INTERNATIONAL DESIGN COMPETITION ROBOCON 2025

Theme for IDC ROBOCON 2025: Enterprising Spirit, Go Ahead !

Background: －“taking the train to Nanjing”

Shanghai Jiao Tong University (SJTU) is one of the famous institutions of higher learning with the longest history and reputation at home and abroad. It is a national key university directly under the Ministry of Education and jointly built with Shanghai Municipality. After 128 years of unremitting efforts, Shanghai Jiao Tong University has become a domestic first-class and internationally renowned university, and further defined the vision on constructing a “comprehensive, innovative and international” world-class university.

Shanghai Jiao Tong University was founded in Shanghai, China, in 1896, with the goal of cultivating talented professionals for the nation. Today, SJTU has become one of the world's top 100 universities and a key university directly under the administration of the Ministry of Education (MOE) of the People's Republic of China and co-constructed by MOE and Shanghai Municipal Government. SJTU is currently comprised of 6 campuses with more than 300 hectares.

SJTU has 34 schools/departments, 12 affiliated hospitals, 13 affiliated research institutes, 23 directly affiliated units and 5 directly affiliated enterprises, with 18,004 full-time undergraduates, 28,439 full-time master degree candidates, and 1,858 overseas students. SJTU faculty includes 3,887 full-time teachers, 30 members of the Chinese Academy of Sciences, and 27 members of the Chinese Academy of Engineering. As a comprehensive university, SJTU offers 75 undergraduate programs covering 9 major disciplines: economics, law, literature, science, engineering, agriculture, medicine, management, and arts.

Over the 128 years of its history, SJTU has educated more than 400,000 talents for the country and the world, including Jiang Zemin, a former president of China, and Tsien Hsue-shen, China's "Father of Space Science." Other famous SJTU scholars include Wu Wenjun, a great master of mathematics and winner of the first National Supreme Award for Science and Technology, as well as Wang Zhenyi, winner of the

Kettering Prize for cancer research. Over 200 members of the Chinese Academy of Sciences and the Chinese Academy of Engineering are SJTU alumni.

SJTU enjoys an increasingly high scientific research level and technological innovation level. Over the past 2 decades, SJTU has won 99 national science awards, and has led the country for the 14th consecutive year in terms of the number of projects founded by the National Natural Science Foundation of China. In 2023, the number of CNS papers hits a historical high with a total number of 51. SJTU is encouraging talents all over the world.

SJTU also prioritizes the quality of its campus facilities, such as libraries, student innovation centers, laboratories, and sports facilities. Committed to education through culture, SJTU has integrated traditional Chinese culture into the campus culture development and has won a series of awards, such as the ACM world Championship, the iGEM Competition, and the MCM/IMC Contest. SJTU took the lead in organizing a variety of activities nationwide and had excellent performances in sports events, drama, symphony orchestra, and other similar activities.

SJTU insists on enhancing educational internationalization, constantly improving its comprehensive strengths and global influence, exploring a future-oriented internationalization strategy, speeding up the implementation of a new international development plan, expanding overseas layout, building overseas centers, deepening strategic cooperation, and promoting in-depth exchange visits so as to make steady progress towards the goal of establishing a world-class institution of higher education.

Carrying forth the mission of preserving cultural heritage, seeking truth, bearing the responsibility of invigorating the Chinese nation and all humankind, today, this centennial university is sailing towards the goal of becoming a comprehensive, innovative, and internationalized world-class university. Shanghai Jiao Tong University belongs to China, but more so, it belongs to the world.

Students of Shanghai Jiao Tong University are rich in the spirit of patriotism and the sentiment of serving the nation. The most famous patriotic school protection movement in history —“taking the train to Nanjing” took place at Shanghai Jiao Tong University. In May 1947, more than 2,800 students from Shanghai Jiao Tong

University traveled by bus to the train station to Nanjing to petition for the rights of the university, its faculty and students. Forbidden to buy tickets, the students pieced a locomotive found in a garage and 35 carriages together to make a train to Nanjing. However, the government ordered the railroad workers to dismantle the tracks in front of the train to prevent the students from traveling. The students had no choice but to dismantle the rear railroad tracks and join them to the front railroad tracks to make their way to Nanjing. In desperation, the then mayor of Shanghai renegotiated with the students and met all their justifiable demands. The vigorous movement to protect the school ended in a victory for the students.

Interactive Components

1. **Building robot**

There are some obstacles,e.g, deep ditches, steps and slopes in the contest field. The robot should build the bridge with the blocks provided across the deep ditch and runs onto the steps with the bulk provided to pave for the mission robot.

Meanwhile, it should put the bulk to help the mission robot run down from the step.

2. **Mission robot**

The mission robot moves on the road simulating the railroad built by the building robot, and collect the balls and then put them into the specific containers to realize its different appeals.

