

Shenzhen Feima Robotics Technology Co.,Ltd.

Website: www.feimarobotics.com

Contact us: marketing@feimarobotics.com
overseas@feimarobotics.com



**FEIMA
ROBOTICS**



E2000S

Feima Intelligent Photogrammetric System

High-precision aerial photogrammetry and
three-dimensional reconstruction of the real world

Shenzhen Feima Robotics Technology Co., Ltd. (hereinafter referred to as Feima Robotics), a Chinese high-tech company, has been jointly founded by senior executives and specialists from IT and UAV domains, with a considerable industrial technology accumulation and marketing experience, as well as IT product design and industrial manufacturing experience. The company has R&D centers in Shenzhen, Beijing and Tianjin, with a R&D team of more than 200 people. After more than 20 years' accumulation of technology and market experience in the drone industry, combined with product design and industrial manufacturing experience in the IT field, it is committed to providing customers with one-stop geospatial data solutions.

Feima Robotics adheres to the core values of innovation, value, and trust, and aims to become a leader in the global civilian drone industry and survey field. So far, based on the Chinese domestic aerial photogrammetry and remote sensing fields, Feima has already released 19 types of intelligent aerial photogrammetry/remote sensing/inspection/emergency UAV platforms, including F series, D series, V series, P series, and 3D mobile measurement products such as handheld laser scanner named SLAM100, S-RTK100 and S-Pack100. Feima Robotics has gained a wide range of user groups and a solid user reputation in China and some overseas countries.

Feima Robotics has two wholly-owned subsidiaries and a training center, namely Beijing Feima Hangyao Technology Co., Ltd., Tianjin Feima Robotics Technology Co., Ltd. and Tianjin UAV System Application Training Center respectively.

High-precision aerial photogrammetry and three-dimensional reconstruction of the real world

E2000S

Feima Intelligent Photogrammetric System

E2000S is an intelligent aerial photogrammetric UAV system launched by Feima Robotics for professional users to meet the needs of high-efficiency, high-precision, and high-precision aerial photogrammetry and remote sensing applications. It is equipped with a 24.3 million-pixel aerial photographing module which can support two operating modes, i.e., orthographic and oblique. The standard take-off weight of the E2000S is 2.8 kg, the standard load is 200 g, and the endurance time is 60 minutes.

E2000S is equipped with a high-precision differential GNSS board and dual-differential antennas, and can optionally be equipped with a physical GNSS base station to realize large-scale image-free control applications based on RTK and PPK fusion calculations. The E2000S comes standard with the software named UAVManager Professional Edition, which has various route modes for different application requirements and supports accurate three-dimensional route planning, precise terrain following flight, three-dimensional real-time flight monitoring. Also, the software supports GNSS fusion calculation, control point measurement, aerotriangulation, one-key to output and browse multiple data results such as TDOM, DOM, DEM, DSM and so on.



System parameters

Net weight	2.8 kg
Symmetrical motor wheelbase	598 mm
Dimensions (excluding blades)	495 mm × 442 mm × 279 mm (Unfold) 495 mm × 442 mm × 143 mm (Fold)
Navigation satellites	GPS, BeiDou, GLONASS
Power mode	Electric
Maximum speed	20 m/s (When the UAV platform is tilted 25 degrees)
Endurance	60 mins
Range	50 km
Working temperature	-20 °C ~ 45 °C

Maximum climb speed	8.0 m/s (manual), 5.0 m/s (automatic)
Maximum descent speed	5.0 m/s (manual), 3.0 m/s (automatic)
Hovering accuracy in RTK mode	Horizontal 1 cm + 1 ppm, Vertical 2 cm + 1 ppm
Differential GNSS update frequency	20 Hz
Maximum take-off altitude	4000 m
Wind resistance	Grade 6 (10.8 m/s ~ 13.8 m/s)
Task response time	Unfold ≤ 10 mins, Withdraw ≤ 15 mins
Control radius	10 km
Take-off and landing mode	VTOL without remote control



Platform configuration

Order	Part name	Unit	Quantity
1	E2000S UAV platform	Set	1
2	E2000S ground data transmission module	Set	1
3	UAVManager Professional Edition (Surveying Edition E)	Set	1
4	E2000S intelligent battery	Groups	2
5	E2000S intelligent battery charger	Set	1
6	E2000S transport box	Set	1
7	E-CAM2000 aerial photogrammetric module (24.3 M)	Set	1

Image control-free topographic mapping

E2000S is equipped with 20 Hz high-precision differential GNSS board; At the same time, it is equipped with 24.3 M pixel APS-C frame sensor, supports orthophoto and oblique operation modes, has GCP-free mapping capabilities, and can adapt to various aerial survey applications.

