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D500

Feima Robotics Aerial photogrammetry, remote sensing,
inspection and emergency system





01 | SYSTEM OVERVIEW

D500 is Feima Robotics' latest high performance multi-motor UAV system designed for multi-industry applications. The whole platform adopts a high-strength T700 carbon fiber integrated streamline design. The body and motors both adopt a self absorption and heat dissipation structure, integrating high-precision differential GNSS board, navigation GNSS module, TOF sensor, millimeter wave radar, visual perception system, FPV camera, and high-definition digital image transmission. The core sensors are redundant for safe and reliable purpose.

The mission payload of D500 continues Feima's traditional modular design, including photogrammetric module, oblique photographing module, LiDAR module and multispectral module, which can meet traditional aerial photogrammetry, real scene 3D modeling, remote sensing and monitoring applications. In addition, the application payloads such as visible light video module, thermal infrared video and remote sensing module, megaphone, lighting and throwing module, can meet the needs of police, emergency, security, power line inspection and other industries.

D500 adopts RTK and PPK fusion operation mode, supports high-precision POS assisted aerial triangulation, and realizes GCP-free application. Equipped with the software of UAVManager Professional Edition (Survey Version), D500 provides route modes for various applications. It supports accurate 3D route planning, 3D real-time flight monitoring, GPS fusion calculation, control point measurement, aerial triangulation, one-key mapping and one-key export of stereo mapping. It provides to process and browse of DOM, DEM, DSM, TDOM and other data results.

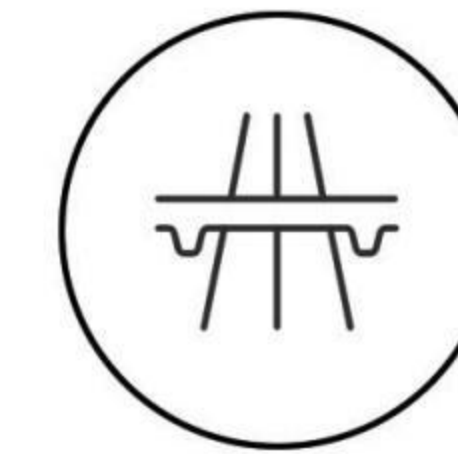
02

SYSTEM CHARACTERISTICS



Mobile take-off and landing

Image matching technology is used to calculate the deviation between the landing point and takeoff point of the UAV in real time, so as to achieve accurate take-off and landing on mobile platforms such as ships or vehicles.



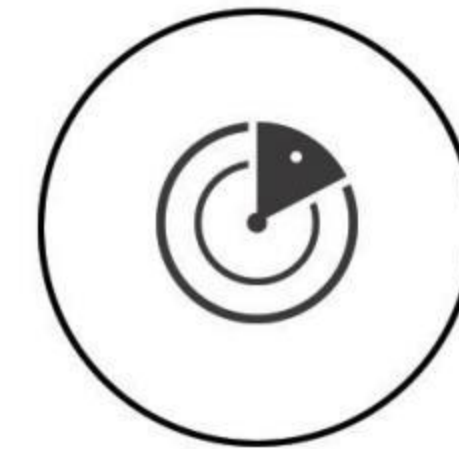
Fly close

Support the fine patrol inspection and industrial measurement of the facade of hydropower station dams, bridge piers, ancient buildings and so on.



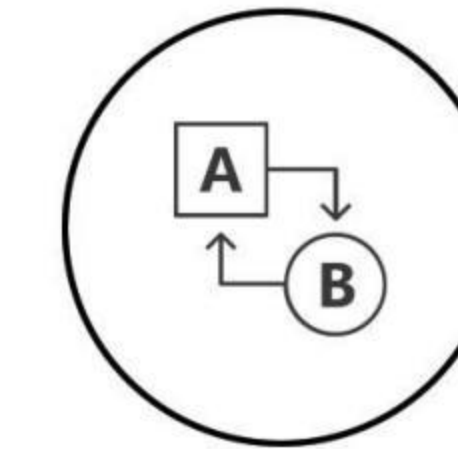
Visual return

D500 can build a real time map of the survey area it flies over. When GNSS is interfered, the aircraft automatically plans the return route, and enables visual navigation to control the aircraft to return to the take-off point.



Automatic obstacle avoidance

The FPV monocular depth technology and millimeter wave radar technology can effectively identify not only large targets such as buildings and mountains, but also small targets such as high-voltage lines, to ensure the safe flight of D500.



Offsite take off and landing

It supports to reset landing position by selecting a point on the map during flight. At the same time, control takeover can be carried out through the ground control terminal in the landing area to achieve mission relay and easy transition.



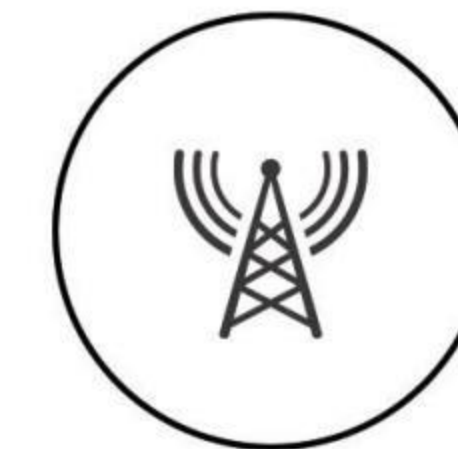
Terrain following flight

With UAVManager Professional Edition software, D500 can achieve accurate terrain following flight, which helps to improve image resolution and ensures the consistency of image resolution during one flight.



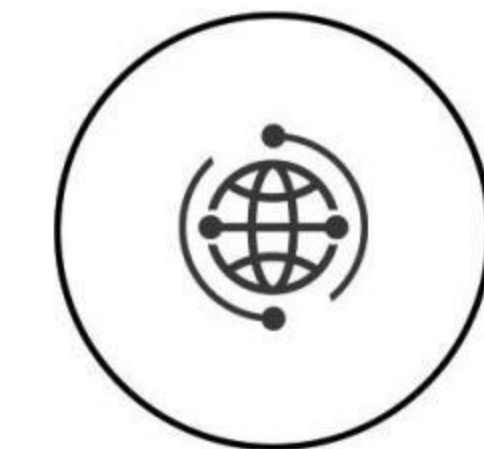
GCP free mapping

The D500 is equipped with a 20 Hz high-precision differential GNSS board, which has the ability of GCP free mapping, and meets the needs of a variety of surveying and mapping, remote sensing applications.



Relay roaming

It supports aerial relay and ground relay, which can achieve full signal coverage within the surveying area and meet the requirements of tasks with medium and long distance or in complex terrestrial environments.



Terminal networking

It has the networking function of multiple control terminals, supports remote takeover of the UAV, and can switch control rights between multiple control terminals, effectively improving the flexibility of applications in public security, emergency rescue and other fields.

Material	Carbon fiber + magnesium aluminum alloy
Symmetrical motor wheelbase	998 mm
Height	370 mm
Power	Electric
Number of motors	4 pcs
Takeoff weight	6.7 kg
Maximum payload weight	2.5 kg
Cruise speed	13 m/s
Endurance	60 mins
Take-off and landing	No remote control VTOL/ground station control
Hover positioning accuracy	Horizontal 1 cm + 1 ppm, vertical 2 cm + 1 ppm
Maximum climbing speed	5 m/s
Maximum descent speed	3 m/s
Altitude ceiling	6000 m
Wind resistance	Force 6
Control distance	35 km
Image transmission distance	10 km
Working temperature	-20 °C - 50 °C
Packing and transportation box	EVA lining of PC equipment box
Task response time	Unfolding ≤ 10 mins, folding ≤ 10 mins
Payload Module	Photogrammetry/oblique photographing/remote sensing/ LiDAR/video/megaphone/lighting/throwing module

03 | SYSTEM PARAMETER



04

EXPLODED VIEW



Folding structure

Motor

The motor adopts self-absorption and heat dissipation structure to effectively improve power output efficiency



Intelligent battery

Intelligent battery is adopted, which supports one click viewing of power, charge and discharge protection, and battery health information.



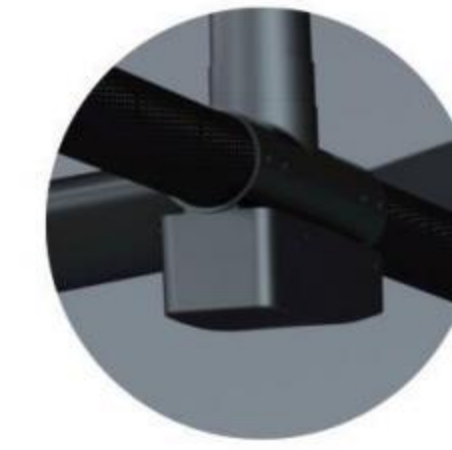
Dual-differential antennas

Under complex conditions, D500 can ensure safer flight and better anti-interference ability, and can take off, land and fly on mining areas, bridges and ships.



Millimeter wave radar

80 meter range; multi-target point cloud millimeter wave radar; with monocular vision to achieve automatic obstacle avoidance



TOF sensor

Based on high-precision range mapping and 30 imaging technology, the functions of range measurement, navigation and height determination are realized.



FPV

1/2.3 stack sensor; high-performance optical lens; integrated navigation based on visual SLAM and differential GNSS



HD image transmission

Adopting H.265 encoding standard; supporting 1080P (30 fps); maximum bandwidth of 8 Mbps; image transmission distance greater than 10 kilometers

05

SYSTEM CONFIGURATION

Order	Component name	Unit	Quantitys
1	D500 UAV platform	Set	1
2	Ground digital radio station	Set	1
3	Intelligent battery	Groups	2
4	Intelligent battery charger	Set	1
5	Transport box	Set	1
6	UAVManager Professional Edition (Survey Version)	Set	1
7	HGS2000 handheld ground station	Piece	1



Transport box

Modular design, easy to carry and transport

Dimensions
869 mm × 558 mm × 470 mm

Total weight
25 kg
(including standard modules and accessories)



06 SUPPORTED PAYLOAD

- **D-CAM2000**
Photogrammetric module
- **DV-CAM20**
Photogrammetric module
- **D-OP4000**
Oblique photographing module
- **D-LiDAR3000**
LiDAR module
- **D-EOV2100**
Visible light module
- **D-MSPC2000**
Multispectral module
- **D-L500**
Lighting module
- **D-T500**
Throwing module
- **D-CAM3000**
Photogrammetric module
- **D-OP3000**
Oblique photographing module
- **D-LiDAR2000**
LiDAR module
- **D-LiDAR500**
LiDAR module
- **D-TIRV1100**
Thermal infrared video and remote sensing module
- **SLAM100**
Handheld laser scanner
- **D-M500**
Megaphone module
- **D-A500**
Atmospheric monitoring module



07 PAYLOAD INTRODUCTION

D-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 parameters	25 mm fixed focus



Flight efficiency table (Ortho mode) Supposing 8 sorties per day, 80% × 60% overlap degree, conventional route design

Speed	GSD	Relative flight height	Area of each sortie	Daily area	Flight range
(m/s)	(cm)	(m)	(km ²)	(km ²)	(km)
13.5	2	128	1.73	13.82	40
	3	192	2.53	20.23	
	5	321	4.05	32.43	
	8	513	6.19	49.52	

Flight efficiency table (Oblique mode) Supposing 8 sorties per day, one block, 80% × 80% overlap degree, conventional route design

Speed	GSD	Relative flight height	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	0.16	0.25	2.73	3.06	
13.5	2.5	123	0.20	0.32	3.39	3.85	40
	3	147	0.23	0.39	4.04	4.64	

D-CAM3000 Photogrammetric module

Camera model	SONY A7RM4
Sensor size	35.7×23.8mm (Full frame)
Effective pixel	About 61M
Lens parameters	40mm fixed focus



Flight efficiency table (Ortho mode) Supposing 8 sorties per day, 80% × 60% overlap degree, conventional route design

GSD	Relative flight height	Area of each sortie	Daily area	Flight range
(cm)	(m)	(km ²)	(km ²)	(km)
2	213	2.31	18.45	35
3	319	3.35	26.77	
5	532	5.29	42.29	
8	851	7.93	63.46	

Flight efficiency table (Oblique mode) Supposing 8 sorties per day, one block, 80% × 80% overlap degree, conventional route design

GSD	Relative flight height	Area of single sortie		Daily area		Flight range
		For best texture	Routine work	For best texture	Routine work	
(cm)	(m)	(km ²)	(km ²)	(km ²)	(km ²)	(km)
1.5	122	0.15	0.25	2.76	3.15	35
2	163	0.19	0.34	3.62	4.23	
2.5	204	0.22	0.43	4.45	5.29	
3	244	0.24	0.52	5.25	6.35	

DV-CAM20

Photogrammetric module

Gimbal	Adjustable orthophoto and oblique mode
Camera model	Phase One iXM-100
Resolution	11664 × 8750 pixels
Pixel size	3.76 μm
Effective sensor area	43.9 mm × 32.9 mm
Lens	RSM 35 mm lens
GNSS/IMU aided mapping	Supported
Attitude angle accuracy	0.006°
Heading angle accuracy	0.03°



Flight efficiency table (Ortho mode)

Supposing 6 sorties per day, 80% × 60% overlap degree, conventional route design

GSD	Relative flight height	Area of each sortie	Daily area	Flight range
(cm)	(m)	(km ²)	(km ²)	(km)
2	186	1.93	11.58	25
3	279	2.77	16.62	
5	465	4.30	25.78	
8	745	6.30	37.82	

Flight efficiency table (Oblique mode)

Supposing 6 sorties per day, one block, 80% × 80% overlap degree, cross-route design

GSD	Relative flight height	Area of single sortie		Daily area		Flight range
		For best texture	Routine work	For best texture	Routine work	
(cm)	(m)	(km ²)	(km ²)	(km ²)	(km ²)	(km)
1.5	114	0.57	0.81	4.44	5.09	25
2	153	0.70	1.07	5.77	6.76	
2.5	191	0.82	1.33	7.04	8.41	
3	229	0.92	1.58	8.26	10.06	

D-OP3000

Oblique module

Camera model	SONY ILCE-6000
Sensor size	23.5 mm × 15.6 mm (APS-C)
Effective pixels	about 120 million (24.3 million for each)
Lens parameters	25 mm fixed focus (nadir)
	35 mm fixed focus (oblique)



D-OP4000

Oblique module

Camera model	SONY ILCE-TRM4A
Sensor size	9504 × 6336 pixels
Effective pixels	about 305 million (61 million for each)
Pixel size	3.76 μm
Sensor size	35.7 mm × 23.8 mm
Lens focus	40 mm fixed focus (nadir)
	56 mm fixed focus (oblique)
Tilt angle	45°



Flight efficiency table

supposing 6 sorties per day, one block, 80%×65% overlap degree, conventional route design

Speed	GSD	Relative flight height	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	96	0.46	0.73	3.86	4.59	25
	2	128	0.87	1.37	7.24	8.57	
13.5	2.5	160	1.01	1.70	8.82	10.68	35
	3	192	1.14	2.02	10.35	12.78	

Flight efficiency table

supposing 6 sorties per day, one block, 80%×65% overlap degree, conventional route design

GSD	Relative flight height	Area of single sortie		Daily area		Flight range
		For best texture	Routine work	For best texture	Routine work	
(cm)	(m)	(km ²)	(km ²)	(km ²)	(km ²)	(km)
1.5	160	0.79	1.38	7.10	8.69	30
2	213	0.94	1.81	9.10	11.52	
2.5	266	1.05	2.24	10.99	14.33	
3	319	1.14	2.66	12.77	17.13	

D-LiDAR2000

LiDAR module

Adapted UAV platforms	D500/D2000/D2000S/D20
Horizontal field of view	70.4°
Vertical field of view	4.5°/77.2°
Accuracy	5 cm @ 50 m
Measuring range	190 m @ 10 % ρ @ 100 klx 450 m @ 80 % ρ @ 0 klx



Laser	Ranging mode	TOF	POS	Horizontal positioning accuracy	0.01 m
	Laser class	Class 1		Vertical positioning accuracy	0.02 m
	Wavelength	905 nm		Roll & Pitch Accuracy	0.006°
	Laser pulse repetition rate	240 kpts/s		Heading accuracy	0.03°
	Echoes	3		GNSS data update frequency	20 Hz
	Echo signal intensity	8 bits		Inertial navigation data update frequency	200 Hz
	Ranging accuracy	±2 cm			

Flight efficiency table

Supposing 6 sorties per day, side overlap of 35%, conventional route

Relative flight height	Point cloud density	Area of each sortie	Daily area	Flight range
(m)	(pts/m ²)	(km ²)	(km ²)	(km)
70	334	1.86	11.19	
100	242	2.57	15.44	
150	169	3.68	22.08	35
200	132	4.71	28.28	
300	94	6.61	39.67	



Topographic mapping



Vegetation statistics



Power line patrol



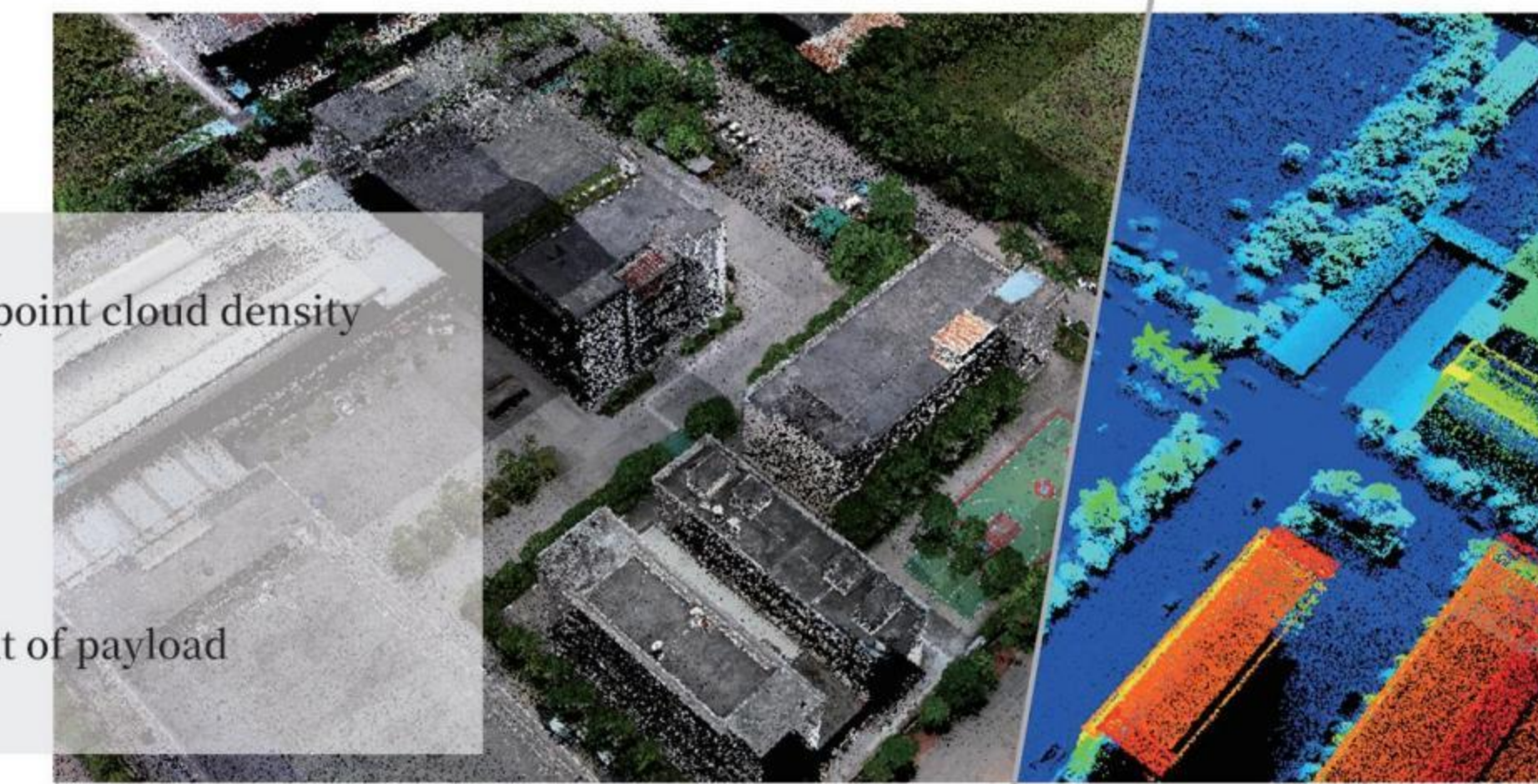
Volume calculation



3D modeling

Advantages

- Low cost, high precision and high point cloud density
- All-day operation
- Automatic data acquisition
- Raw data compression
- Supporting secondary development of payload

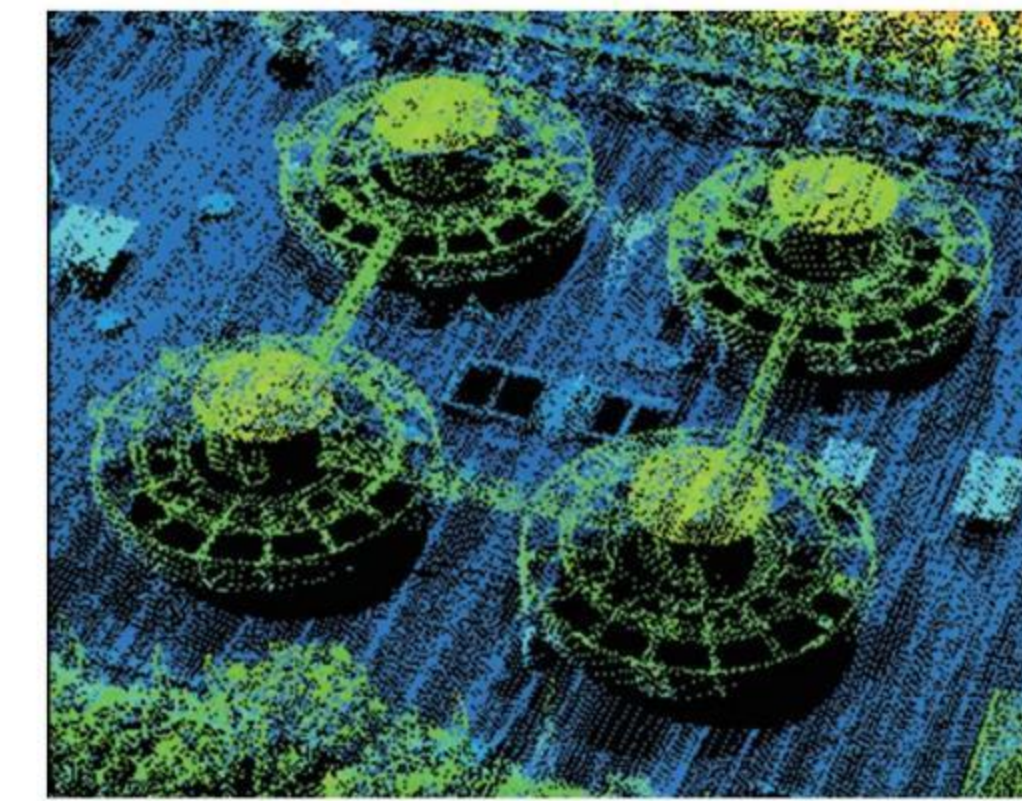


D-LiDAR3000

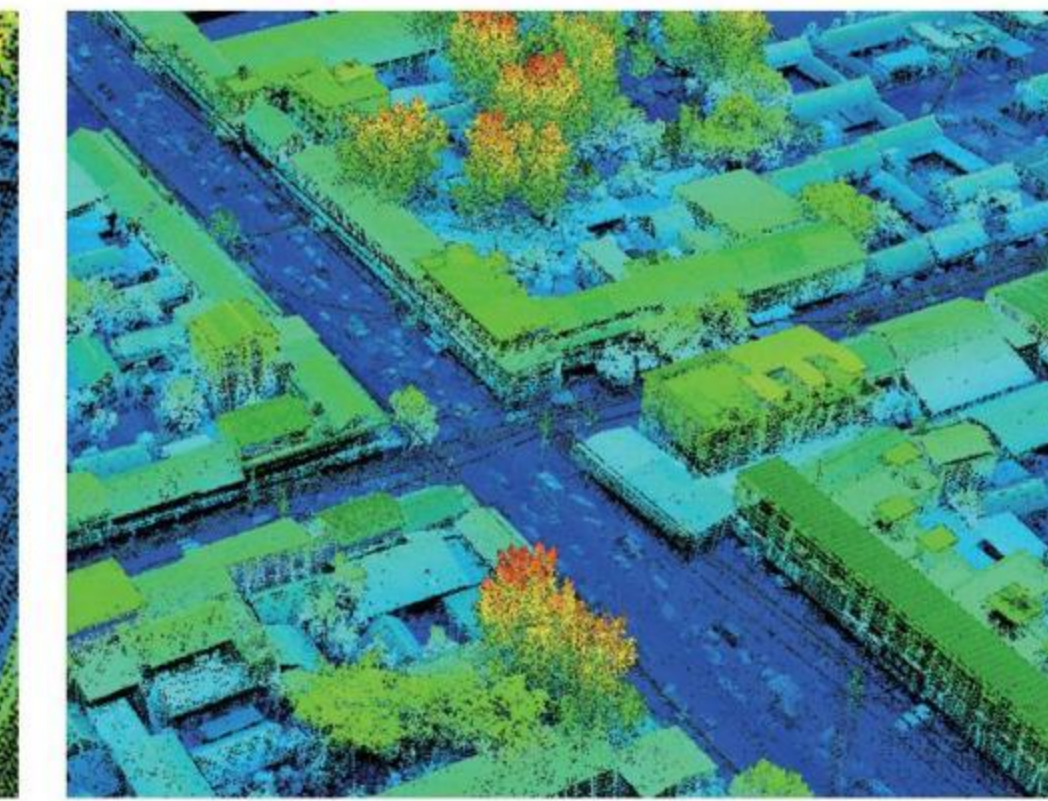
LiDAR module



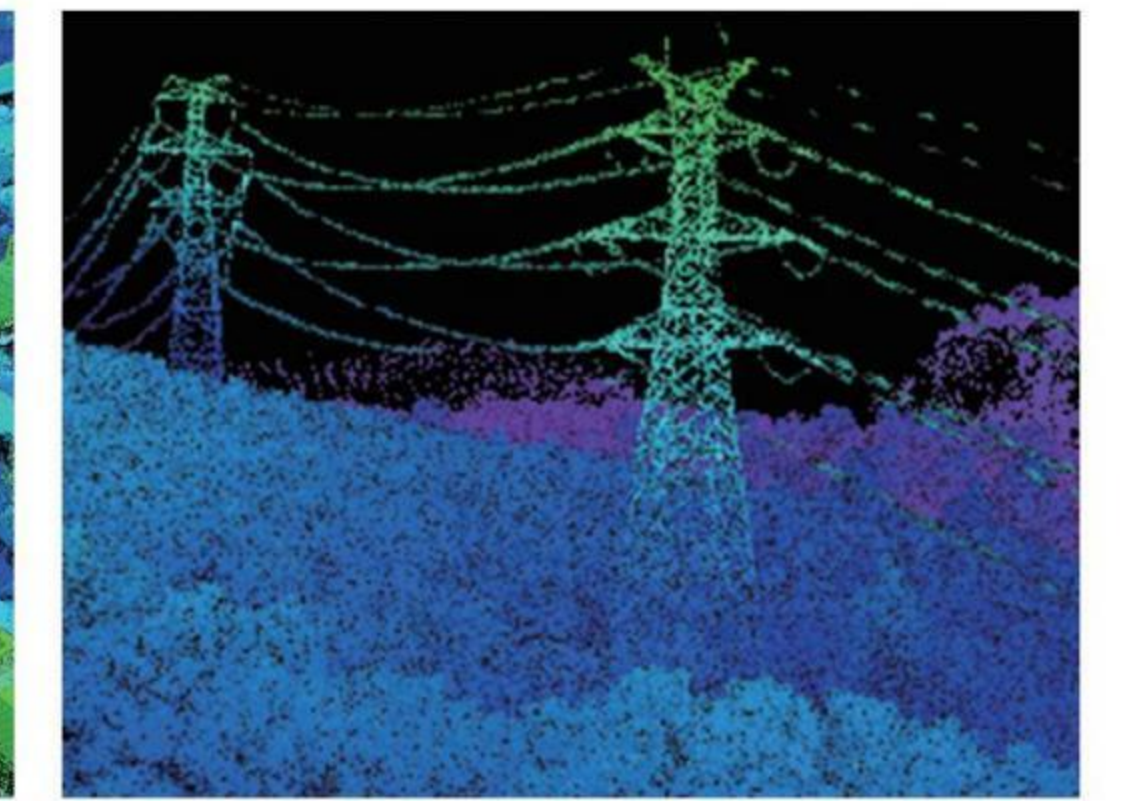
Adapted UAV platforms	D500/D2000/D2000S/D20
Accuracy	5 cm @ 100 m
Storage	32 GB + 32 GB (Max 256 GB)