3. **Control methods**

We provide many different controlling methods. The robots can be controlled with Wifi, RF controller, Raspberrypi 4B etc, when it finishes the task there will be different scores.

At the same time, the students need to design the controlling hardware circuit using the LM2596 DC/DC power module, Raspberrypi 4B, receiver subordinate to the RF controller, L298 motor driver module and the Robot Bluno Romeo etc.

It is recommended that student should refer to detailed technical datasheets and user guidance on their official websites themselves to learn basic application methods when designing the mission robot and the building robot.

Online Mode

Field description

The Field is composed of several obstacles, e.g. small ditches, slopes and steps meaning difficulties on the way the train runs. So , the mission robot must overcome these difficulties to realize its appeals.

It's dimension is about 2400mm (Length)× 2000mm(Width) × 900mm(Height), and slope is about 20°， and the ditch is about 1400mm (Length)× 250mm(Width) × 700mm(Depth)，as show in Fig.1.

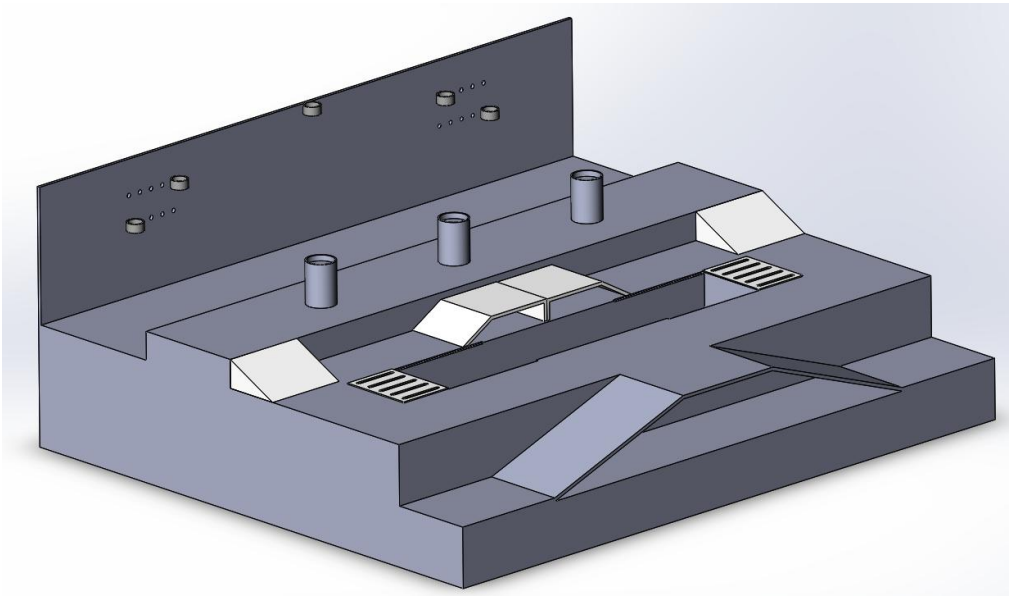

Fig.1 The Contest Field used in online mode

And the contest field will be provided in Solidworks *.sldasm and .SLDPRT format for assembly and separate parts accordingly.

(next contents are as same as what required in RoboCon2024)

Part 1: Overview of required software

- ROS (Robot Operating System) for creating and controlling robot software
- Gazebo for simulating robots in a virtual environment
- CAD software (SolidWorks is preferred) for designing the robot

You may try many time to build the software to run.

Part 2: Designing the Robot and Generating URDF format

1. Designing the Robot

• Use CAD software like SolidWorks to design your robot.

• Ensure that all parts are properly dimensioned and compatible for simulation.

2. Generating URDF (Unified Robot Description Format):

• Export the CAD model to a format compatible with URDF generators (e.g., STL files from SolidWorks).

• Use a tool like .sw_urdf_exporter for SolidWorks or similar in other software to generate the URDF file.

• Validate the URDF file to ensure there are no errors in the robot's structure or syntax.

Part 3: System Requirements and installation

System requirements :

•Ubuntu Linux (recommended version 20.04 LTS) as the host operating system.

•Sufficient disk space (at least 10GB free) and a stable internet connection.

Installation links :

• ROS installation : https://wiki.ros.org/noetic/Installation/Ubuntu

• Gazebo installation : https://classic.gazebosim.org/tutorials?tut=ros_installing&cat=connect_ros

Part 4: Simulating in Gazebo

1. Setting Up the Simulation Environment: Load the provided world description file into

Gazebo to set up the simulation environment.

2. Launching the Simulation: Use ROS to launch the robot model in Gazebo:

roslaunch your_robot_package gazebo.launch

3. Testing and Validation: Perform initial tests to ensure your robot interacts correctly with the virtual environment. Check for mobility and interaction with simulated objects.

