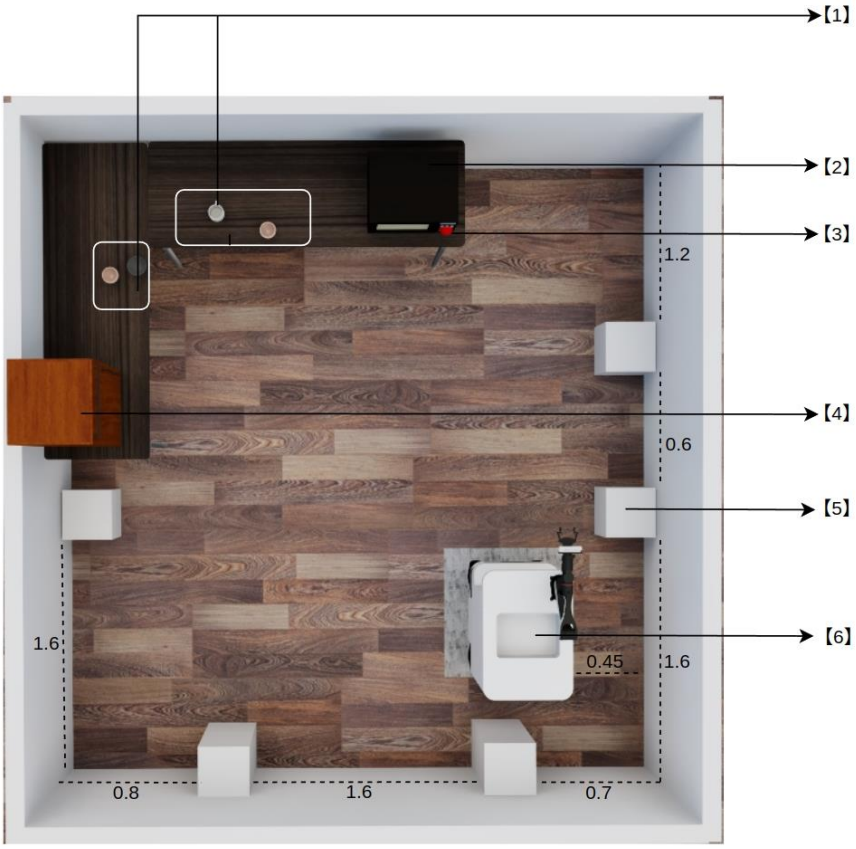
In the AgileX Sim2Real Challenge track ("AXS") of the Robotics Sim2Real Challenge, teams need to design algorithms to enable the robotic system to autonomously sort and organize kitchen utensils (bowls, cups) in a kitchen environment and correctly place the different utensils into the corresponding utensils as required to earn points. The teams need to design algorithms to enable the robot system to autonomously classify and organize kitchenware (bowls, cups) in a kitchen environment, and to correctly organize different kitchenware into corresponding utensils according to the requirements in order to gain points. The competition will customize a matching simulation environment in the OmniGibson platform and seamlessly integrate our robot. The robotic system, AirBot, is equipped with a mobile chassis and is connected to an upper robot arm through a support structure. Participants are required to train algorithms in the simulator to make the robot complete different stowage sub-tasks within the 15-minute competition time to earn points. The organizing committee will then deploy the code in a real scenario consistent with the simulation environment in a physical robot to complete the tasks through Sim2Real mode. In the final competition, the advanced teams can deploy the algorithms in real scenarios, and the organizing committee will provide the robot platform to complete the tasks and get the scores.

Figure 1-1 AirBot

2 Competition Area

All site props described in the full text are within ±5% of the dimensional tolerances.