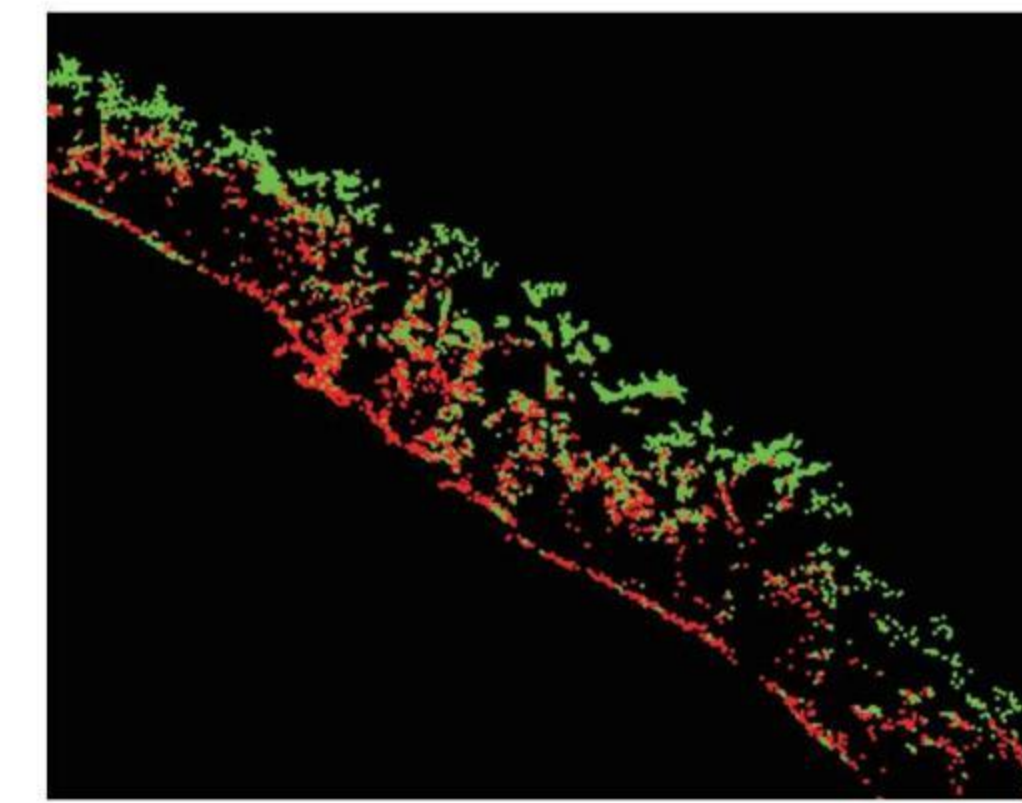
Fine



High precision



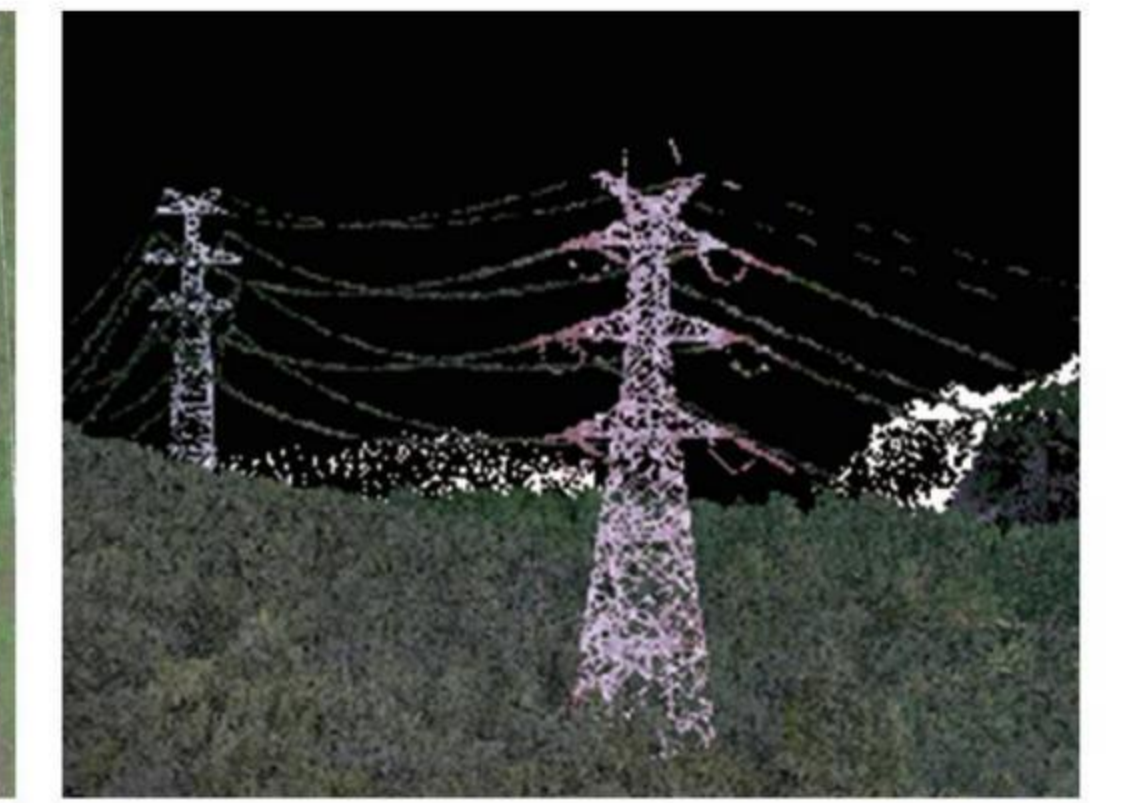
Strong power line detection



Strong vegetation penetration



GCP-free orthophoto



Synchronous texture

	Laser		POS		Camera	
	Ranging mode	TOF	Horizontal positioning accuracy	0.01 m		
Laser class	Class 1	Vertical positioning accuracy	0.02 m			
Wavelength	905 nm	Roll & pitch accuracy	0.006°			
Laser pulse repetition rate	320 kpts/s	Heading angular accuracy	0.03°			
Echoes	2	GNSS data update frequency	20 Hz			
Echo signal intensity	8 bits	Inertial navigation data update frequency	300 Hz			
Ranging accuracy	±2 cm	Effective pixels	2.43 million			
Horizontal field of view	360°	Sensor size	23.5 mm × 15.6 mm			
Vertical field of view	30°	Focal length	25 mm			
Measuring range	200 m	Field of view	50.4°			

Flight efficiency table

Supposing 6 sorties per day, side overlap of 35%, conventional route

Relative flight height	Point cloud density	Area of each sortie	Daily area	Flight range
m	pts/m ²	km ²	km ²	km
60	73	2.34	14.04	30
80	55	3.12	18.72	
100	44	3.90	23.40	
120	37	4.68	28.08	
150	29	5.85	35.10	

D-LiDAR500

LiDAR module

Adapted UAV platforms	D500/D2000/D2000S/D20
Weight	1060 g
Dimensions	145.3 mm × 110 mm × 137.2 mm

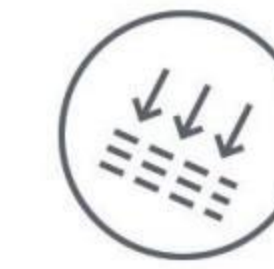


D-LiDAR500 adopts a small Chinese domestic high-precision LiDAR and equipped with a 20 mm focal length APS-C frame camera, with the characteristics of high laser pulse repetition rate, long measuring range, and three echoes, and can perform high-precision terrain mapping, power line inspection and other three-dimensional point clouds acquisition.

Laser	Ranging mode	TOF	POS	Horizontal positioning accuracy	0.01 m	
	Laser class	Class 1		Vertical positioning accuracy	0.02 m	
	Wavelength	905 nm		Roll & pitch accuracy	0.006°	
	Laser pulse repetition rate	640 kpts/s		Heading angular accuracy	0.03°	
	Echoes	3		GNSS data update frequency	20 Hz	
	Echo signal intensity	8 bits		Inertial navigation data update frequency	300 Hz	
	Ranging accuracy	±2 cm		Effective pixels	2.43 million	
	Horizontal field of view	360°		Camera	Sensor size	23.5 mm × 15.6 mm
	Vertical field of view	40.3°			Focal length	20 mm
	Measuring range	300 m			Field of view	61°



300m Measuring range
Longer ranging, high operational efficiency, and more flexible flight plans



Three echoes
Three echoes of first, strongest, last retain more valid data



360° × 40.3° field of view
Combined with the intelligent laser cutting algorithm integrated in SmartLiDAR, the side data is easier to protect



High laser pulse repetition rate
32 channels and a single echo contains 640,000 points per second, suitable for high-density demand scenarios



Flight efficiency table

Supposing 6 sorties per day, side overlap of 35%, conventional route

Relative flight height	Point cloud density	Area of each sortie	Daily area	Flight range
m	pts/m ²	km ²	km ²	km
60	146	2.34	14.04	30
80	110	3.12	18.72	
100	88	3.90	23.40	
120	74	4.68	28.08	
150	58	5.85	35.10	

D-MSPC2000

Multispectral module

Adapted UAV platform	D500/D2000/D2000S/D20
Sensor parameters	CMOS: 1/3" global shutter
Resolution	1280 × 960 pixels
Sensor size	4.8 mm × 3.6 mm
Focal length	5.2 mm
Field of view	HFOV: 49.6°, VFOV: 38°
Aperture	F/2.2
Shooting speed	One time per second
Ground resolution	GSD: 8.65 cm/pix, AGL: 120 m
Storage	128 GB (Maximum)
Number of bands	6
Band configuration (standard)	450 nm (35 nm)
	555 nm (25 nm)
	660 nm (22.5 nm)
	720 nm (10 nm)
	750 nm (10 nm)
	840 nm (30 nm)



Land feature classification



Growth assessment



River monitoring



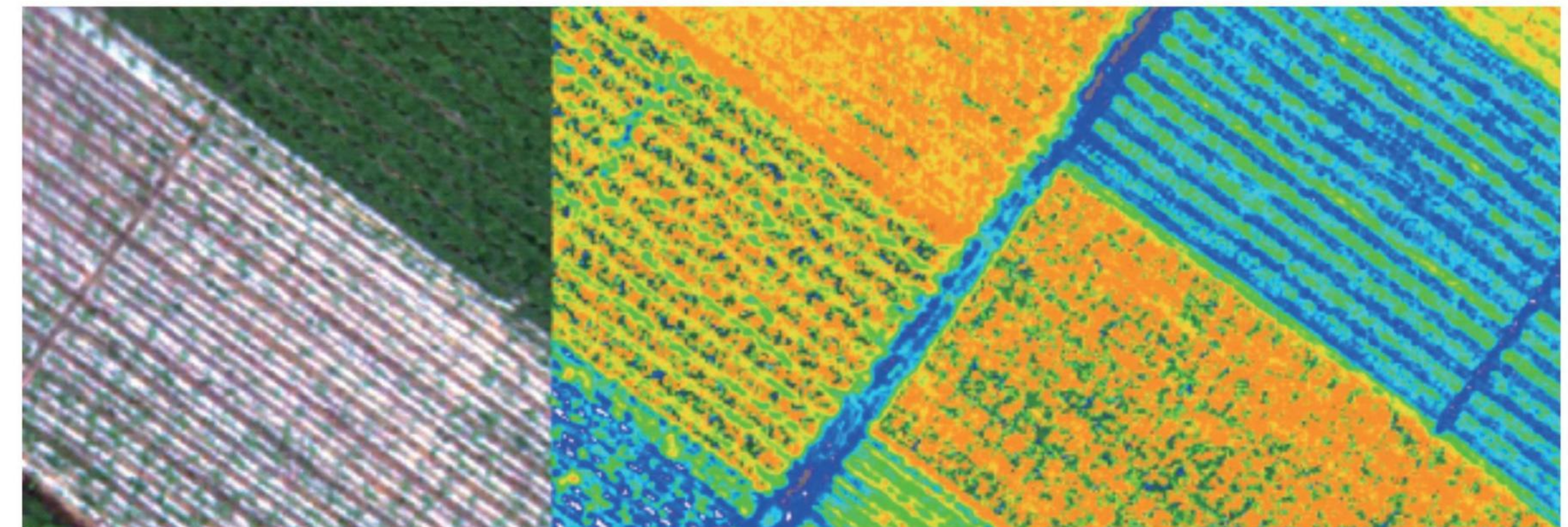
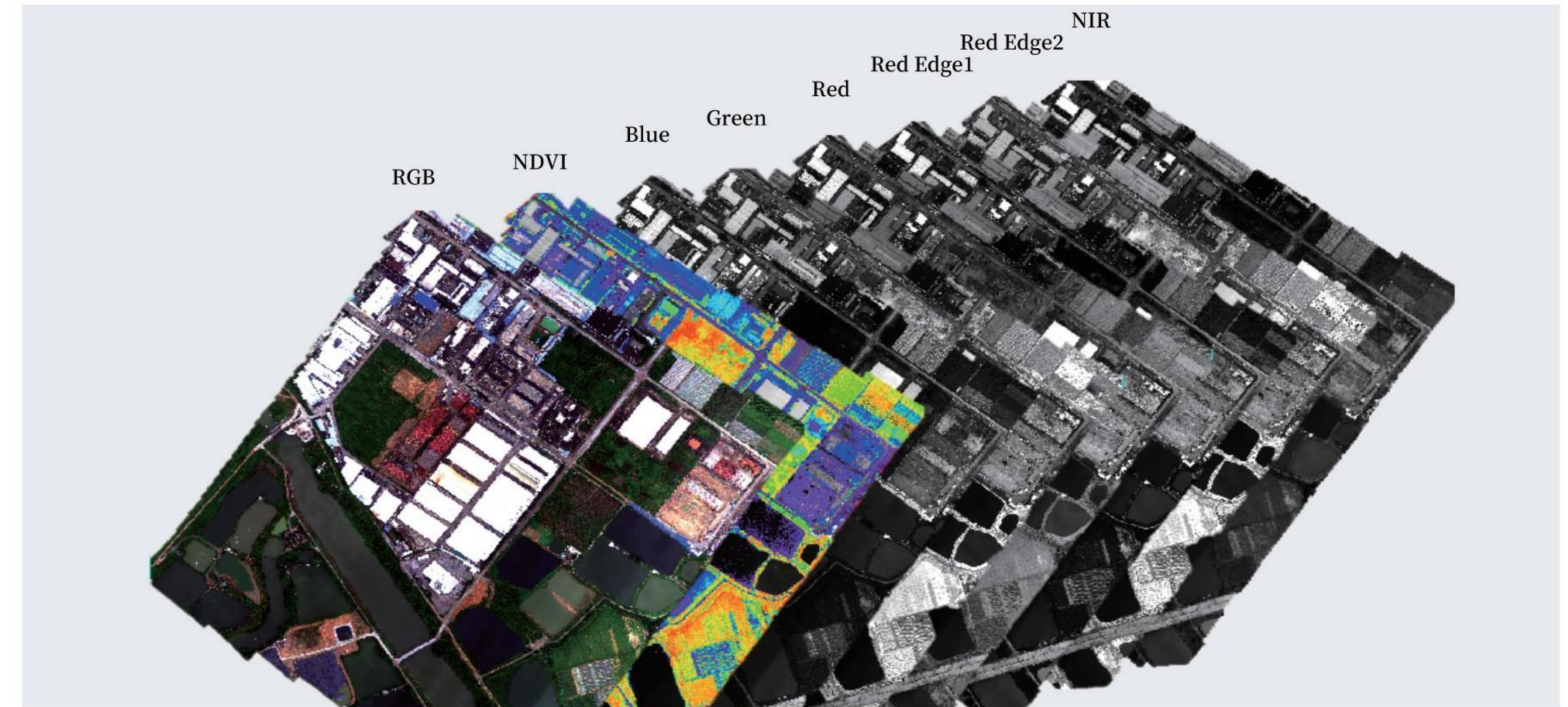
Forestry survey



Vegetation statistics



Environmental monitoring





D-TIRV1100

Video module

Thermal infrared and visible video dual sensor payload



One-inch, 20.3 megapixel visible light sensor

640 × 512 @ 50 fps thermal infrared sensor

Up to 8X continuous zoom

Three-axis gimbal stabilization and electronic image stabilization

Supporting dual-screen mode and linked zoom (both visible light and thermal infrared video have the same vision)

Supporting PIP mode

With pointing and positioning, visual surrounding function

With intelligent tracking function (automatic zoom during tracking)

Supporting both high-definition video and high-resolution image acquisition

Supporting extended 4G/5G networking function (need to purchase additional extended communication module)



Continuous zoom



Local image transmission



Pointing and positioning



Remote transmission

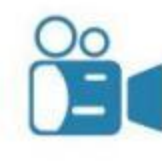


Photo and video recording



PIP



Visual tracking



Visual surrounding

	Detector type	Vanadium Oxide Uncooled Infrared Focal Plane Detector
	Video resolution	640 × 512 (thermal infrared)
	Detector frame rate	50 Hz/30 Hz
	Response band	8 μm ~ 14 μm
	Lens focal length	13 mm (equivalent focal length 57 mm)
Thermal infrared movement	Digital zoom	1.0~8.0×Continuous zoom (step of 0.1)
	Piexl size	12 μm
	NETD	≤50 mK@25°C, F#1.0
	Stabilization gimbal	Three-axis stabilization gimbal
	Temperature measurement range	-20°C ~ +150°C, 0°C ~ +550°C
Visible light sensor	Sensor size	inch
	Effective pixels	20.3 million
	Lens focal length	12 mm
	Stabilization gimbal	Three-axis stabilization gimbal

D-EOV2000

Video module

Dual visible light video module

Dual one-inch, 20.3 megapixel sensors

Dual constant aperture lens (fixed & zoom)

Up to 12X lossless zoom

Up to 4K @ 60 fps mode

Three-axis gimbal stabilization and electronic image stabilization

Supporting PIP mode

With pointing and positioning, visual surrounding function

With intelligent tracking function (automatic zoom during tracking)

Supporting both high-definition video and high-resolution image acquisition

Supporting extended 4G/5G networking (need to purchase additional extended communication module)



Continuous zoom



Local image transmission



Pointing and positioning



Remote transmission



Photo and video recording



PIP



Visual tracking



Visual surrounding

Video movement gimbal	Sensor size	1 inch
	Sensor effective pixels	20.3 million + 20.3 million
	Video resolution	3840 × 2160, 2376 × 1536, 1920 × 1080, 1280 × 720
	Image transmission resolution	1920 × 1080, 1280 × 720
	Real-time video frame rate	30 fps
	Zoom factor	12X (720p), 8.3X (1080 p)
	Lens focal length	12 mm + 35 mm
	Lens aperture	F/4.0+F/4.0
	Onboard video storage	Supported
	Storage format	Mp4
Parameter image transmission	Video encoding	H.265 (default), H.264 (optional)
	Storage method	Built-in 32 Gigabyte TF card
	Number of axes	Three axes
	Gimbal stabilization accuracy	Relative stabilization accuracy ±0.005°, Absolute stabilization accuracy ±0.1°
Tracking	Controllable rotation range	Tilt: -20° to + 120°, Pan: + 270°
	Structural designed rotation range	Tilt: -60° to + 160°, Pan: ± 300°, Roll: -65° to + 65
	Target size	15 to 510 pixels
	Automatic target detection	Supported
	Target turn and U-turn tracking	Supported
One-time tracking	Supported	
Tracking target dynamic switching	Supported	

D-M500

Megaphone module

Dimensions	140 mm × 140 mm × 125 mm
Weight	560 g
Maximum volume	130 db
Effective loudspeaker distance	300 m
Maximum power	25 w
Ingress protection	IP43
Communication link	4G
Operating temperature	-20°C ~ +50°C



D-T500

Throwing module

Weight	320 g
Dimensions	78 mm × 98 mm
Power	20 w
Number of mounts	4 pieces
Load weight	≤ 5 kg (D500 supports 2 kg at most)
Operating temperature	-20°C ~ +50°C



08 GROUPED EQUIPMENT

D-L500

Lighting module

Weight	730 g
Dimensions	166 mm × 110 mm × 137 mm
Power	65 w
Luminous flux	4000 lm
Gimbal rotation range	Pitch: - 110 to+30 °, horizontal: ± 135 °
Operating temperature	-20°C ~ +50°C



UAV dedicated radio

1. Independently innovated and developed by Feima Robotics
2. Conforming to the special frequency band 840.5MHz~845MHz for UAV
3. Frequency hopping design enhancing anti-interference capability



HGS2000 handheld ground station

Portable ground station; compatible with D500, D2000S, D20; built-in tablet and radio; supporting route planning, flight monitoring and flight control



Screen size	8 inches (with touch)
Screen resolution	1920 × 1200 @ 60 Hz
Built-in battery capacity	13000 mAh
Operating system	Linux
Adapter parameters	19 V/4.4 A
Storage	Built-in 32 GEMMC + external MicroSD card holder
Built-in video frequency	1427 HMz ~ 1447 MHz
Built-in data transmission frequency	840 M ~ 845 M
Front camera	500 million pixels
Microphone	Built-in and external headset
USB interface	TYPE A+TYPE C (Compatible with USB2.0)
Wireless network	5G network Wi-Fi (optional)
Wired network	RJ45 interface supporting Gigabit Ethernet
Power bank charging	Supported (requiring a power bank that supports PD)
HDMI output	Supported
Total Weight	1700 g
Dimensions	305 mm × 175 mm × 70 mm
Total power consumption	13 W
Battery life	≥6 H
Operating temperature	-10°C ~ 50°C
Storage temperature	-20°C ~ 60°C

