



2022 BRICS Skills Competition

(BRICS Future Skills Challenge)



TECHNICAL DESCRIPTION

System Integration and Application for Robots with Artificial Intelligence (Offline)

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1. Introduction

1.1 Name and description of the skill competition

1.1.1 Name of the skill competition

System Integration and Application for Robots with Artificial Intelligence

1.1.2 Description of the skill competition

The organization of System Integration and Application for Robots with Artificial Intelligence of 2022 BRICS Skills Competition based on competition platform of system integration and application for robots with artificial intelligence, by artificial intelligence industrial robot platform, machine vision application platform, artificial intelligence cloud platform, PLC and human-computer interaction system, Competitors need through computer, electrical tools, artificial intelligence cloud platform, robot and PLC development platform for offline assessment. The competition is a team skill competition, and each team has two Competitors.

The skill of system integration and application for robots with artificial intelligence, by artificial intelligence include several aspects: system hardware and software installation and debugging, artificial intelligence architecture construction and deployment, PLC control system programming, intelligent robot and visual system programming, human-computer interaction system programming.

The professionals of system integration and application for robots with artificial intelligence need to have the following job skills:

(1) At the customer site, it can apply the knowledge of automation, electrical technology, electrical technology and electronic technology, sensors, industrial robots, data collection, artificial intelligence data processing and analysis, and complete the system hardware and software installation and debugging of artificial intelligence and robot application training platform and machine vision application module.

(2) Can use the AI cloud platform tools to complete the deep learning model training of data, face model training and recognition, speech recognition and other typical applications of artificial intelligence.

(3) Can use the PLC electrical control module to complete the programming of the execution module and the communication setting of each module, and can use the touch screen to design and program the human-computer interaction interface.

(4) Can use the robot development platform to complete the connection and process programming of the robot and the visual system.

1.2 Relevance and importance of this document

This document contains information on the standards required for this skill competition, as well as the evaluation principles, methods, and procedures for managing the competition.

Each expert and competitor must understand and understand this technical description.

If there is any conflict between the technical instructions in the different languages, the English version shall prevail.

2. Skills standard

2.1 General description of the skill standards

Skills standards define knowledge, understanding, and specific skills that are international best practice in technical and professional performance. It will reflect a global consensus on what the relevant job role or profession is represented in industry and business.

The skill competition is designed to reflect the international best practices described by the skill standard and the extent to which it can reach. Therefore, the standard is a guide for the training and preparation required for skills competitions.

The standard is divided into different sections with titles and reference numbers.

Each fraction was assigned a percentage of the total score to indicate its relative importance in the criteria. This is often referred to as "weights". The sum score for all percentages was 100. The weights determine the allocation of the scores in the scoring criteria.

By testing the items, the scoring scheme only evaluates the skills listed in the standard. They will reflect the criteria as fully as possible under the constraints of skills competitions.

The scoring scheme will be performed within the actual possible range to the score assigned in the criteria. A 5% change is allowed, but the weight assigned by the standard specification shall not be changed.

2.2 Skill Standards

Part		Weight (%)
1	professional quality	10
	Competitors need to understand and understand: <ul style="list-style-type: none">– Principles and methods of safety work implementation;– The use, use, maintenance and maintenance of all equipment and	

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	<p>materials and their impact on safety;</p> <ul style="list-style-type: none"> – Environmental and safety principles and their application in good housekeeping; – Principles and methods of work organization, control and management; – Principles of communication and cooperation; – The scope and limitations of the roles, responsibilities and obligations of competitors and others, individually and collectively; – Parameters to be followed when planning activities; – Principles and techniques of time management. 	
	<p>Competitors should be able to:</p> <ul style="list-style-type: none"> – Prepare and maintain a safe, tidy, and efficient working area; – Prepare for the task at hand, including the full consideration of occupational health and safety; – Arrange work to maximize efficiency and reduce schedule disruption; – Abide with safety standards; – Restore the work area to the appropriate state; – Pay attention to teamwork; 	
2	Artificial intelligence application technology	10
	<p>Competitors need to understand and understand:</p> <ul style="list-style-type: none"> – Industrial application of artificial intelligence; – Elements and core technologies of AI system; – Artificial intelligence technology open source algorithm framework structure; – Cloud service cognition, cloud service interface call, cloud service result processing; – Deep learning neural network model principle; – Master the machine learning model training, deep learning model training, deep learning model reasoning application; 	
	<p>Competitors should be able to:</p> <ul style="list-style-type: none"> – Proficient in using the Python computer design language; – Proficient in using the PyTorch open source deep learning platform; – Establishment of cloud platform development environment; – Image acquisition, encoding and transmission; – Face registration and recognition; – Speech recognition and semantic analysis; – Command map establishment; 	

