

V1.0



Using a 32-bit motor driver chip and Field-Oriented Control (FOC), the RoboMaster G200 Brushless DC Motor Speed Controller enables precise control over motor torque.

Designed for the RoboMaster M2000 19V Brushless DC Motor Starter and G200 Brushless DC Motor Speed Controller, the M2000 Assembly Kit includes several cables and a terminal board.

RoboMaster System Specification Manual, RoboMaster User Manual, Introduction of RoboMaster System Module

The M2000 Assembly Kit includes several cables and a terminal board, ensuring a complete connection system when for your RoboMaster system.

# ROBOMASTER 2023

## University Sim2Real Challenge

# RULES MANUAL

Prepared by the RoboMaster Organizing Committee  
Released on November 2022

## Statement

The RoboMaster Organizing Committee (hereinafter referred to as “the RMOC”) encourages and advocates for technological innovation, and open-source technology, and respects the intellectual property of participating teams. All rights related to the intellectual property developed during the competition are owned by the individual teams. The RMOC will not be involved in the handling of intellectual property disputes within teams. The participating teams must properly handle all aspects of intellectual property rights among internal school members, company members, and other members of the team.

While using the supporting materials provided by the RMOC, teams should respect the owners of all intellectual property. Teams are also prohibited from engaging in any behavior that violates intellectual property rights, including but not limited to reverse engineering, replication, or translation.

With regard to any behavior that may infringe upon the intellectual property rights relating to educational materials provided for the competition by the RMOC or co-organizers, the intellectual property rights owners are entitled to hold the infringing parties responsible in accordance with the law.

## Release Notes

Date	Version	Changes
November 14, 2022	V1.0	First release

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# 1. Introduction

The RoboMaster University Sim2Real Challenge (“RMUS”) at its core allows participants to win points by rearranging minerals using fully automated RoboMaster EPs that have been modified officially. The match lasts for five minutes with a sim2real-based format, where robots rearrange minerals based on the information shown on the exchange tags to earn points. Participants will be ranked according to their total points won. The objective of the challenge is to assess how well a program completed on a simulation platform can be operated in real application environments. Teams are required to develop and debug their algorithms in a simulator and submit their codes by the specified deadline. The office staff will deploy corresponding codes in physical robots of the same models to rearrange minerals. Compared to other RoboMaster University events, this challenge does not require teams to build physical robots, allowing participants to focus entirely on algorithm design.



Figure 1-1 RoboMaster EP

## 2. Competition Area

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The error margin for the dimensions of all Competition Areas and Components described in the document is  $\pm 5\%$ . The unit for the size parameters on the site drawings is mm.

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### 2.1 Overview

The competition area is a 4 x 5 m rectangle consisting of infrastructures such as Starting Zone, Exchange Station, Mineral Zones, Obstacle Block, and Road, as shown below.

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The labels for Mineral Zones below only indicate their general areas and do not represent their specific locations real-site.

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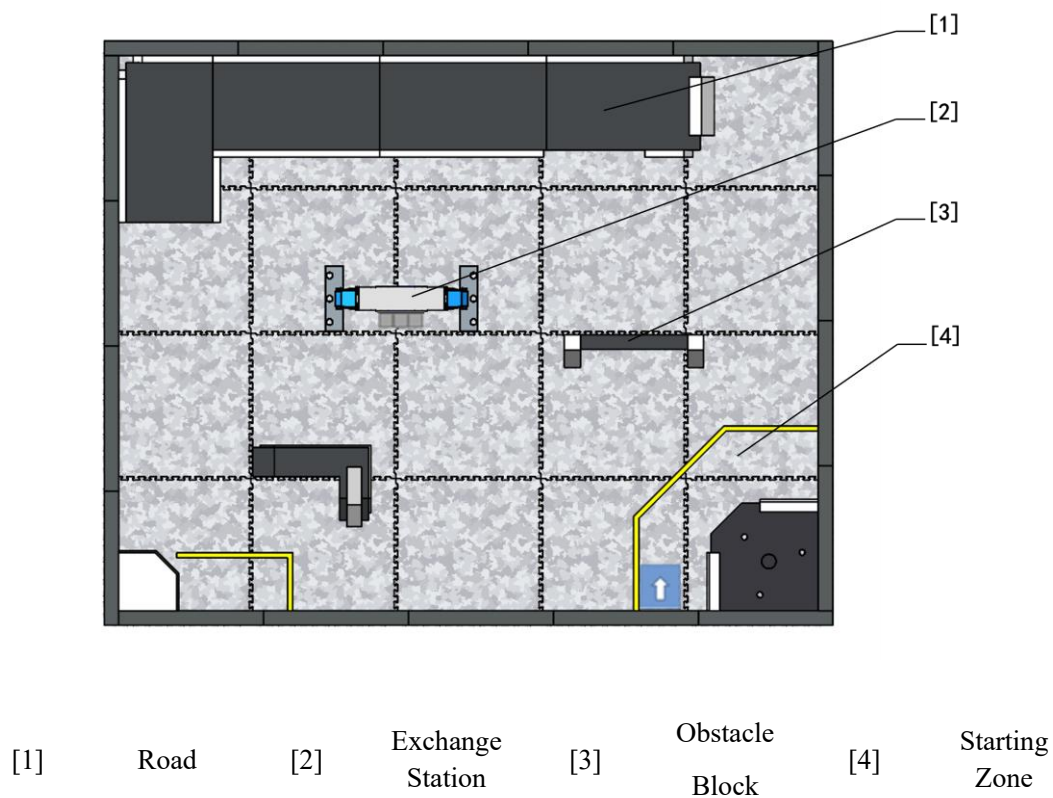


