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Competition for unmanned aircraft vehicle operation competition

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Contents

Foreword

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Competition for unmanned aircraft vehicle operation competition

1 Scope

This document specifies the basic requirements, safety regulations, assessment proportion, competition result evaluation and award setting for the unmanned aircraft vehicle operation skill contest, including but not limited to the resource requirements for personnel, site and equipment for the operation skill contest.

This document is applicable to the holding and organization of unmanned aircraft vehicle operation skill contest.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
unmanned aircraft vehicle;UAV
aircraft managed by control stations (including remote control or autonomous flight), including fixed wing UAVs, UAV helicopters, and multi rotor UAVs

3.2
UAV system
system consisting of UAVs, related control stations, required command and control data links, and any other components specified in the approved model design

3.3
multi-rotor UAV
type of unmanned aircraft vehicle heavier than air, whose flight lift is mainly generated by multiple power driven rotors, and the manipulation of its motion state change is generally achieved by changing the rotor speed

3.4
run within visual range
operation of a UAV within the range where the pilot maintains direct visual contact, with a horizontal radius of no more than 500 meters and a relative altitude of no more than 120 meters

3.5
running beyond visual range
operations conducted by UAVs other than those within line of sight

3.6
flight controller
flight control, also known as unmanned aircraft vehicle flight controller, is the electronic control part of the aircraft, which includes hardware such as main control MCU/sensors/other interface parts. The software includes flight control algorithms, etc

3.7
circuit system
mainly responsible for providing power energy for UAVs, controlling the speed of motors, and ensuring stable and reliable power support for UAVs under various environmental conditions

3.8
sensor system
collection of devices for sensing and acquiring environmental information. This system collects data through different types of sensors to provide key information for UAV flight control, navigation, obstacle

avoidance, target identification, etc.

4 Competition overview

4.1 Name of competition

UAV operation competition

4.2 Name of occupation

The encoding and names of the occupational names (types of work) involved in the competition in the code of occupational classification of the People's Republic of China (2022 edition) are UAV drivers (4-03-04-06), UAV installation, commissioning and maintenance workers (6-23-03-15) and UAV mapping operators (4-08-04-07). The national occupational skill standard level is above Level III.

4.3 Purpose

UAV operation skill competition is an organized mass UAV operation skill competition activity based on the national professional skill standards of UAV drivers, UAV installation, commissioning and maintenance workers and UAV mapping operators, the demands of national economic construction for highly skilled talents and the actual demands of production and service work.

5 Basic requirements

5.1 General world skills standards specification (WSSS) requirements

This document defines the basic knowledge, understanding and specific skills required for UAV technology and profession to achieve the best level of technical and professional work practice, reflecting the understanding of the job and position in the industry. The purpose of the skills competition is to reflect the best international practice described in this document so that it can be implemented. This document is a guide to the training and preparation required for skills competitions.

In the skills contest, knowledge and understanding of UAV technical skills will be assessed by the actual skill performance of the player and the professional level will be determined. The standard specification is clearly divided into sections clearly defined by title and reference number. Each section is assigned a percentage of points to indicate its importance in this document . The sum of all score percentages is 100.

Scoring schemes and competition items only evaluate skills specified in this document. They reflect as fully as possible the requirements of the skill standards and specifications under the specified conditions of the skill contest.

Skills requirements and scoring schemes see table 1.

Table 1 Skills requirements and scoring schemes

NO.	Skill module	Knowledge requirement	Skill requirement	Percentage (%)
1	Work organization and management	Existing health and safety regulations related to the UAV operation industry Use and maintain personal protective equipment and clothing Recommendations and information published by product and equipment suppliers or manufacturers Procedures for maintenance and use of specialized equipment Terms and symbols related to UAV assembly	Capable of applying occupational health and safety regulations to the UAV operation industry Be able to use and maintain personal protective clothing and equipment Capable of setting, using, adjusting and maintaining all professional equipment Promote safe and healthy operations in the workplace The recommendations and information published by the supplier or manufacturer of the	5