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	<ul style="list-style-type: none"> - Semantic analysis and calling; - Image preprocessing and processing methods; - Image template matching method; - Ethernet communication between Python and PLC. 	
3	machine vision technology	20
	<p>Competitors need to understand and understand:</p> <ul style="list-style-type: none"> - Machine vision system cognition; - Hardware selection of machine vision system: camera selection, lens selection, light source selection - Application characteristics and working principle of machine vision system software 	
	<p>Competitors should be able to:</p> <ul style="list-style-type: none"> - Create, edit, modify, and save a visual scheme - Complete the system debugging, master the system calibration and calibration - Use the visual system software application tools correctly to master the image acquisition, processing and detection - A server or client for establishing TCP communication in the visual system - Machine vision can identify, classify, measure and detect the output results in the peripheral system, and then locate and grasp the objects. 	
4	Intelligent robot technology	30
	<p>Competitors need to understand and understand:</p> <ul style="list-style-type: none"> - The structure characteristics and working principle of the four-axis robot; - Learning and mastering of the robot coordinate system; - Robot motion control principle; - Technical specifications of the hardware technology platform; - General use and use safety of robotics and practical operation. 	
	<p>Competitors should be able to:</p> <ul style="list-style-type: none"> - Installing and operating the robot control software; - Correct install and debug the hardware modules of the robot and its integrated system; - Plan and control the robot movement through demonstration teaching, Blockly programming and script programming; - Master the I / O communication process; - Master the TCP / IP communication process. 	

5	PLC control technique	20
	<p>Competitors need to understand and understand:</p> <ul style="list-style-type: none"> – Basic links of electrical control; – Hardware composition and working principle of PLC; – Programmable controller programming basis; – S7 series PLC hardware system and instruction system; – Design of programmable controller programming application system; 	
	<p>Competitors should be able to:</p> <ul style="list-style-type: none"> – Ability to wire and connect the PLC system; – Ability to wire and connect common electrical components; – Be able to write the electrical module control program in the PLC; – Ability to write the network communication management program in the PLC; – Ability for pneumatic element control and sensor detection; – Capable to install and communicate the configuration software; – Be able to control the operation of the motor module with PLC programming; – PLC program troubleshooting; – Can use PLC to realize the control system sequence control, logic control, delay control and other functions; – Can use PLC communication with external equipment, realize voice control PLC, complete the system debugging; 	
6	Interactive system programming	10
	<p>Competitors need to understand and understand:</p> <ul style="list-style-type: none"> – Understand the basic principles of the graphical user interface (GUI); – Understand the framework of Digia QT5 applications; – Proficient in the configuration and application of HMI. 	
	<p>Competitors should be able to:</p> <ul style="list-style-type: none"> – Build and configure the PyQt5 development environment; – Create controls such as buttons, check boxes, scrollbars, list boxes, etc.; – Use the application to add status bars, toolbars, and menu bars; – Complete the layout management of the interactive interface; – Realize HMI data collection and monitoring and control. 	

3. Scoring scheme

3.1 Scoring method

The scoring of this competition will be completed by the referee group offline. If the competitors cheats or commits other violations during the competition, the referee will deal with them according to the competitors' violations, and the results will be canceled.

3.2 Scoring rules

1. The person with the high overall score ranks first;
2. For those with the same total score, the highest module score will rank first in the order of module A, module D, module C, module B and module E.

According to the above two rules can not discharge the order, the cumulative competition time is short ranking in the top.

3.3 Evaluation basis

During the event design process, the choice of criteria and evaluation methods will be determined through the scoring scheme and test items.

Evaluation basis, including, but not limited to:

- The correctness and standardization of industrial robot module and system installation and wiring
- The correctness and standardization of visual kit installation and debugging
- The correctness and standardization of artificial intelligence cloud platform competition modules such as construction, deployment, model training, face recognition and speech recognition
- The correctness and standardization of the communication connection and programming of the PLC control system
- The integrity and rationality of the touch-screen interface design
- The correctness of artificial intelligence application system connection adjustment
- The correctness and standardization of professional quality and safety consciousness
- Proficiency in using AI cloud platforms

4. Test project

4.1 Common precautions

Whether it is a single module or a series of separate or associated modules, a test item can evaluate the application of knowledge, skills, and behavior as defined in the Standard (Skill Specification).

Combined with the scoring scheme, the purpose of the test project is to provide comprehensive, balanced and real opportunities for standard evaluation and scoring. The relationship between test items and scoring schemes and standards will be a key indicator of quality, as is the relationship between standards and actual work performance.