HINT_1: you may try various combinations with different kinds of versions of ROS、Ubuntu system and Gazebo to make simulations run normally and smoothly.

Competition Rules and Guidelines

Robot Design (25 scores): Only the mission robot is needed. Participants must use

the same robot design for the online mode as used in the offline competition. Ensure to generate a URDF file for your robot from Solidworks or other software you use.

Simulation (25 scores): All robot simulations must be conducted using ROS on the Gazebo platform. And the environment should run normally.

World Setup (25 scores): A world description file will be provided to all participants. This file must be used to import your robot into the Gazebo environment.

Competition Task:

Path-building: the team could use all the Solidworks file to reconstruct the path for the mission robot in accordance with next steps.

Step 1: remove the media step, because only the mission robot is used;

Step 2: adjust two bulks' position to cover the ditch;

Step 3: import the bulk to reconstruct the path for the mission robot;

Step 4: draw and import the golf ball , the yellow table tennis ball and the white table tennis ball provided;

Step 5: put total 3 golf balls, 3 yellow table tennis balls and 3 white table tennis balls onto 3 columns. There should be 1 golf ball, 1 yellow table tennis ball and 1 white table tennis ball onto one column.

Mission completion:

The mission robot starts from one of two start zones adjacent to the slope, then runs onto the front platform along the slope, runs onto the step through the blocks, runs down the step with the bulk imported and onto the rear platform

Then, the mission robot gets balls from columns then put them into different containers to complete tasks with different scores. Please refer to Table.1.

Table.1 different score with different height and different balls

	Highest Container	Medium Container	Lowest Container
Golf ball	60	55	50
White table tennis ball	40	35	30
Yellow table tennis ball	25	20	15

Score = Robot Design + Simulation +World Setup +Competition Task

Offline Mode(Onsite Mode)

Filed description

The contest field includes many functions and requirements, it is made of wood board without any paint coated on its surface.

Start Zones: There are total four start zones for robots. The zones in blue shown in Fig.2 are the start zones for two mission robots, they are not removable.The mission robots must start from the start zones, and any part of the mission robot can not touch the slope.