Long endurance, high efficiency and high reliability

The hovering time at sea level for a single flight is 60 minutes. The modules such as IMU, barometer, magnetometer, and GNSS module adopt redundant design. The components such as ultrasonic wave, optical flow module and double differential antennas are utilized to provide multiple guarantees. A number of components and the whole UAV platform have passed the reliability test to ensure product safety and reliability.

Dual-differential antenna

Double dual-differential antennas are the standard configurations of the E2000S, which enhance the anti-interference ability and help to operate in complex environments such as mining areas, bridges, and ship-borne take-off and landing platforms.

Precise terrain following flight

Combined with the software of UAVManager Professional Edition, the E2000S can achieve accurate terrain following flight, improving the image acquisition resolution and ensuring the consistency of image resolution.

Automatic obstacle avoidance

E2000S is equipped with a front-mounted milliwave radar obstacle avoidance module, which can automatically detect obstacles ahead and improve the safety level.

One-stop software solution and advanced data processing workstation

The software of UAV Manager Professional Edition supports the whole process from accurate 3D flight route planning, 3D real-time flight monitoring, control point measurement, aerial triangulation to providing and browsing a variety of data results such as DOM, DEM, DSM, TDOM, LiDAR point cloud and so on.

Cloud-based active service

Based on cloud services, the system supports information push, project synchronization, flight data sharing, active UAV maintenance, flight real-time display and playback afterwards. Also, remote monitoring and video streaming can be accomplished based on 4G/5G networks.

System characteristics



Exploded views



Transport box

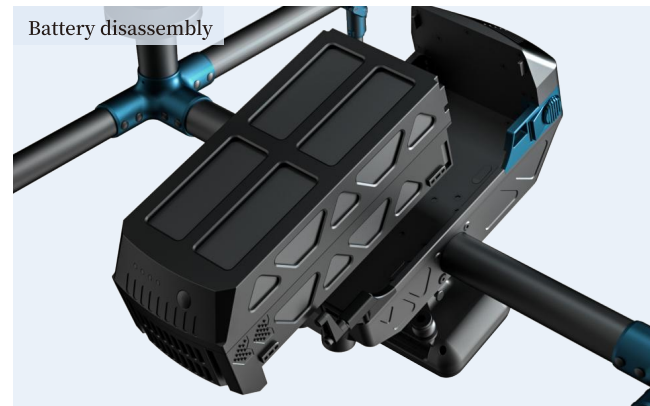
Modular design, easy to carry and transport

Dimensions

55 cm × 29.5 cm × 67.5 cm

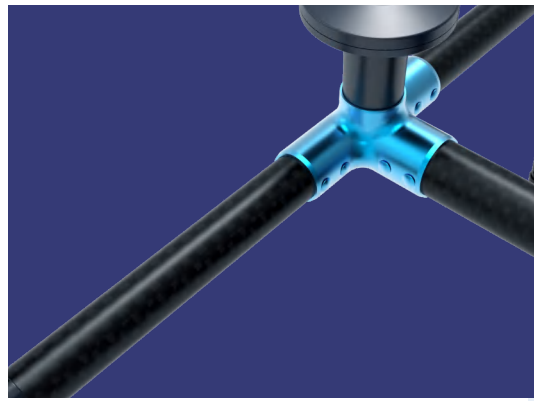
Total weight

12.34 kg
(including standard modules and accessories)



Carbon fiber structure

The fuselage of E2000S can be folded quickly, and the whole body can be stored in a transport box for easy transportation.



Motor

High efficiency, high reliability, low vibration, low noise motor



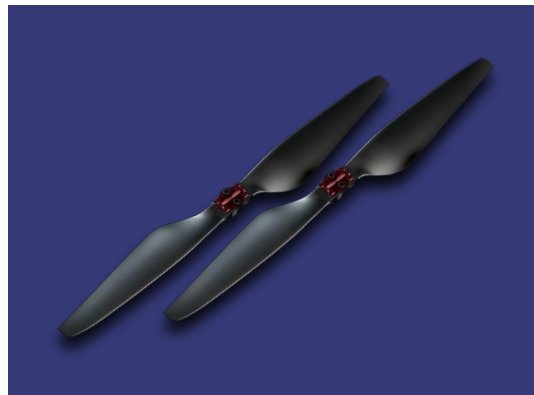
Intelligent battery

With an innovative battery protection scheme, it is easy to view parameters such as battery power and battery working status. Moreover, a complete safety protection logistic is developed to reasonably and comprehensively ensure the safety of battery use.