Table 1 *(continued)*

NO.	Skill module	Knowledge requirement	Skill requirement	Percentage (%)
		and commissioning Terms and symbols for UAV handling Terms and symbols used in the UAV industry	product and equipment can be applied Compliance with manufacturer's safety instructions	
2	UAV assembly and commissioning	Basic knowledge of UAV system Basic knowledge of UAV control Basic knowledge of aviation meteorology Fundamentals of flight principles Communication basics Basic knowledge of navigation Basic knowledge of flight safety protection for UAV test Basic knowledge of UAV fault detection Basic knowledge of UAV fault maintenance Knowledge of mechanical drawing recognition Basic knowledge of mechanical technology Basic knowledge of materials Basic knowledge of UAV mechanical structure Basic knowledge of UAV mechanical assembly tools and measuring tools Basic knowledge of UAV mechanical assembly process Basic knowledge of UAV mechanical assembly safety protection Basic knowledge of electronic circuit Knowledge of electrical drawing Fundamentals of sensors Basic knowledge of UAV electrical installation tools, materials and instruments Basic knowledge of UAV electrical installation process Basic knowledge of UAV electrical installation safety protection	Complete configuration selection of flight platform Capable of completing UAV layout structure selection Capable of UAV material selection Capable of UAV power system selection Complete flight control and navigation system selection Complete communication system selection Capable of completing takeoff and landing system selection Capable of completing task load system selection Complete machine assembly Capable of mission load system assembly Be able to prepare assembly report Flight control and navigation system debugging Capable of joint commissioning of takeoff and landing system Capable of joint commissioning of task load system Capable of completing UAV performance and function test Be able to prepare test report sheet Complete troubleshooting of the complete machine Be able to prepare maintenance report Capable of completing UAV system upgrade Complete layout structure optimization	30

Table 1 *(continued)*

NO.	Skill module	Knowledge requirement	Skill requirement	Percentage (%)
3	UAV control application	Aviation meteorological knowledge Knowledge of aerodynamics Aircraft flight philosophy Principles of radio communication UAV system knowledge UAV system operating specification UAV aerial photography application knowledge UAV plant protection application knowledge UAV patrol inspection application knowledge UAV security application knowledge UAV logistics application knowledge UAV surveying and mapping application knowledge General emergency operation knowledge UAV maintenance knowledge Basic knowledge of computer operation Related software application knowledge Knowledge of labor protection Knowledge of equipment use Disposal methods for waste batteries, fuel residue, agricultural residue and other wastes	Capable of UAV route planning Capable of UAV task analysis Capable of completing flight risk assessments Capable of conducting preflight inspection Capable of UAV flight control Be able to handle UAV flight emergencies Capable of completing application flight operations Capable of completing flight data processing Capable of UAV maintenance Capable of UAV inspection and maintenance	35
4	UAV programming development	Image recognition knowledge AI Fundamentals Knowledge of 3D Model Route planning principle Flight control capability Image acquisition capability Data processing capacity	Capable of acquiring flight image data Capable of collecting basic modeling data Capable of developing image recognition AI models Capable of building 3D models Capable of autonomous UAV flight path planning Capable of data processing	30
Total				100

5.2 Competition environment

The net height of the competition arena shall not be less than 7 m, with good lighting, lighting and ventilation. The ambient temperature and humidity shall meet the equipment use regulations and meet the normal competition requirements of the participants. The area of outdoor competition arena shall not be less than 7 000 m^2, which is close to the indoor competition arena, convenient for transfer, legal airspace use procedures, and unmanned airspace meets the outdoor flight requirements of intelligent aircraft. In the indoor competition arena, one computer console and two station commissioning tables are arranged for each competition position. The floor area of a single competition position shall not be less than 12 m^2, and the competition positions shall be isolated without mutual interference. The area of each indoor flight test site shall not be less than 9 m^2 and shall be isolated through safety net. The site layout should be rectangular or square, as shown in figure 1; The layout of a single station is shown in figure 2.