The site is a rectangular area of 3.8 x 4 meters, with the areas shown below:



[1] Area for random tableware placement [2] Microwave [3] Table [4] Cabinet [5] Marker [6] Start-stop zone

Figure 2-1 Site diagram

Figure 2-2 Tableware

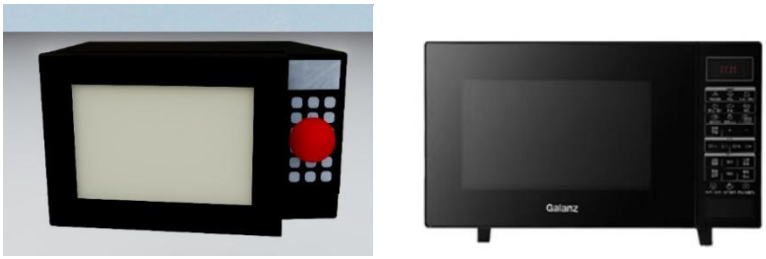


Figure 2-3 Microwave

Figure 2-4 Table

Figure 2-5 Cabinet

Figure 2-6 Marker

【1】 Areas for random tableware placements are two rectangular areas measuring A: 0.3×0.3 and B: 0.3×0.7 meters, they are on two desktops.

【2】 The size of the microwave is 0.45×0.5×0.3 meters, and the initial state of the microwave door is open.

【3】 The table size is 1.8×0.6×0.7 meters.

【4】 The cabinet size is 0.43×0.45×0.75 meters, and the initial state of the cabinet door is closed.

【5】 The marker is a cube with a side length of 0.3 meters.

【6】 The Start-stop zone is the area where the cars will be placed at the start/end of the race.

3 Simulation Technology Architecture

3.1 Simulation Platform

The simulation platform for the competition was OmniGibson, which is an intelligent robot simulation platform based on Isaac Sim. It supports physics engines and rendering of rigid bodies, liquids.

3.2 Data Interface

The competition chooses ROS as the standard communication interface, using ROS to connect the OmniGibson simulation platform with the resources of existing robots. The organizing committee provides a unified robot sensor data acquisition interface and actuator control interface based on ROS, and the participating teams will focus on the development of robot algorithms. For sensor data and other specific parameters provided by the robot, please refer to the official Tutorial document.

3.3 Platform Architecture

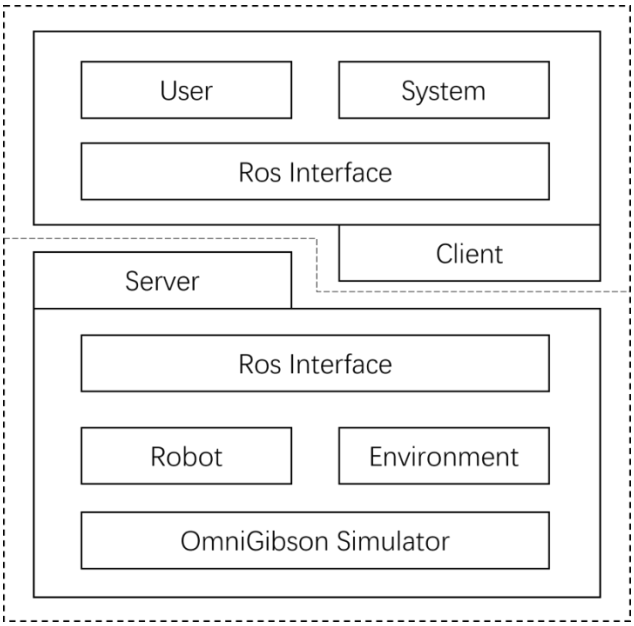


Figure 3-1 Platform architecture

The simulation architecture consists of two components: the Server and the Client.

Server is a Docker image of the OmniGibson environment configured by the organizing committee. In the simulation environment, Server will provide the robot model and the

competition venue to the teams. The Environment module includes: the competition kitchen scene, kitchenware and other props, and the Robot module includes: sensor data interface and actuator control interface. Please refer to the official Tutorial document for specific interface descriptions.

Client is the hardware resource that simulates the main control of AIRBOT robot, which is packaged here as a separate Docker image for the competition task. Participating teams can call the interfaces provided in the Server image to develop algorithms for the competition tasks in the Client image. The User module includes the demo program provided by the organizing committee and the function modules that the participating teams need to develop.