Figure 2-1 Site modules

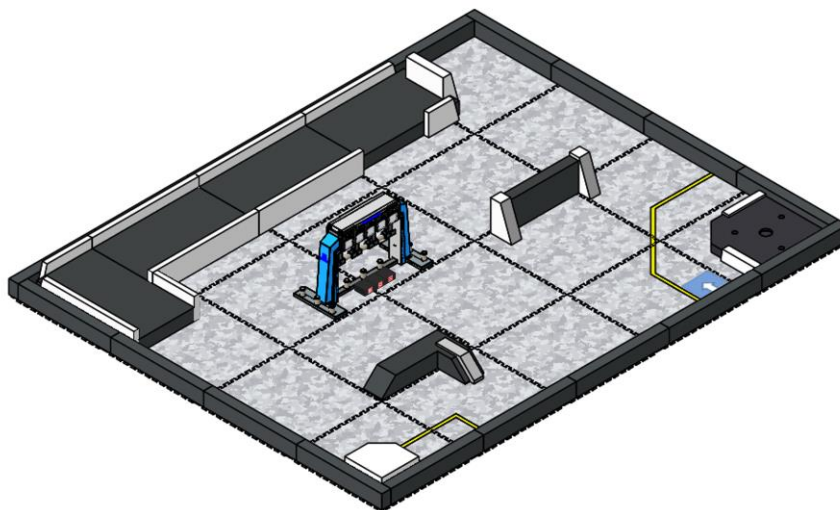


Figure 2-2 Site axonometric view

The floor is covered by 20-mm-thick EVA mats. The Road and other modules on the site are also made of EVA.





Figure 2-3 EVA mat

## 2.2 Starting Zone

The Starting Zone is where robots are placed before a match starts. A robot is placed in the blue square area with a special positioning frame at the start of the match. The robot's gripper must face the same direction as the arrow.

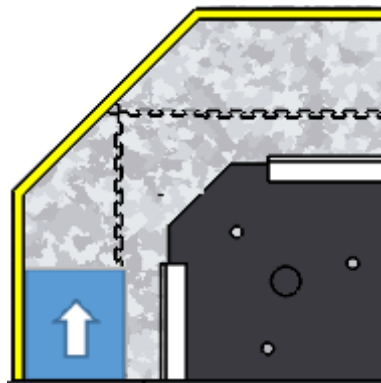
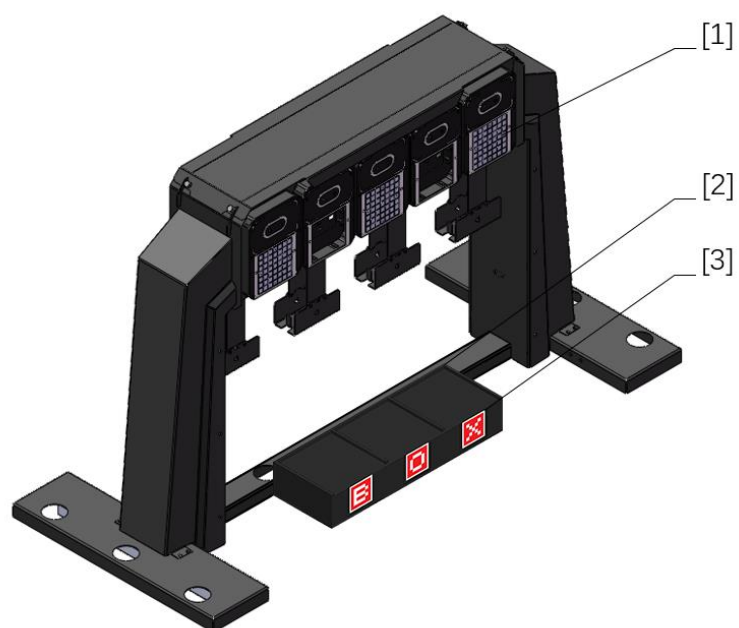
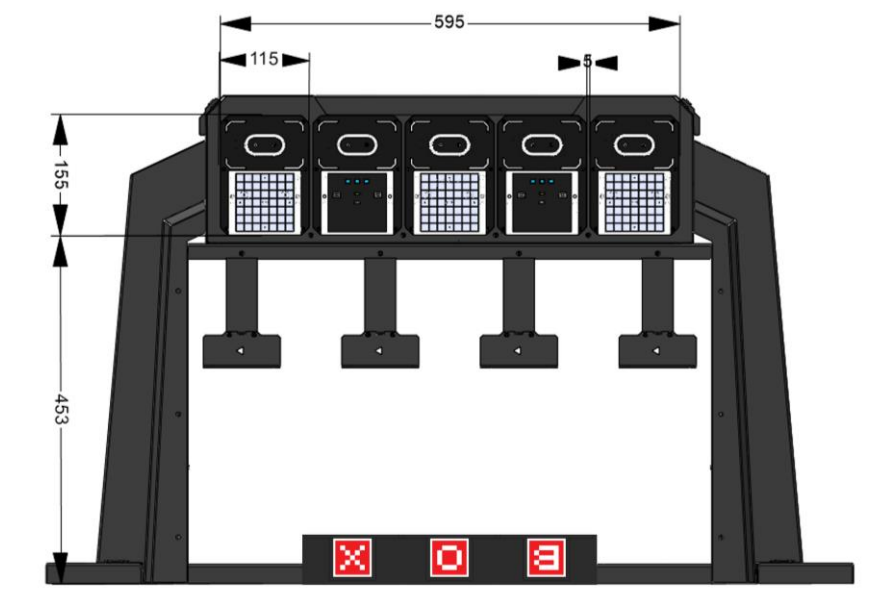


Figure 2-4 Starting Zone

## 2.3 Exchange Station

An Exchange Station is made up of three exchange markers and a receptacle.