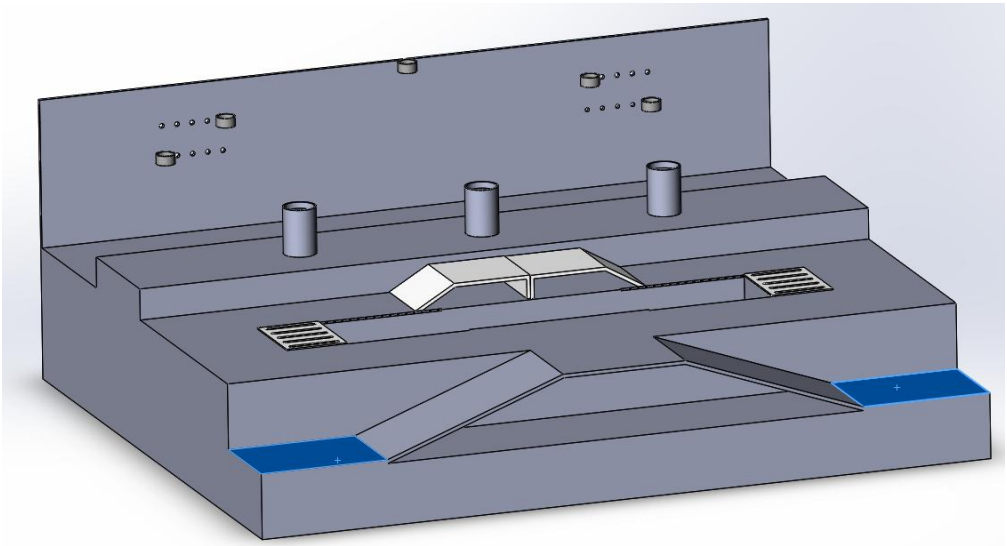

Fig.2 Start zones for two mission robots

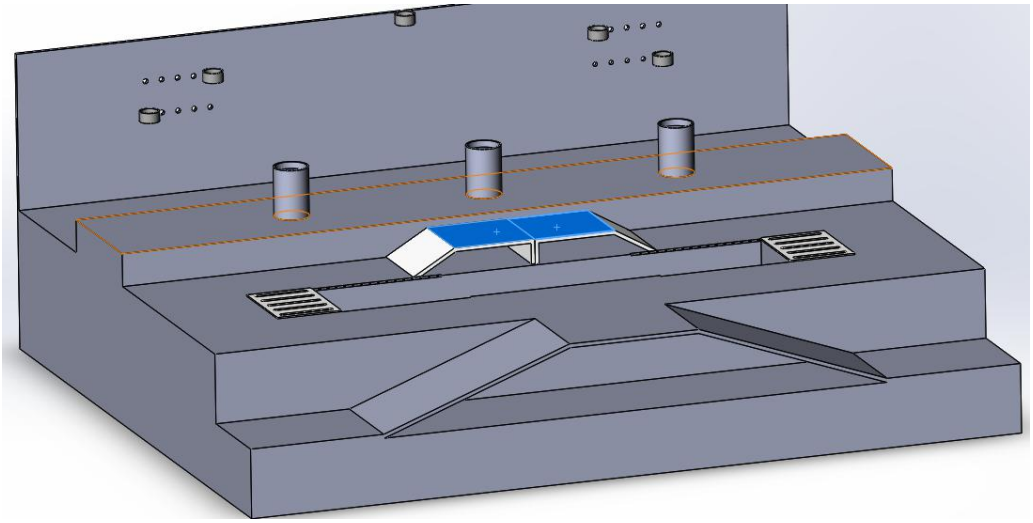

Fig.3 Start zones for building robots

Also, there are two start zones namely media step for building robots, and the

building robots must start from these two zones shown in Fig.3. They will be removed by the referees on-site after the building robot runs down, so they are removable.

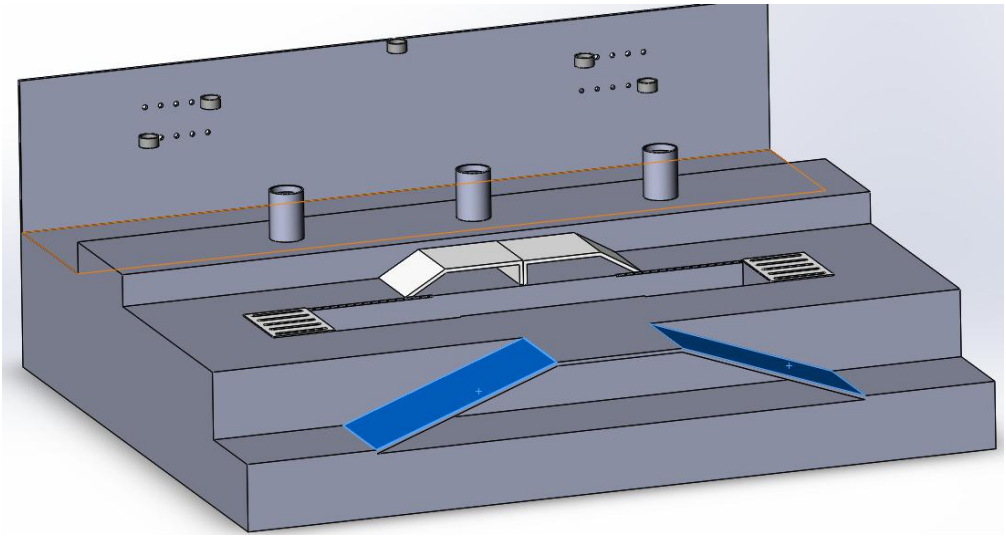

Fig.4 Two slopes for mission robots

The two slopes are build of 20° for mission robots to run from start zones onto the platform, they are not removable. As shown in Fig.4.

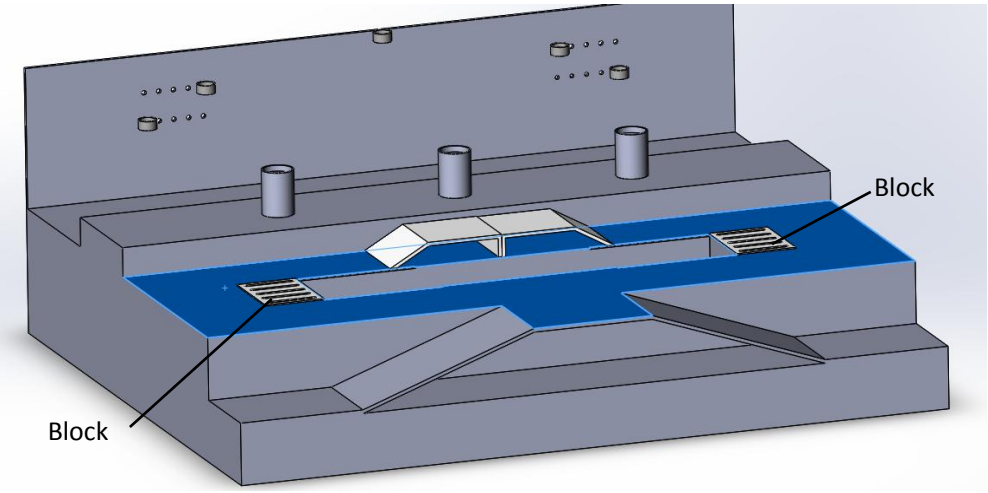

Fig.5 Front platform for the contest field

There are two parts of platform for robot run on, they are horizontal. The first is the front platform shown in Fig.5. There are two blocks made of 4mm acrylic plates for the building robots to make path for the mission robots. According to students' requirements, we may put another 1 plate for him at his side.