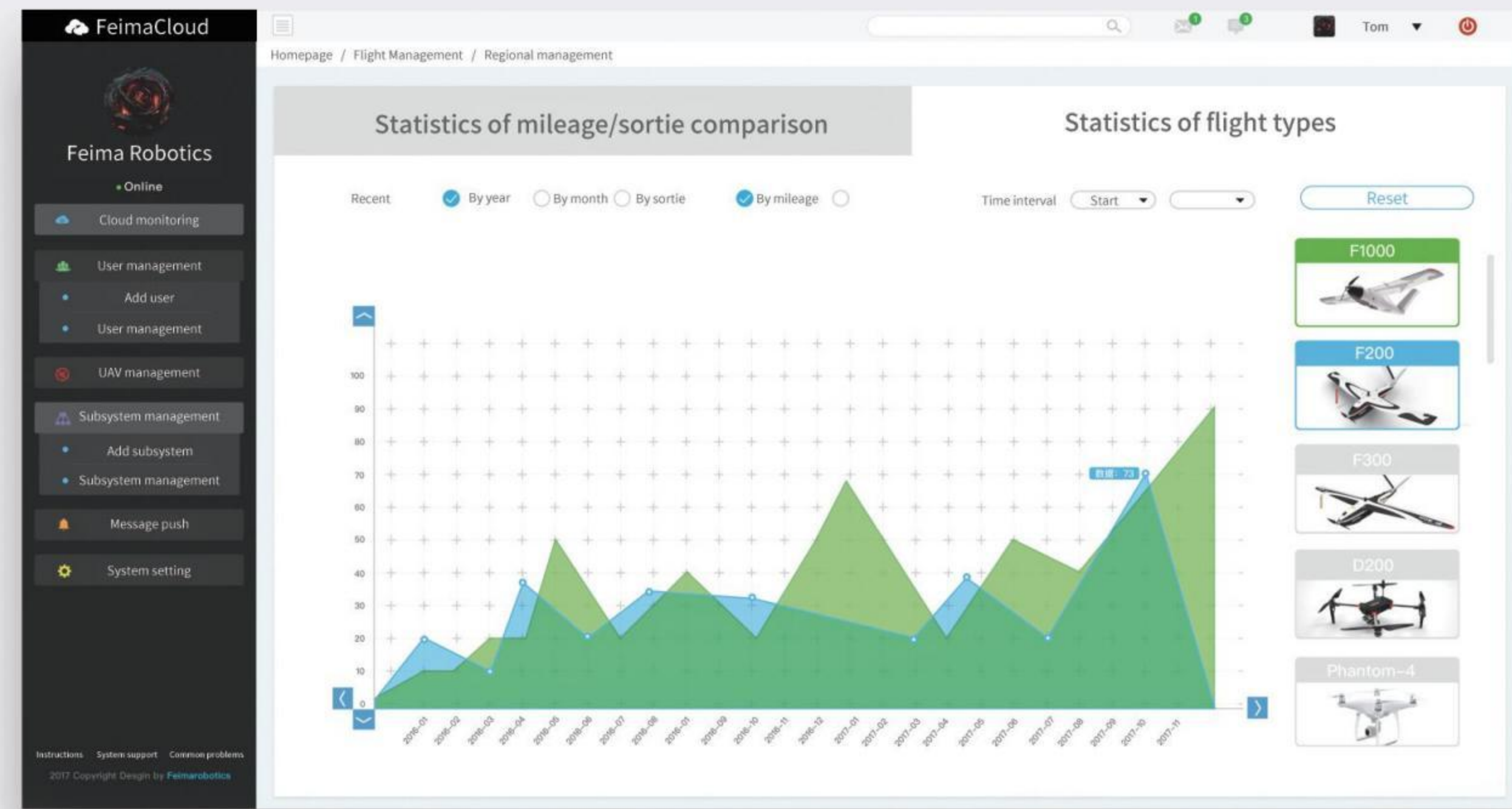
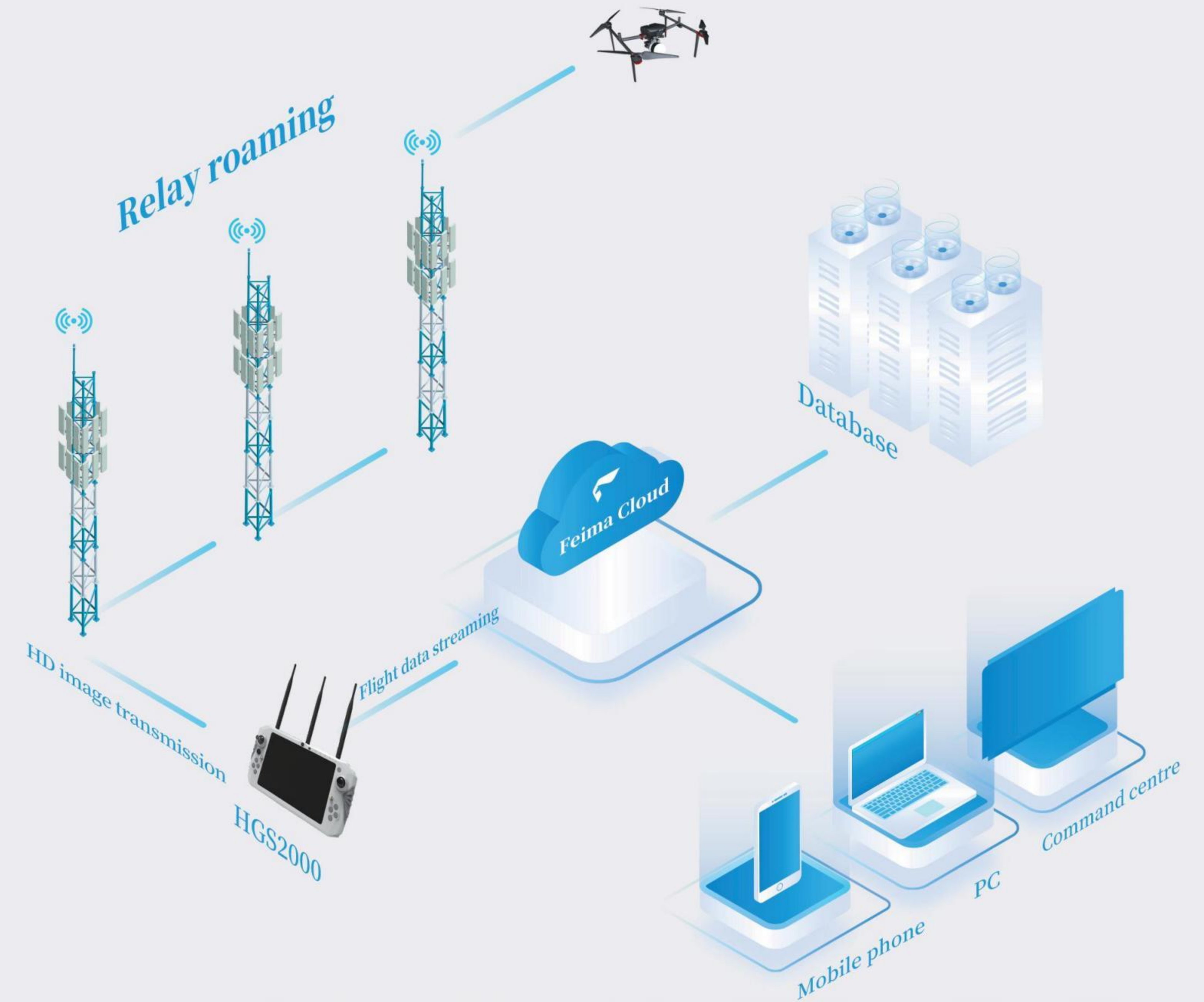
D500

All-weather video/megaphone/lighting payloads, making rescue and search simple and efficient



09 VIDEO INSPECTION SOLUTION

The D500 is equipped with D-EOV2100 and D-TIRV1100 dual optical modules, which can achieve up to 12 times of lossless zoom, support picture in picture mode, and have the functions of point positioning, visual surrounding, AI identification, tracking and so on. It can satisfy the needs of various inspection applications in long-distance and complex terrain environments with air-ground relay roaming.



- User management
- Flight management
- Dongle management
- Realtime broadcasting
- History playback
- Data statistics
- Task push
- Message push





- Traffic management
- Public security
- Mountain rescue
- Investigation and evidence collection
- Water rescue
- Forest inspection



Forest fire protection



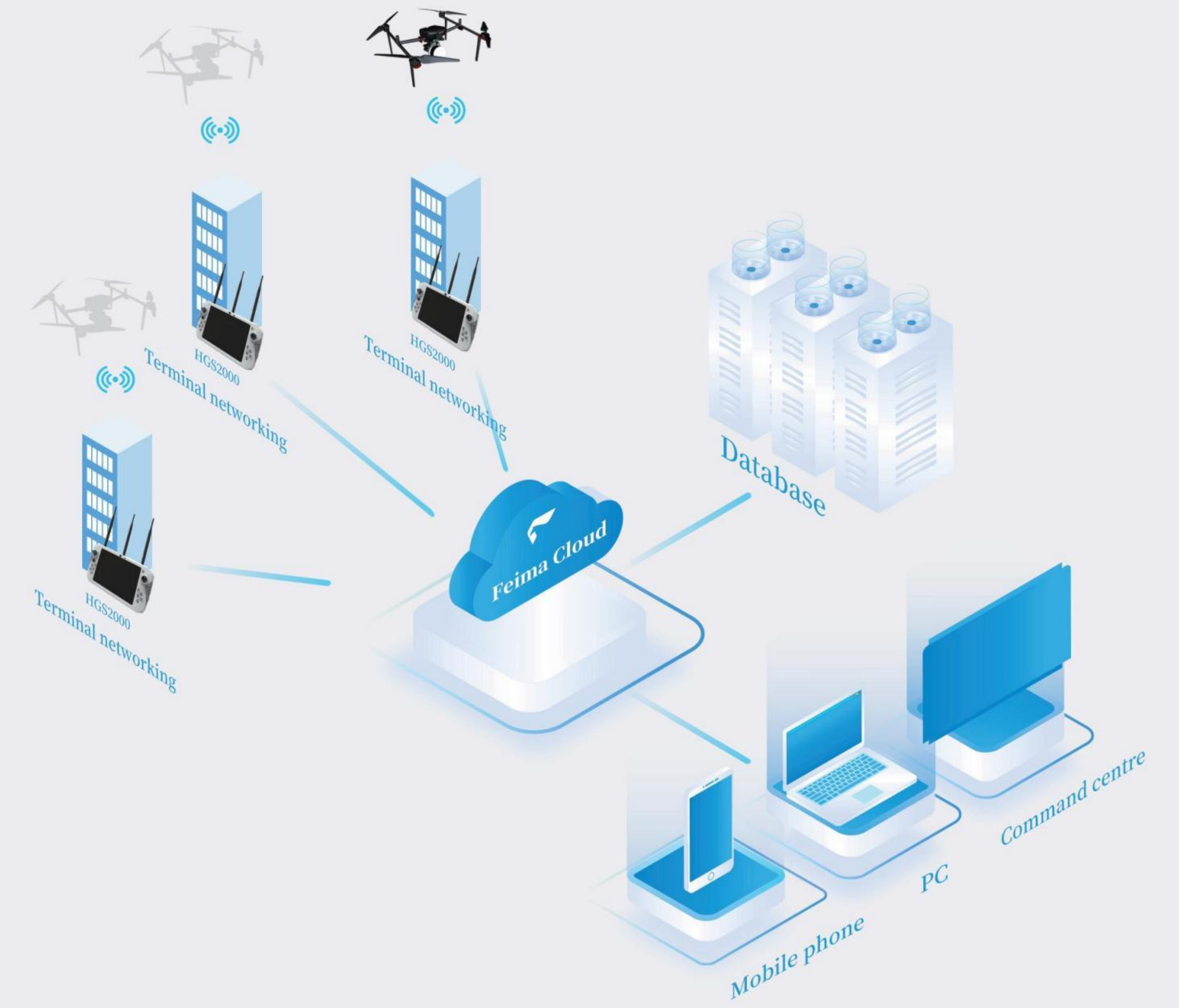
Security activities



Disaster rescue

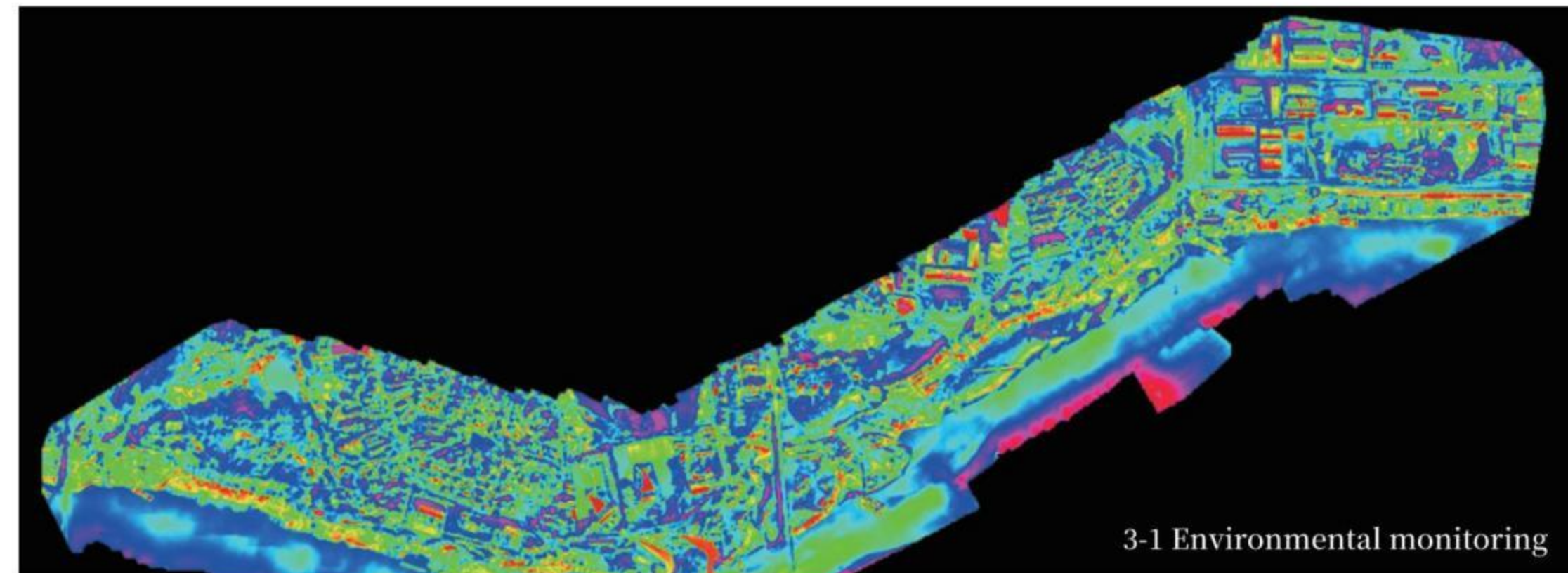
10 | EMERGENCY MANAGEMENT SOLUTIONS

The D500 supports simultaneous carrying of three payloads, i.e., video, megaphone and lighting. Users can combine and switch according to the actual application. It supports offsite takeoff and landing and terminal networking. It can realize multiple control, flexible takeoff and landing, remote takeover and other functions, and meet the requirements of multi-function, high time efficiency and high flexibility in the field of emergency management.