Quick release propeller

Professional pneumatic shape design and exquisite processing technology ensure the performance and quality of the propellers. The propellers of E2000S can be quickly disassembled and assembled without tools, which is convenient and reliable.



Key components



UAV special data transmission radio

It is independently innovated and developed by Feima Robotics, with 840.5 MHz ~ 845 MHz special frequency band, which is certified by the Radio Approval Committee of china. The radio adopts hopping design to enhance anti-intefere-nce capability.



RTK100 GNSS base station (optional)

RTK100 is an independently developed GNSS reference stations by Feima Robotics, supporting RTK and PPK fusion solution via the software of UAVManager Professional Edition.





Autopilot of E2000S

Model-based flying control logistics

Advanced multi-sensor data fusion algorithm

Redundant sensor design for increased operational security

Real-time fault detection and fault isolation algorithms

High-precision heading and attitude measurement system

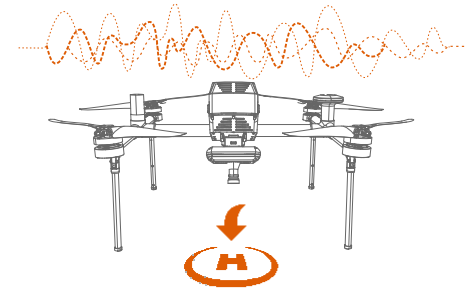
Fully automatic task mode

Efficient embedded software system and modular design, supporting multiple payloads

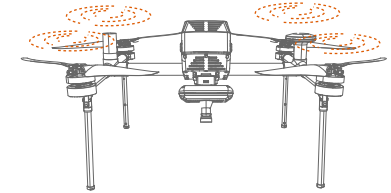
Supporting RTK, PPK and their fusion solution to provide centimeter-level positioning accuracy



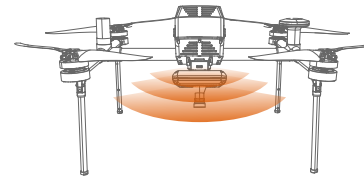
Automatic return without GNSS



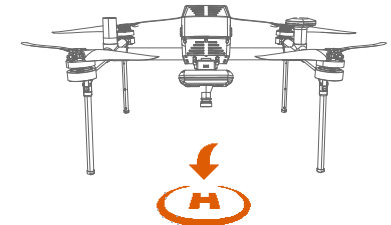
Lower and hovering when GNSS is out of lock



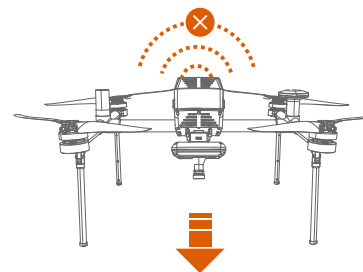
Forward radar to avoid obstacles



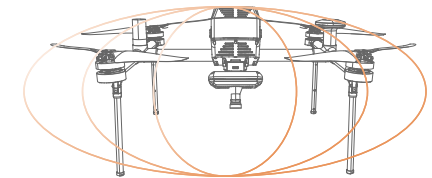
Automatic return when datalink fails connection



Landing when sensor failure happens



Automatic check after powering up the UAV





E-CAM2000

Photogrammetric module

Camera model	SONY ILCE-6000
Sensor size	23.5 mm × 15.6 mm (aps-c)
Effective pixels	About 24.3 million
Lens	25 mm fixed focus

Flight efficiency table (orthophoto photography)

Speed	GSD	Relative altitude	Area of each sortie	Daily area	Flight range
(m/s)	(cm)	(m)	(km ²)	(km ²)	(km)
13.5	2	128	2.09	16.72	45
	3	192	3.12	24.92	
	5	321	5.13	41.04	
	8	513	8.10	64.80	

Supposing 8 sorties per day, 80% × 60% overlap degree, conventional route design

Flight Efficiency Table (oblique photography)

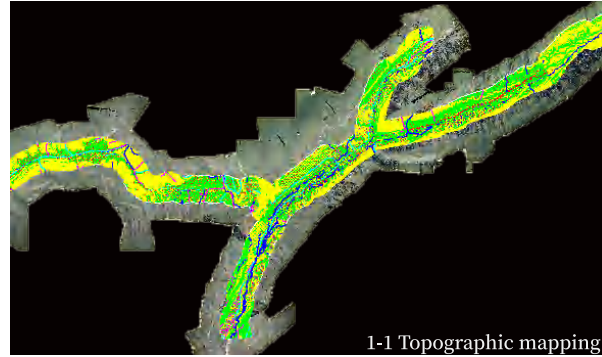
Speed	GSD	Relative altitude	Area of single sortie		Daily area		Flight range
			For best texture	Routine work	For best texture	Routine work	
(m/s)	(cm)	(m)	(km ²)	(km ²)	(km ²)	(km ²)	(km)
8	1.5	74	0.08	0.12	1.45	1.63	30
	2	98	0.20	0.29	3.13	3.48	
13.5	2.5	123	0.24	0.37	3.90	4.39	45
	3	147	0.28	0.45	4.64	5.28	

