2025

BRICS Skills Competition

(BRICS Future Skills & Tech Challenge)

Drone Operation

BRICS-FS-14

Test Project

(International Final)

July 2025

Contents

1. Project introduction

1.1 Project description

The Drone Operation of 2025 BRICS Skills Competition (BRICS Future Skills & Tech Challenge) comprises three components: UAV system assembly, UAV material transportation at low altitude, and intelligent development of UAVs. Contestants must utilize their theoretical knowledge combined with practical thinking to complete assessments on the following platforms: multi-rotor UAV assembly and commissioning training system, intelligent development of UAVs, and UAV AI application. The Drone Operation Event is a double-member contest.

1.2 Competition objectives

(1) Promoting emerging technology application and innovation

Advancing cutting-edge UAV technologies through competitions to deepen the integration of AI, automated control, remote sensing and mapping with UAV operations. This fosters innovative industry applications and accelerates technology commercialization.

(2) Facilitating international skill standards harmonization

Establishing a BRICS UAV technology exchange platform to promote mutual recognition of skill certification systems, safety protocols, and industry standards among member states, thereby supporting global UAV industry standardization.

(3) Cultivating interdisciplinary high-skilled talent

Leveraging competitions to stimulate learning and teaching, this enhances participants' comprehensive capabilities in UAV piloting, task planning, data processing, and troubleshooting - cultivating globally competitive professionals with both theoretical mastery and practical expertise.

(4) Serving regional economy and sustainable development

Aligning with BRICS nations' needs in agriculture, logistics, environmental protection, and emergency response to drive industrial upgrading through UAV technologies, addressing practical societal challenges while advancing sustainable development goals.

(5) Deepening BRICS technical cooperation and cultural exchange

Utilizing skills competitions as a vehicle to enhance collaborative R&D, education/training, and market resource sharing among members, ultimately building a mutually beneficial UAV industry ecosystem that consolidates the "BRICS+" partnership.

2. Abilities that the contestants must possess

Contestants must possess solid expertise in UAV systems, foundational AI algorithm knowledge, engineering logic proficiency, precision operational capabilities spanning assembly/commissioning to task execution, as detailed below:

(1) Be proficient in UAV structure, power systems, and flight control principles.

(2) Understand application logic of AI recognition algorithms for target detection in UAVs.

(3) Complete basic programming tasks using Python.

(4) Select components per task requirements, execute hardware assembly, and perform parameter calibration.

(5) Be proficient in optimizing flight performance using parameter adjustment software.

(6) Optimize flight routes based on payload, range, and weather conditions for safe and efficient operations.

(7) Possess troubleshooting skills for UAV system failures - including diagnostics, maintenance, and final system reactivation.

(8) Articulate technical solutions, delegate tasks rationally, and execute efficiently in team-based tasks.

3. Competitive events

3.1 Competition module

Drone Operation Event consists of 4 modules, which are required to be completed within 5 hours and 30 minutes. Refer to the table below for specific module names and time requirements:

List of Modules and Time Requirements

No.	Module name	Completion time
1	Module A: theoretical professional knowledge assessment	30min
2	Module B: UAV assembly	120min
3	Module C: UAV system maintenance	30min
4	Module D: UAV material transportation at low altitude	30min
5	Module E: intelligent development of UAVs	150min

3.2 Task content

Module A Theoretical Professional Knowledge Assessment

Duration: 30 min

1. Background

With the advance of artificial intelligence, UAV technology is constantly changing the lifestyle of human society and the world. UAVs are expected to be the most disruptive technology in the coming decades, with applications everywhere. The safety of UAVs has always been a topic of great concern. Mature UAV operators may cause flight accidents if they neglect some details. Therefore, all personnel engaged in the UAV industry need to have solid theoretical knowledge and safe flight awareness.

As a professional technician, please answer the questions according to the theories, regulations and professional ability examination provided by the arena, and check your professional theories, flight regulations and professional ability.

II. Task content

Key points: UAV flight principle, aircraft structure and composition, aeronautical meteorology, multi-rotor principle, navigation knowledge, UAV flight management regulations, UAV flight safety, UAV maintenance and UAV control professional quality; task content: the theoretical and regulatory assessments are conducted in the form of standardized problems, which consists of 30 single-choice questions and 10 multiple-choice questions, with manual invigilation or online assessment.