The three markers are above the receptacle, which has three slots, each corresponding to a marker above. A localization marker can be found on the front of each slot to facilitate localization by robots.



- |     |                    |     |            |     |                        |
|-----|--------------------|-----|------------|-----|------------------------|
| [1] | Exchange<br>marker | [2] | Receptacle | [3] | Localization<br>marker |
|-----|--------------------|-----|------------|-----|------------------------|

Figure 2-5 Exchange Station

The dimensions of the receptacle are as shown below (in mm):

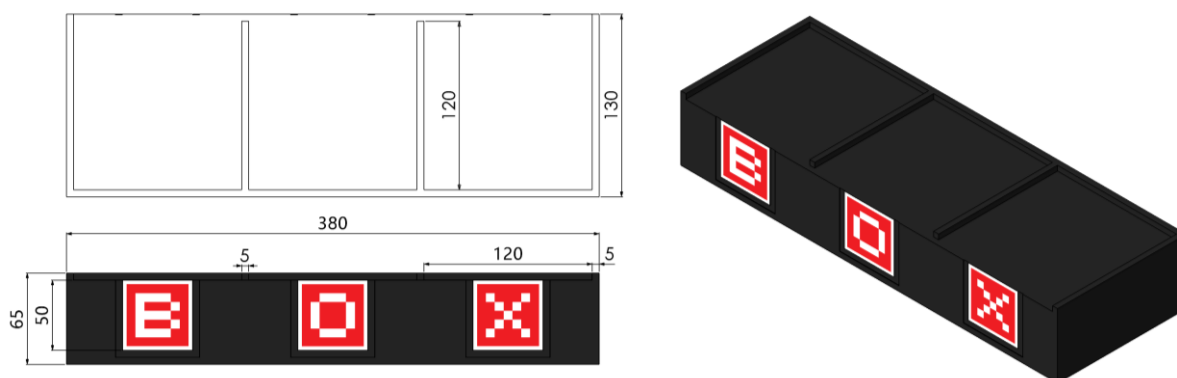


Figure 2-6 Receptacle dimensions

## 2.4 Mineral Zones

The full ground area of the site, as shown in Figure 2-7, is the mining area, while the yellow ground region 200 mm from the site's boundary and the edge of the props is the prohibited area.

Distribution of minerals in the mineral zones: The initial positions of the five minerals are distributed randomly throughout the site. The minerals can be placed in any site area outside of the restricted areas, but they must be 100 mm apart and cannot be stacked.

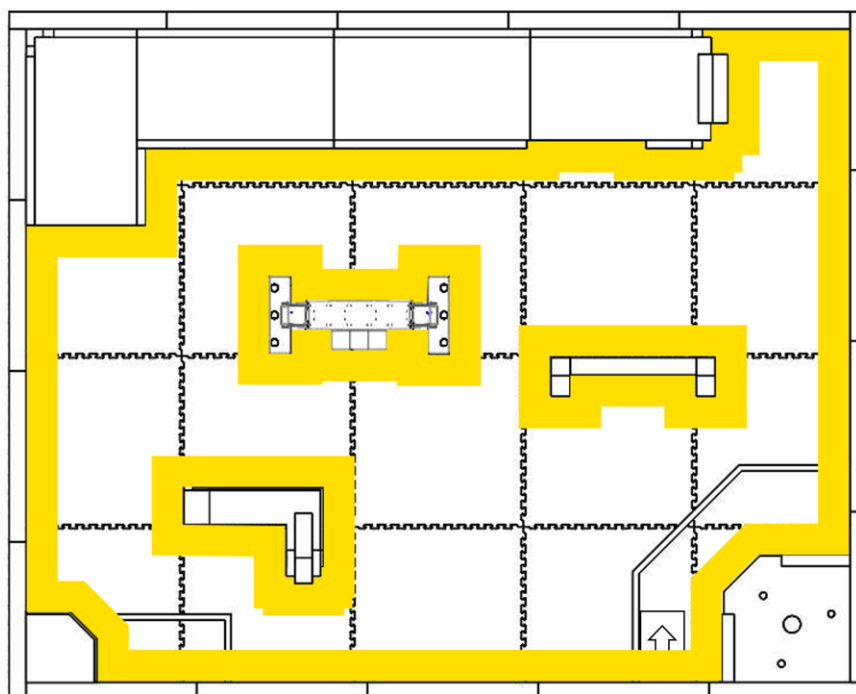


Figure 2-7 Mineral Zones

## 2.5 Minerals

The mineral is a cube with 50mm-long sides that weighs around 98g and is manufactured from ABS. Each mineral's surface has the same digital identification label; the backdrop color is a 45-mm red square digital label, and the value range of each mineral's digital identification label is between 1 and 5.