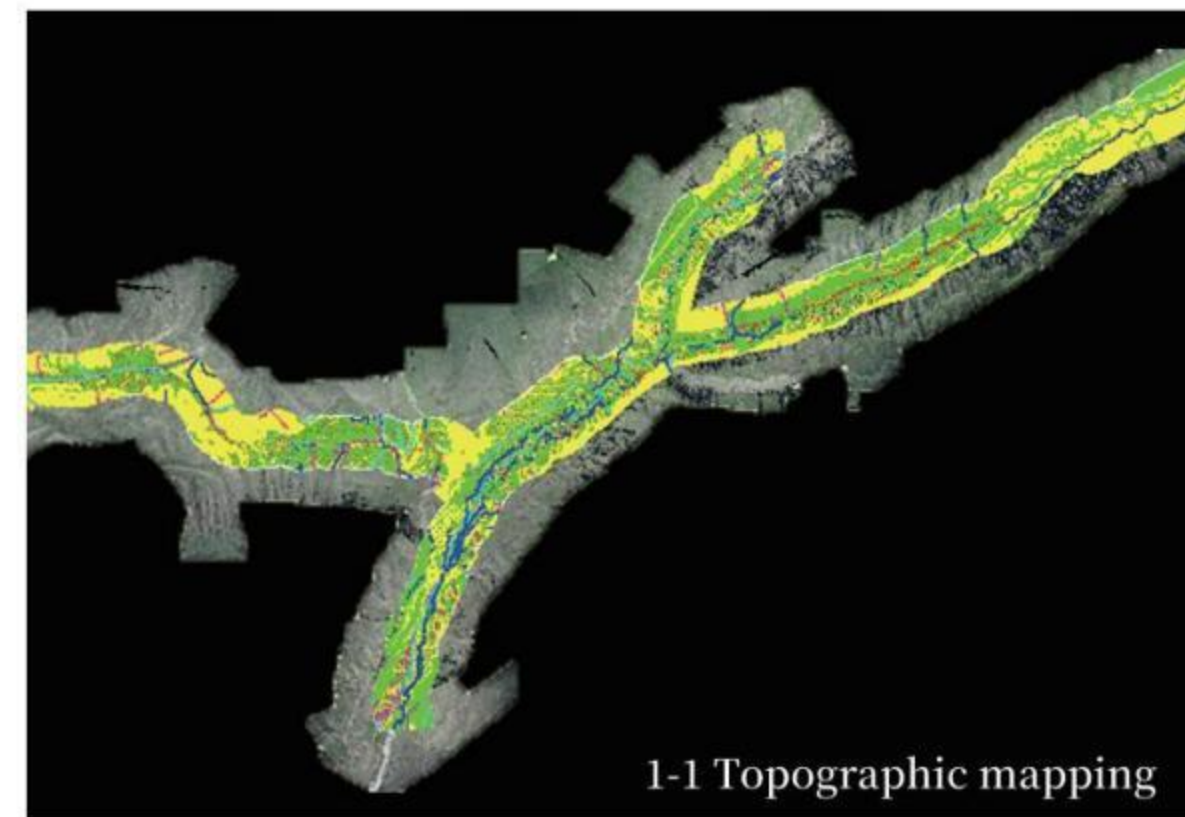
High-precision topographic mapping

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



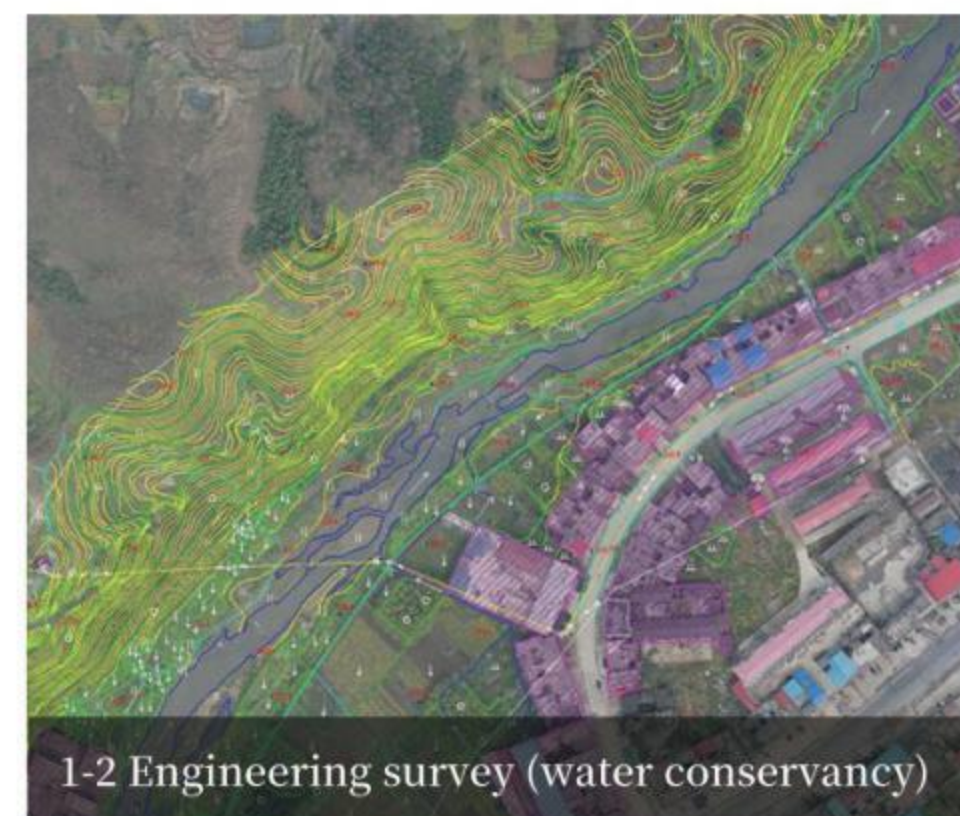
High-precision 3D modeling

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

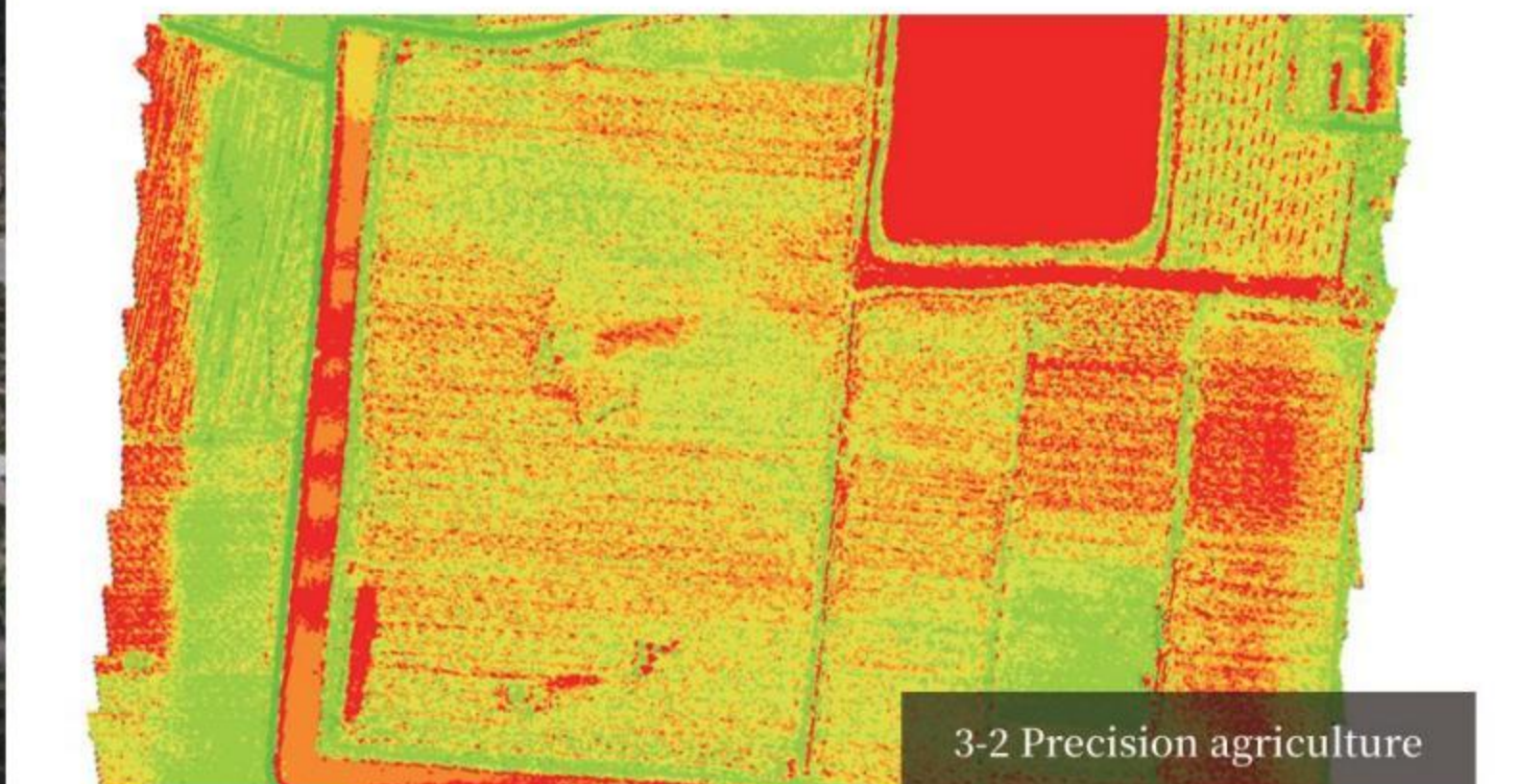


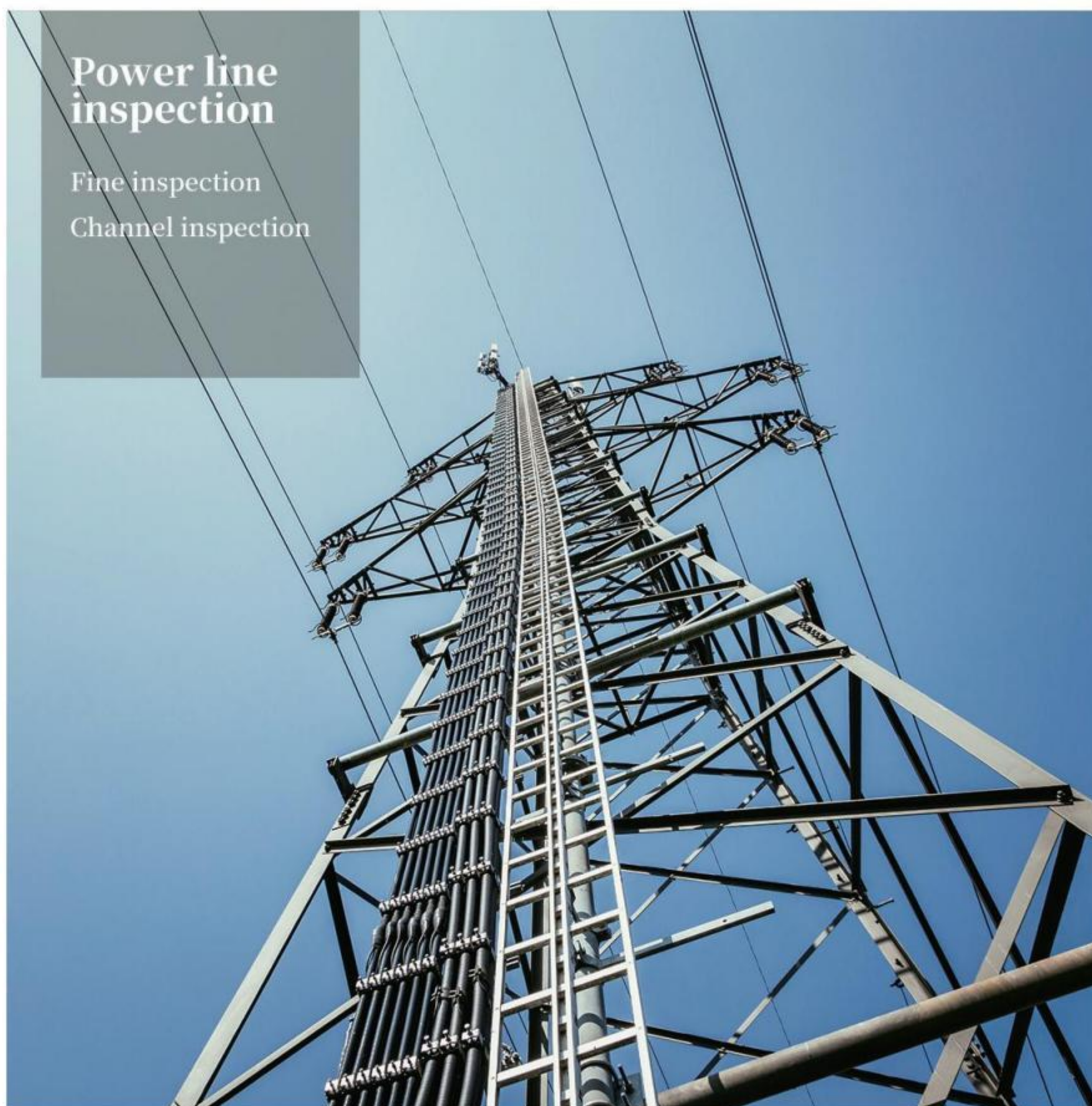
Remote sensing monitoring

- 3-1 Environmental monitoring
- 3-2 Precision agriculture



11 INDUSTRY APPLICATIONS





12 | UAVMANAGER PROFESSIONAL EDITION





SmartPlan

Simple and reliable 3D route design

SmartPlan is a route planning software for fixed-wing and rotor UAVs. It can automatically generate the best flight plan and route for post-processing based on high-precision real 3D terrain according to the terrain fluctuations and image requirements of the mission area. The task area can be automatically divided at any angle and the route angle can be adjusted to meet the needs of post-processing. Adapting to the requirements of sensor application mode, the terrain fitting automatic route algorithm based on high-precision 3D model generates accurate terrain following flight plans and routes to ensure the consistency of the acquired data throughout the flight.

Software features

1. Scene-adaptive high-precision automatic 3D route

According to the aerial photography parameters such as the area scope, terrain fluctuations, image resolution, payload, and overlap requirements, the optimal flight route that adapts to different terrains is automatically generated based on the 3D terrain data. A variety of strip routes are supported such as block route, strip route, control strip route, cross route, facade route and surrounding route.

2. Precise terrain following route based on high-precision 3D terrain

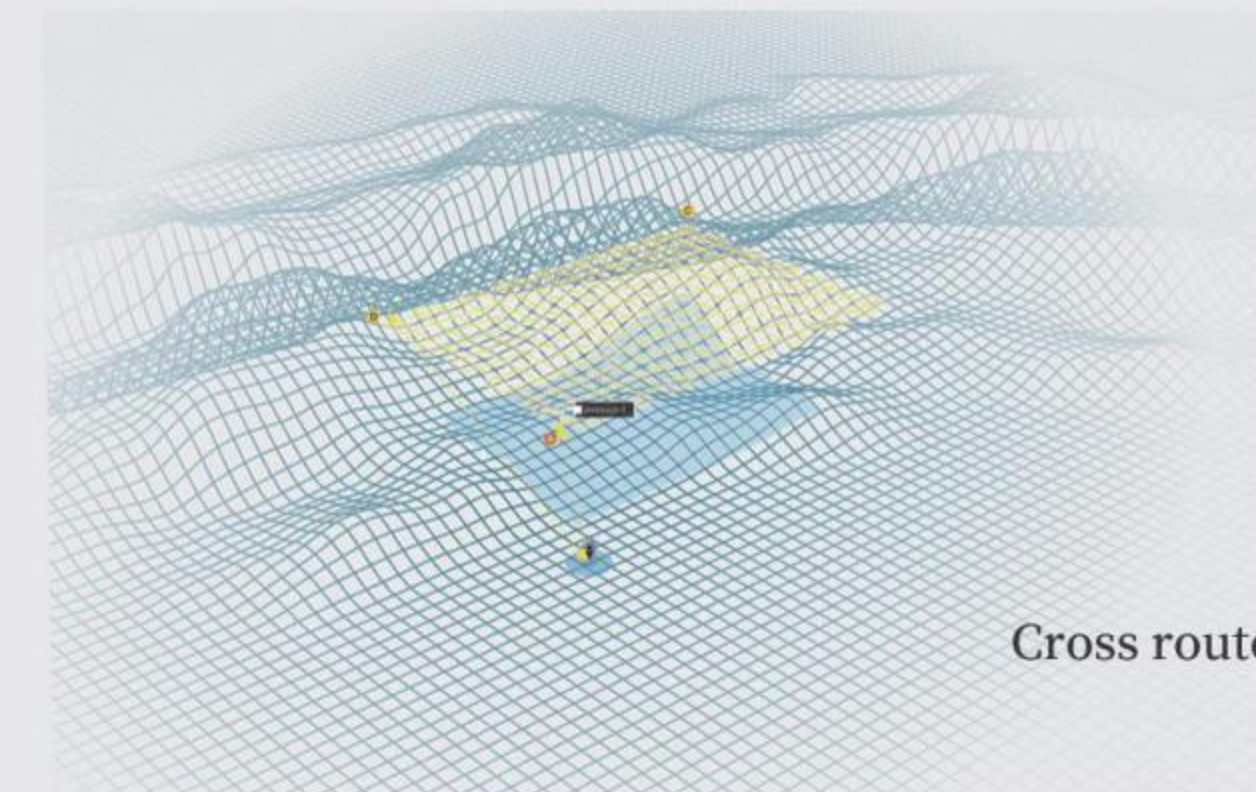
It adapts to the requirements of payload operation and application over complex ground scenes. Combined with the generic or self-imported high-precision 3D terrain data and self-developed automatic routing algorithm, it can automatically generate accurate terrain-fitting routes to ensure the consistency of obtained image resolution and LiDAR point cloud density.

3. Easy mapping

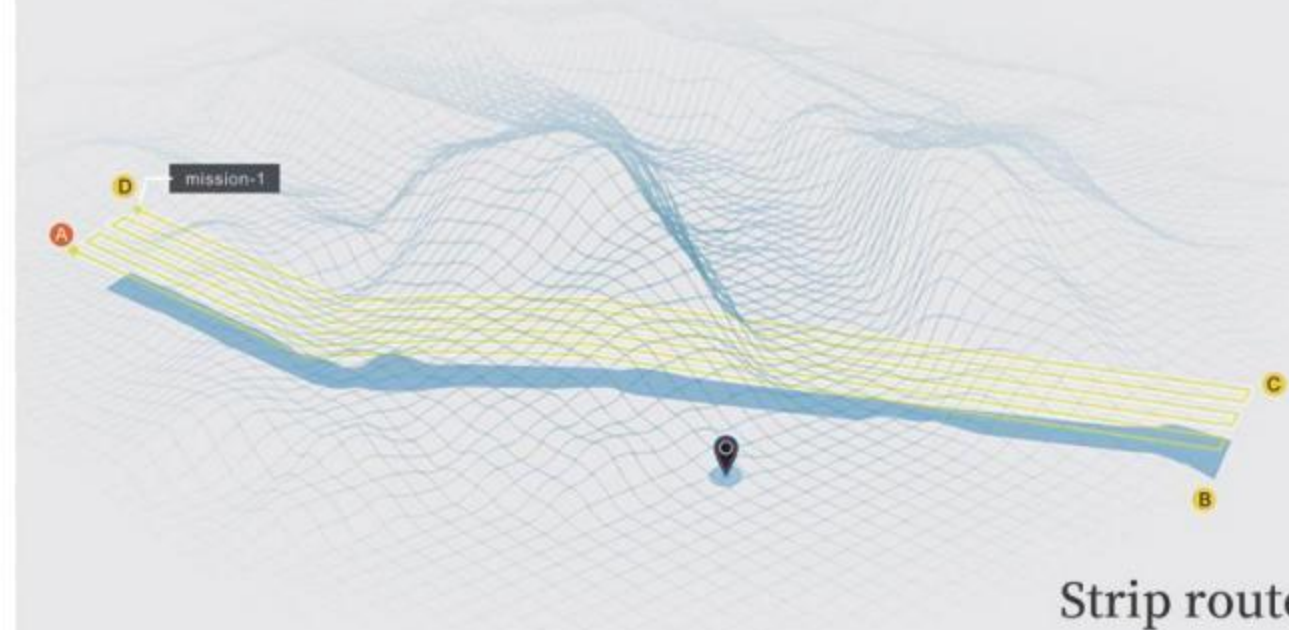
It is easy to outline an area for aerial photography by drawing polygons, rectangles or arbitrary lines. Moreover, the KML format file import, manual coordinates input, and map data caching are supported as well.

4. Intelligent flight block division

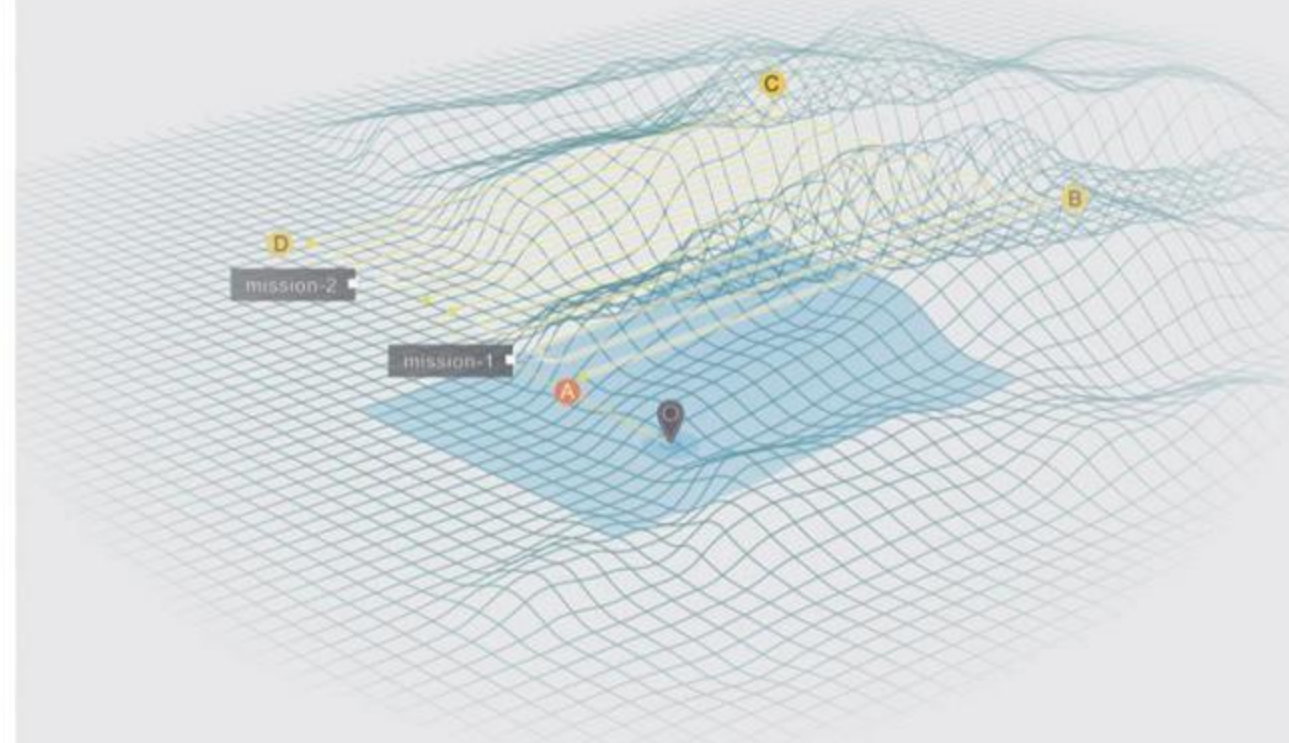
As for super large survey areas, the automatic block partition algorithm pioneered by Feima Robotics is used to achieve one-key division, edge matching and overlap, and mission assignment and management. It can also support block splitting at any angle for optimizing the route generation which is closer to the ideal planning of aerial photography in the survey area.



Cross route



Strip route



Conventional route

13

UAVMANAGER PROFESSIONAL EDITION



SmartFly

Real-time 3D display of flight status

SmartFly is a UAV flight monitoring software, which can visually monitor the flight status and parameters in real-time 3D scenes, modify certain flight control parameters, and provide intelligent early warning to ensure the safe execution of flight missions. By regarding the pending project as a virtual sortie, it helps to obtain the data of a single sortie according to the actual field conditions, and automatically continue the flight through the software to complete the coverage of the whole area and improve the work efficiency.

Software features

1. It provides a unified monitoring interface for both the fixed-wing and rotor UAVs. It supports different monitoring modes with aerial photographing videos and supports operations using multiple sensors for different applications.
2. Visualization of 3D scenes, sorties, and status is supported, which enriches the information content for flight monitoring and improves monitoring quality for users.
3. It furnishes real-time visualization of flight track, UAV condition, wind speed, ground velocity, battery condition, onboard temperature, GPS positioning status, and other parameters.
4. Smart alert of flight abnormality and one-key return
5. Visualization playback of flight process
6. Guided interface design helps the beginners to fulfill take-off preparatory work with ease.

Operations before takeoff

Task settings

HOME point position

Latitude	*0.252342°
Longitude	**6.256878°
GPS altitude	100 m

Mission range

- Full flight
- Continue last flight
- Custom flight

- 2. Camera inspection !
- 3. UAV inspection !
- 4. Task upload !
- 5. Summary of pre-flight situation !



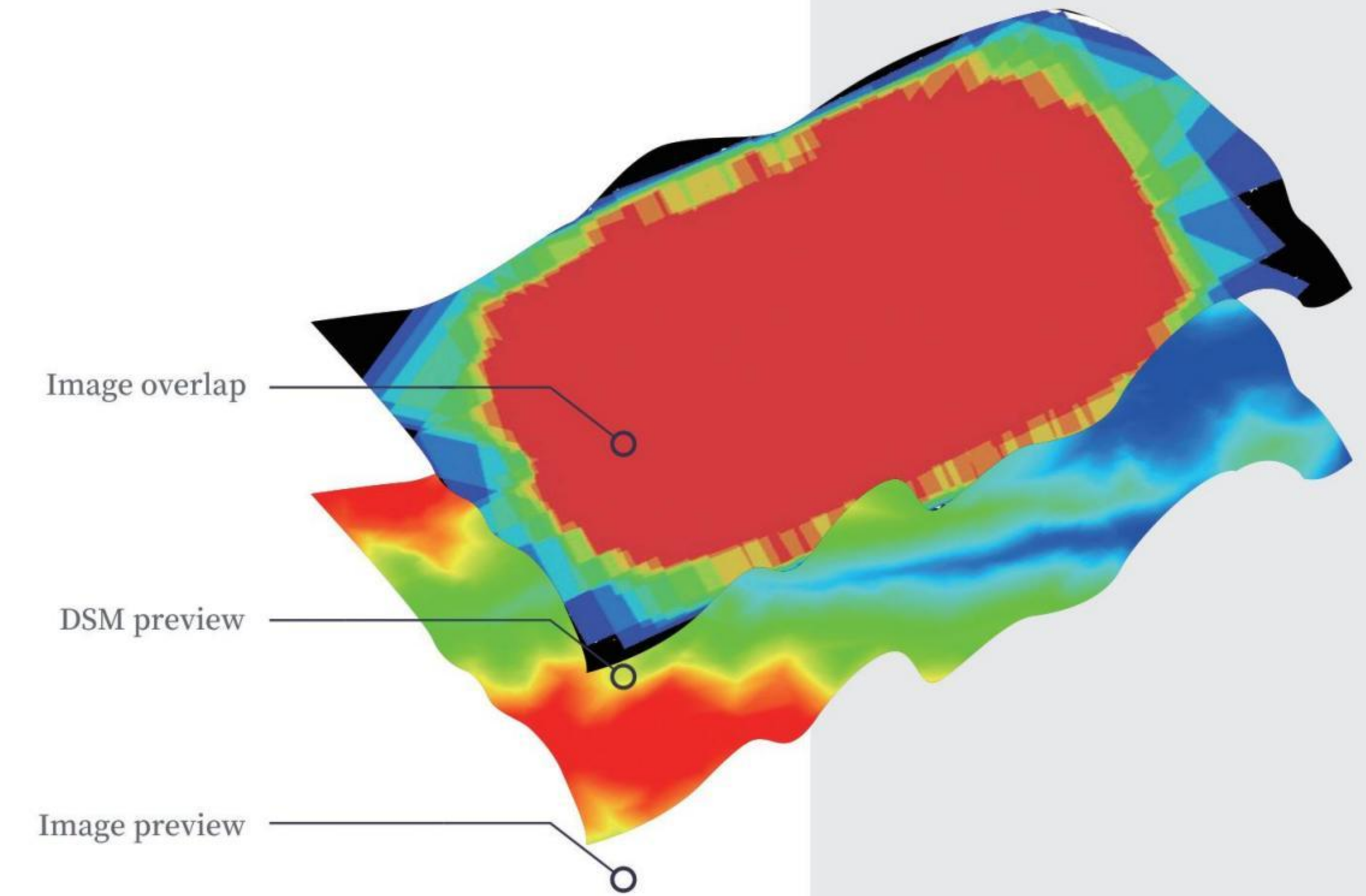
SmartCheck

Clearly displayed flight date and quality report

SmartCheck is a professional and automatic software system for on-spot flight quality inspections and assessments. It helps to quickly generate quality reports and to improve the efficiency of data quality review and the reliability of subsequent image processings.

Software features

1. The highly automatic software system can complete data quality inspection for aerial photography with one click. It is easy to use with simple training even for beginner users.
2. Based on GPU parallel computing, it only takes 5 to 10 minutes from image input to quality report output. It is convenient for aerial photography operators to identify problems and take counter-measures in a timely manner.
3. It provides professional UAV data quality reports by means of graphical results and summary statistics for certain indices.
4. It supplies a variety of information, e.g., exposure stations, footprint, attitude over-run, and image connectedness for users to inspect data quality from multiple aspects.



Software interface

- Exposure stations
- Footprint map
- Image ID
- Connection strength
- Image
- Route strips
- IMU over-run

Roll > 4°
Pitch > 4°

Strip adjustment
Strip

Refresh route
Refresh image

Mapping scale: 1:1000
Mapping resolution: 0.10
Forward overlap: 60%
Side overlap: 30%

Reset POS
View result
Run

Quality inspection report
Thumbnails
POS data

UAV data quality inspection report

Project overview	
Project name	Test_area
Operation time	2016-11-04 10:37:04
Survey area	6.9 square kilometers
Camera type	DSC-RX1
Average ground resolution	0.04 meters
Coordinate system	UTM zone 49N
Processing time	10'27"

Matching and adjustment	
Calculated images	1086
Adjustment situation	1086 successful
Matching pixels	40009
Number of matched pixels per image	42
Overlap distribution of matching points	2degrees: 7623 3degrees: 7755 4degrees: 6548 5degrees: 6117 5+degrees: 11966
Mean Elevation of matched points	-3.26 meters

Quality inspection conclusion

Flight requirements	
Mapping scale	1:1000
Mapping resolution	0.10 meters
Forward overlap ≥	60%
Side overlap ≥	30%

Quality inspection conclusion

The average resolution of the survey area is 0.04 meters, the forward overlap is 78%, and the side overlap is 55%.

Report number:
Calibration date:

Feima Robotics Digital camera calibration report

Camera body number:
Camera lens number:

S/N	Calibration content	Calibration value
1	Image width × height (unit: pixel)	
2	Pixel size (unit: micron)	
3	Principal point x0: (unit: pixel)	
4	Principal point y0: (unit: pixel)	
5	Focal length f: (unit: pixel)	
6	Radial distortion coefficient k ₁	
7	Radial distortion coefficient k ₂	
8	Radial distortion coefficient k ₃	
9	Eccentricity distortion coefficient P ₁	
10	Eccentricity distortion coefficient P ₂	
11	CCD non-square scale coefficient α	
12	CCD Orthogonality distortion coefficient β	

Distortion model:

$$\begin{cases} \Delta x = (x-x_0)(k_1r^2+k_2r^4+k_3r^6+L) + p_1[r^2+2(x-x_0)^2] + 2p_2(x-x_0)(y-y_0) + \alpha(x-x_0) + \beta(y-y_0) \\ \Delta y = (y-y_0)(k_1r^2+k_2r^4+k_3r^6+L) + p_2[r^2+2(y-y_0)^2] + 2p_1(x-x_0)(y-y_0) \end{cases}$$

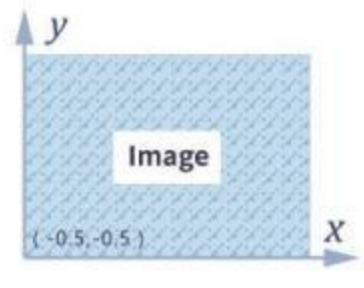
The collinear condition equation introduced into the distortion model is:

$$\begin{cases} x-x_0 + \Delta x = -f \frac{a_1(x-x_0) + b_1(y-y_0) + c_1(z-z_0)}{a_1(x-x_0) + b_1(y-y_0) + c_1(z-z_0)} = -f \frac{x}{Z} \\ y-y_0 + \Delta y = -f \frac{a_2(x-x_0) + b_2(y-y_0) + c_2(z-z_0)}{a_1(x-x_0) + b_1(y-y_0) + c_1(z-z_0)} = -f \frac{y}{Z} \end{cases}$$

Principal point coordinate system:

$$r = \sqrt{(x-x_0)^2 + (y-y_0)^2}$$

x, y It is the image point coordinate in the image coordinate system, and the coordinate system is shown in the right figure;



Camera calibration report



Camera calibration



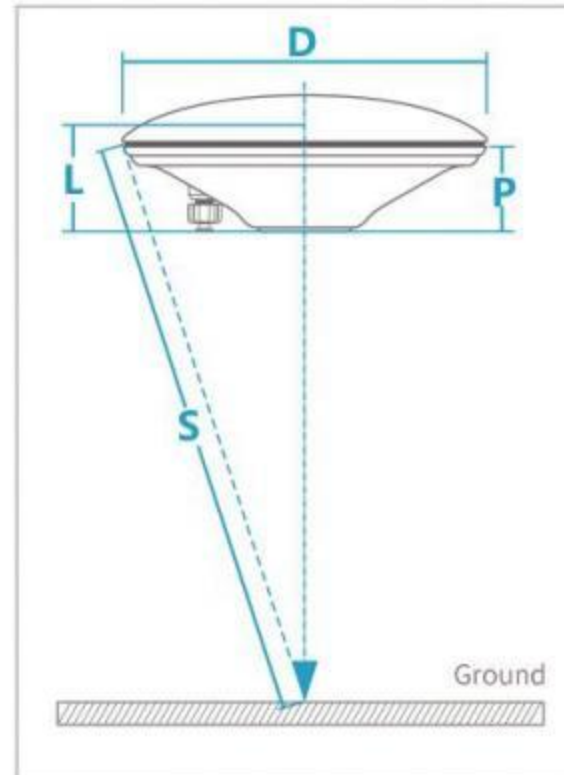
SmartProcess

Abundant UAV data processing toolbox

SmartProcess is UAV data preprocessing software, which provides advanced camera model self-calibration algorithm based on calibration field model constraints, distortion removal tools, etc., to meet the high quality and high precision requirements of UAV survey and mapping.