The System module includes the monitoring system for all game tasks, the Log system, and the communication system for the referee system, etc. The process priority of the System module is higher than that of the User module.

4 Competition Mechanism

Each game is limited to 15 minutes. At the beginning of the round, the official staff will place 3 bowls (2 of the same color and 1 of a different color) and 1 cup in a random initial position in the designated area on the L-shaped table, then all teams in the round will play with the random tableware distribution of the round. After the robot starts from the start-stop zone, it needs to be completed separately (no order is required)：

- Sub-task 1: The robot finds a cup on the desktop, puts the cup into the open microwave oven, and closes the microwave oven door；
- Sub-task 2: After the robot opens the closed cabinet with a handle, it finds the bowl on the desktop and puts the three bowls into two different floors of the cabinet respectively. The bowls of the same color should be placed on the same floor. Different points are awarded depending on the position of the bowl.

After the completion of the task, the robot needs to return to the start-stop zone. The projection of the robot is judged as successful parking in the start-stop zone. If the parking is not successful, the overall score will be deducted 1 point. The race ends when the robot finishes parking or runs out of time.

If the judge requests the termination in advance (unofficial reasons cause the accident of the participating robot) or the team members apply for the termination, the team will end the challenge opportunity, and consume one challenge opportunity, and no result will be achieved in the round.

4.1 Rules for redeeming points

The competition consists of two main sub-tasks, and the teams will get points for completing the key links of the two sub-tasks respectively. The points will be based on the status at the end of the competition. Specific rules are as follows:

1. Score 1 point with the cup inside the microwave;
2. Score 1 point with the microwave door close (the microwave oven is initially open);
3. Score 1 point with the cupboard door open；
4. Score according to the state of the three bowls in the cabinet：

a) Basic points：one bowl in the cabinet scores 1 point；

b) Bonus points for layering：Two of the three bowls were on the same floor of the cabinet, and the other bowl was on the other floor of the cabinet, scoring 1 point;

c) Reward points：If the final position is two bowls of the same color placed in the same floor, and one bowl of different colors placed separately in another floor, an additional 1 point is added. That is, in this case, the highest score of the bowl placement stage is:

3*1 (Basic points) + 1 (Bonus points for layering) + 1 (Reward points) = 5 points.

5. Parking penalty points: When the robot finishes parking or the race time runs out, the race time is recorded at the end of the race. The projection of the robot is judged as successful parking in the parking area, and 1 point will be deducted from the overall score if it fails to park successfully, and no point will be deducted if it meets the parking requirements.

Figure 4-1 5 points

Figure 4-2 4 points

Figure 4-3 3 points

4.2 Scoring rule

In each round, the winner will be the one who gets the most points. In the case of the same points, the short timing time at the end of the race wins (accurate to 0.1s).

The specific ranking rules are as follows：

R1：The highest points of the three rounds is selected for ranking；

R2：If the highest points are the same, the third round of high points are compared, and so on;

R3：If there is a tie in match times, the time of the third scoring point in the round is compared, and if that time is still the same, the time of the second scoring point is compared, and so on.

R3：If the points are equal in three rounds, the match will be replayed. Replay results are only used to distinguish the ranking of teams with the same points, and do not participate in the overall ranking.

Table 4-1 Ranking Example

Ranking	Competing teams	highest score			Next highest score			Lowest Score		
		Score	Final time (s)	Time for the first three tasks(s)	Score	Final time (s)	Time for the first three tasks(s)	Score	Final time (s)	Time for the first three tasks(s)
1	A	8	909.5	100.8/150.4/300.9	7	979.1	101.8/153.4/307.9	6	965.3	105.8/155.4/317.1
2	B	8	909.5	110.1/156.7/350.9	7	989.3	110.7/159.7/356.9	6	966.7	111.7/169.7/366.5
3	C	8	939.4	110.1/156.7/350.9	7	939.3	110.7/159.7/356.9	6	986.7	111.7/169.7/366.8
4	D	7	909.1	109.1/156.7/350.9	7	939.1	107.1/166.5/350.9	7	979.1	115.1/156.7/350.9
5	E	6	979.6	102.1/136.7/340.9	5	969.1	109.1/176.6/350.6	5	949.1	149.1/196.7/370.7
6	F	5	969	119.1/156.7/350.9	4	959.1	139.1/156.7/350.9	4	919.1	159.1/156.7/350.5

5 Stage

The challenge is made up of three stages: Simulator Stage, Sim2Real Stage, and Formal Match.