Within the scope, there exits a ditch of 1400mm×250mm dimension. To ensure reliability , there designs four 400mm(Length)×10mm(Width)×4mm(Depth) grooves from the left-side and the right-side of the ditch to fix the block.

The second part is the rear platform shown in Fig.6. This part of platform works for the mission robot and the building robot.

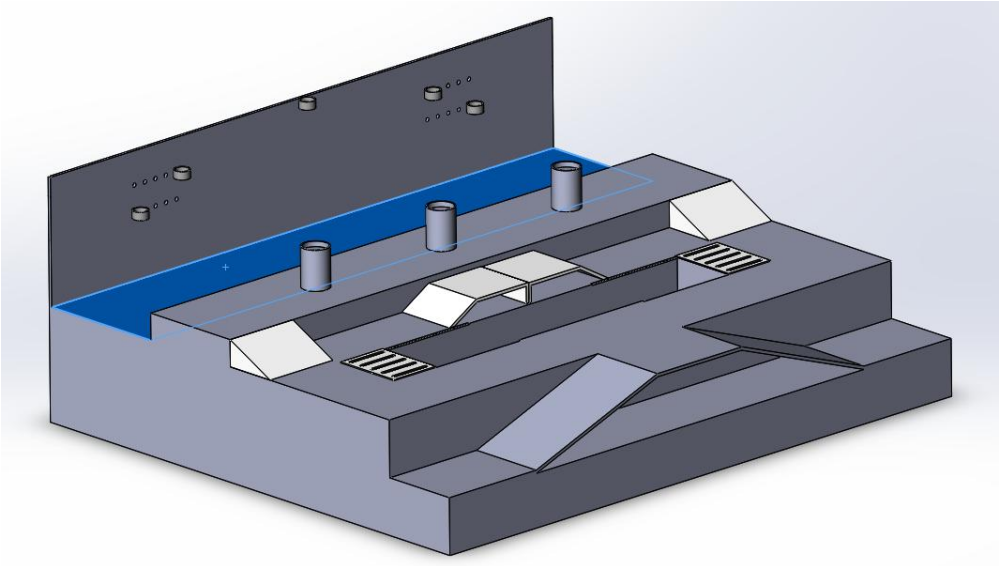

Fig.6 Rear platform for the contest field

There is a 400mm(Width)×100mm(Height) step shown in Fig.7 on the platform, the mission robot and the building robot should run on and run down to complete the task described herein.

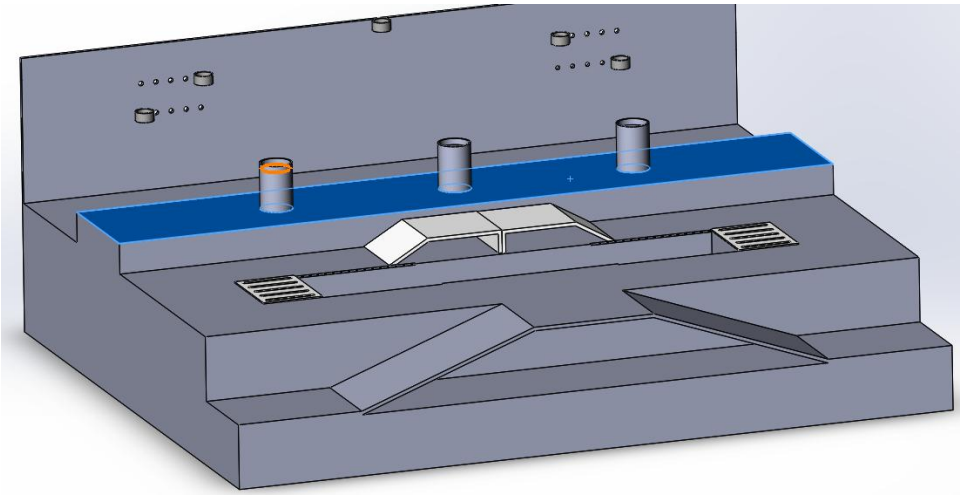

Fig.7 Step

And there setup 3 columns shown in Fig.8, and puts 3 balls on the top of every column, the specifications of balls are shown in the part of **Mission completion.**