In addition, it also provides preprocessing functions such as image homogenization, enhancement, pyramid creation, format conversion, and result accuracy checking.

GPS



Calculation mode: Single point positioning Differential calculation

GPS antenna height: D 0.147 m L 0.052 m P 0.037 m S 1.504 m

Vertical height of GPS antenna: H 0 m

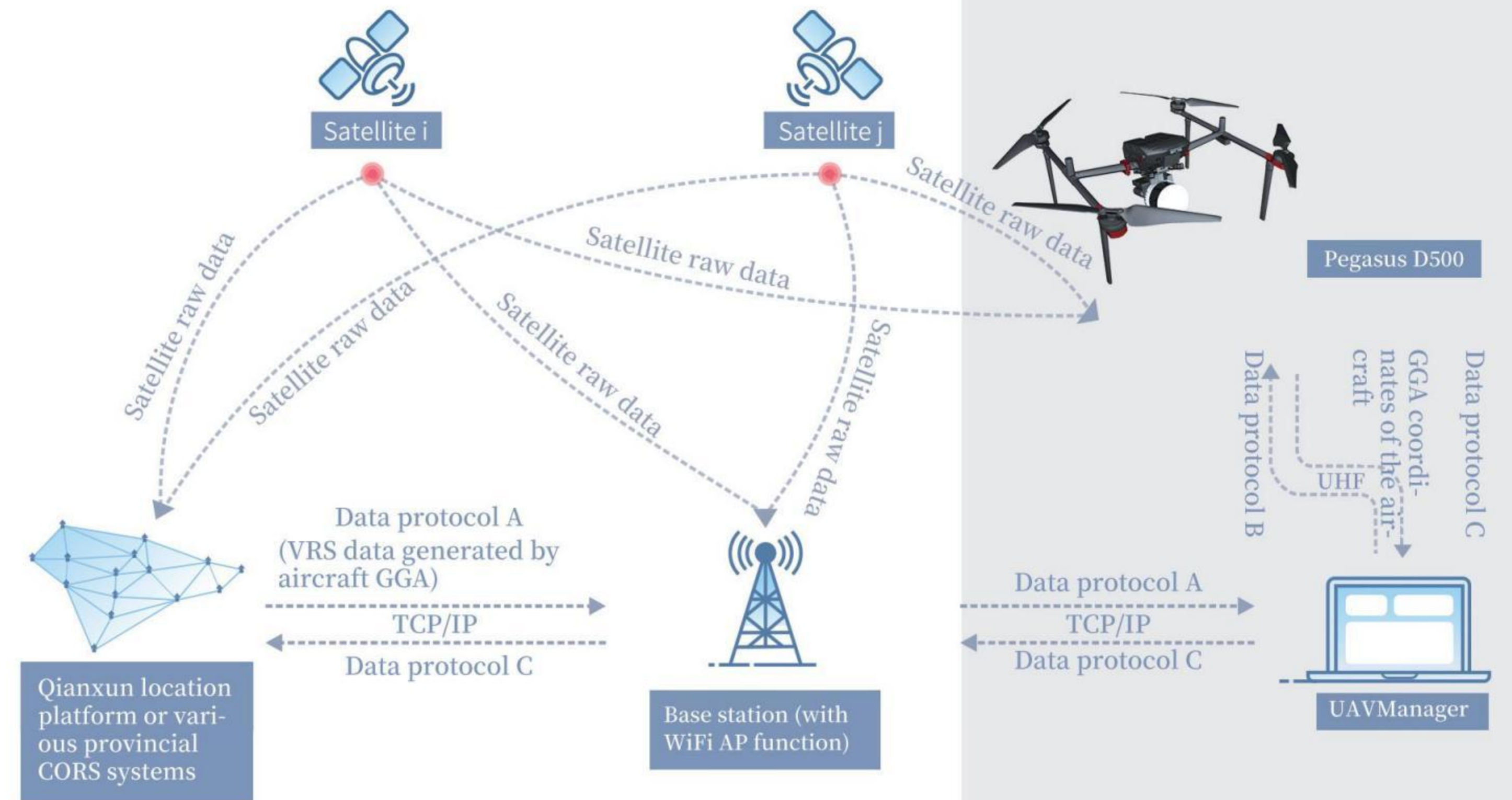
Sampling interval: 0.1 (S)

GNSS systems: GPS BeiDou GLONASS SBNS

Reference POS:

Output direction:

GNSS calculation



Data protocol A: RTCM2.3, RTCM3.0, RTCM3.2, CRM, CRM+;

CORS mode

Data protocol B: Repackaged RTCM2.3, RTCM3.0, RTCM3.2, CRM, CRM+;

Data protocol C: NMEA-0183

Software features

1. Advanced camera calibration and distortion removal

It supports flight data self-checking and calibration of camera models to meet general use. Also, it provides a camera self-checking and calibration method based on the constraints of the ground calibration field model, outputs a more robust and accurate optimal camera model, and ensures large-scale mapping accuracy requirements. It supports the functions of non-destructive precision import of common domestic camera calibration models, image distortion removal, etc., to ensure the seamless connection between aerotriangulation and stereo mapping.

2. RTK/PPK fusion solution

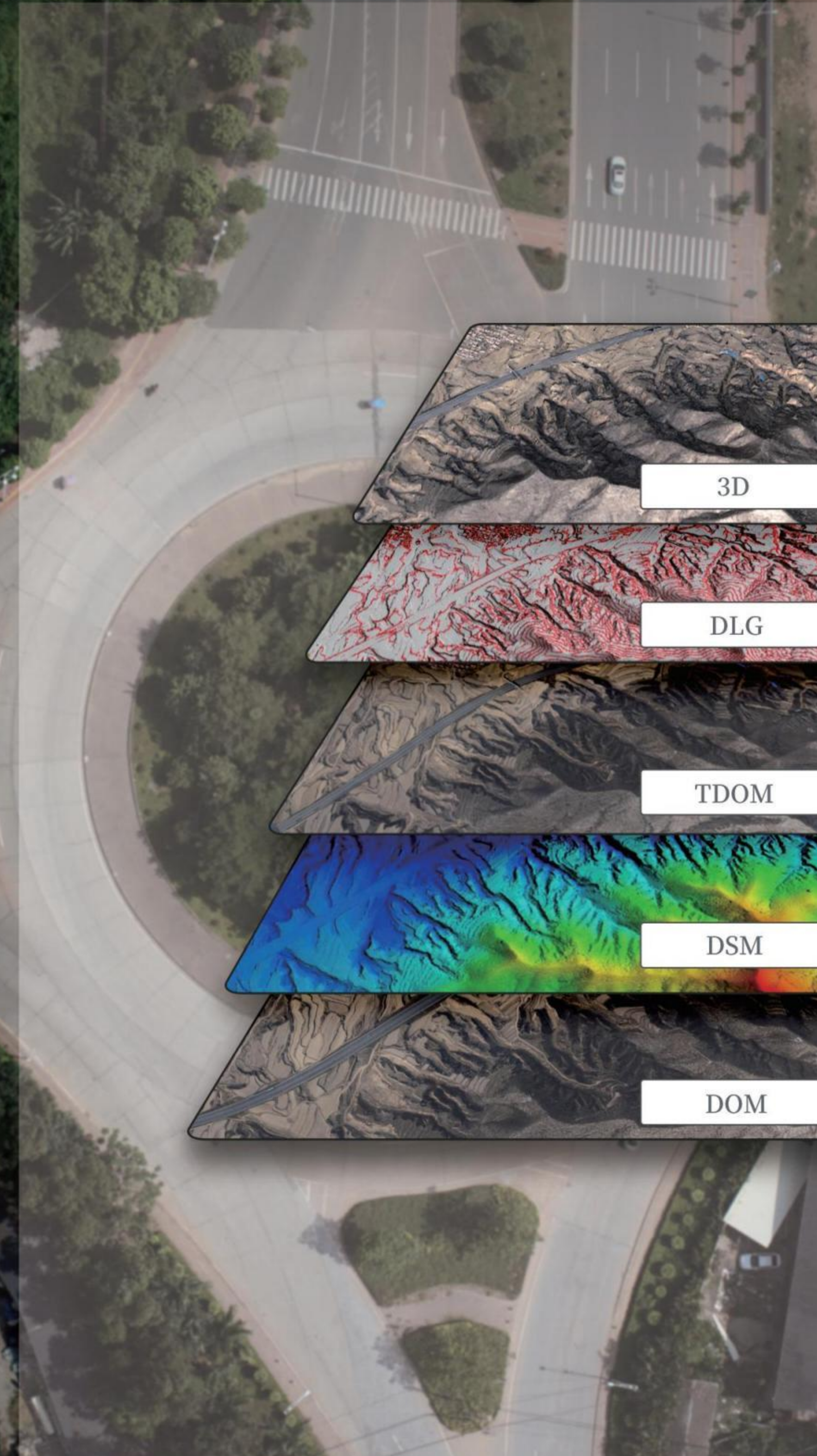
It supports one-click differential data calculation based on PPK mode, supports GPS, Beidou, GLONASS and Galileo data, and outputs high-precision POS. It supports fusion and differential calculation based on RTK and PPK fusion mode, supports single base station and CORS operation modes, and automatic collection of known point coordinates. It directly incorporates the POS data of flight exposure points into the final target coordinate system.



SmartMap

High-precision, fast, and total outputs processing software system

SmartMap is a one-key UAV data processing software system with its processing chain covering orthophoto and oblique-photo aerial triangulation, adaptive feature points matching, control points measurement, ortho-rectificaion, color balancing, stitching, full-pixel and high-density point cloud matching, TDOM and 3D reconstruction. Traditional DEMs and DOMs, high-precision and high-quality DSMs and TDOMs, and real scene 3D models can be generated and output by SmartMap. Intelligent control points measurement, GPS-supported aerotriangulation, PPK mode image mosaic, and fast 3D data viewing are also supported.



Software features

1. Powerful core algorithms

Powerful core algorithms of image matching and aerotriangulation, for both ortho and oblique photography, enable users to handle issues, such as irregular image arrangements, large swing angles, irregular overlaps and so on. In addition, it is compatible with image data acquired from different cameras, over differing terrains, and in different weathers and surroundings.

2. Strong processing performance and rich types of results

UAVManager Professional Edition is powerful for data processing and can generate various output types. More than 10,000 image frames can be handled simultaneously. Dense point clouds, TDOMs, and out door scene 3D models are supported as well.

3. Intelligent control point measurement and POS auxiliary aerotriangulation

Intelligent control points measurement and GNSS-aided aerotriangulation remarkably reduce field workload. Both manual and automatic measurements are supported in the control point measuring module of UAVManager. The robust GNSS-aided aerotriangulation can guarantee mapping accuracy even with very few control points, thus improving the efficiency of large-scale mapping with UAV platforms.

4. Based on RTK and PPK high-precision GNSS additional parameter control-free orientation algorithm, to achieve control-free mapping

An orientation algorithm with additional parameters, based an RTK and PPK fusion high-precision GNSS, supports mapping without ground control. With RTK and PPK fusion calculation of the more accurate GNSS positions of exposure stations, optimized camera calibration model fitting based on 3D calibration fields, and lever arm correction based on additional parameter aerotriangulation, high-precision direct orientation without ground control is accomplished, thus greatly decreasing field work in UAV-based aerial photography and making data acquisitions in dangerous areas possible.



Cluster processing

UAVManager Professional Edition cluster processing, i.e., multiple computers running at the same time, supporting cluster processing of quick mapping, DSM, TDOM, 2.5D and 3D meshes and so on.

The survey version and full version of UAVManager Professional Edition supports 3 computing nodes, and its efficiency will be increased by 3 times compared with the stand-alone version, which can meet the rapid production needs of regular customers.

In addition, for large data, it also supports users to customize and expand more computing nodes, which can improve the efficiency by N times (basically proportional to the nodes).

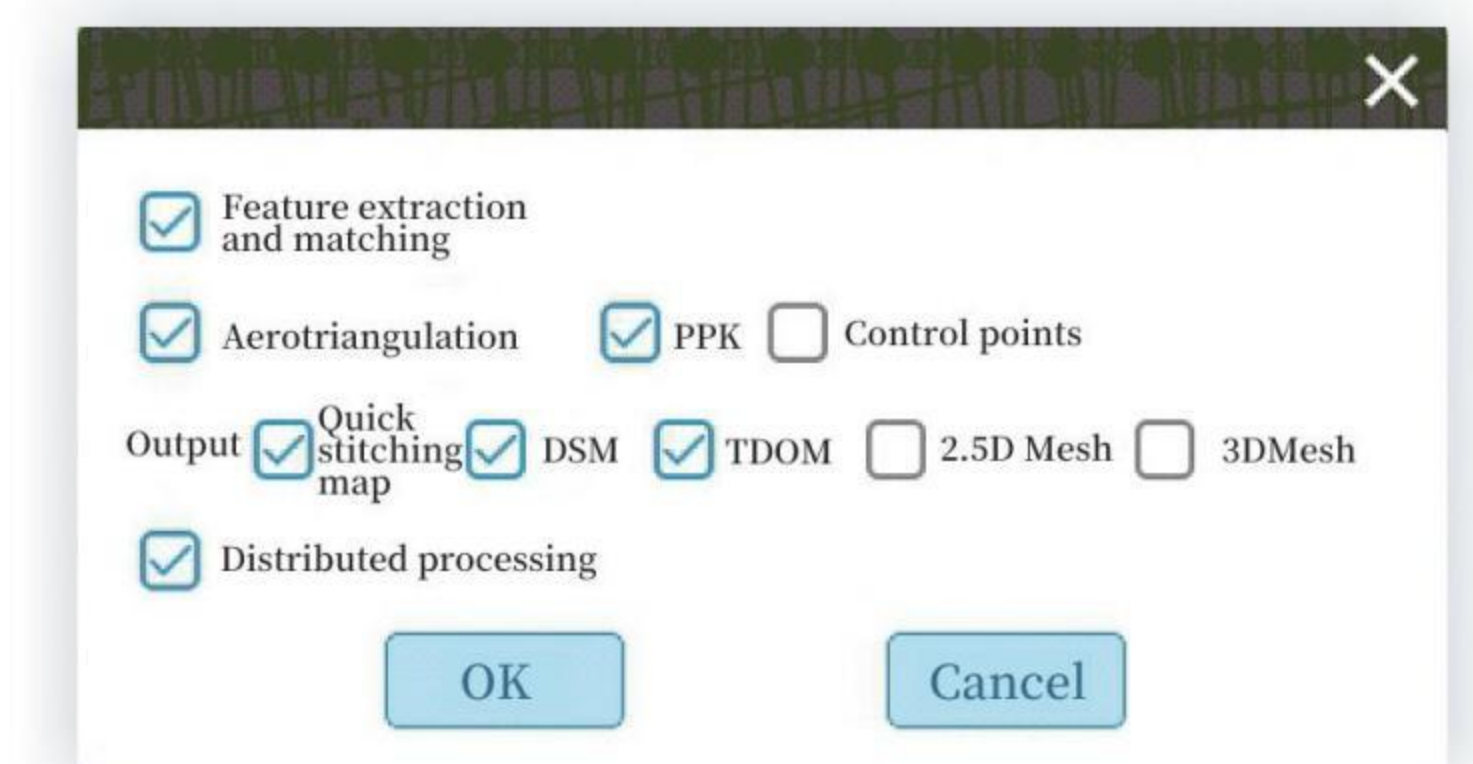
Software features

1. The cluster setting is simple, and the cluster operation can be performed by connecting to the local area network, sharing between groups, and opening the service. One host can be configured with multiple computing nodes (the number of nodes depends on the number of concurrent software licenses).

2. Using the data distribution method for data block processing can greatly reduce the dependence of data processing on the host storage space, reduce the frequent transmission of data, and improve data processing efficiency.

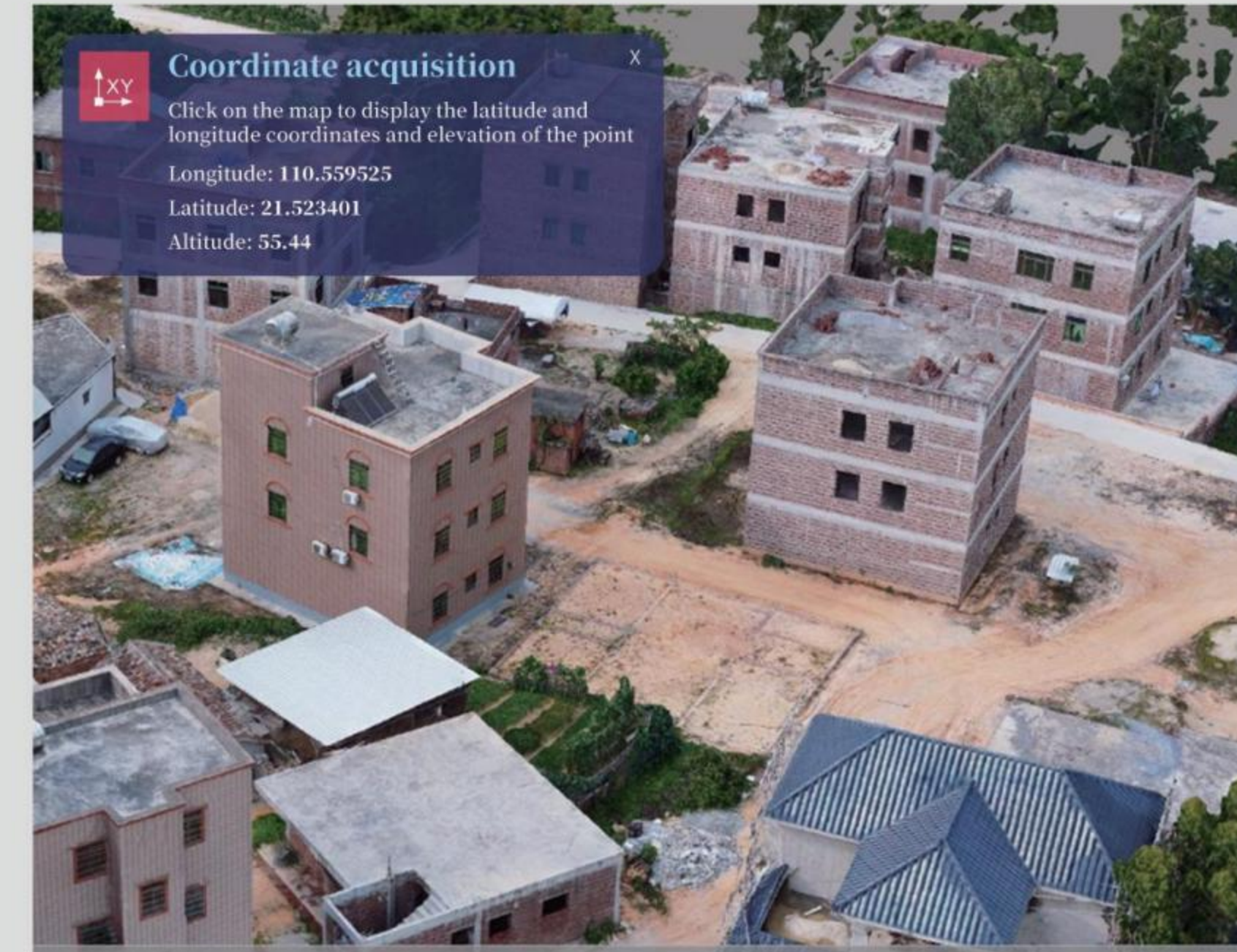
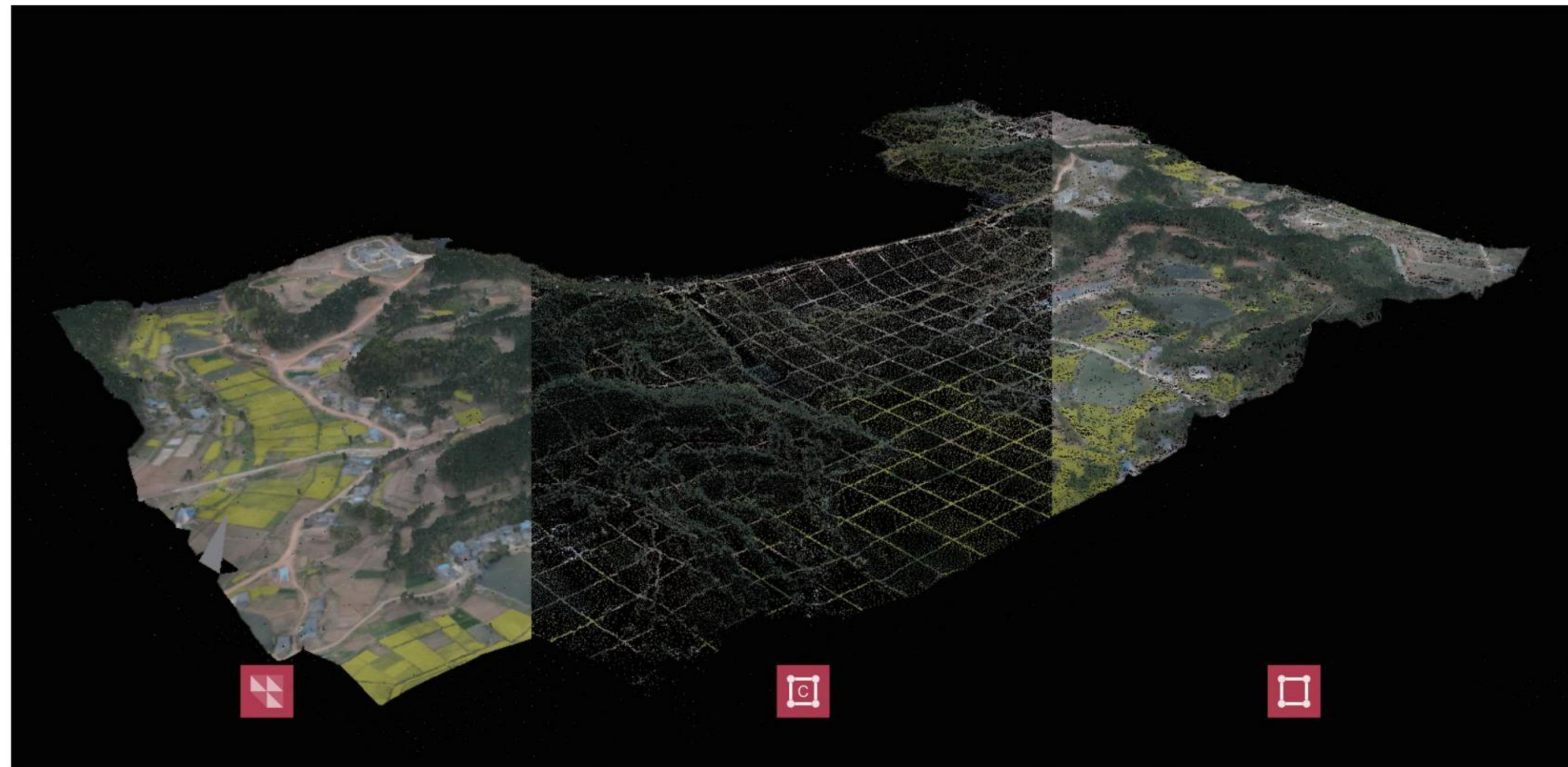
3. It supports the needs of data segmentation and merging, and meets the cutting needs of large data volumes.

4. It supports multi-project and multi-mission queuing processing to make full use of cluster resources.



3D 3D Viewer

Feima 3D Viewer is an application software system for 3D data generation from oblique photography. It supports the import of current popular OSGB 3D products to 3D digital earth and provides versatile functions, such as roaming, distance measuring, area measuring, volume measuring, and model import. Feima 3D Viewer provides a unified display platform for existing 3D terrain models, oblique high-resolution 3D terrain models, and fine 3D models.