5.1 Simulation Stage

The Simulation Stage begins from January 15, 2024 and ends on March 10, 2024. In this stage, the main task of the participating teams is to develop the algorithm in the simulator environment and complete the task, which mainly includes the following parts:

1. Download the Docker image of the OmniGibson environment and the Docker image of the competition tasks specified by the organizing committee;
2. Configure the local environment by referring to the official Tutorial document, run the Demo routine, get the sensor data of the robot, and control the robot to move and grasp;
3. Complete the development of tableware placement task according to the competition rules, and submit the code to the window designated by the organizing committee;
4. The Organizing Committee will determine the list of competitions that will advance to the next stage through the technical review on March 15, 2024.

5.2 Sim2Real Stage

The Sim2Real Stage starts on March 15, 2024 and ends on May 3, 2024. In this stage, the main task of the successful team is to adjust and optimize the algorithm based on the test data of the real field. The main operation process is as follows:

1. The participating teams submit their codes to the submission window designated by the Organizing Committee；
2. The Organizing Committee deploys the code submitted by the participating teams to run on the real robots and execute the competition tasks under the real venue；
3. During the test, the feedback data of the robot and the video of the competition will be released by the Organizing Committee on the designated platform for the participating teams to download；

4. The participating teams will optimize their algorithms based on the feedback data and match videos.

During this stage, the participating teams will repeat the above 4 processes, continuously adjust and optimize the algorithm and apply for field tests.

5.3 Real-Robot Final Stage

The official competition phase starts from May 4 to May 10, 2024. The organizing committee deploys the code submitted by the teams to run on real robots to execute the competition tasks under the real venue, with a total of three rounds of execution. Participating teams will be ranked based on the highest scores and will be recognized with certificates and corresponding prizes.

The exact entry process will be announced prior to the official start of the tournament.

5.4 In-person Competition Stage

At the offline competition venue set up on-site during the ICRA conference, offline teams can personally deploy and debug algorithms on the robotics platform provided by the organizing committee to complete the competition. Participating teams will be ranked according to the highest scores and will be recognized with certificates and corresponding prizes.

Rankings in the offline stage will not be counted as rankings in the official competition stage.

Details of the entry process will be announced prior to the start of the offline stage.

6 Season Schedule

Table 6-1 Season Schedule

Date	Activities	Remark
January 15, 2024	Official registration opens	official Sim2real website
February 15, 2024	Registration Deadline	official Sim2real website
January 15, 2024 - March 10, 2024	Simulation Stage	Participating team members submit their codes through the official website
March 15, 2024	Simulation Stage Result	Ranking based on simulator simulation: Determine the list of selected teams Secondary confirmation of participation information
March 15, 2024 - May 03, 2024	Sim2Real Stage	Organizing Committee Download Team Code Real-world field testing and feedback test data
May 04, 2024 - May 10, 2024	Final Stage of Real Robot	One submission only
May 16, 2024	Real Robots Offline Competition Stage Notification of Final Results and Awards	Optional offline entry or not

7 Participation

Participants form a team based on the teams and the participants, and complete the registration process through the official Sim2real website.

7.1 Participating Teams

1. Every team member is allowed to join only one team in a competition season.
2. Each team must have a minimum of one and a maximum of five members. Each member's roles and responsibilities must be detailed in the application form.
3. Each team must have a registered team captain, who is responsible for managing the progress of the competition, maintaining contact with the organizing committee, submitting competition reports, etc.