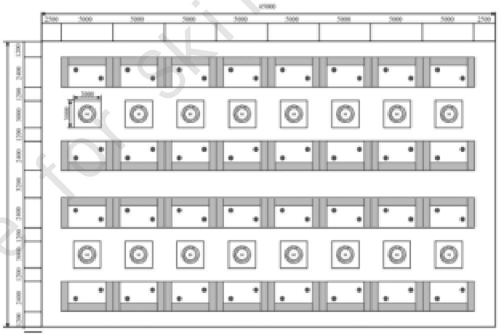

Figure 1 Site layout

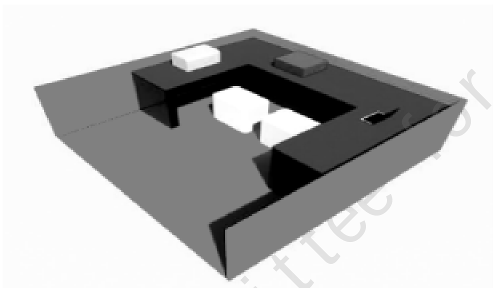

Figure 2 Station layout

5.3 Participants

5.3.1 Requirements for age

Over 16 years of age and under 50 years of age without gender restrictions.

5.3.2 Group mode

There are 5 participants, including 2 team players, 1 interpreter, 1 trainer and 1 leader.

6 Competition content

6.1 General

The UAV operation contest is composed of three modules, including UAV assembly and commissioning, UAV control application and UAV programming development. The competition is based on the application of artificial intelligence technology and environmental awareness technology on the intelligent aircraft carrier. The focus is on the comprehensive technical application ability and professional quality of students in type selection design, assembly and commissioning, flight control, data acquisition, simulation modeling, machine learning, remote control, etc.

6.2 Competition task

The competition consists of 3 modules, including UAV assembly and commissioning, UAV control application and UAV programming development.

Module A UAV assembly and commissioning: the participants shall complete the assembly and commissioning of a multi-rotor UAV by using the alternative parts provided in the competition within the specified time and selecting the reasonable design scheme, so as to achieve the optimal flight performance of the UAV. This module focuses on the comprehensive ability of the competitors in the aspects of UAV overall structure awareness, design selection, assembly and commissioning.

Module B UAV operation and control application: mainly assess the accurate operation and control ability of the UAV flight control platform and industrial application ability of the competitors. The player shall use UAV flight control platform and industrial application loading equipment to complete typical tasks in the industry such as UAV flight control, data acquisition, data processing and load application within the specified time. The scene shall be selected from five scenes: UAV aerial photography, mapping, patrol inspection, plant protection, search and rescue.

Module C UAV programming development: the participants shall complete the collection of basic modeling data based on the image acquisition function of the intelligent aircraft within the specified time. Developed AI model for image recognition based on acquired data, and completed 3D model data acquisition and 3D model establishment of task target area. Based on the requirements of a given application scenario, complete tasks such as UAV autonomous flight path planning, image autonomous acquisition or specific data processing, and complete specific UAV flight control tasks under the application scenario of the industry.

6.3 Score specific gravity

Module A UAV assembly and commissioning 30%; Module B: UAV control application: 40%, with professional quality accounting for 5 points; UAV programming development 30%.

6.4 Duration of competition

See table 2 for competition duration distribution table.

Table 2 Competition duration distribution table

Competition content	Duration (min)
UAV assembly and commissioning	90
UAV control application	10-30
UAV programming development	150

6.5 Project task release

The test questions, evaluation standards and scanned samples are confidential and shall not be disclosed. However, the technical working documents of the competition, competition samples and relevant facilities, equipment, tools, etc. shall be published on the website designated by the technical working committee of the competition before the competition.

The open competition sample questions shall be officially announced no later than 15 days before the competition, and the official competition information platform shall release the competition sample questions to the participants.

6.6 Confidentiality requirements

The final contest will be determined by the chief expert, who shall be responsible for the printing, storage, collection and recovery of the contest.

7 Scoring standard

7.1 Evaluation score

Assessment scoring method: judges score separately, and the difference between judges shall be less than or equal to 1 point.

Judges are evaluated in four levels 0-3. Such assessment is used to make subjective judgment on the quality of the assessment object, and 3 experts are required to participate in the assessment. Each expert shall makes his or her own assessment, in which case the difference between the expert ratings shall not exceed 1 point. If more than 1 point is given, the assessment is invalid and the judgement shall consult as appropriate. The weight table is shown in table 3.