SmartMonitor

UAV flights under control

SmartMonitor is a characteristic module of UAVManager Professional Edition, providing functions such as visualization and review of flights, flight records analysis, and summary display.



mission1

Project name – survey area name



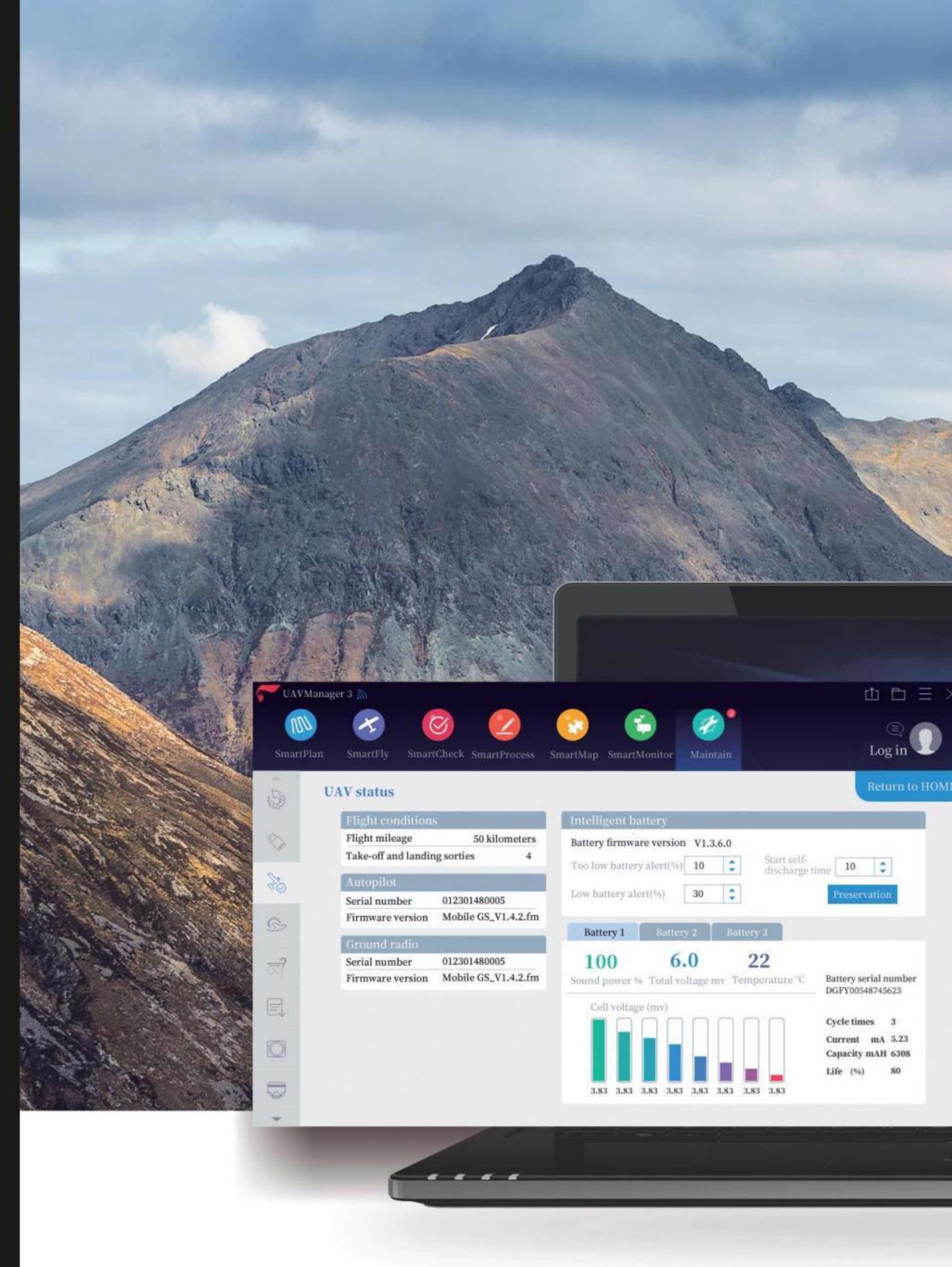
D500
Drone Model

Camera type	V-OP1000
Scale	1:500
Resolution	4cm/px
Course overlap	80%
Side overlap	60%
Route spacing	96m
Baseline	32m
Default airspeed	10m/s
Relative height	205m
Estimated area	1.133km ²
Estimated time	33min
Estimated mileage	20.226km

Average altitude of the survey area	43m
The peak	
Resolution	4cm/px
Altitude	47m
Forward overlap	80%
Side overlap	59%
Lowest ground point	
Resolution	4cm/px
Altitude	40m

Flight record

2017 / 09 / 23	09 : 36 : 23	▶
2017 / 09 / 25	14 : 12 : 56	▶
2017 / 10 / 13	12 : 56 : 20	▶
2017 / 10 / 26	15 : 25 : 53	▶



Maintenance

UAV health status assistant

It can realize online upgrade of UAVManager Professional Edition, online health analysis, UAV fault diagnosis and firmware upgrade of all Feima's UAV platforms.



Firmware upgrade
Autopilot Ground radio Camera Ground base station



Dongle information
Authorization Serial number of dongle Validity period Mileage Active date UAV serial number



UAV condition
UAV condition Autopilot Ground radio Parachute Intelligent battery



Flight settings
Radio loss protection time



Troubleshooting
Software version Operating system Fault category Problem description Uploading onboard logs



Data download
GNSS Base station Camera POS



Camera settings
Camera parameters Test shot Clear all data



Base station settings
High-precision operation mode Known point acquisition



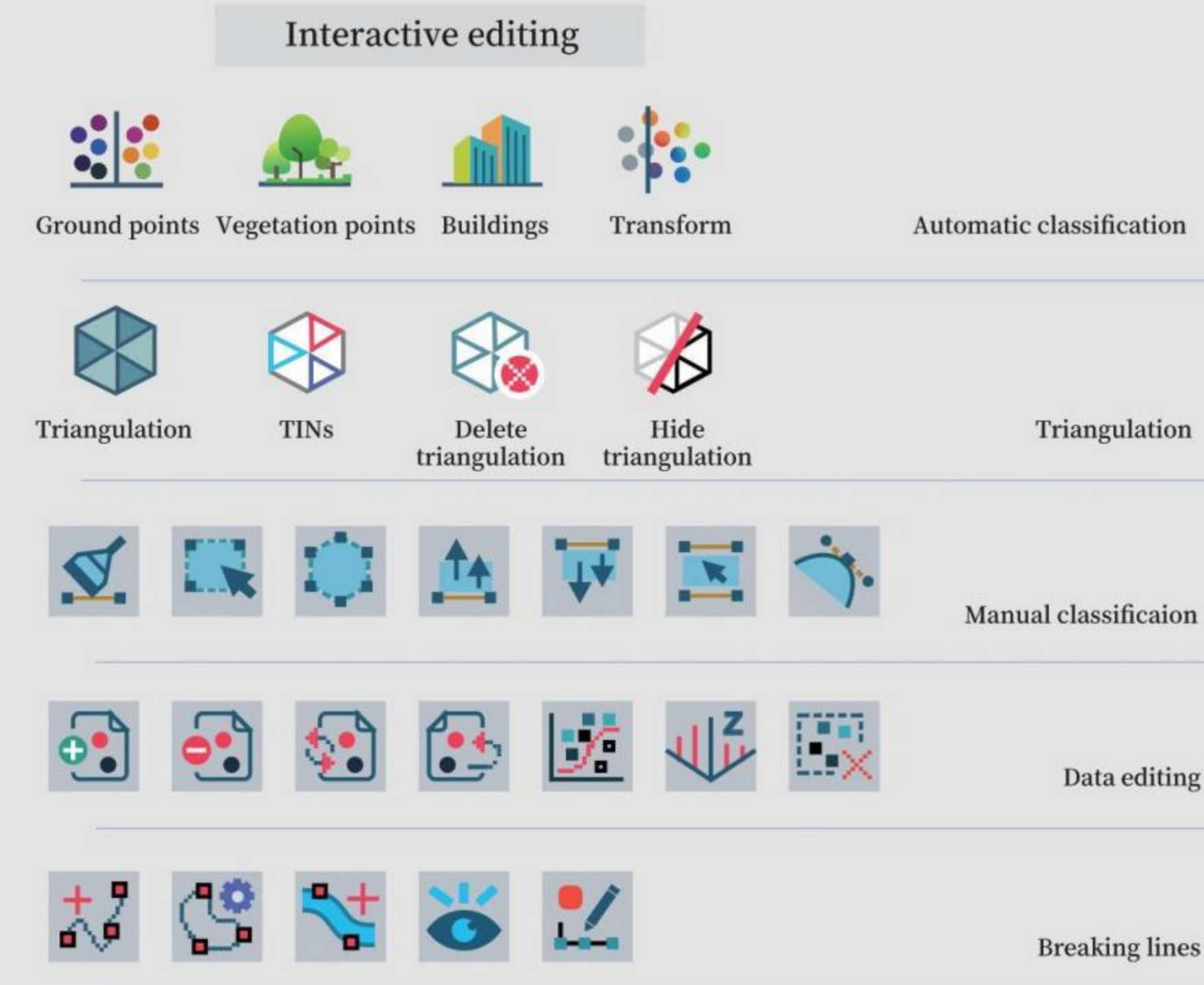
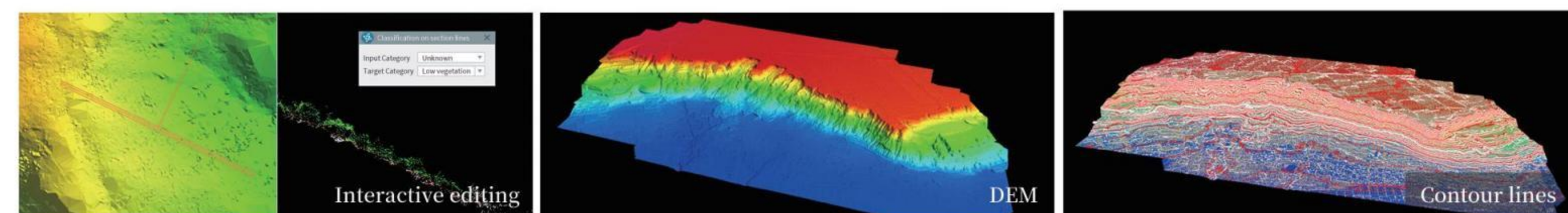
SmartPointCloud

Integrated laser point cloud preprocessing software

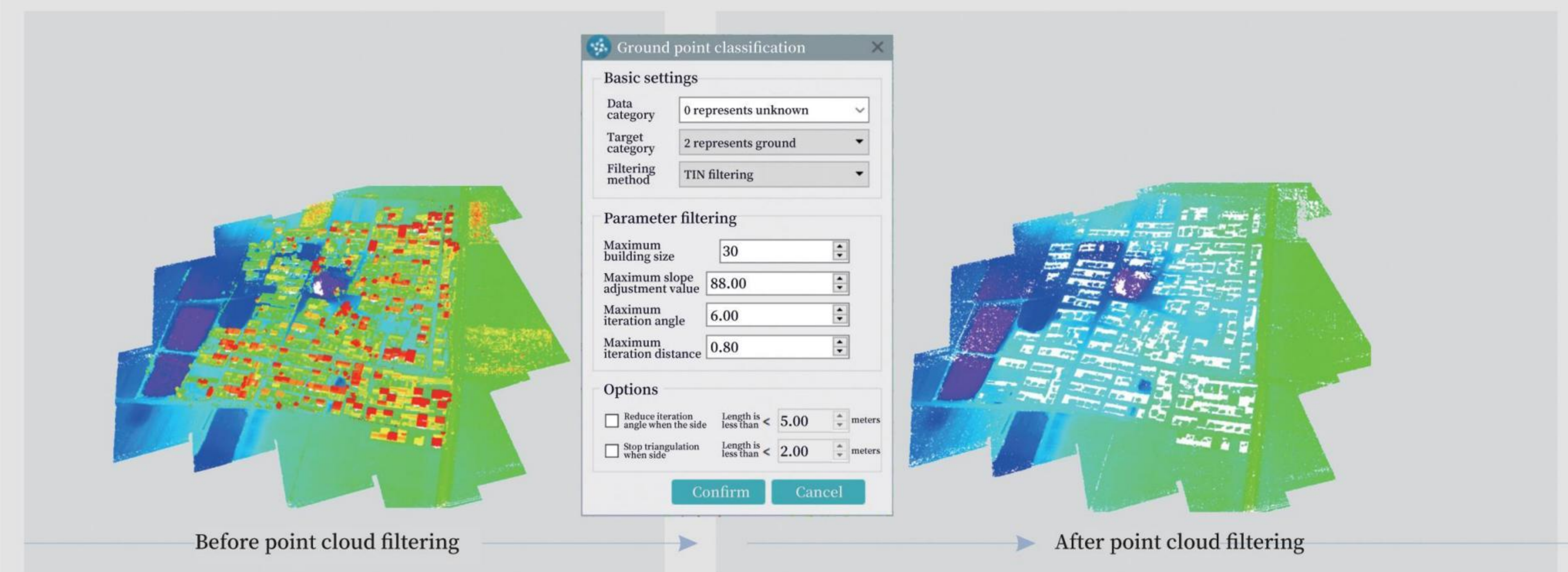
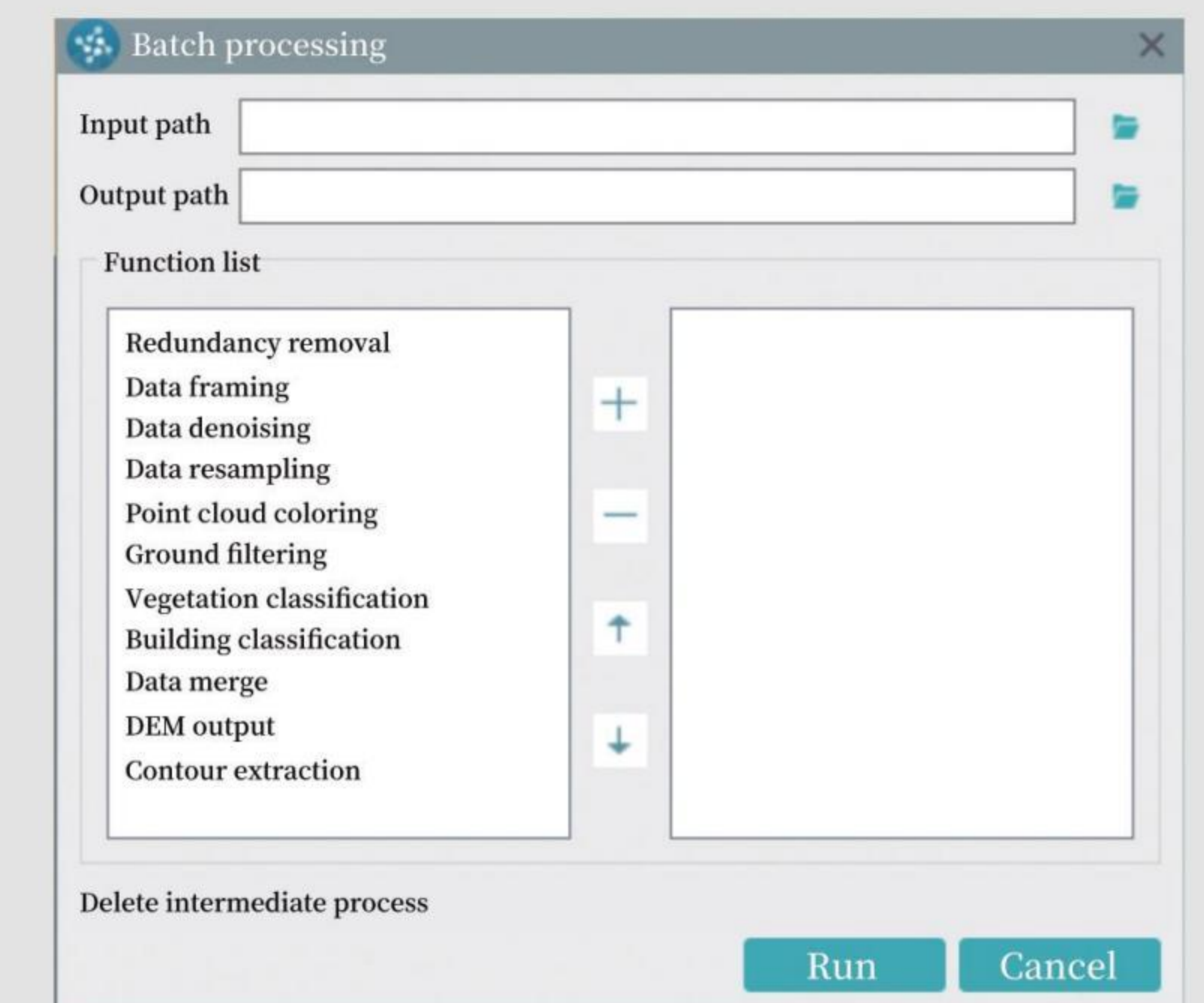
SmartPointCloud is a point cloud data post-processing software that supports various data sources. It can browse, display, process and edit point cloud data. It includes automate point cloud classification algorithms and comprehensive interactive editing tools, and can produce standard terrain results and other thematic results.

Software features

1. Supporting point cloud data processing such as dense matching point cloud, airborne LiDAR, and ground scanning
2. Browsing and displaying large amount of point cloud and supporting renderings of elevation, texture, section and so on
3. Providing automatic point cloud filtering, vegetation extraction and building filtering and classification algorithms
4. Providing various interactive editing tools for point cloud classification
5. Supporting section display and editing, real-time update and display of point cloud triangulation, convenient for assisting point cloud classification and judgment
6. Supporting the output of elevation points, DEM, contour lines and other results
7. Supporting import and automatic generation of mileage points, and one-click road section extraction and visual display based on point cloud
8. Supporting output of road section files in vector and latitudinal formats



Automatic processing algorithms

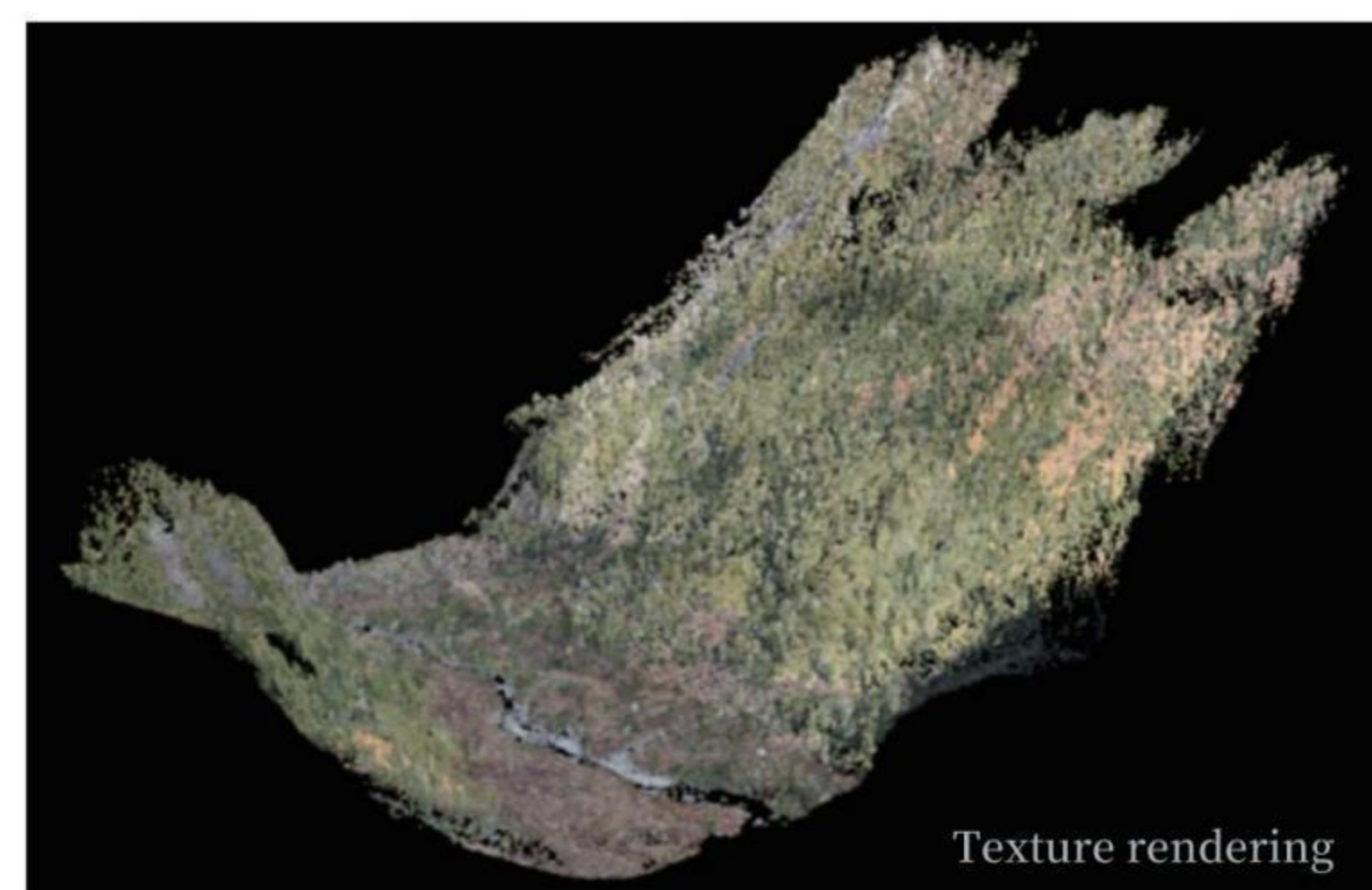
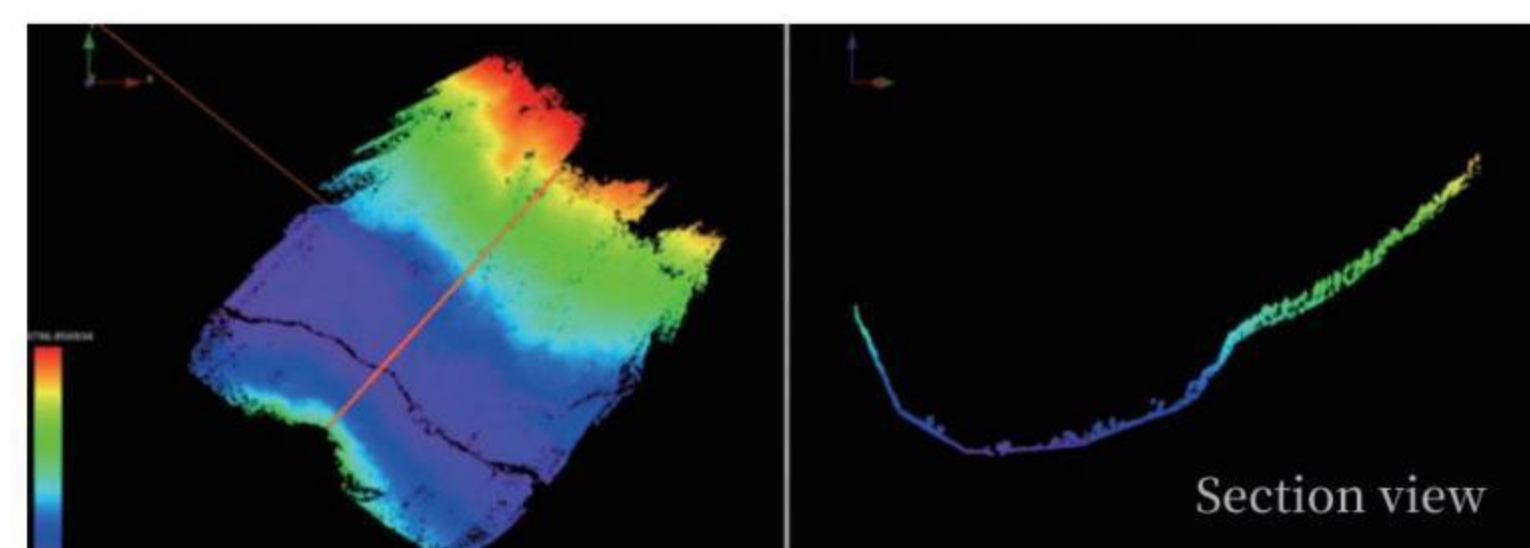
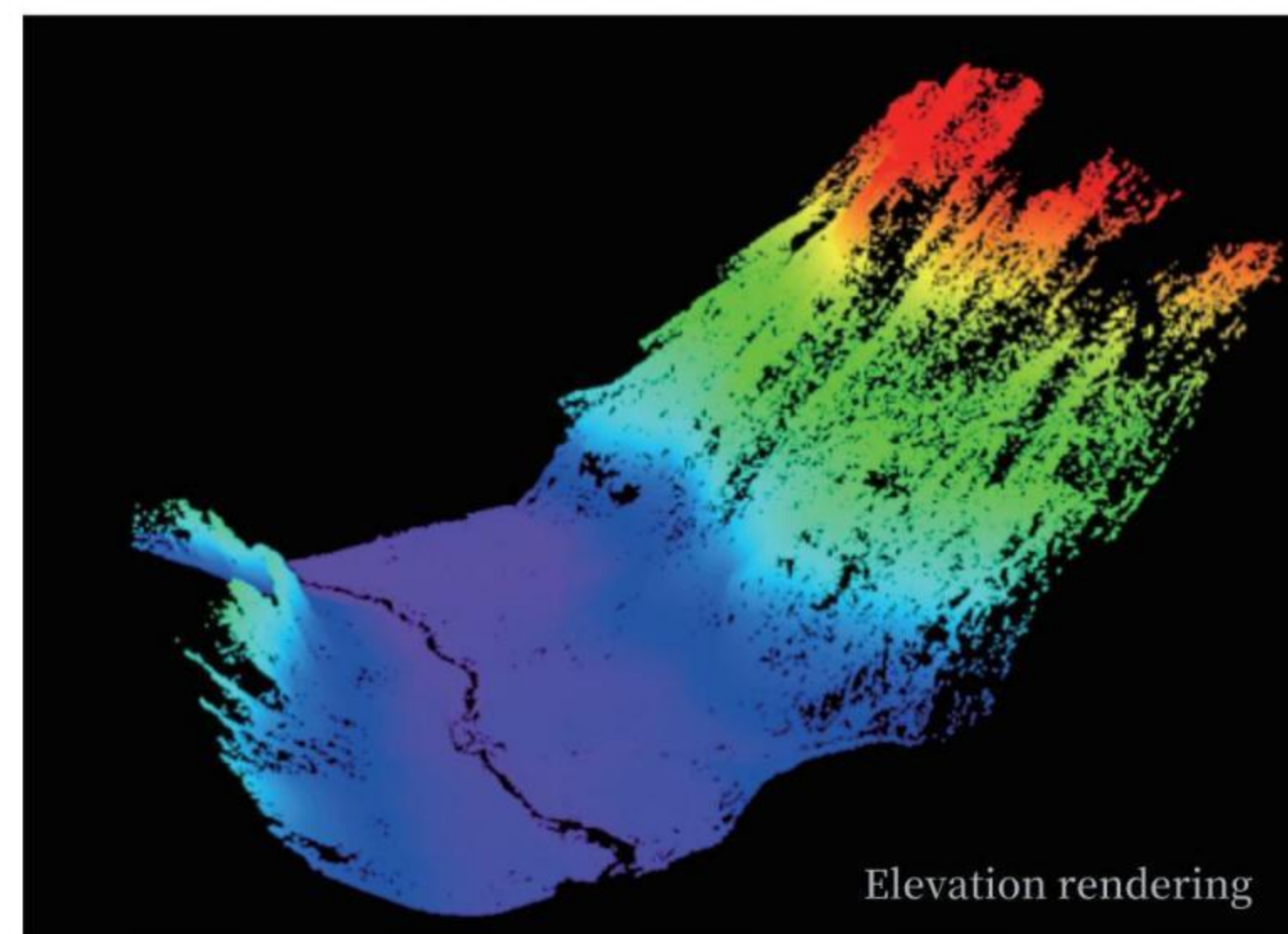
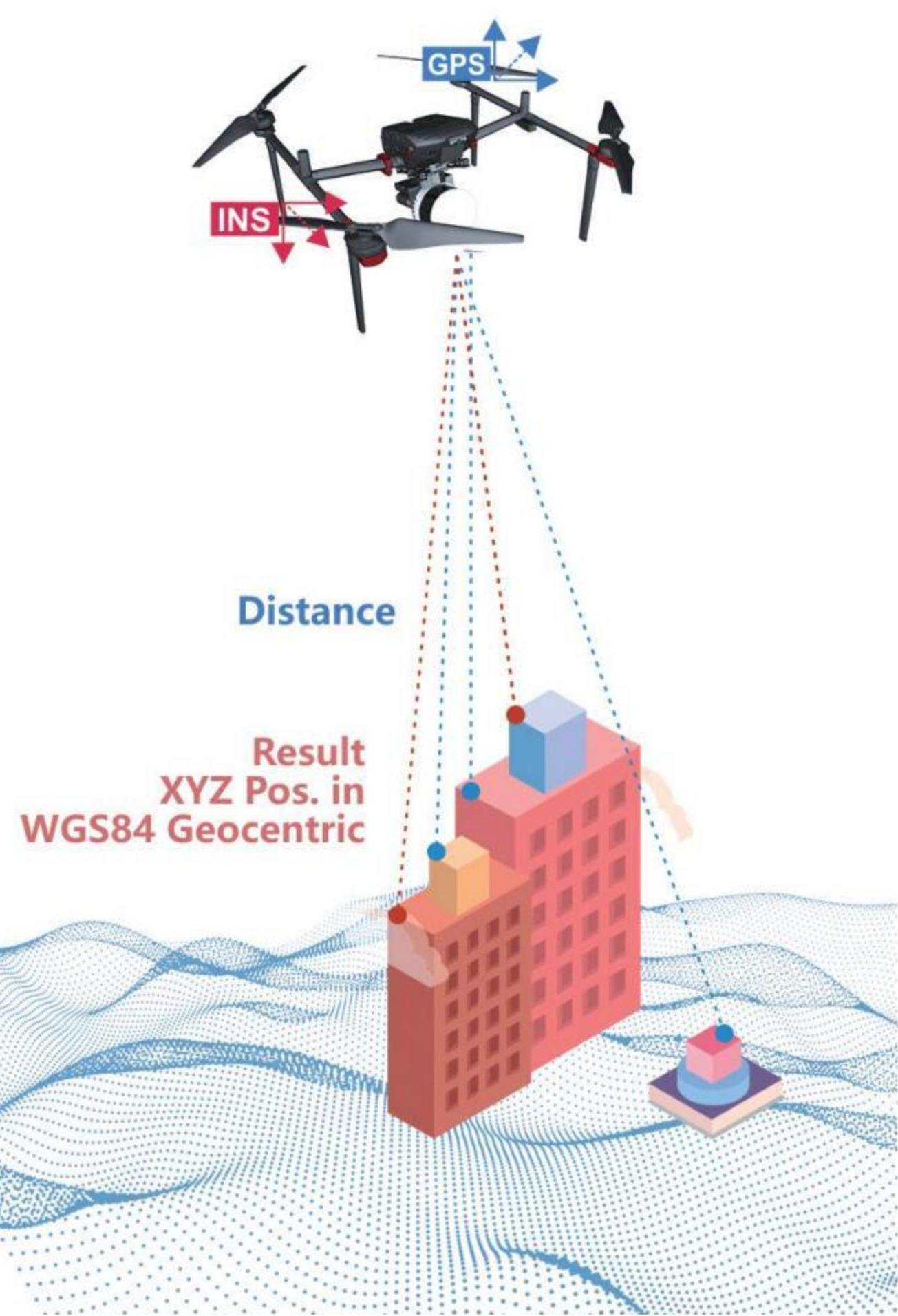