Test items did not include aspects other than the criteria and did not affect the balance of scores within the criteria.

The evaluation of the knowledge and understanding of the test items is carried out only through their practical application.

4.2 Test the project format / framework

The test item is composed of four relatively independent and connected modules:

Module A: Artificial intelligence application technology

Module B: Machine vision technology

Module C: Intelligent robot technology

Module D: The PLC control technology

Module E: Interactive system programming

4.3 Time allocation and score weight of test items

module	duration (min)	Score weight (%)
Module A: Artificial intelligence application technology	180	30
Module B: Machine vision technology	120	15
Module C: Intelligent robot technology	120	15

module	duration (min)	Score weight (%)
Module D: The PLC control technology	180	25
Module E: Interactive system programming	120	15
amount to	720	100

4.4 Operation content and requirements of each module

The competition covers AI application technology, machine vision technology, intelligent robot technology, PLC control technology, interactive system programming and other contents, and comprehensively examines the technology application and the implementation ability of project tasks in the platform of system integration and application for robots with artificial intelligence.

Module A artificial intelligence application technology: complete the collection and screening of the data set, and then conduct the data annotation. Select the appropriate AI model to complete the model training, import model, cloud deployment and other assessment tasks. At the same time, the deployment and opening of cloud reasoning and face recognition and other service functions, and cooperate with the hardware system to complete the application of artificial intelligence scenarios, the above is the key assessment points;

Module B machine vision technology: using the visual system calibration, positioning, recognition and other functions, design with the robot and visual communication, output visual scheme flow chart, assist the robot to complete coordinate conversion, spatial positioning, complete the workpiece detection, recognition, grasp, coding and other actions, the above is the focus of assessment;

Module C intelligent robot technology: plan and write a reasonable and efficient action process of the robot to avoid operation risks. Through teaching programming and script programming, supplemented by visual system calibration and communication, PLC system communication control, to complete the task action of the robot in the system integration as the focus of the assessment;

Module D PLC control technology: refer to the given PLC initial program, the corresponding I / O address table, the robot sorting operation process and the communication requirements of the upper computer, write the PLC function program, complete the intelligent control of the sensor, motor, cylinder, gas supply system, and the auxiliary system joint debugging is the focus of the assessment;

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Module E interactive system programming:

To complete the interface design of the interactive system, it can realize the interface of practical training account management, instruction issuance, information recording, real-time data synchronization and other functions as the assessment focus on the computer system.

Module number	Module name	Scope of operation
A	Artificial intelligence application technology	<ol style="list-style-type: none"> 1. Installation and debugging of face recognition camera 2. Voice module installation and debugging 3. Collection and screening of the dataset 4. Data annotation 5. Artificial intelligence model training, import model, and cloud deployment 6. Deploy and open cloud reasoning and face recognition and other service functions
B	machine vision technology	<ol style="list-style-type: none"> 1. Installation and debugging of camera, lens and light source 2. Complete the visual calibration file 3. Complete the robot coordinate transformation and visual TCP communication 4. Flow chart of the identification and detection of configuration parameters 5. Cooperate with the integrated system to complete the function item demonstration and the system automation joint adjustment test
C	Intelligent robot technology	<ol style="list-style-type: none"> 1. Install and secure the robot correctly 2. Complete the installation and installation of robot control system and electrical system 3. The robot motion control is completed by teaching, and the robot coordinate system / tool coordinate system is established 4. Complete the robot motion control and system communication by teaching / script programming 5. The installation task requires the system to complete the robot grasping, sorting, coding and other functions

D	PLC control technique	<ol style="list-style-type: none"> 1. Correctly install the PLC master control system components or the associated electrical wiring 2. Confirm that the system wiring is correct, troubleshooting and risk 3. Check the pre-provided PLC initial procedure file against the attachment 4. PLC program for supplementary task requirements, written using ladder id / ST / SCL 5. Download the program to the device, and run the verification system connection adjustment
E	Interactive system programming	<ol style="list-style-type: none"> 1. Install the interactive system software and hardware installation correctly 2. Complete the system software account management function 3. Complete the system software / HMI instruction issuance, function control, order ordering and other functions, and cooperate with the system for installation tasks

4.5 Announcement of test items

The test items will be published via the website.

<http://en.brskills.com/event/BRICSSkillsCompetition/2022-07-14/261.html>

4.6 Changes of test items

Before the official competition, the test items will be 30% changed.

5. Skill management and communication

5.1 The Expert Group

The skill expert group is composed of the chief expert, the deputy chief expert and the expert members, who are responsible for jointly further revising the technical documents of the remote final and the daily skill management.