Contestants are required to log in to the https://www.examcoo.com/ website using the account and password drawn by lot to take the online theoretical exam. There are two methods to access the exam after logging in:

1. Click on “My Exam” under your account name in the top right corner, then select “To-Do List” and finally “Exam Notifications”

2. Alternatively, click on “Enter Class”, then navigate to “Class Exams” and select the corresponding “Test”

Upon completing the exam, contestants must submit their answer sheets, signal the referee to record their scores, and thereby complete this module of the competition.

Module B UAV Assembly

Duration: 120 min

1. Background

The quadrotor UAV, a representative model of multi-rotor UAVs, is the most common and widely used form of UAV. Currently, the company has received a production task for a batch of small logistics quadrotor UAVs. The UAV frame is made of carbon fiber and aviation aluminum, and is equipped with a set of logistics grasping payload devices. As a technician, based on the bill of materials, assembly process drawings, and related documents, please select the UAV components from the company’s material warehouse and proceed with the assembly of the frame and payload devices.

2. Introduction to components

The UAV assembly and adjustment kit for this competition features a conventional quadrotor design, with a perforated lower center board that allows for the mounting of various task modules, with its motors configured in an X-type quadrotor layout.

(1) Multi-rotor UAV assembly and adjustment kit

The assembly kit for multi-rotor UAVs includes upper and lower center boards, motor bases, arms, landing gears, and mechanical grippers

(2) UAV payload kit - mechanical gripper module

The mechanical gripper is constructed from hard aluminum alloy material, featuring a serrated edge design on the inner edges. It achieves a maximum open span of 130 mm, with adjustable open span size.

3. Task content

Based on the flight task requirements, preparatory work for UAV assembly should be performed prior to conducting full-airframe assembly and payload systems integration. Specific assembly tasks include: UAV assembly and UAV payload system integration.

Task I UAV assembly and commissioning

1) Task requirements

No.	Description
1	UAV frame assembly
2	UAV system commissioning
3	UAV payload installation and commissioning
4	Sensor assembly and commissioning

2) Technical requirements

The complete UAV assembly must comply with assembly process specifications. Welding operations shall adhere to standardization requirements, ensuring firm welds free from cold solder joints, and conform to applicable national standards and technical regulations.

Payload system assembly must satisfy process requirements, featuring secure installation, reliable operation, smooth movement functionality, and collision-free component integration without mechanical interference.

Task II Flight challenge

Conduct comprehensive testing of the UAV system performance and mounted payload functionality. Pre-flight commissioning and inspections must be rigorously performed. Through manual control of the UAV, execute required maneuvers to verify flight handling characteristics and validate the operational functionality of the payload delivery system.

1) Task requirements

No.	Description
1	Within the flight cage, power on the UAV to conduct motor-off commissioning and pre-flight inspections.
2	The operator executes required task maneuvers in accordance with task specifications.
3	Perform grasping operations targeting irregularly shaped objects using the mechanical gripper.
4	Manually pilot the UAV along the designated flight path outlined in the task book to complete obstacle navigation.
5	Achieve high-precision payload release accuracy across multiple materials.
6	Execute precise landing procedures.

Module C UAV System Maintenance

Duration: 30 min

1. Background

The exponential proliferation of UAVs has expanded their operational footprint across modern society, concurrently elevating demands for advanced damage assessment and repair diagnostics capabilities due to heightened risks of multi-faceted failures and structural compromises during deployment. Furthermore, increasingly sophisticated structural designs integrating cutting-edge sensors, electronic subsystems, and mechanical assemblies necessitate certified technicians to perform accurate fault isolation and damage evaluation when malfunctions occur. This critical process determines root causes and quantifies degradation levels, thereby informing subsequent maintenance protocols and logistics support frameworks. Consequently, UAV damage assessment and repair competitions serve to enhance technical competencies in identifying failure patterns and implementing response protocols across diverse operational scenarios.

2. System components

The equipment consists of a training platform, a flight testing module, an UAV parameter configuration module, and an UAV maintenance and damage assessment system.

3. Task content

1. The maintenance and damage assessment station encompasses a UAV flight test cage, detection tools, UAV units, remote controllers, safety cutoff switches, competition software, and parameter adjustment software. Contestants shall

autonomously select required modules during the event.