SmartLiDAR

Integrated laser point cloud preprocessing software

SmartLiDAR can generate accurate point cloud data based on the original data such as distances, positions, and attitudes obtained by UAV's LiDAR module. Cloud data calculation, LiDAR module calibration, strip adjustment, massive point cloud visualization, standard point cloud output and other functions are integrated in this software.



The screenshot shows the SmartLiDAR software interface with various processing options and a 'One-click point cloud solution' dialog box.

Point cloud trajectory

Point cloud trajectory

Point cloud profile

Software features

- Supporting strip inspection and calibration, and supporting multi-sortie adjustment
- Massive data point cloud browsing and viewing

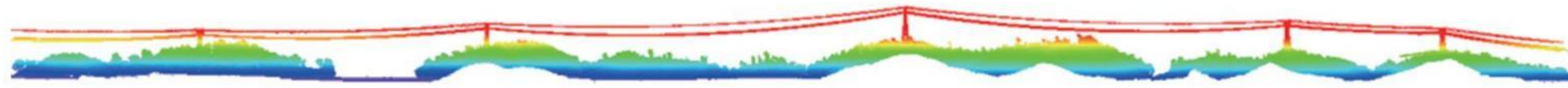


SmartPowerLine

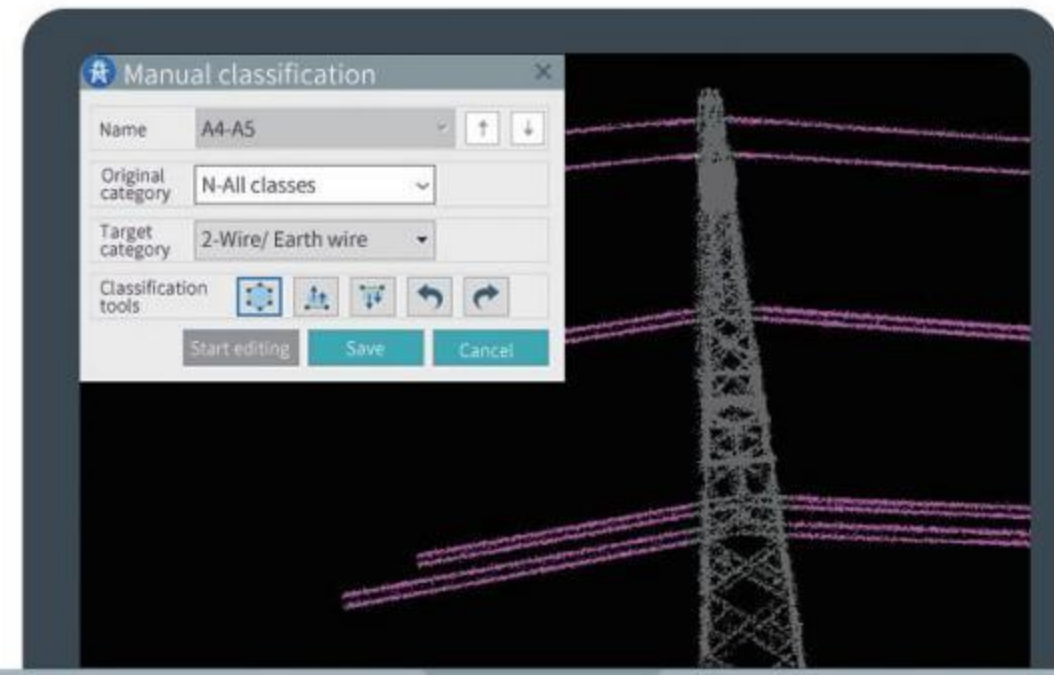
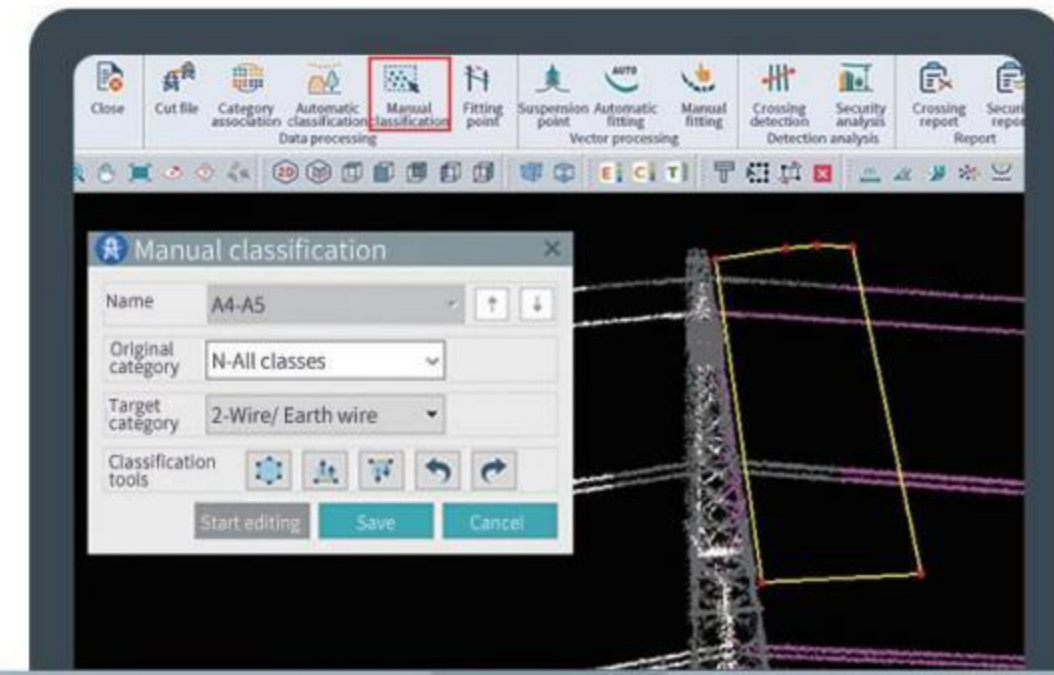
Overhead transmission line inspection system, making line inspection simple, efficient and reliable

SmartPowerLine is a software specially designed for patrol inspection and analysis of overhead transmission line channels. It can perform tower calibration, channel cutting, point cloud classification, and wire vectorization processing for massive airborne, ground, densely matched and other multi-source point cloud data. It is able to establish a three-dimensional point cloud visualization ledger of powerlines, conduct spatial three-dimensional information analysis on the point cloud data according to the relevant operation specifications of the overhead transmission lines, efficiently and accurately discover the hidden dangers of the line channel and output the real-time working condition and crossover report, which helps to efficiently solve the problems of slow efficiency and poor accuracy of traditional manual inspection.

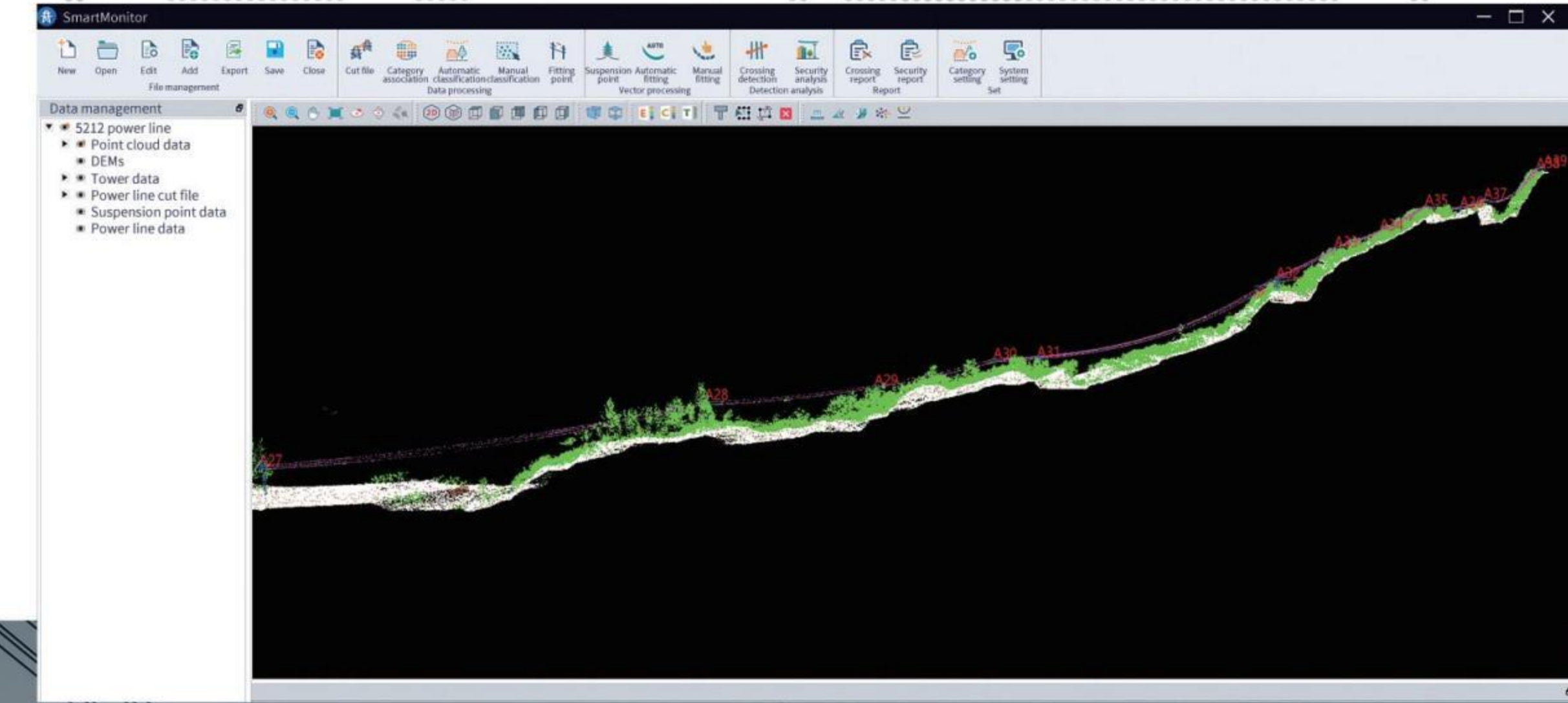
Original point cloud



Automatic classification effect



Manual interactive editing



Software features

1. Massive point cloud carrying capacity

Supporting loading a single point cloud data set larger than 40 Gigabytes, and enabling fast browsing of massive point cloud data

2. Powerful point cloud classification capability

The GPU-based automatic point cloud classification algorithm can quickly and efficiently extract point clouds of ground, vegetation, towers, wires, buildings, etc., and can adjust adaptive parameters to deal with different terrain scenarios. The classification accuracy is over 90%.

3. Guided interface and user-friendly interaction design to improve user experience

The guided interface design from point cloud data loading, file cutting, classification, detection to report output makes the data processing more intuitive and easier. Plentiful humanized interactive tools improve the processing speed of manual editing.

4. One-key detection analysis and output channel inspection report, supporting fast inspection based on classified point cloud and conductor vector lines

It can help to quickly find vegetation, buildings, ground, railways, graded highways, etc., and related hidden dangers. Also, it can output real-time operating conditions and cross-span reports with one click.

5. Customized service

The channel hidden danger detection template can be set according to different project requirements, and the function can be customized and developed according to user needs.



D-MSPC2000

A typical regional multispectral data collection was conducted in the suburbs of a Chinese city, with a 25 minutes flight covering a total area of 0.8 square kilometers and obtaining a total of 563×6 multispectral images. There are typical scenes such as factories, ponds, banana orchard, and vegetable gardens in the area.

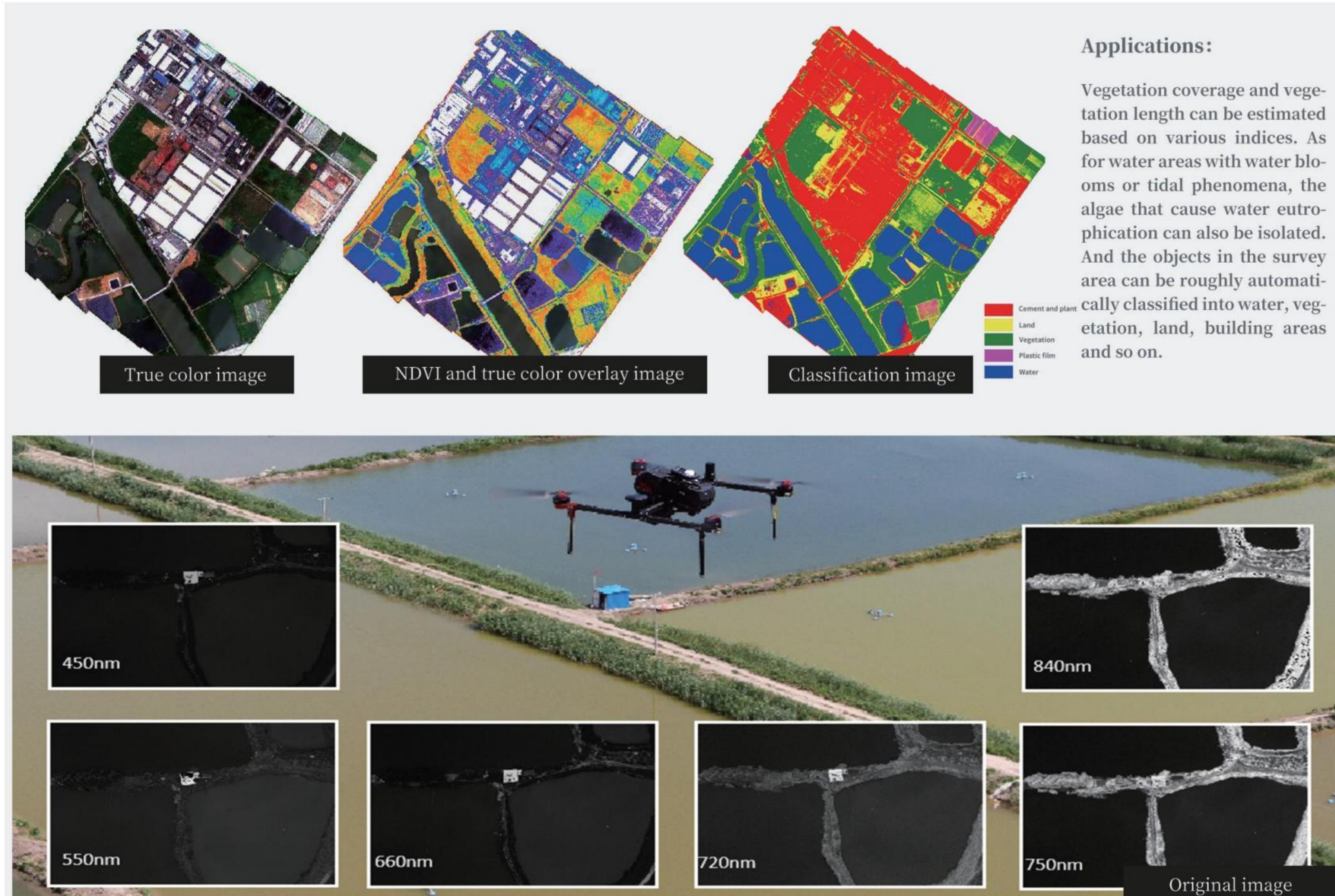
14

CLASSIC CASES

Applications:

Vegetation coverage and vegetation length can be estimated based on various indices. As for water areas with water blooms or tidal phenomena, the algae that cause water eutrophication can also be isolated. And the objects in the survey area can be roughly automatically classified into water, vegetation, land, building areas and so on.

- Cement and glass
- Land
- Vegetation
- Plastic film
- Water



D-TIRV1100

Detection of Spontaneous Combustion Area in an Opencut Coal Mine

For large-area opencut coal mining areas, D500 equipped with thermal infrared payload is used to obtain thermal infrared data, and remote sensing methods are used to quickly and accurately detect the temperature and range of the spontaneous combustion area in opencut coal mines, solving the problem of low efficiency and poor accuracy of traditional manual detection methods.

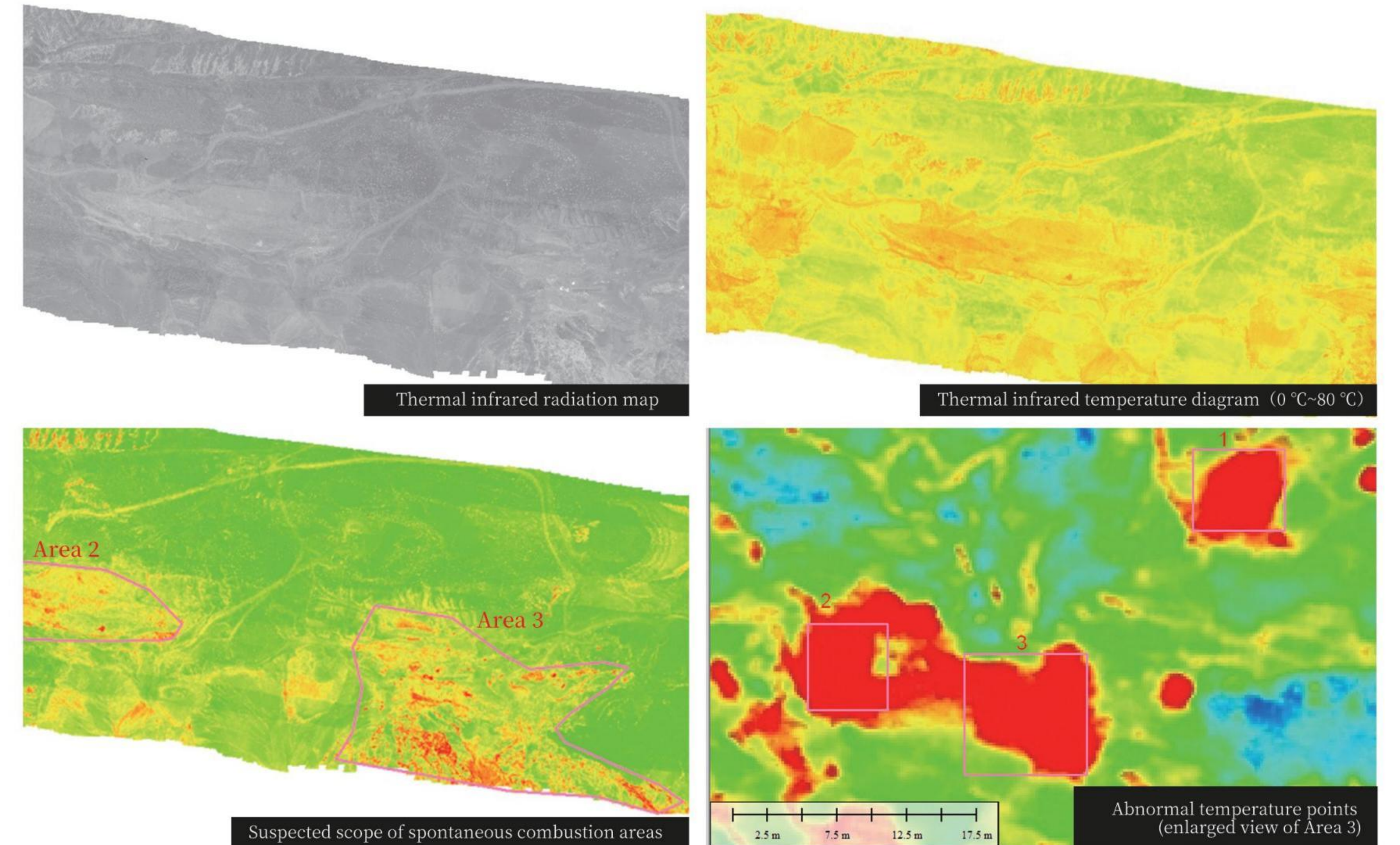
Relative flight height: 153 m

GSD: 20 cm

Forward overlap: 80%

Side overlap: 60%

Taking accurate terrain following flight to obtain thermal infrared data of 1.5 square kilometers mining area





DV-CAM20

Aerial photographing project of offshore oyster rows

For large sea area of weak texture, DV-CAM20 integrated with high-precision GNSS/IMU is used to obtain high-precision differential positions and attitudes of exposure points.