7.2 Team Member

Table 7-1 Team Member' roles and responsibilities

Roles	Role Instructions	No. of Persons	Status	Responsibilities
Supervisor	● The main person in charge of the team, responsible for the formation and management of the team ● Responsible for communicating	0-1	Faculty members with research and teaching qualifications from October 2023 to June 2024 in the institutions of higher learning where the participating teams are located	● Be responsible for the personal and property safety of all team members, and guide and manage the use of team funds during the competition ● Instructs the team in developing their project plan and solving R&D issues, and helps the

Roles	Role Instructions	No. of Persons	Status	Responsibilities
	and liaising with the committee ● Must not be an official team member			team complete the challenge successfully ● During the challenge, the supervisor must actively cooperate with the committee and ensure the captain reports to the committee regularly on the team's progress and other matters
Regular members	● Including the captain and general team members ● Must not be a supervisor	1-5	With proof of full-time student identity up to September 2024	

Table 7-2 Roles and responsibilities of regular members

Roles	Role Instructions	No. of Persons	Responsibilities
Captain	● Core team member, the team's technical and tactical leader ● The main liaison with the committee	1	● Responsible for the division of labor, overall planning and tactical arrangement and adjustment ● Attends the Captains Meeting, represents the team in confirming match results and participates in appeal processes and any subsequent hearings ● Responsible for passing on the team's expertise and the team's future development after the challenge
Team Member	● Including the captain and general team members ● Must not be a supervisor	1-5	

7.3 Other Requirements

R1. The same team must use the same team's name for different competitions. Team names must be in the form of "Team XXX", where "XXX" is the team's customized name. The customized name of the team must not exceed 16 characters (each Chinese character counts as 2 characters and each English letter counts as 1 character), and must not contain the name of the school, the abbreviation of the name of the school, the abbreviation of the name of the school in English, the words "team", "group", "squadron", etc. or special symbols such as "*/-+"; The team's name should reflect the positive and progressive spirit of the participating teams and must comply with the relevant national laws and regulations. If the Organizing Committee decides that the team's name is not in line with the spirit of the competition, it has the right to request the participating teams to change their team

names.

R2. A team must be based at an institution of higher education and meet the role, number and identity requirements set out in "7.2 Team Member". If a team fails to meet the requirements, the offending team will be disqualified from the competition up to the maximum.

R3. Each university/college is allowed to have more than one team participating in the competition. However, only the team with the highest score from each university/college in the Simulation Stage will advance to the next stage.

8 Awards

Table 8-1 Awards Setup

Prize	Ranking	Quantity	Awards
First Prize	First Place	1	● Achievement Certificates (for each member) ● $3,000 pre-tax
	Second Place	1	● Achievement Certificates (for each member) ● $2,000 pre-tax
	Third Place	1	● Achievement Certificates (for each member) ● $1000 pre-tax
Second Prize	Fourth to eighth places	5	● Achievement Certificates (for each member)
Third Prize	Entering Sim2Real Stage	Several	● Achievement Certificates (for each member)

Offline Prize	Ranking	Quantity	Awards
First Prize	First Place	1	● Achievement Certificates (for each member)

Offline Prize	Ranking	Quantity	Awards
			• $1,000 pre-tax
Second Prize	1	1	• Achievement Certificates (for each member) • $700 pre-tax
Third Prize	1	1	• Achievement Certificates (for each member) • $300 pre-tax
Fourth Prize	Teams in the Offline Competition	Several	• Achievement Certificates (for each member)

9 Appeals

9.1 Appeal Materials

How to appeal: Save the edited video (contents of which to be prepared by the team) and the text files containing the appeal materials in a folder (its total size not exceeding 100MB), and send it to the arbitration staff via Sim2Real website or E-mail.