2. Contestants must deduce fault causes via remote controller arming procedures and multimeter measurements based on observed failure symptoms. Fault diagnoses shall be submitted through the competition software interface. Correct submissions will trigger automatic fault clearance, while erroneous entries consume one correct answer quota.

3. The competition features multiple fault scenarios deliberately engineered across critical components including the UAV frame, remote control system, flight controller parameters, and others.

4. Within strictly enforced time constraints, contestants must accurately identify all faults, restore full functionality, and activate UAV takeoff via remote controller arming. Subsequent manual flight validation requires executing pitch and aileron control inputs to verify attitude maneuverability. Finalization protocols mandate precision landing followed by rotor locking and system power-down.

Module D UAV Material Transportation at Low Altitude

Duration: 30 min

1. Background

The deployment of UAVs in warehouse material handling operations is accelerating the automation-intelligence convergence within the logistics sector. With advancing UAV capabilities, these systems now execute material transfer, inventory auditing, and rack inspection tasks with elevated efficiency and precision-based execution, slashing labor expenditures while boosting warehousing throughput. UAVs demonstrate distinct advantages in optimizing spatial utilization and accelerating operational tempo, yet concurrently face persistent technical hurdles and safety-critical considerations. Bolstered by regulatory endorsement and technological maturation, UAVs are poised to assume expanding roles across warehouse logistics ecosystems - particularly amid mounting demands for high-density warehousing and automated operational frameworks.

2. Task content

Task I: UAV image information acquisition

The contestants complete flight beyond visual range by using a UAV control application platform equipped with a 3-axis PTZ camera, and shoot and acquire 10 QR code images posted on the target object in the order of 1-4-5-7-9-2-3-6-8-10. The height of the image posted above the ground is 1.5 m. After the acquisition, they proceed to Task II (handling task). After the handling task, they return to the apron and land smoothly towards the tail.

Task II: Using UAVs to handle materials

A material handling area and a material storage area are set on the competition site. The contestants control the application platform by using UAVs to sequentially handle multiple target materials over the designated area, pick up the target materials with a manipulator, fly to the material storage area, and place them in the corresponding material storage area through the manipulator.

There are objects with multiple elements in the materials, and requirements for the location of object handling. The contestants complete the inspection before takeoff, and then signal the referee. After the referee confirms the start of the task through the management task monitoring terminal, the contestants conduct flight tasks according to the sound prompts broadcast by voice.

After confirming that the equipment status is normal, the contestants signal the referee. When they hear the “start” command from the referee, the contestants unlock the takeoff mode and the referee starts timing. Upon task completion, contestants control the UAV to land, and the referee stops timing after the propeller stops rotating.

Module E Intelligent Development of UAVs

Task I: AI Model Training

Duration: 120 min

1. Background

In recent years, natural disasters such as earthquakes, floods, forest fires and landslides as well as various sudden events occur frequently, so higher requirements are required for the speed, accuracy and efficiency of emergency rescue. For example, search for survivors in the ruins after an earthquake, and search for trapped people in flooded areas. Traditional rescue methods are often limited by the environment and difficult to quickly and comprehensively grasp the on-site situation, so more efficient technical means are needed to assist. However, the intelligent aircraft provides new methods to solve this problem. The AI image recognition technology of intelligent aircraft makes significant progress, which can quickly and accurately identify target objects such as personnel, vehicles and buildings in the images and videos captured by UAVs. This is of great significance for quickly determining the location of trapped personnel, identifying hazardous areas, and assessing disaster losses in emergency rescue.

2. Task content

In this module, test the development abilities of the contestants on the intelligent aircraft application platform and the visual recognition of target objects. The typical scenario application competition platform is DJI M350 RTK, which is equipped with DJI Zenmuse H20T 3-axis PTZ load module, Tianyi SDK-TY cloud box onboard computer module, and Tianyi Doper throwing device. It is used for AI recognition

learning and development of target objects at target points, with complete autonomous flight, recognition and photography functions. Labeling AI recognition and labeling software is configured on the competition computer in the arena area. This module requires permission from the referee when executing flight tasks.