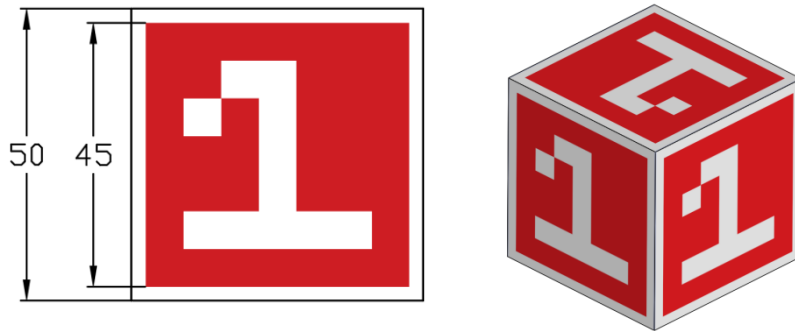


Figure 2-8 Mineral

## 3. Simulation Technology Architecture

### 3.1 Simulation Platform

The simulation platform used for the challenge is AI Habitat 2.0. The platform is mainly comprised of two components: Habitat Sim and Habitat Lab. Habitat Sim is a high-performance physics-enabled 3D simulator, while Habitat Lab is a modular library for end-to-end training tasks.

### 3.2 Data Interface

The standard communication interface used in the challenge is ROS, which bridges the AI Habitat platform with existing robotics resources via ROS-X-Habitat. The RMOC will provide a standardized sensor data sampling interface and an actuator control interface for the robots, so teams only need to focus on the development of their robotic algorithms. For more details on the sensor data and other parameters provided by the robots, please refer to the officially released “Tutorial” file.

### 3.3 Platform Architecture

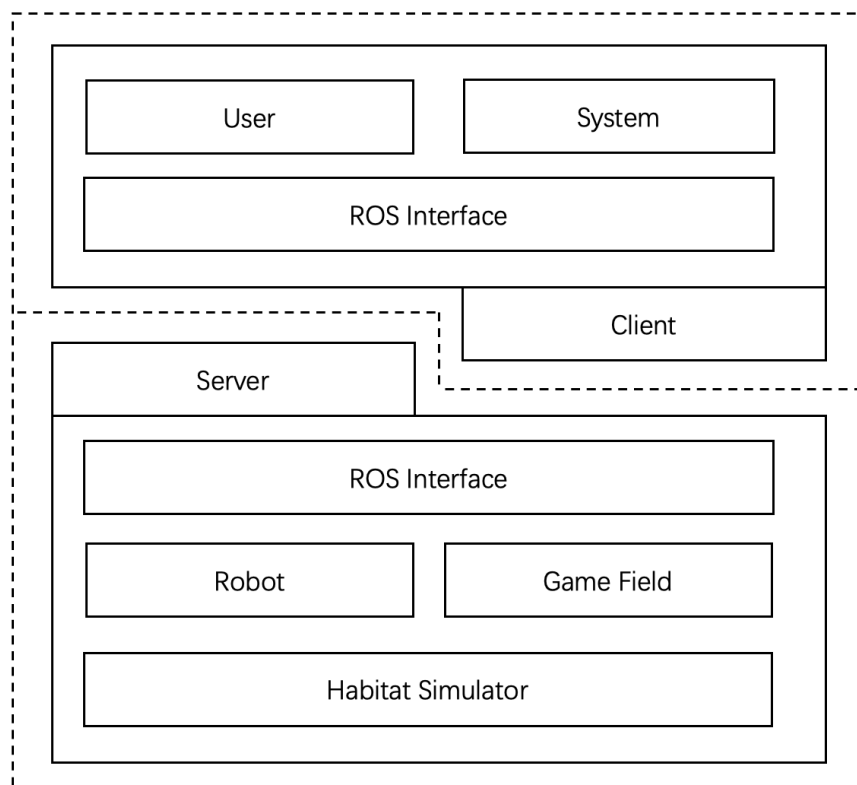


Figure 3-1 Platform architecture

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

The Server is a Docker image for the Habitat preconfigured by the RMOC. In a simulated environment, the Server will provide robot models and the competition site to the team. The Game Field Module includes the Competition Area, Exchange Station, Minerals, and other equipment. The Robot Module consists of the sensor data sampling interface and the actuator control interface. For specific descriptions of the interface, please refer to the officially released “Tutorial” file.

The Client is a Docker image simulating the hardware resource of the main controller of the RoboMaster EP robot and serves as an independently packaged Docker image for the challenge mission. Teams can call the interface provided by the Server image and develop algorithms for the challenge mission in the Client image. The User Module consists of the Demo program provided by the RMOC and the functional modules required to be developed by the teams. The System Module consists of the monitoring and logging systems for all challenge missions and the communication functions for the referee system. The System Module has a higher process priority than the User Module.

## 4. Competition Mechanism

Each game requires both teams to finish two matches. In one match, one side completes the mineral distribution adjustment task, while the other side completes the mineral search and exchange task. After one match, the two sides exchange tasks and calculate the score based on the number of minerals exchanged by both sides. If the scores are identical, the winner is the participant who completed the mineral search and exchange task in the shortest amount of time.

**Mineral distribution adjustment task:** The team must control the robot from the start area in order to automatically search for minerals in the mine region and rearrange the location of five minerals in the mineral zones of the site using the submitted code. The time restriction for the task phase is 5 minutes.

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During the stage of the mineral distribution adjustment task, if the participating robot placed a mineral in a restricted distribution region, the official issued a caution for this behavior. Immediately, the assignment was concluded. Officially, the robot was taken from the field. The illegal mineral will be adjusted and placed in the closest conforming distribution mineral zones in order to start the opponent's mineral search mission.