5.2 Discussion Forum

For questions about software and hardware preparation and test environment deployment before the competition, participants can enter Dobot Chines Forum (<https://forum.dobot.cc/c/Give-or-get-a-lit-help-with-problem-solving>) for feedback in the section of training competition platform of system integration and application for robots with artificial intelligence. The training and exchange of this competition will also be carried out through the forum before, during and after the competition.

Online communication will be carried out using the instant messaging tool wechat (standby: QQ or nail), and the offline discussion forum will be held by the organizing committee to release the meeting time.

6. Safety requirements

6.1 Competition Environment

- (1) The competition site is full of light and good lighting; the power supply facilities are normal and safe; the site is clean and tidy.
- (2) The competition venue shall be set up with isolation belts, and non-referees, competitors and staff are not allowed to enter the competition venue.
- (3) There are security, fire, medical and equipment maintenance on standby to prevent emergencies.
- (4) Safety channels and warning lines should be set up in the competition field to ensure that the personnel for visiting, interviewing and inspecting the competition field are limited to the safe area to ensure the safe and orderly conduct of the competition.

6.2 Safety requirements

(1) Safety training

Before the competition, the equipment management personnel shall conduct safety operation training to the competitors, and the competitors shall strictly follow the safety instructions of the equipment. If the competitors is found to operate the equipment illegally, the referee and the examination personnel shall inform the referee in time and suspend the game. If the competitor finds any operation safety problems in the equipment, he shall inform the examination staff and the chief judge in time for safety treatment.

(2) Safety facilities The stadium must have a safe passage.

The competitors and referees must be clearly informed about the safety passage and

safety location before the game. The field must be equipped with fire extinguishing and placed in a prominent position.

(3) The management and restriction of toxic and harmful substances prohibit the competitors and all participants in the competition from carrying any toxic and harmful substances into the competition site.

(4) Medical equipment and measures The competition field must be equipped with corresponding medical personnel and first aid personnel, and shall be equipped with corresponding first aid facilities.

6.3 Environmental protection

The stadium strictly abides by China's environmental protection law. All the waste in the stadium should be effectively classified and treated, and the unused materials of the competitors should be recycled.

6.4 Epidemic prevention and control

(1) The strategy of "preventing the imported virus and preventing the spread from inside" has been implemented, and various preventive measures have been taken in a timely and effective manner to prevent and control novel coronavirus pneumonia in a legal, scientific and standardized manner, and to ensure "early detection, early reporting and early isolation" to ensure the health and life safety of participants, judges and staff.

(2) Participants, judges and staff to fully understand the epidemic severity, complexity, attaches great importance to will be coronavirus pneumonia and other infectious diseases prevention and control work, in accordance with the principle of management, pay attention to epidemic change, strengthen disease propaganda, timely start plan, to carry out the prevention and control measures, to do the prevention and control work, resolutely prevent the spread of the epidemic.

(3) Protective items (masks) must be worn at all public times, except during competitions and during meals.

(4) Whole-process supervision, set up an isolation area, and establish a green channel for emergencies. Ensure that in case of injury, abnormal body temperature and other emergencies, you can immediately form a seamless connection with the hospital. We will pay close attention to the changes in the epidemic, strengthen disease publicity, launch contingency plans in a timely manner, implement prevention and control measures, do our best to prevent and control the work, and resolutely prevent the spread of the epidemic.

7. Materials and Equipment

7.1 Infrastructure list

The list of infrastructure details all the equipment and facilities to be prepared by the participants, see the "List of Infrastructure of Competition of System Integration and Application for Robots with Artificial Intelligence of 2022 BRICS Skills Competition".

7.2 Competitor's kit

Participants can use their own tools. They need to be approved by technical experts for safety reasons. Tool and tools with open blades shall not be used to avoid damage (except pneumatic hose cutters with a maximum opening of 8 mm of the clamp opening).

Recommended tools for performing tasks:

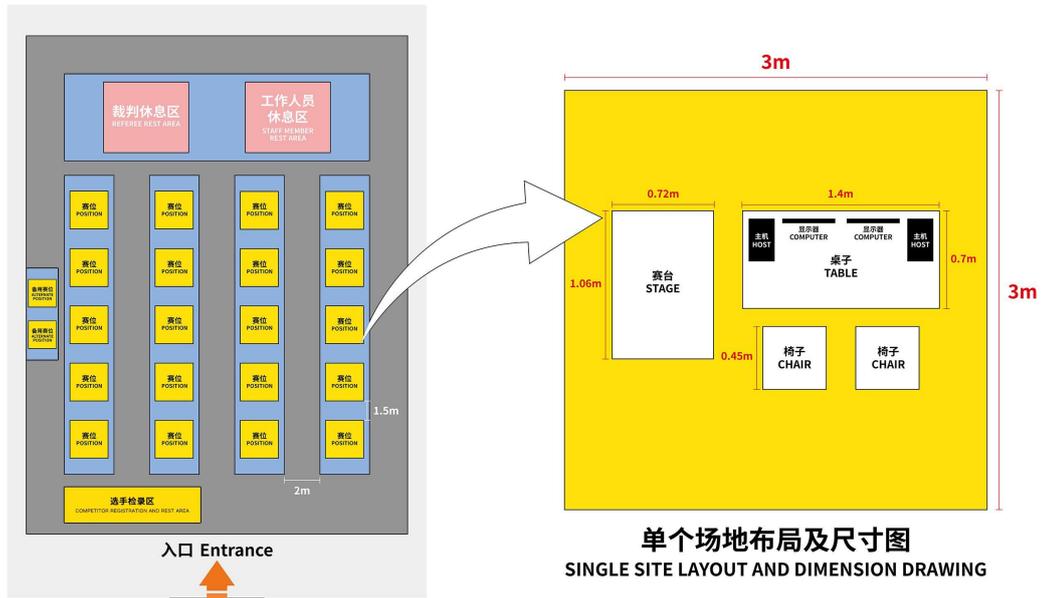
- Screwdriver (one word, cross)
- connection cover cutting pliers
- Electrical inspection pen
- multimeter
- inner hexagon spanner
- band tape

When other special tools are needed, the chief expert of the competition will announce them.

7.3 Materials and equipment prohibited in the skill area

Any materials and equipment carried by the participant shall be declared (presented) to the expert. Experts may prohibit the use of any items unrelated to the performance of the mission or that may confer an unfair advantage on a competitor.

7.4 Suggested competition area and workstation layout



8. Skills-specific rules

Skills-specific rules cannot contradict or prioritize the rules of the game. They will provide specific details and clear illustrations of different aspects that vary by skill competition. They include, but are not limited to, personal computing devices, data storage devices, Internet access, work procedures, and document management and distribution.

Themes / Tasks	Skills-specific rules
Using technology- -U disk	<ol style="list-style-type: none"> 1) Participants can only use the U plates provided by the competition organizers. 2) Do not drive U disks or any other portable storage devices out of the workshop. 3) U disks or other portable storage devices must be given to the Lead expert or Deputy Lead expert for safe storage at the end of each day.
Technology used: personal laptops, tablets, and mobile phones	<ol style="list-style-type: none"> 1) Experts and interpreters can use personal laptops, tablets, and cell phones off the site. 2) Participants are not allowed to bring personal laptops, tablets or mobile phones into the venue.
Using Technology-Personal	<ol style="list-style-type: none"> 1) Participants, experts and interpreters can use the personal photo and video equipment only after the test program is completed or with the consent of the lead expert.

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Camera	
Evaluation of the test items	<ol style="list-style-type: none"> 1) For each workstation (module), the lead expert assigns the supervisor with the highest level of expertise in the field. During the participant's completion of the test program, the expert controls OHS compliance, the completion or failure of the test program points, that can only be assessed during the participant's completion of the task. The designated expert is fully responsible for the fairness of the competitors' assessment. 2) If on the workstation, the participant and the expert are from the same organization, the expert can be replaced once during the duration of the module.
<p>In the test project</p> <p>In, 30%, the changes of the</p>	<p>During the introduction of 30% changes (on Day C-2), the expert must perform the following:</p> <ol style="list-style-type: none"> 1) According to the equipment and software provided by the competition sponsor (all modules): <ul style="list-style-type: none"> -Update the installed assembly drawing (or photo); -Updated the electrical and pneumatic schematic diagram; -Update task point instructions on device software and hardware features provided by competition sponsors. 2) According to the artificial intelligence system data <ul style="list-style-type: none"> -Update the data to be collected; -Update the artifact verification data; -Update the requirements for cloud platform data verification; 3) According to the application process flow <ul style="list-style-type: none"> -Update the visual scheme framework process; -Update the robot motion control function; -Update the automatic operation process scheme of the master control system;
Participants had technical problems during completing their mission	<ol style="list-style-type: none"> 1) If a technical problem occurs during the implementation of the test program (not due to the fault) of the participant, the participant will receive an additional time equal to the time from the discovery of the defect to the complete elimination of the defect. 2) If the technical problem is found to be caused by the fault of the competitor, the competitor will not receive additional time.

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PPE (Personal Protection)	Safety helmet and competition clothes are provided by the competition organizer.
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