After checking the typical scenario application competition platform environment, the contestants shall raise their hands and signal the referee. With the permission of the referee, the data acquisition task result images are stored in the corresponding contestant folder on the workstation computer desktop. The contestants use the acquired inspection object images as the dataset, select relevant delivery target point learning material images, and perform selective deep learning in the Python language environment based on AI recognition learning, to complete the training and development of the AI recognition model. After the AI learning, the contestants shall identify the location for automated delivery of small goods at designated points with the results of deep learning training, and achieve multi-angle automatic photography for evidence collection after automatically identifying the fixed-point target. Finally, they complete the delivery of goods in the designated area based on the identified information.

The reference process for AI recognition model training tasks is as follows:

1. Open the recognition and labeling software to label the target point image material, and select the appropriate labeling result format to ensure subsequent use.

2. All the files required for the competition are stored in the computer task path, and the contestants import the materials and label the results themselves.

3. Complete the model training for AI recognition of target objects by relevant command code programming.

4. Convert the format of the AI model file.

4. AI model verification: After completing all tasks, the contestants raise their hands and signal the referee, copy the verification materials, and verify the materials through their model. The confidence level of each material will be used as the basis for scoring.

The commands and steps for operation codes related to AI training are as follows:

1. Labeling data

2. AI model training

(1) conda activate yolovcude

(2) cd workspace\yolov5\yolov5-6.1

(3) Store label files and training photos in Bastante, training photos in images/train, and label files in labels/train

(4) Enter the Bastante directory to change the labels and paths in the yam file

(5) Start training

(6) Convert the model in the folder path

Module E Intelligent Development of UAVs

Task II: Verification of Typical Application Scenarios

Duration: 30 min

1. Background

In this module, test the development and use of automatic recognition programs by

contestants in intelligent aircraft river garbage inspections, autonomous flight task execution of intelligent aircraft, and image acquisition and data processing capabilities. Focus on the assessment of the contestants' overall planning ability, work efficiency, quality awareness, safety awareness, energy conservation and environmental protection awareness, teamwork spirit and other professional quality levels.

2. Task content

Based on the intelligent aircraft programming and development in Module II, DJI Jingwei M350 RTK is used to automatically acquire rescue area data and automatically throw rescue materials in this module. The contestants shall connect the Tianyi SDK-TY cloud box (referred to as the onboard computer) to the computer. First, program the files inside the onboard computer to develop the automatic throwing function for identifying target objects. Then, import the model results obtained from Module II into the onboard computer with FileZilla software. The contestants import the route file (.kmz) and onnx model, complete the flight recognition of the patrol task on site through real scenarios, and automatically acquire relevant photo information.

3. Task requirements

1. Change the model file name.

2. Store the converted model and route files into the execution folder.

3. The contestants write code for the "main.cc" file in the ty-log/Droper directory on the onboard computer.

Writing requirements: When the onboard computer module runs the recognition

program with the UAV, the camera obtains image information and successfully compares it with AI model data. After that, the aircraft can complete the automatic throwing task. For example, it is required to fly to the first waypoint and open the throwing device port 1 for throwing, fly to the second waypoint and open the throwing device port 2 for throwing, and fly to the third waypoint and open the throwing device port 3 for throwing.

3. After the code writing, the contestants shall compile the code themselves.

4. The contestants install the onboard computer onto the UAV, start the firmware with the remote controller, complete the flight recognition test of the patrol task, and enable the UAV to automatically fly to recognize the target object and throw rescue materials. During the competition, the contestants can repeatedly write, compile and simulate code for a test. After the test, the contestants shall raise their hands and signal the referee to conduct recognition application evaluation (assessment opportunity once per team). Before the assessment, the contestants shall clear all current camera data. After using the routines in the remote controller and PSDK to start the task, the contestants are prohibited from manipulating the UAV remote controller again during flight recognition. The UAV will fly autonomously, complete automatic recognition and photography, and return for landing.

During the automatic detection, when a target object is detected, the intelligent aircraft will descend to a height of about 6 m and throw it in the recognition status. If the UAV does not descend or stops descending halfway, the model comparison fails. The contestants who successfully compare throwing devices will open the throwing port for throwing. After the throwing, the contestants shoot 1 photo directly at the target point to obtain information about the target point. The referee will score based on the results obtained from the target point information and the standardization of the

contestants’ operation.

5. Onboard computer login information

Host: 192.168.55.1

User name: nvidia

Password: nvidia

Port: 22