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**Mineral search and exchange task:** After the team responsible for mineral adjustment completes the task, the team responsible for mineral search and exchange must control the participating robot from the starting area using the submitted code, automatically search for mineral distribution and obtain minerals, and place the corresponding mineral into the correct exchange slot to complete the mineral exchange according to the number on the exchange marker. The time restriction for the task phase is 5 minutes. The match concludes when three minerals are successfully exchanged or when the tournament time limit is reached.

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During the mineral search and exchange task phase, robots can only transport one mineral at a time. Otherwise, it will be considered cheating, and the competition will be promptly terminated by the officials. The team involved in the bureau receives no results, and the opponent wins the game.

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If the referee demands termination in advance (for unofficial reasons such as producing an unanticipated scenario in the participating robot) or if a member of the team asks for termination, the team will end the round.

### 4.1 Mineral Distribution Adjustment Rules

Rules of judgment and conduct for dealing with unique circumstances in the match game's adjustment of mineral distribution:

1. If the team does not submit the mineral distribution adjustment code, it is presumed that they have forfeited the right to alter the mineral distribution, and the official will adjust the positions of the five minerals at random.

2. The robot will be taken from the field if all adjustments are not accomplished within five minutes of the time restriction. If the robot is carrying a mineral, the mineral will be placed in the last robot stop location; if the region is a prohibited zone, the mineral will be placed in the closest mining area that meets the regulations.
3. If the team places a mineral in a prohibited region, the official will make the necessary adjustments in the closest mining area that meets regulations.

## 4.2 Exchange Markers Mechanism

At the start of a match, the exchange markers will show three different randomized digits from 1 to 5. The numbers will remain unchanged throughout the match. To earn points, the robot is required to place minerals in the correct receptacles by matching the number tags on the minerals with the numbers on the exchange markers.

## 4.3 Rules on Exchanges

To successfully exchange minerals, the following conditions must be met simultaneously:

1. The robot places the mineral into the receptacle whose exchange marker corresponds to the mineral's number tag (in no particular sequence);
2. Any side of the mineral is in full contact with the bottom of the receptacle.



If two or more minerals have been dropped in a receptacle, the points will be calculated based on the first mineral placed.

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The following are illustrations of different exchange statuses:

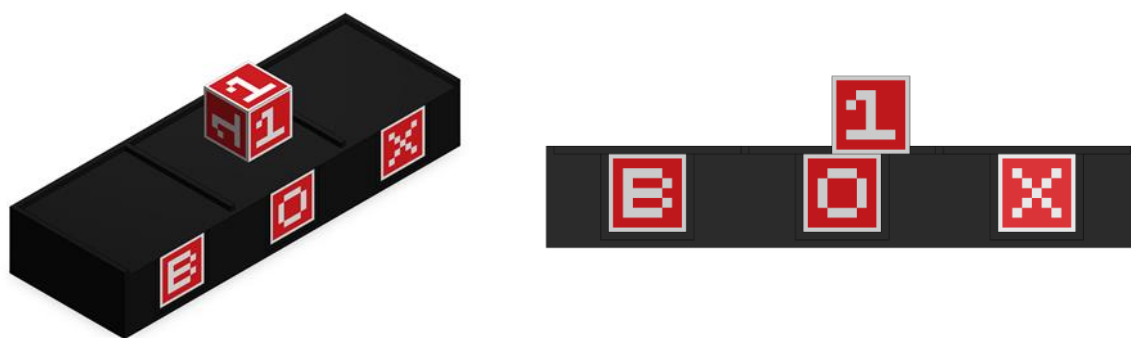


Figure 4-1 Exchange successful

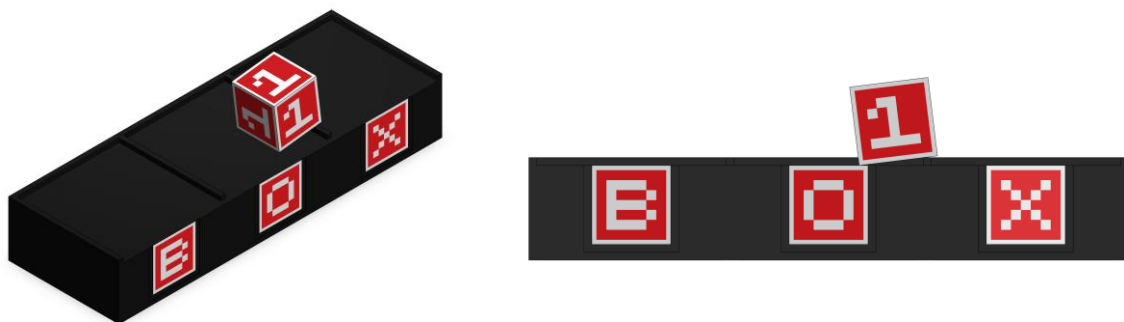


Figure 4-2 Exchange failed

(None of the mineral's sides are in full contact with the bottom of the receptacle.)



Figure 4-3 Exchange failed

(The mineral is not in any of the receptacles.)