Table 3 Weight and weight table of evaluation

Weighted score points	Description of requirements
0	All aspects are below industry standards, including 'not tried' or unacceptable, and can be used as a 'dangerous example' for demonstration in teaching.
1	Meets industry standards but performs poorly. The execution level is at the beginner level and requires more guidance and practice. It can be demonstrated as a "common mistake" in teaching.
2	Meet industry standards and exceed them in certain aspects. The task is completed at a level that a student can achieve without further guidance or assistance, and can be demonstrated as an 'expected outcome'.
3	Reaching the excellent level of industry standards, perfect. The task demonstrates proficient operation and usage skills, surpassing the conventional industry standards, and can serve as an "excellent example" for demonstration.

7.2 Measurement points

Measurement scoring mode: each group consists of 3 judges. All judges in each group shall discuss together, and only one point shall be given after agreement on the actual score of the player in this item. See table 4 for details of measurement.

Table 4 Example of objective scoring

Type	Example	Maximum score	Correct score	Incorrect score
Full or zero	Motor unlocks responsive and turns correctly	6	6	0
Deduct from full score	There are 6 forms of data related to three types of propellers in the test report. If the data of a single form is incomplete or the data is wrong (there may be a certain error), calculate the missing of a single form, and deduct 1 point for missing one form. Player errors 2.	6	2	4
Accumulation from zero	Observe and record the fault, 0.6 point for each correct fault; Competitors meet the requirements in 2 places.	6	1.2	4.8

7.3 Evaluation and measurement score distribution

See table 5 for details of measurement.

Table 5 Distribution of evaluation and measured values

Module	Competition task	Evaluation score	Measurement score	Total
A	UAV assembly and commissioning	3	27	30
B	UAV control application	10	30	40
C	UAV programming development	3	27	30
Total	-	16	84	100

7.4 Score ranking

Score ranking:

a) The one with higher total score ranks first;

b) If the total score is the same, the module with higher score shall rank first according to the sequence of module B, module A and module C.

7.5 Result release

The chief expert shall be responsible for the preparation of competition documents, venue management and score evaluation. After the score is completed and signed by the judges, the chief expert shall confirm it and submit it to the competition organizing committee for unified publication.

7.6 Awards setting

7.6.1 Certificates

The teams shall be granted a certificate of award issued by the BRICS chamber of commerce and industry.

7.6.2 Gold, silver, bronze and winner awards

The teams of BRICS countries are ranked uniformly, and the top 3 competitors in the competition project shall be awarded with gold, silver, copper medals and certificates; Winner medals and certificates shall be issued to the top 3 players but above 1/2 of the participants; certificates issued to other participants.

7.6.3 Other awards

Issue an execution certificate to the members of the expert panel participating in the arbitration and the executive judgment; The organization making outstanding contributions to the competition shall be awarded the "outstanding contribution award"; The "excellent organization award" shall be awarded to the countries that actively organize the participation, carry out the pre-competition selection training and have no violations during the competition.

7.7 Technical review

The basic points of technical review (summary) are as follows:

a) Competition purpose, technical standards and evaluation; composition of competition modules, proportion among modules and main purpose of arrangement of modules; main technical standards and requirements for each module proposition; the process, rule, method and case analysis of judgment;
b) Analysis on competition of participants; analyze the overall competition results and the specific performance of the participants; through the comparative analysis of the competition results (workpiece) of the participants, summarize the skill highlights and problems reflected in the competition process, and put forward opinions and suggestions.

8 Responsibilities of adjudicators, leaders and translators

8.1 Responsibilities of chief expert

8.1.1 Setup and roles

The chief expert is the top person in charge of the judging team, one of whom is mainly responsible for the overall guidance and supervision of the judging activities of the events. After the competition, organize the technical summary and technical review of the project.

8.1.2 Formulation and approval of rules

Organize the preparation of contest questions and evaluation standards before the competition, and review and confirm the final contest questions and evaluation standards.

8.1.3 Dispute resolution

In case of any judgement dispute during the game, the chief expert shall intervene immediately to ensure that the problem can be solved fairly and quickly.

8.1.4 Coordination and management

Coordinate the work of deputy chief experts, judges, leaders, translators and other team members to ensure smooth judgment process and timely and effective information communication.