Supposing 8 sorties per day, one block, 80% × 80% overlap degree, cross-route design



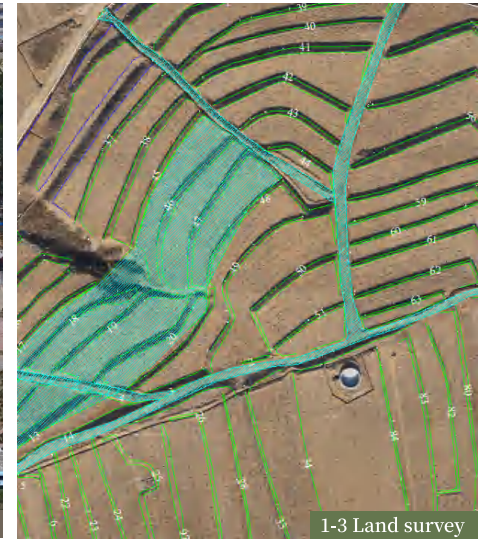
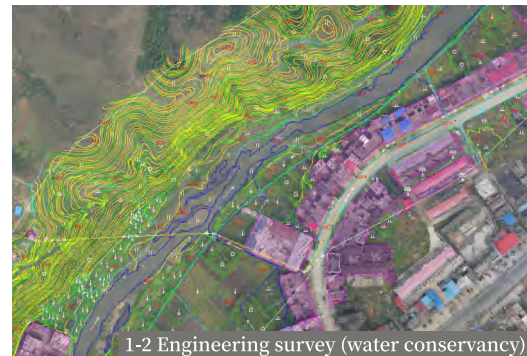
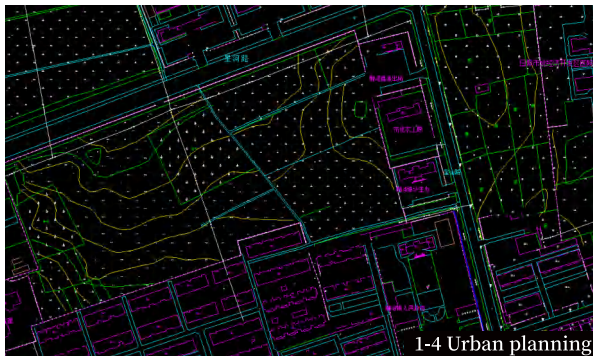
High-precision topographic mapping

- 1-1 Topographic mapping
- 1-2 Engineering survey (water conservancy)
- 1-3 Land survey
- 1-4 Urban planning



High-precision 3D modeling

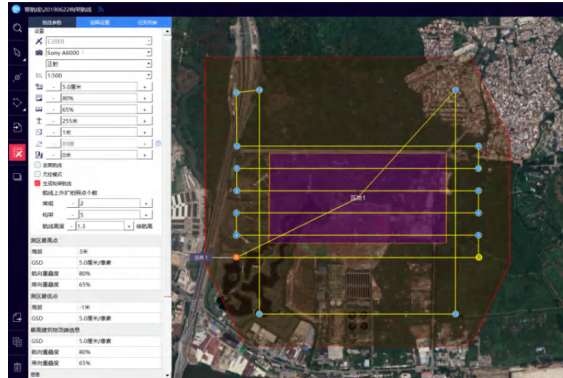
- 2-1 Digital city
- 2-2 Cultural relics protection
- 2-3 BIM application
- 2-4 Emergency monitoring





Large-scale image-control free mapping test (control strip)

The E2000S is equipped with a single camera for data acquisition in a certain area. The route is designed as a control strip mode. The relative altitude is 255 meters with the corresponding ground resolution being 5 centimeters. And the forward overlap and side overlap are 80% and 65% respectively. Besides, RTK and PPK fusion differential solution is adopted to acquire high-precision GNSS data.