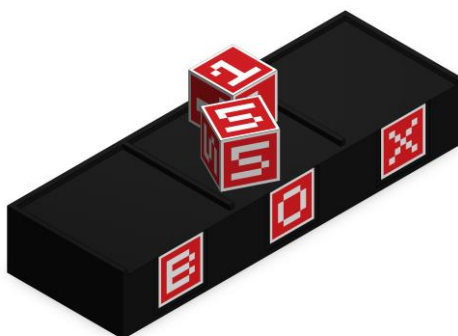


Figure 4-4 Exception

(The exchange is deemed successful if the first-placed mineral satisfies the conditions for a successful exchange.)



## 4.4 Scoring

The amount of successfully traded minerals will be used to determine the initial point total. If the quantities of minerals exchanged are the same between two or more teams, they will be ranked according to the amount of time it takes to complete the exchange. The team with the shortest exchange time will receive a higher ranking.



Exchange Duration: The time spent to complete all successful mineral exchanges in a round (precise to 0.1 s).

## 5. Competition Process

The challenge is made up of four stages: Simulator Test, Sim2Real Test, AI Adversarial Test, and Formal Match.

### 5.1 Simulator Test

The Simulator Test runs from November 14 to March 1. In this stage, teams will focus on developing algorithms in a simulated environment and completing the **mineral search and exchange task**, which consists of the following:

1. Downloading the Docker images for the Habitat and the challenge mission from the official website.
2. Configuring the local environment based on the official “Tutorial” file, running the Demo program, obtaining the robot’s sensor data, and controlling the movement and grabbing mechanism of the robot.
3. Completing the mission algorithms according to the competition rules and submitting the codes to the portal designated by the RMOC.
4. The organizing committee determined that each team had completed its tasks at this stage and advanced the next stage.

### 5.2 Sim2Real Test

The Sim2Real Test runs from December 1 to March 1. In this stage, the main goal for participating teams is to adjust and optimize the algorithm for the mineral search and exchange task using test data from the real site. The main operation process is as follows:

1. Teams submit their codes to the portal designated by the RMOC.
2. The RMOC will deploy and run their codes on RoboMaster EP robots to execute the challenge mission on the real competition site.
3. The robot’s feedback data and the match videos will be uploaded by the RMOC on a designated platform for teams to download.
4. The teams will optimize their algorithms based on the robot’s feedback data and the match videos.

In this stage, the teams will repeat the four steps above and continue requesting real-site tests and adjusting and optimizing their algorithms.

5. The weekly team test results will be updated and published in a leaderboard format.
6. Throughout the period, the organizing committee will use the overall leaderboard and the team's technical review to choose which teams will advance to the next stage of the AI Adversarial Test.



The duration of the weekly real-site test is limited. The schedule will be posted on the official page for submissions. Teams should plan their schedules accordingly. The submission deadline for team codes is March 1.

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## 5.3 AI Adversarial Test

The AI Adversarial Test runs from March 16 to May 15. In this stage, each team will compete for two months against the AI algorithm provided by the commit in order to fine-tune their strategy for mineral distribution adjustment task & mineral search and exchange task. . The main operation process is as follows:

1. Participating teams submit the code to the submission window designated by the Organizing Committee;
2. The organizing committee will deploy the code submitted by each team to run on the EP robot and complete the following tests:
  - 1) AI Adversarial Test:
    - The official AI code adjusts the mineral distribution for the team to search and exchange.
    - The team code adjusts the mineral distribution for the official baseline code to search and exchange.
  - 2) Team Mock Adversarial Test:
    - The team code adjusts the mineral distribution for themselves to search and exchange with their code.
3. The robot's feedback data and the match videos will be uploaded by the RMOC on a designated platform for teams to download.
4. The teams will optimize their algorithms based on the robot's feedback data and the match videos.

In this stage, the teams will repeat the four steps above and continue requesting real-site tests and adjusting and optimizing their algorithms.



The duration of the weekly real-site test is limited. The schedule will be posted on the official page for submissions. Teams should plan their schedules accordingly. The submission deadline for team codes is May 18.

- The Organizing Committee will verify and confirm all teams participating in the AI Adversarial Test, in addition to selecting the official competition list and performing the official competition drawing and grouping session.

## 5.4 Formal Match

The Formal Match will be held place in London, United Kingdom, on (date and time to be confirmed). The challenging flow is as follows:

- All qualifying teams are allocated into groups by random draw. The organizing committee will assign each team's final code for the mineral distribution adjustment task & mineral search and exchange task to the officially modified EP robot (if the team does not submit a layout code, the official random distribution code will be utilized);
- Formal Match Method: each side will play the role of AI to set up the random minerals for the other team for one round and vice versa for the other round. The score is calculated on the number of minerals exchanged. If the scores are identical, the winner is the participant who completed the mineral search and exchange task in the shortest amount of time.
- Group Round-robin: The format is BO2. For a round-robin event, teams will be divided into four groups, with each team in each group having an equal opportunity to play. The participating teams are ranked according to the group round-robin concept, with the top two teams in each group advancing to the semifinals.

Table 5-1 Round-robin Points

Format	Match Result	Score	Remark
<b>BO2</b>	1:0	3:0	The winner gets three points.
	1:1	1:1	Both sides of the draw receive one point each.
	0:0	0:0	Neither side completes the score of zero points each.

The ranking of the group round-robin competition is decided by the sum of each match's points. If the points are equal, the one with the shorter amount of time will be ranked higher.