8.2 Responsibilities of deputy chief expert

8.2.1 Setup and assistance

One deputy chief expert is appointed to assist the chief expert and jointly ensure the efficient operation of judgment.

8.2.2 Responsibility of agent

When the chief expert is unable to perform his or her duties for some reason, he or she shall automatically take over the duties of the chief expert to ensure the continuity of the judgment work.

8.2.3 Daily work

Participate in the discussion and formulation of evaluation standards, assist in solving technical problems in the evaluation process and provide professional opinions.

8.3 Responsibilities of judges

8.3.1 Team composition

In principle, each team shall appoint one umpire to participate in the field and scoring execution of events, pre-competition training and technical discussion, and master the technical rules of competition.

8.3.2 Implementation of judgment

Independently and objectively judge the technical ability, work quality, innovation and other aspects of the team according to the established evaluation standards. Obey the work arrangement of the chief expert and do a good job in his/her own work; carry out the arbitration in a fair and just manner without favoritism and fraud; stick to the post, strictly abide by the time arrangement of enforcement, and ensure the normal implementation of enforcement.

8.3.3 Record and report

The judgement process shall be recorded in detail and the judgement report shall be submitted to the chief expert or deputy chief expert if necessary, indicating the judgement basis and score distribution.

8.4 Leader's responsibilities

8.4.1 Setup

One leader for each team.

8.4.2 Responsibilities

The team leader shall be responsible for the daily management and discipline maintenance of each team to ensure that the teams abide by the game rules and order. As the contact between the team and the judging board, assist in conveying information and answering questions about the game rules.

8.5 Translation responsibilities

8.5.1 Setup

Interpreter per team.

8.5.2 Responsibility

Translators shall provide multilingual translation services to ensure that there are no barriers to communication between teams, judges and staff from non-native countries. Facilitates cross-cultural understanding, ensures accurate information in the judgment process, and reduces misunderstanding due to language differences.

9 Selection and generation of judges

The chief expert shall be generated by direct transfer and selection. chief experts to be selected shall be selected by the organizing committee according to the selection conditions and work scheme.

The deputy chief expert shall be nominated by the chief expert to the organizing committee for approval and filing. The chief expert and deputy chief expert shall be finally announced by the organizing committee. In principle, one umpire is recommended for each team. If the number of judges fails to meet the needs of the work, the chief judge shall propose an application for increasing the number of judges no later than 6-8 weeks before the game. After discussion by all judges and approval by more than 2/3, the application shall be submitted to the executive committee for review and to the organizing committee for approval.

10 Judge management

10.1 Training

10.1.1 Training contents

The latest development trend of UAV operation technology, international judgment criterion, judgment system operation, ethics and crisis management, etc.

10.1.2 Training mode

The online and offline methods are combined, including theoretical learning, case analysis, practice drills, etc.

10.1.3 Examination and verification

Upon the completion of the training, the written examination and practical operation examination shall be passed to ensure that the judges meet the post standards.

10.2 Evaluation

10.2.1 Evaluation period

During and after the game, the judges' professional ability, fairness, teamwork attitude and professional ethics shall be comprehensively evaluated.

10.2.2 Evaluation method

At the end of the game, under the guidance of the organizing committee, organize staff, judges and other personnel to evaluate the work of the chief expert in real name through online mode. The chief expert assesses the work of the deputy chief expert and the judges.

10.2.3 Application of results

The evaluation shall be carried out according to three grades: A (excellent), B (ordinary) and C (poor). The evaluation results serve as the reference basis for the judges to participate in similar events in the future. Those who perform excellently shall be commended, and those who fail shall be guided or adjusted.

11 Technical platform

11.1 Software platform

11.1.1 Operating system

Win 10 , 64 bit Astra Linux,Linux_Mint, Harmony PC, etc.

11.1.2 Text processing software

MS-Office, WPS-Office, CalliSuite, Adobe Reader, etc.

11.1.3 Industrial application software

Photoshop,Adobe premiere,DaVinci Resolve, Shear mapping etc.

11.1.4 Mapping application software

Context Capture, DJI Drawing, etc.

11.1.5 Programming development software

IDLE, Pycharm, CI, Visual Studio, Vscode, etc.