Route design

Measuring positions relative to actual positions of check points (m)

ID	TYPE	Dxy	Dz
xk0184	CHK	0.12	-0.12
xk0284	CHK	-0.052	0.08
xk0384	CHK	0.081	-0.043
xk0584	CHK	0.076	0.052
xk0684	CHK	0.085	-0.12
RMSE		0.085	0.089

Output DOM and DEM accuracy statistics



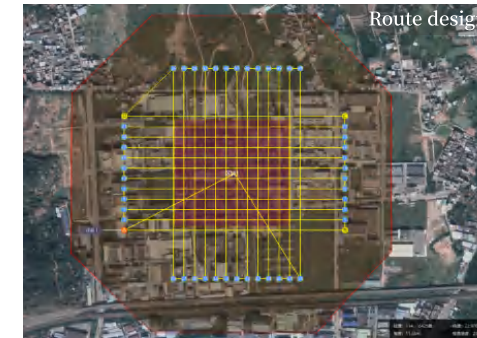
Result map

Regular oblique photography

The flight area of this case is a suburb of Dongguan City, Guangdong Province, China, and the survey area is about 0.16 square kilometers. After adjusting the E-CAM2000 mounted on the E2000S to the tilt mode, SmartPlan module of UAVManager Professional Edition is utilized to generate the oblique photography route.

The designed route, i.e., a cross route with a range of about 20 kilometers, has a relative flight height of 147 meters, an image resolution of 3 centimeters, and both the forward and side overlap of 80%. Only one sortie is needed and 658 images are acquired.

The pictures below shows the route planning interface in SmartPlan module and the result digital map.



Route design



Result map (enlarged view)



Result map

Orthophotography (for areas of undulating terrain)

For areas with undulating terrain, the E2000S' precise terrain following flight can be adopted to ensure the consistency of image resolution.

A set of orthographic data was obtained by precise terrain following flight in a certain area in Shandong Province, China, with a relative altitude of 191 meters, a ground resolution of 3 centimeters, a forward overlap of 80%, and a side overlap of 60%. One 13 minutes sortie is needed and 340 images are acquired. Besides 10 checkpoints are set up in the same area. RTK and PPK fusion calculation is adopted to test the image-control free large-scale mapping ability.

After the POS-assisted aerotriangulation calculation, check the point prediction of the checkpoints, and it can be seen that the RMSE of the checkpoints is within 2 pixels. According to the aerotriangulation report, the RMSE of plane in the X direction is 0.047 meters, 0.035 meters in the Y direction, and the RMSE of elevation is 0.066 meters.

Accuracy report of GCP-free aerotriangulation

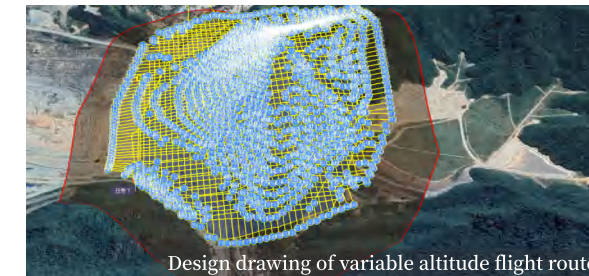
ID	TYPE	Dx	Dy	Dz
F1	CHK	-0.055	0.03	-0.065
F2	CHK	-0.006	-0.042	-0.036
F3	CHK	0.045	-0.027	0.03
F4	CHK	-0.023	0.032	-0.083
F5	CHK	-0.070	-0.013	-0.08
F6	CHK	0.045	0.012	0.056
F7	CHK	-0.067	-0.023	-0.072
F8	CHK	0.035	0.067	0.08
RMSE		0.047	0.035	0.066



Oblique photography (for areas of undulating terrain)

The flight area of this case is a mountainous area with large terrain fluctuations in Henan Province, China. Precise terrain following flight is adopted to obtain high-resolution image data. The survey area is about 1 square kilometers. After adjusting the E-CAM2000 mounted on the E2000S to the tilt mode, SmartPlan module of UAVManager Professional Edition is utilized to generate the oblique photographing route.

The designed cross route has a relative flight height of 98 meters, a range of 118 kilometers, a image resolution of 2 centimeters, and both the forward and side overlap of 80%. Three sorties are needed and 7400 images are acquired.



UAVManager Professional Edition



UAVManager professional Edition supports both Windows and iPad clients.



UAVManager Professional Edition is a one-stop intelligent GIS system for UAV flight plan and manipulation, data acquisition, data processing, display and management, and UAV maintenance.

According to different kinds of application purposes, automatic and accurate flight planning based on real scene 3D terrain data are integrated to UAVManager Professional Edition for both fixed-wing UAVs and rotorcrafts. Moreover, 3D real-time monitoring, fast quality inspection for flights, pre-processing tool box, robust accuracy control and automatic stitching, 4D outputs, visual monitoring center, and cloud services (e.g., system update, intelligent maintenance, and information pushing) are provided by UAVManager.