4. Semi-finals, third-place matches, championship matches: the format is BO3 (two rounds of the BO3 format of three games need to be won);
5. The codes of all participating teams are completed at the organizing committee venue. After that, the organizing committee will publish the competition scores on the designated platform for the participating teams to check the final scores of their respective competitions.
6. According to the actual situation of each group of competitions, the organizing committee will publish the feedback data of the referee system and EP robot during the competition process and the competition video on the designated platform for the participating teams to download;
7. Each participating team can compare their final results with the official feedback data and competition videos to confirm whether their results are correct.



During the Formal Match, teams will have one opportunity to update their team code after completing each phase, and if they do not update, they will use their latest submitted code for the next phase.

Table 5-2 Competition Flow

Item	Description
Setup period	Competition area reset
<b>Mineral distribution adjustment</b> code download	Launch Team's code
<b>Mineral search and exchange</b> code download	Launch Team's code
Referee system initialization	Countdown initialization
Start of match	The calculation of points by the System
Match conclusion	Generating scores and confirming match results

## 6. Season Schedule

Table 6-1 Season Schedule

Date	Activities	Notes
November 14, 2022	Release of Competition Rules and Relevant Materials	RoboMaster official website
November 14, 2022 – December 31, 2022	Formal Registration	RoboMaster official website
November 14, 2022 – March 1, 2023	Simulator Test	Teams submit codes on the official website.
December 1, 2022 – March 1, 2023	Sim2Real Test	The organizing committee downloads the team code. Real-site testing and feedback data will be provided.
March 1, 2023 – March 15, 2023	Mineral Search and Exchange Task Ranking Competition Technical Assessment Review	Based on the ranking of the Sim2Real Test, 1. Qualified teams are shortlisted 2. Double-confirming the competition details
March 16, 2023 – May 15, 2023	AI Adversarial Test	The organizing committee downloads the team code. Real-site testing and feedback data will be provided.
May 20, 2023	Code Submission	Each team is allowed to submit the codes only once.
ICRA 2023 Date:(to be confirmed)	Formal Match	Participating teams are not required to arrive on-site.

The time of the Formal Match will be based on the local time zone of the competition venue, while the time of other matches is based on UTC+8 (Beijing time).

## 7. Participation

Participants are required to form teams and complete the application process on the registration page of the official RoboMaster 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. Every team must have one registered captain, who will be responsible for managing the team's progress in the competition, liaising with the RMOC, and submitting competition reports, among other tasks.

## 7.2 Team Member

Table 7-1 Team Member' roles and responsibilities

Roles	Role Instructions	No. of Persons	Status	Responsibilities
Supervisor	<ul style="list-style-type: none"> <li>The main person in charge of the team, responsible for the formation and management of the team</li> <li>Responsible for communicating and liaising with the RMOC.</li> <li>Must not be an official team member.</li> </ul>	0-2	Faculty members of the team's college or university who are qualified for teaching and scientific research during the period of October 2022 to June 2023	<ul style="list-style-type: none"> <li>Responsible for the safety of team members and property, as well as instructing and managing the use of the team's funds</li> <li>Instructs the team in developing their project plan and solving R&amp;D issues, and helps the team complete the challenge successfully</li> <li>During the challenge, the supervisor must actively cooperate with the RMOC and ensure the captain reports to the RMOC regularly on the team's progress and other matters</li> </ul>
Regular members	<ul style="list-style-type: none"> <li>Including the captain and general team members.</li> <li>Must not be a supervisor.</li> </ul>	1-5	With proof of full-time student identity up to September 2023	

Table 7-2 Roles and responsibilities of regular members

Roles	Role Instructions	No. of Persons	Responsibilities
Captain	<ul style="list-style-type: none"> <li>● Core team member, the team's technical and tactical leader</li> <li>● The main liaison with the RMOC</li> </ul>	1	<ul style="list-style-type: none"> <li>● Responsible for the division of labor, overall planning and tactical arrangement and adjustment</li> <li>● Attends the Captains Meeting, represents the team in confirming match results and participates in appeal processes and any subsequent hearings</li> <li>● Responsible for passing on the team's expertise and the team's future development after the challenge</li> </ul>
General Member	<ul style="list-style-type: none"> <li>● Including the captain and general team members.</li> <li>● Must not be a supervisor.</li> </ul>	1-5	

## 7.3 Other Requirements

R1. Any team participating in different competitions must use the same team name. A team's name must be in the format of "XXX Team", where "XXX" shall be the team's self-chosen name. The total length of the self-chosen name should not exceed 16 English letters or 8 Chinese characters. The self-chosen name must not include the school name or its abbreviation in Chinese/English, the word "team", "squad" and other equivalent terms in Chinese/English, or other special symbols such as "\*/-+". The team name must reflect the positive and pioneering spirit of the team and comply with relevant state laws and regulations. If the RMOC determines that a team's name does not align with the spirit of the competition, it has the right to require the team to change its name.

R2. Each team must represent a university/college and meet the requirements for the roles, number and identity of members stated in "7.2 - Team Member". If a team fails to meet the requirements, it may be disqualified from the competition.

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 Sim2Real Test will advance to the next stage.