11.2 Hardware platform

11.2.1 Model and parameters of UAV assembly and commissioning system kit

Model and parameters of UAV assembly and commissioning system kit:

a) The rack layout is "X"; wheel base of machine ≥ 250 mm;
b) Body material: carbon fiber and aviation aluminum; equipped with ABS plastic removable shell; the whole system adopts box design, the box adopts aviation box material, and the lining adopts EVA sponge material; use scenarios; Indoor and outdoor;
c) The maximum flight time shall not be less than 5 min and the maximum takeoff weight ≥ 1 kg;
d) Supporting range of working environment temperature: - 10 ℃ to 40 ℃;
e) Maximum rising speed ≥ 4 m/s; the maximum descending speed is ≤ 5 m/s; maximum horizontal flight speed ≥ 7 m/s;
f) Maximum allowable wind speed ≥ 8m/s; hovering accuracy, vertical ± 0.5 m, horizontal ± 1 m (GPS status); the maximum elevation angle shall not be less than 35 °;
g) The lower central board of the engine block is designed as a PCB circuit board, and the electronic circuit is designed as a buried circuit board. The PCB circuit board is provided with obvious signal line serial number identification to prevent installation line sequence error during assembly and commissioning. Plug-in and plug-out design is adopted for connection plug to ensure reusability;
h) QR code icon is attached to the body. By scanning the QR code icon, students can view the assembly video of the model on the mobile terminal. It is convenient for students to call and check the teaching progress at any time during the assembly process, and the model shown in the assembly video is consistent with this model;
i) Specification and model of brushless motor: stator diameter ≥ 23 mm; Height ≥ 12 mm; Kilovolt ≥ 1 000 KV, with positive and negative thread;
j) Blade specification and model: blade size ≥ 76.2mm; Material: plastic;
k) Electrical regulation specification and model: continuous working current ≥ 30 A, maximum instantaneous current ≤ 40A, applicable to 2S-6S battery;
l) Battery: battery specification ≥ 4S/2000 mm/14.8 V, discharge ratio ≥ 30, lithium battery;
m) The intelligent flight controller is designed with aviation aluminum shell, which is light in weight, reduces magnetic interference and enhances flight control stability; The built-in integrated buzzer of flight control is free of external buzzer module; FLASH storage ≥ 8 MB, power supply range 4.8 V to 5.5 V;
n) The sensor module at least includes an air speed sensor module, a magnetic compass sensor module, a barometric altimeter module, a gyro sensor module, a CAN bus module, an audio alarm module, an indicator module, a low-voltage differential power supply module, a flight data storage module, a level conversion module, a parameter storage module, a master controller module, and an input/output controller module; The peripheral serial port shall at least include the peripheral data transmission serial port, RTK serial port, GPS serial port, external compass, optical stream serial port: TF serial port;
o) Flight mode at least supports fixed point mode, fixed height mode, mission mode and return mode;
p) Flight control shall at least have the functions of magnetic compass anomaly correction, single parameter adjustment, multi-sensor fusion and ultra-fast secondary development;
q) The remote controller supports at least SUS and PWM signal output, with operating voltage of 7.4 V to18 V. DSSS&FHSS hybrid dual spread spectrum technology is used to realize combination of anti-jamming and anti-jamming. The number of remote controller channels is not less than 8.

11.2.2 Parameters of UAV application flight platform

Parameters of UAV application flight platform:

——Symmetrical wheelbase of machine body: 250mm ≤ wheelbase ≤ 1 050 mm;
——The boom spreading mode shall be foldable; Scaffold installation mode: quick removal and installation;
——Spreading size: ≥ 810 mm × 670 mm × 430 mm;
——Maximum load ≥ 1kg, maximum takeoff weight ≥ 2.5 kg;
——Operating frequency: 2.4 GHz to 3.6GHz; 5.580 GHz to 5.725 GHz;
——Hovering accuracy: ± 0.1m (normal operation of visual positioning), ± 0.5 m (normal operation of GPS)
——Maximum rotational angular velocity: pitch axis ≥ 300 °/s, course axis ≥ 100 °/s;
——Maximum rising speed ≥ 6m/s, maximum falling speed ≥ 5 m/s; Maximum horizontal flight speed ≥ 23 m/s;
——Maximum flight altitude ≥ 5 000 m;
——Maximum wind speed ≥ 12 m/s;
——Protection grade ≥ IP55;
——Maximum flight time (no-load): no less than 50min;
——Maximum map transmission distance (without occlusion and interference) ≥ 15 km;