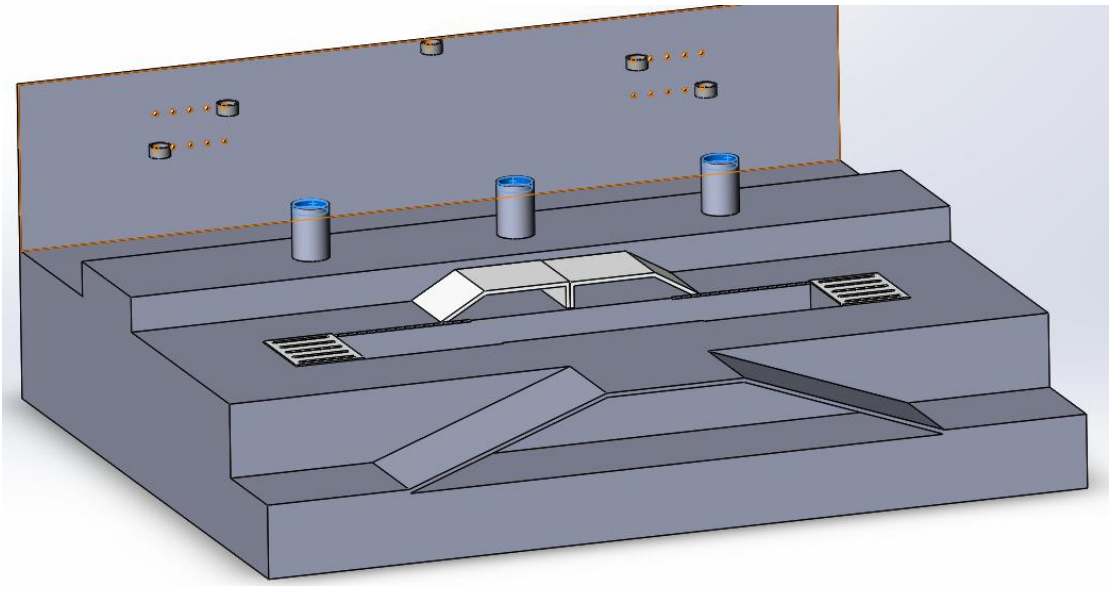

Fig.8 Three columns

There are 3 kinds of containers with different heights to denotes different difficulties to realize the tasks, as shown in Fig.9.

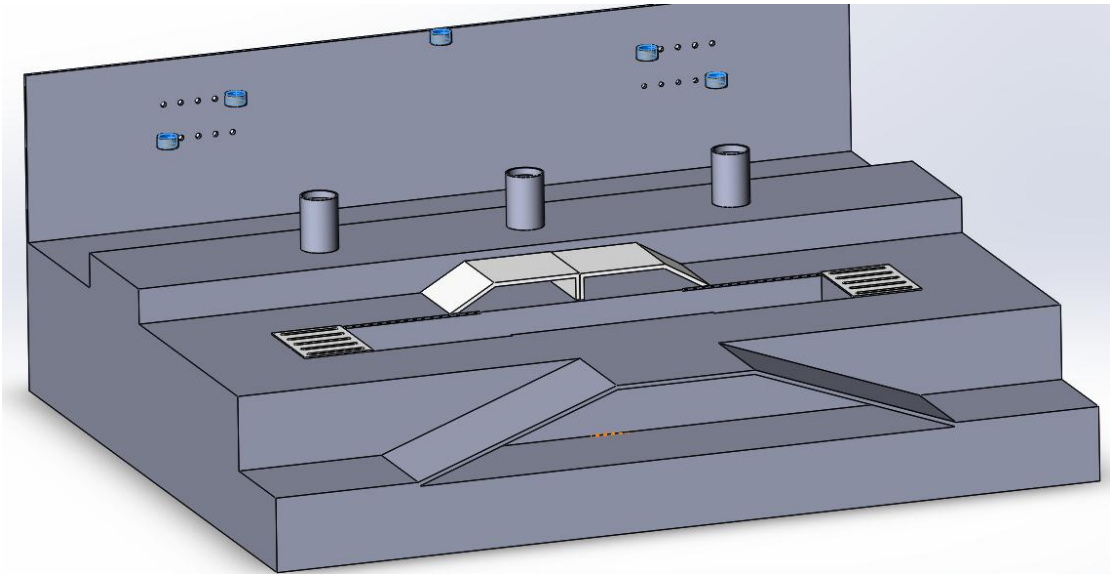

Fig.9 Five containers

Rules and regulations

First step

The mission robot must move from the zones shown in Fig.2 to the platform through the slope, this is the first step to get its first score of 10.

Rule_1: Any part of the mission robot can not touch the slope.

HINT_2: here hides a dimension limitation of designing mission robot

Second step

When the mission robot reaches the platform, it has to stop there. Then the building robot can move, it must start from the start zone shown in Fig.3. After the building robot runs down the media step, the media step will be removed by the referee. And the building robot should pull or push the block with 4mm thickness to cover the ditch to make a railway-like path with one or two blocks. But, if the team uses only 1 block, the bulk is put at the outermost side of the front platform and closed to the step,as shown in Fig.10.