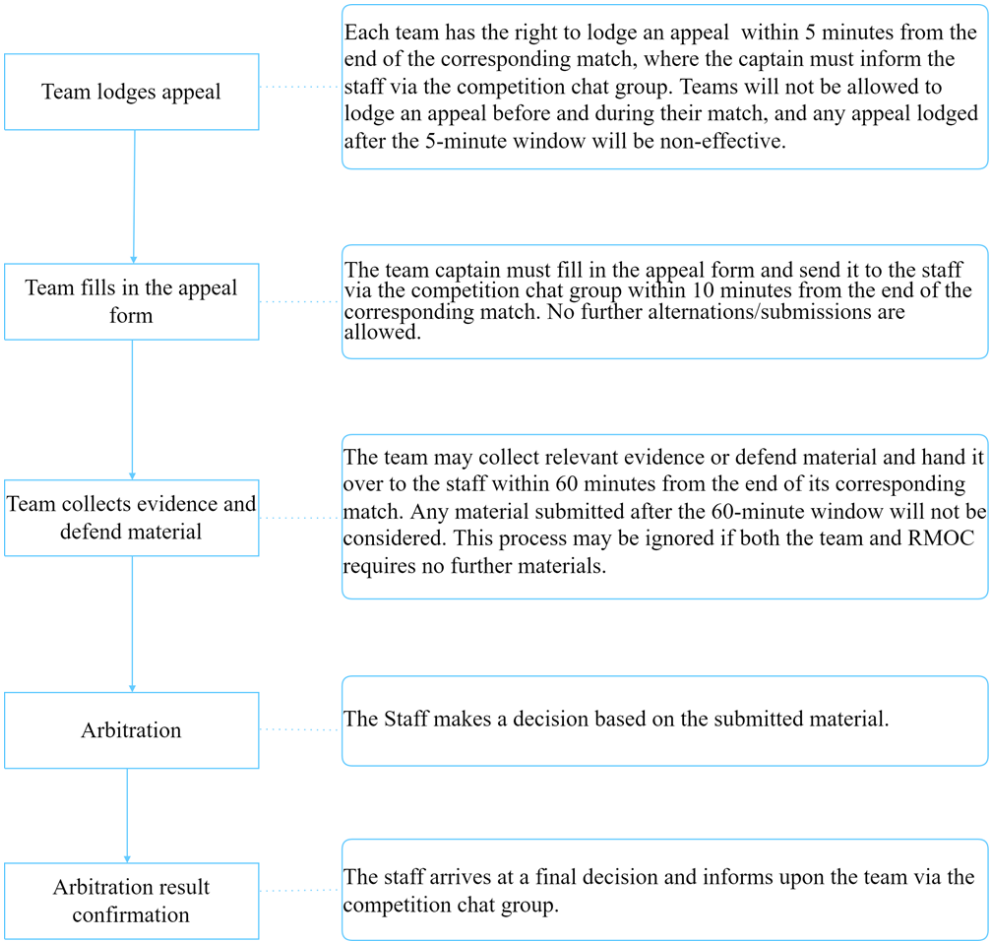
Material format: No video may exceed one minute in length. The name of the video must indicate the specific match, the round of the match and the time it was taken (rounded to minutes). The videos should be compatible with the latest version of Windows Media Player; the photos must be in JPG format; and the text documents must be in PDF format and not exceed 1,000 characters in length.

Naming of materials: The file name of each video and photo must be within 30 characters.

Text requirements: One text file can only correspond to one video or a photo, which must be indicated in the text. Only the violations reflected in the corresponding materials need to be addressed in the text files.

9.2 Appeal Process

Teams lodging an appeal must follow the procedure below:



9.3 Appeal Decision

Arbitration results include: upholding the original game results, and replaying the game. The arbitration result issued by the Arbitration Committee is not subject to re-appeal.

If the arbitration result requires the parties to have a rematch, the organizing committee will notify the time of the rematch at the same time of giving the arbitration result. If the replay is not accepted, the appeal will be considered as unsuccessful and the original result will be maintained.

10 Q&A

Frequently Asked Questions during the competition will be published and updated regularly through the official Sim2Real Website. Teams can ask questions via E-mail and Website.