——Operating environment temperature: - 20℃ to 50℃;
——The remote controller is provided with a built-in bright touch screen, and the size is not less than 177.8mm;
——Bluetooth, satellite positioning and other functions, and support connection to the Internet through Wi-Fi or 4G wireless network card;
——It supports the operation with built-in battery or the combination of built-in battery and external battery;
——There are at least three ways to operate and control the aircraft with remote controller; The remote controller has an aircraft mode switch;
——The battery type of remote controller is LiPo, and the endurance time is not less than 5 h; And the charging time is less than 2h;
——Effective lighting distance of supplementary light ≥ 5 m; Lighting mode: normally on;
——FPV camera resolution shall not be less than 960 p; Frame rate ≥ 30 fps;
——Have automatic return function and at least three return modes; Landing protection function;
——With flight data recording function, all flight data can be stored in the aircraft, the aircraft is kept connected to the computer, and the flight data can be exported through corresponding software;
——Built-in RTK module of the aircraft can provide strong anti-electromagnetic interference capability and ensure reliable flight under complex strong magnetic interference environment;
——The aircraft shall provide at least 3 PSDK expansion interfaces, and the external power supply capacity of PSDK expansion interfaces shall be ≥ 17 V;
——Supporting advanced dual control mode, applicable to simultaneous operation of one aircraft by two persons;
——Supporting two-way 1080 p map transmission；
——The aircraft supporting software APP supports route planning, automatic operation and other functions;
——Aircraft health management system: including abnormal diagnosis, log management, maintenance guidance and other modules;
——Geographical fence system is provided to provide real-time airspace information and flight safety and flight restriction information to realize flight restriction function in special areas.

11.2.3 Three axis gimbal load parameters

The parameters of the three-axis gimbal load are as follows:

a) Waterproof grade ≥ IP44, human eye safety grade ≥ Class 1M;
b) Equipment storage temperature supports - 20 ℃ to 60 ℃;
c) The PTZ installation mode supports dismountable type;
d) Pan/tilt angle jitter ≤ ± 0.01 °;
e) Zoom camera image sensor 1\1.7 CMOS, effective pixel not less than 20 million;
f) There are at least two exposure modes, and automatic and manual program exposure are supported;
g) It supports at least two light measurement modes: point light measurement and central key light measurement, and at least supports light measurement locking;
h) The maximum speed of electronic shutter shall not be less than 8000/s;
i) Photo ISO range: 100~25600;
j) Video resolution not less than 3840x2160 @ 30fps;
k) Supporting at least the format of MPEG video shooting and JPEG photo shooting;
l) Effective pixels of wide-angle camera shall not be less than 12 million;
m) Video shooting resolution of wide-angle camera shall not be less than 1920 × 1080@30fps;
n) The thermal imaging camera senor is an uncooled vanadium oxide microbolometer;
o) At least 1x, 2x, 4x, 8x digital zoom;
p) Video shooting resolution of thermal imaging camera shall not be less than 640 × 512 @ 30 Hz;
q) Temperature measurement mode at least supports point temperature measurement and regional temperature measurement;
r) At least support high temperature alarm function;
s) The wavelength of laser range finder shall not be less than 905 nm;
t) The measuring range of laser range finder shall not be less than 1200m;
u) The zoom factor of mixed optical zoom of camera shall not be less than 23 times;
v) At least support linkage shooting mode, zoom, wide angle and thermal imaging camera to take photos/video at the same time;
w) The maximum zoom multiple shall not be less than 200 times;
x) At least support pointing function, ultra-clear matrix shooting function and night scene shooting mode;

y) The focusing mode at least supports manual focusing, automatic continuous focusing and automatic single-point focusing;
z) Infrared thermal imaging shall at least provide color palette, isotherm, point temperature measurement and digital zoom functions.