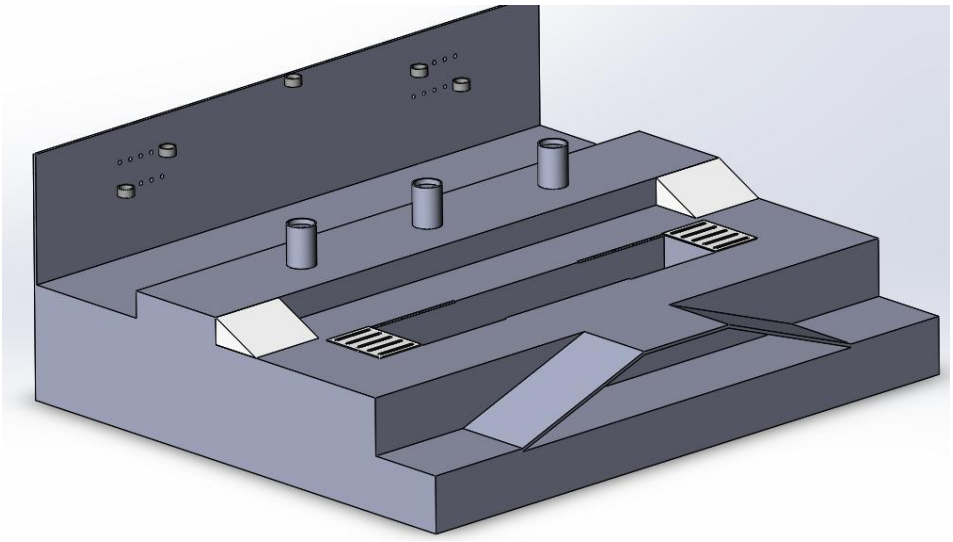

Fig.10 Two bulks at the outermost sides of the front platform

If the team uses two blocks to build the path, he can select the bulk position himself.Once the building robot puts one or two blocks on the ditch, it may get its second score of 20. If the building robot can not put the block on the ditch, its next scores will be zero.

HINT_3: here hinds another dimension limitation of the mission robot, the gravity center also must be calculated and design to maintain its balance when it moves along the slope.

Rule_2: At least 2 wheels must run over the block put on the ditch, the team can get the second score of 20. This means that the building robot make the path successfully.

Rule_3: Once the mission robot stops at the platform, the building robot must start within 2 seconds. Otherwise, the team will get penalty points of 2.

Rule_4: The mission robot can not stop on the platform more than 5 seconds after

the building robot starts. If duration exceeds 5 seconds, the team will get penalty points of 5.

Rule_5: During the building robot pushes the block, the building robot of the opposing team can interfere in your working by not touching your building robot directly within 5 seconds. If duration exceeds 5 seconds, the opposing team will get penalty points of 5.

Rule_6: Once the building robot pushed the block onto the ditch successfully, the building robot of the opposing team can run onto it to prevent the mission robot from running on the block within 5 seconds. If duration exceeds 5 seconds, the opposing team will get penalty points of 5.

Rule_7: Once the mission robot runs onto the block, the building robot of the opposing team is forbidden to destroy, push, pull or drag the block. Otherwise, the opposing team will be direct loss in this game.

What to be mentioned is that the platform excluding the ditch is wide enough to run for the mission robot, but the mission robot is not allowed to run on this part to avoid the path built by the building robot.

Third step

The building robot runs on and then runs down the step and puts the bulk in triangle or other shape closely attached to the step. When the mission robot runs down the step along the bulk and on the rear platform, the team will get the third score of 20.

HINT_4: it is more difficult for the mission robot and the building robot run down the step than they run onto the step.

Rule_8: The building robot of opposing team can prevent the building robot from putting the bulk within 5 seconds without direct touch. If duration exceeds 5 seconds, the opposing team will get penalty points of 5.

Rule_9: After the bulk is put on the rear platform, the building robot of opposing team can push it out of the contest field before the mission robot touches the bulk.

Rule_10: Once the mission robot ran down the step, the building robot of opposing team can hinder it without direct touch within 5 seconds.If duration exceeds

5 seconds, the opposing team will get penalty points of 5.

Rule_11: The bulk can be used as obstacle to prevent the mission robot of opposing team from getting balls. It can be removed by the building robot or the mission robot of opposing team out of the contest field.

If the team operates without this step, the third score will be zero.

Fourth step

The mission robot gets the balls denoting different appeals from the columns after it ran down the step or it rests on the step and put the balls into containers, then the team gets the fourth score according to height it puts the balls in.

IF the mission robot gets the balls and put the balls with AI, and the building robot identifies the step and puts the bulk to assist the mission robot to run down the step, the team will get reward scores (to be determined).

HINT_5: You can combine color recognition with shape recognition to identify the golf ball and the table tennis balls. If you can identify the ball and put the balls into the containers automatically, it can be seen as AI. This should be confirmed by referees.