## 8. Awards

Table 8-1 Awards Setup

Prize	Ranking	Quantity	Awards
Grand Prize	First Place	1	<ul style="list-style-type: none"> <li>● Achievement Certificates (for each member)</li> <li>● \$5,000 pre-tax</li> </ul>
First Prize	Second Place	1	<ul style="list-style-type: none"> <li>● Achievement Certificates (for each member)</li> <li>● \$3,000 pre-tax</li> </ul>
	Third Place	1	<ul style="list-style-type: none"> <li>● Achievement Certificates (for each member)</li> <li>● \$2,000 pre-tax</li> </ul>
	Fourth Place	1	Achievement Certificates (for each member)
Second Prize	Fifth-Eighth Place	4	Achievement Certificates (for each member)
Third Prize	The teams that enter the AI Adversarial Test but did not make it to the quarterfinals	(Several) To be determined based on the results of all teams	Achievement Certificates (for each member)
Participation Award	The teams that enter the Sim2Real Test but do not enter the AI Adversarial Test	(Several) To be determined based on the results of all teams	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.

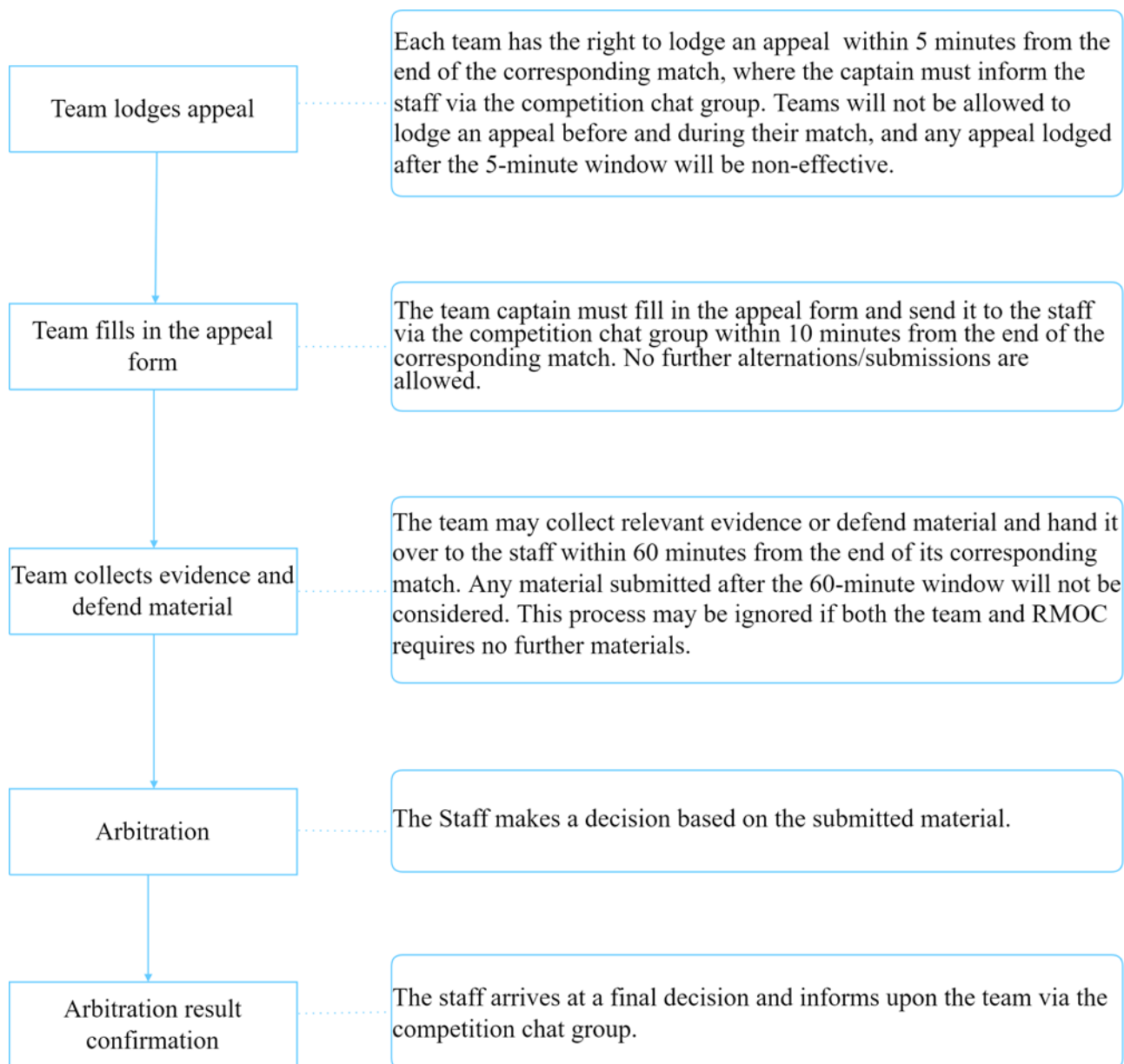
**Material format:** No video may exceed one minute in length. The name of the video must indicate the specific match, the round of the match and the time it was taken (rounded to minutes). The videos should be compatible with the latest version of Windows Media Player; the photos must be in JPG format; 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:



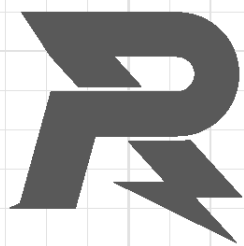
## 9.3 Appeal Decision

The arbitration decisions that can be made include: Maintaining the original match results or ordering a rematch. Teams may not appeal against the decision made by the Arbitration Commission.

If a rematch is required by an arbitration decision, the RMOC will inform the teams of the time of the rematch when announcing the decision. If the team refuses the rematch, the appeal is deemed failed and the original match results are maintained.

## 10. Q&A

After the start of the competition season, the RMOC will set up an official chat group in which it will conduct online Q&A sessions and upload frequently asked questions in the competition onto the group's "Q&A Files".



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