11.3 Varieties of tools and raw materials

Relevant tools and raw materials are required for UAV assembly, commissioning and performance test, and the specific requirements are shown in table 6.

Table 6 List of tools and raw materials

No.	Tool materials	Quantity
1	M1.5 Hexagon screwdriver	1
2	M2.0 Hexagon screwdriver	1
3	M2.5 Hexagon screwdriver	1
4	M3.0 Hexagon screwdriver	1
5	Flat head screwdriver	1
6	Cross head screwdriver	1
7	Diagonal cutting pliers	1
8	Wire stripper plier	1
9	Wallpaper knife knife	1
10	Soldering iron holder	1
11	Soldering tin wire	1
12	rosin	1
13	Electric soldering iron	1
14	Hot air gun	1
15	Power battery measuring device	1
16	Multimeter set	1
17	Horizontal measuring column	1
18	File cutting machine	1
19	Screw gum compound	1
20	Banana head welding platform	1
21	Test pencil	1
22	USB parameter modulation line	1
23	Hot melt glue gun	1
24	Solder suction device	1

Table 6 *(continued)*

No.	Tool materials	Quantity
25	Straight head nipper	1
26	Elbow nippers	1
27	Glue bar	6
28	List of Items	1

12 Site

12.1 Site environment

12.1.1 Water, electricity and gas

Stable water, electricity, air source and power supply emergency equipment shall be provided, and standby power supply equipment shall be provided.

12.1.2 Competition space

The clear height of indoor site shall not be less than 3.5 m, with good daylighting, lighting and ventilation, and the ambient temperature and humidity shall comply with the equipment use regulations, with a comprehensive CCTV monitoring environment. The outdoor site shall be free of obstacles within the site and 20 m outside the site, and shall be provided with all-around CCTV monitoring environment.

12.1.3 Racing position area

The single station for indoor competition shall be over 12 m^2 and the single station for outdoor competition shall be over 50 m^2 which shall be isolated from each other, so that the competitors can carry out the competition independently without being affected by the outside world. In addition to the normal competition position, more than 2 standby positions shall be set.

12.1.4 Track passage

The main passage shall more than 3 m wide and meets the safety emergency evacuation standard.

12.2 Site layout

Such public service areas as maintenance service, medical and living supply stations shall be set up at the venue to provide services for the players and participants.

The competition area shall be provided with player operation area, competition preparation area, judgment area, scoring area, material preparation area, confidentiality room, arbitration room, recording area, site service and technical support area, rest area, medical area, observation channel (arranged according to the layout of the venue), etc.

12.3 Site management

Venue management should focus on the following aspects:

a) Warning lines and safety areas shall be set around the competition site to prevent irrelevant personnel from entering;
b) Observe and interview personnel in the safe passage;
c) At the end of each stage (module) competition, when the participants leave the venue, the adjudicator shall organize the inspection of the facilities, equipment, competition workpiece (results), tools, materials, etc. of each station, and uniformly arrange the demobilization;
d) For equipment requiring initialization and parameter restoration, the chief judge shall handle it with experts and judges to ensure the consistency of competition environment.

13 Competition safety

13.1 Safety training

The safety director organizes all judges, staff and players to receive safety training, and may participate in the competition only after passing the training examination.

13.2 Safety facilities

The following aspects should be taken into account for safety facilities:

a) The layout of the competition venue, the equipment and devices inside the venue comply with safety regulations, and construction is strictly carried out in accordance with safety construction standards;

b) There are necessary safety isolation measures and safe passages in the arena, equipped with complete emergency response facilities such as fire extinguishing. Post safety operation procedures in prominent locations and set up safety evacuation signs;

c) Set up security check equipment at the entrance of the competition venue and prohibit the entry of unauthorized items;

d) Management and restriction of toxic and harmful substances;

e) Prohibit athletes and all participants from bringing any toxic or harmful substances into the competition venue;

f) Chemicals used in competitions must be accompanied by safety operating instructions. When using hazardous chemicals, it is necessary to wear safety protective equipment that complies with relevant regulations and operate in a standardized manner.

13.3 Medical equipment and measures

The competition site shall be equipped with corresponding medical personnel and first-aid personnel, as well as corresponding first-aid facilities and plans.

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