HINT_6: How to get the balls is one of the biggest challenges for students, you must take many factors into consideration.

Rule_12: The building robot of opposing team can hinder the mission robot in the game not more than 5 seconds. If duration exceeds 5 seconds, the opposing team will get penalty points of 15.

Rule_13: According to mechanic design, you can put one ball securely into the container. But it is possible to put two or more balls simultaneously. Even if your opposing team hits the balls you put out of the container, you will also get the corresp -onding score shown as Table.1.

Rule_14: The fourth score is shown as Table.1.

Rule_15: Only the the balls and other devices rest within the scope of the contest field can be used. Once they roll, slide, hit or be pushed out of the contest field, they can not be used again in the game.

Rule_16:

The total score = 20% ×Score of online mode + 80% ×Score of offline mode

Design Regulations for IDC RoboCon2025

Each team must complete online virtual design with ROS/Gazebo and design two robots, that is, the building robot and the mission robot to complete offline contest.

WARNING: No glue. Any kind of glue is not allowed to use to design the robot. IT IS RECOMMENDED TO USE CABLE TIE, NUT AND SCREW in designing.

Total Specifications

We provide 5 DC motors including one motor with encoder and two different servos to design the robots. The DC motor must run under voltage not more than 12VDC, and the servos must run under 5VDC;

Each team can use the acrylic plate not thicker than 4mm to design the robots, with the total area less than 400mm×400mm;

Each team can use the 3D print material to design the robots with the total weight not more than 100g;

Only the material we provide can be used;

Different control methods, e.g., Radio Frequency control, Bluetooth control, Wifi Control and AI control on Raspberrypi 4B is preferred;

Match Setup and Robot Configuration

•**Pre-Match Configuration**: Teams are allowed to select which side of the field to begin with coin-guessing method;

•**Preparation Time**: Teams can prepare their machines prior to each round in Zone1 and within a 2-minute. The robot can not be touched once it starts.

•**Field Adaptability**: There is no adaptability test time for each team prior to formal contest, you should test the robots comprehensively in turn after the contest field is there.

Special Contest Rules

•**Golden Ball Law**: Once the team puts 5 balls into five different containers, that is, there is one ball in each container, the team will win this contest.

Fair Play

1. **Referee commission:** We will establish a judging panel to ensure fair play;

(next contents are as same as what required in RoboCon2024)

2. Irreversible Scoring: Once points are scored, they cannot be nullified by defensive actions of the opposing team, although further scoring attempts can be defensively blocked.

3. Non-Aggressive Conduct: Any form of aggressive behaviour including damaging, overturning, pushing, or lifting an opponent's robot is strictly prohibited.

4. Contest Field Integrity: Participants must not damage the contest field or any control equipment. Violations may lead to disqualification.

5. Accidental Damage: In instances of accidental damage as judged by the referees, teams may be allowed to repair their robots and a rematch may be scheduled.

6. Human Interaction: No direct physical interference with the robots or any field elements by any human is permitted during matches.

7. Retrieval of Items: Components or objects that exit the arena boundaries must not be reintroduced manually during ongoing rounds.

8. Prohibited Devices: The use of nets or any devices designed to entangle or trap opponents is forbidden. Defensive strategies that do not involve such mechanisms are allowed.

9. Judgment Post-Match: There sets 3 minutes for each game. After the allotted time expires, the referee will declare the winner based on the accumulated scores.

10. Safety Compliance: Machines deemed dangerous by the judges are not allowed, and all safety rulings by the judges are final and must be adhered to without delay.

11. Surveillance and Monitoring: All robots may be subject to random checks during and after matches to ensure compliance with all rules, including size, weight, and material restrictions.

12. Pre-Match Checks: Before each match, robots must pass a pre-match inspection by the judges to ensure they meet all competition specifications and safety standards.

13. Sportsmanship: Teams are expected to always conduct themselves in a sportsman -like manner. Unsportsmanlike conduct, such as taunting, rude gestures, or inappropri -ate comments, will be penalized.

14. Signal Integrity: Teams must not attempt to interfere with the control signals of

opposing teams, whether through electronic jamming or other means.

15. Soccer Rules: The team will get 3 points if he wins, and get 1 point if the game ends in draw. In group matches, the draw is acceptable. But in semi-final and finals, two teams will play off their tie if they pull the game even.

Safety Guidelines

1. **Machining**: the students are prohibited to use lathe machines to make all kinds of mechanical parts
2. **Electric Shock**: the students are prohibited to use the power supply without any safety fuse, and avoiding over-heat of mobile power supply or rechargeable batteries;
3. **Burning avoiding**: the students should use the soldering gun carefully to avoid burning. And the soldering gun is not allowed to plug into power supply when it is not used, and you should unplug it.

There may be slightly changed, then we will renew it as soon as possible.