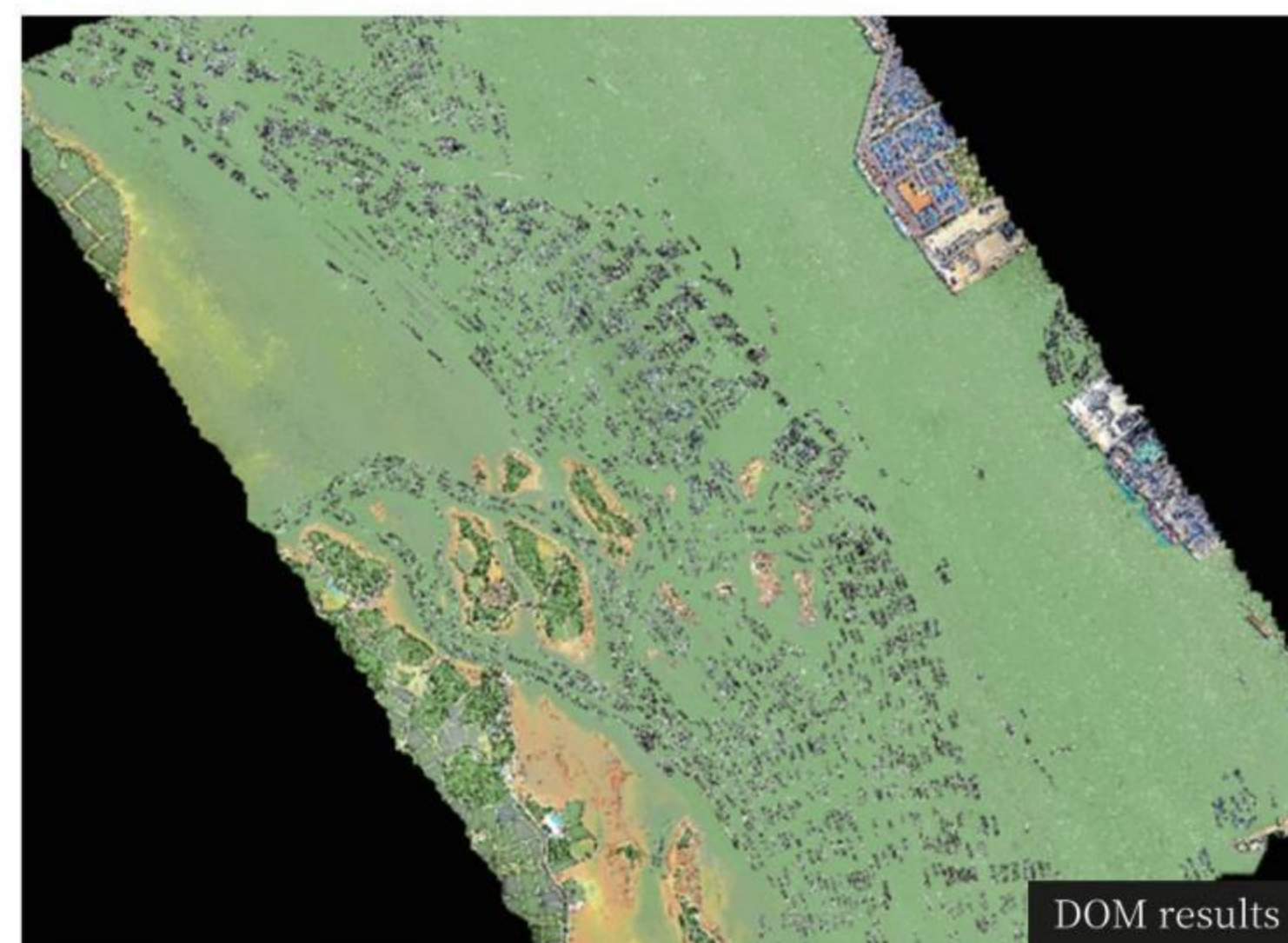
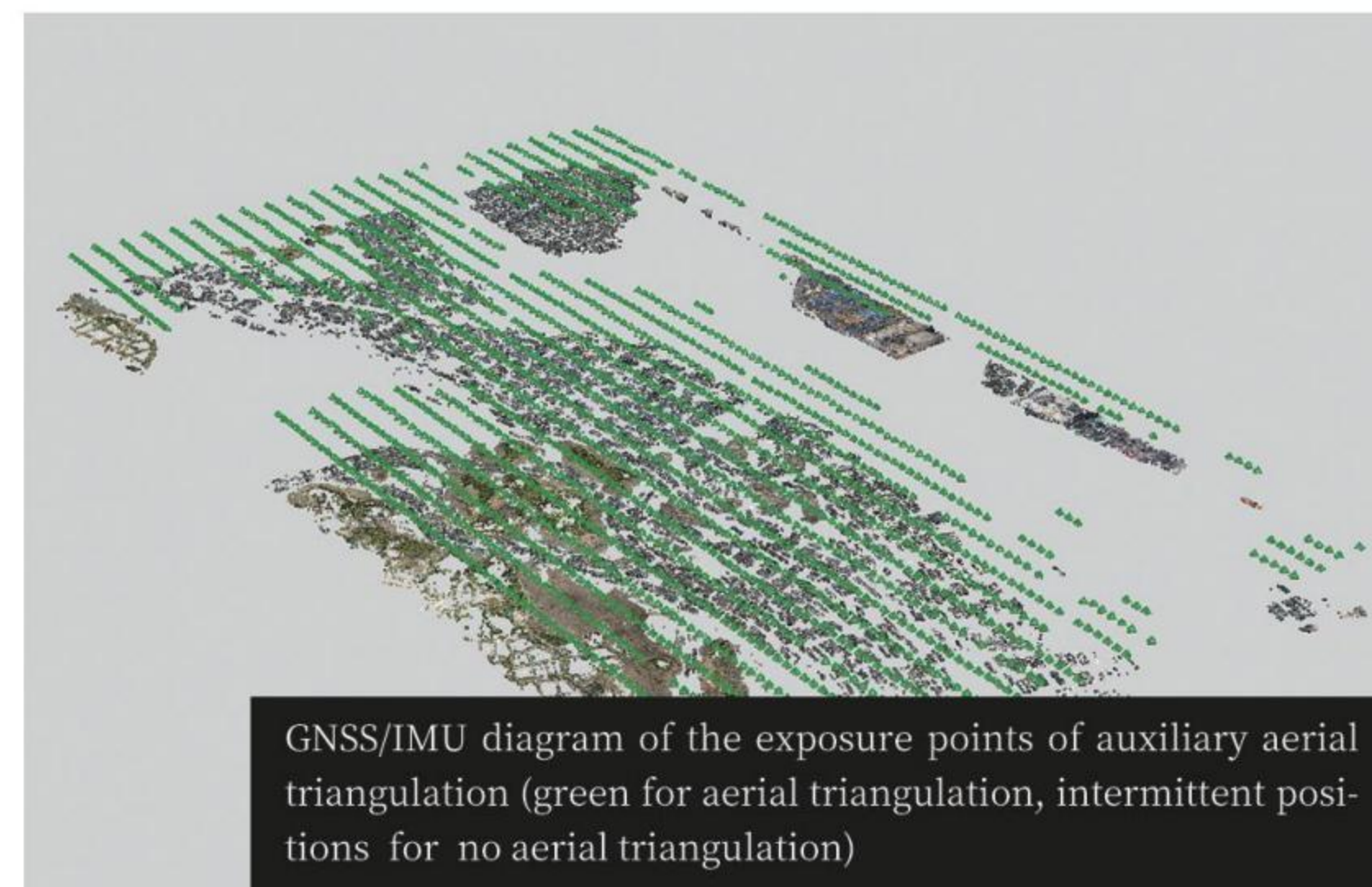
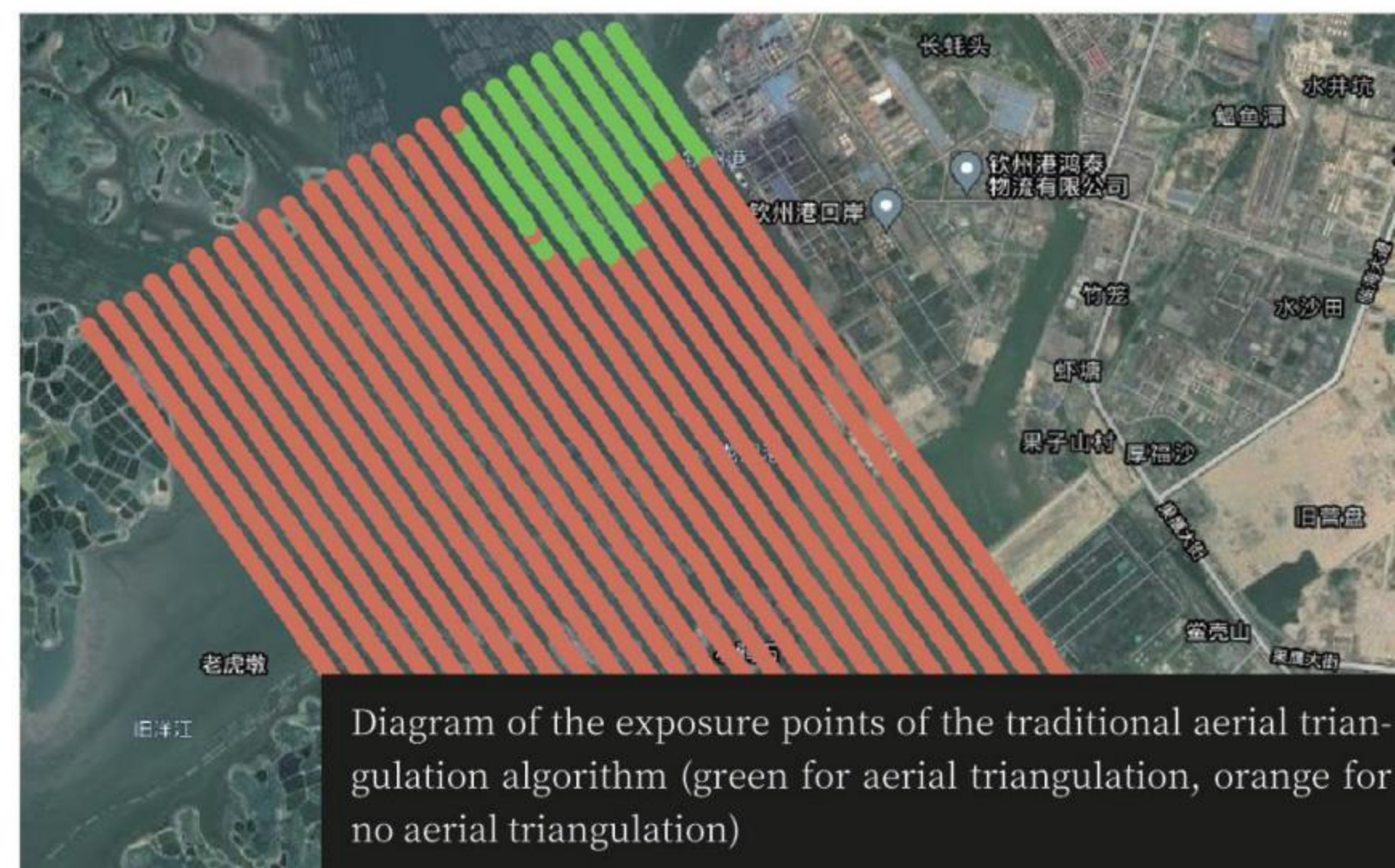
Auxiliary aerotriangulation based on GNSS/IMU positioning and orientation integrated in UAVManager Professional Edition is adopted to solve the problem of large-area aerotriangulation disconnection. For photos that still fail in aerotriangulation, direct orientation is adopted to realize the global image stitching.

Survey area: 15.24 km²

GSD: 3 cm

Forward overlap: 80%

Side overlap: 60%



D-CAM2000

A mining area large-scale mapping

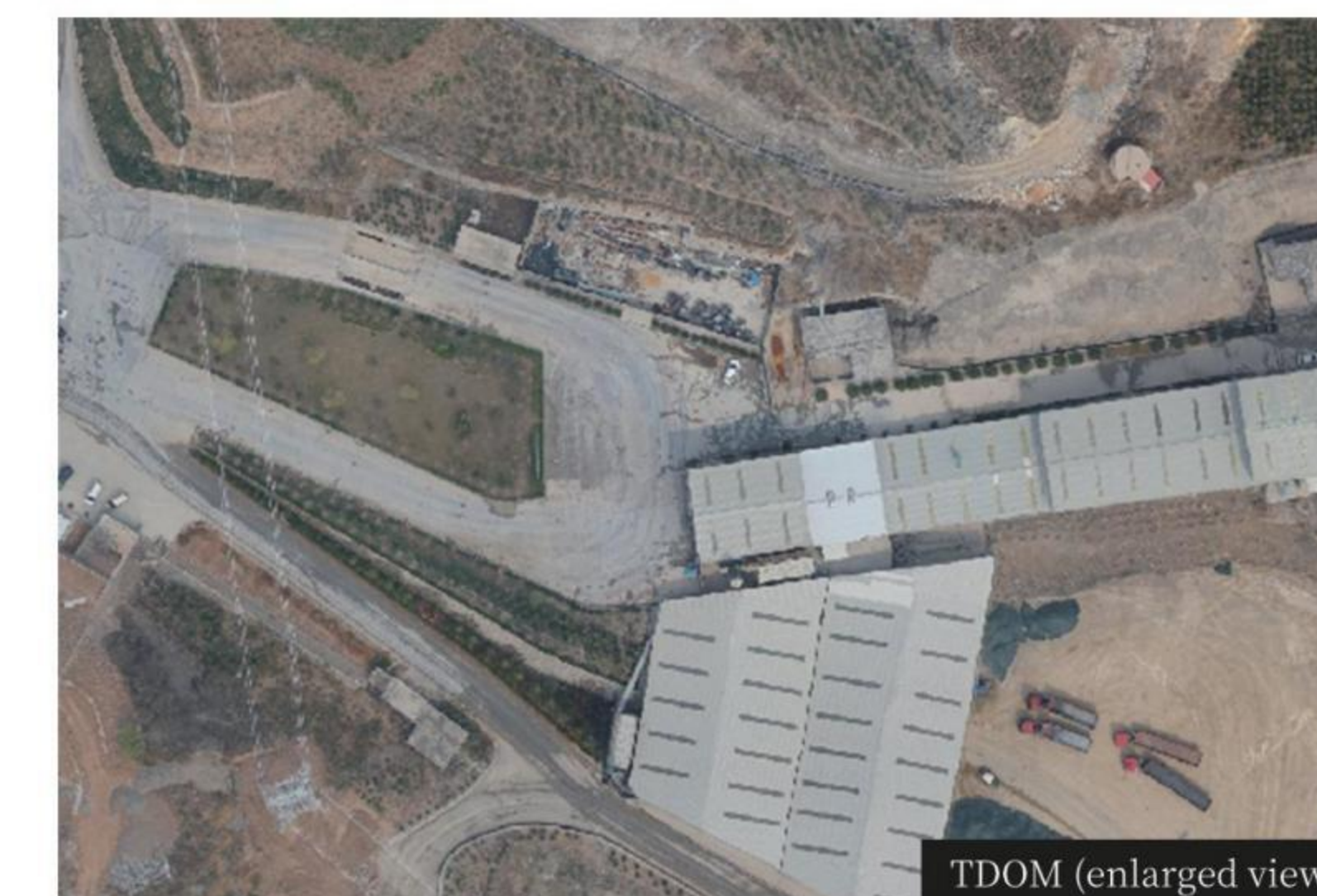
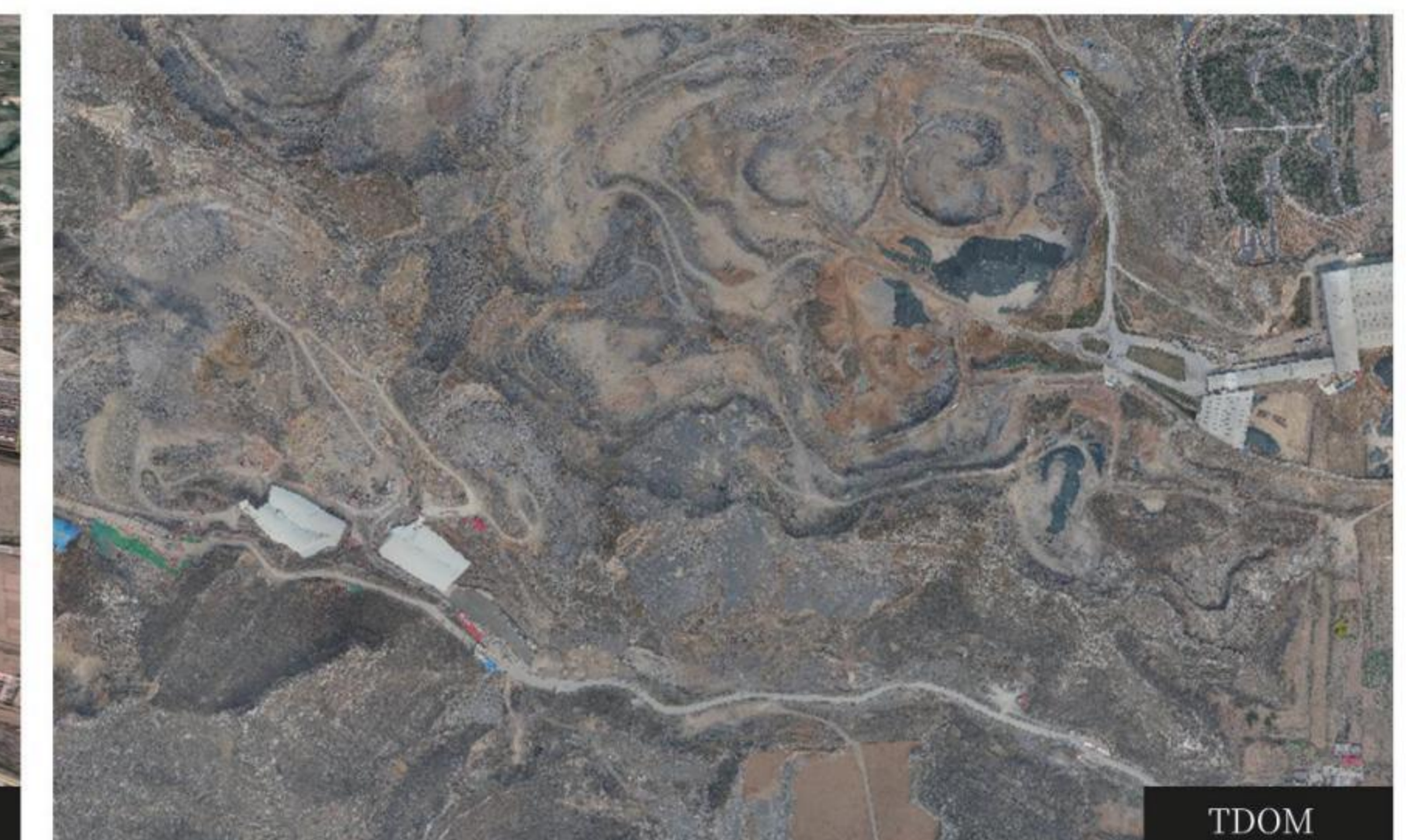
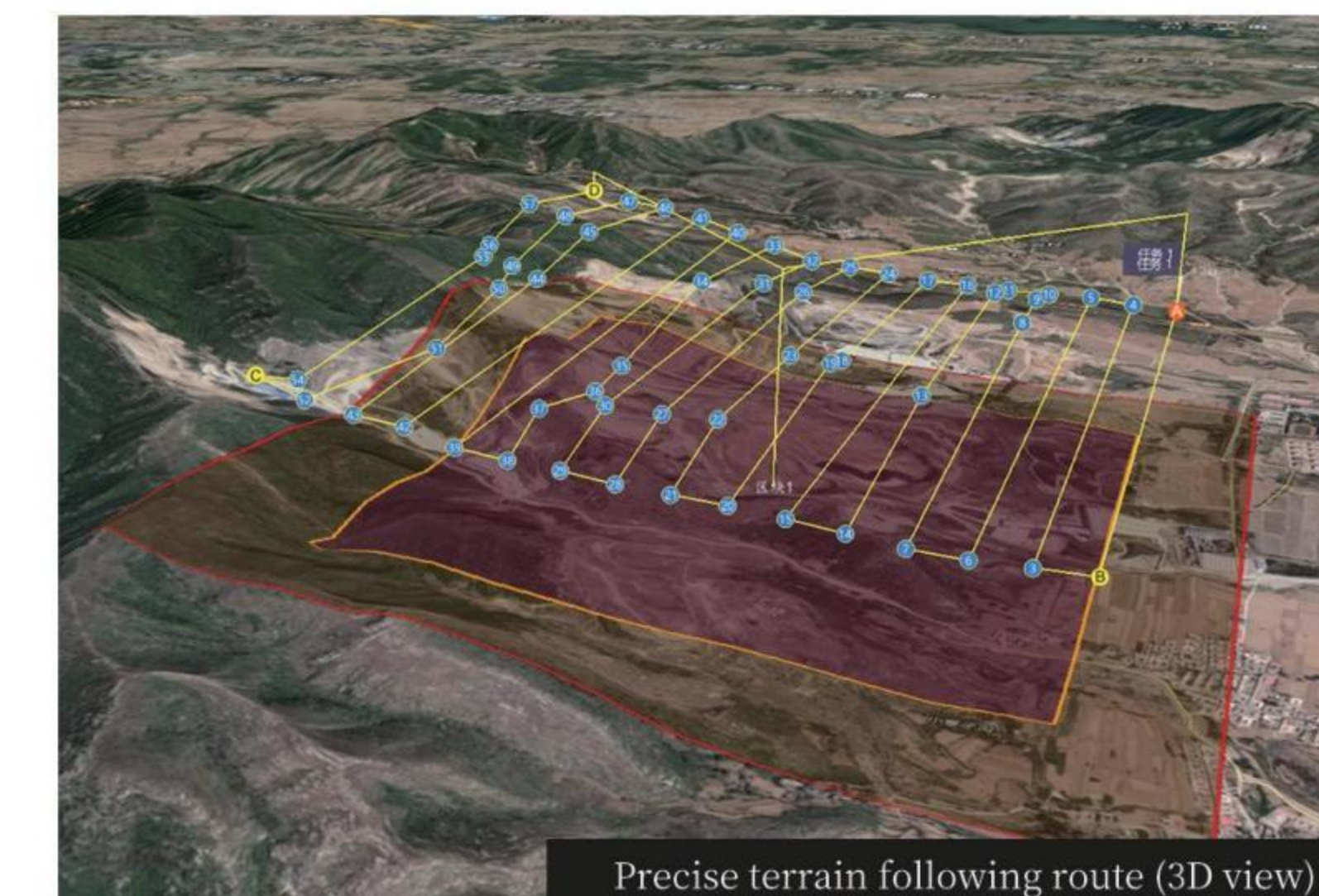
For large-scale image control-free topographic survey in a mining area, D500 equipped with D-CAM2000 was selected and the precise terrain following route design was adopted to ensure the consistency of image resolution during the orthographic photographing. Based on high-precision POS for aerotriangulation, adjustment and mapping, the final horizontal root mean square error (RMSE) is 7.6 cm, and the RMSE of elevation is 7.2 cm, which meets the accuracy requirements of China's 1:500 scale topographic surveying and mapping after verification by in situ check points.

Survey area: 0.8 km²

GSD: 4 cm

Forward overlap: 80%

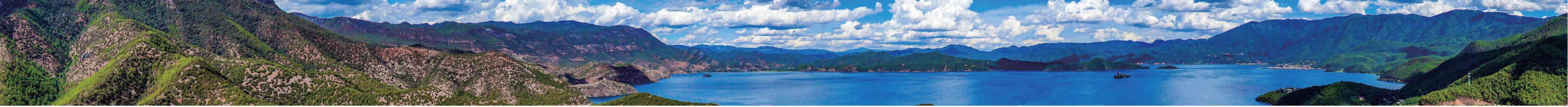
Side overlap: 65%



GCP-free aerotriangulation report

ID	TYPE	DX(m)	DY(m)	DZ(m)
xkd1	CHK	-0.004	0.055	-0.015
xkd2	CHK	0.002	-0.062	0.12
xkd3	CHK	0.125	0.004	-0.027
xkd4	CHK	-0.051	-0.042	-0.053
xkd5	CHK	0.026	0.038	0.089
RMSE of plane		0.076 cm		
RMSE of elevation		0.072 cm		

Aerial triangulation report



D-OP3000

In a cadastral surveying and mapping project, the terrain around the houses in the survey area is undulating, and D500 equipped with D-OP3000 was selected and the precise terrain following route design was adopted to ensure the consistency of image resolution during the oblique photographing. Based on high-precision POS for aerotriangulation, adjustment and modeling, the final horizontal root mean square error (RMSE) is 3.8 cm, and the RMSE of elevation is 1.6 cm, which meets the accuracy requirements of China's cadastral surveying and mapping after verification by in situ check points.

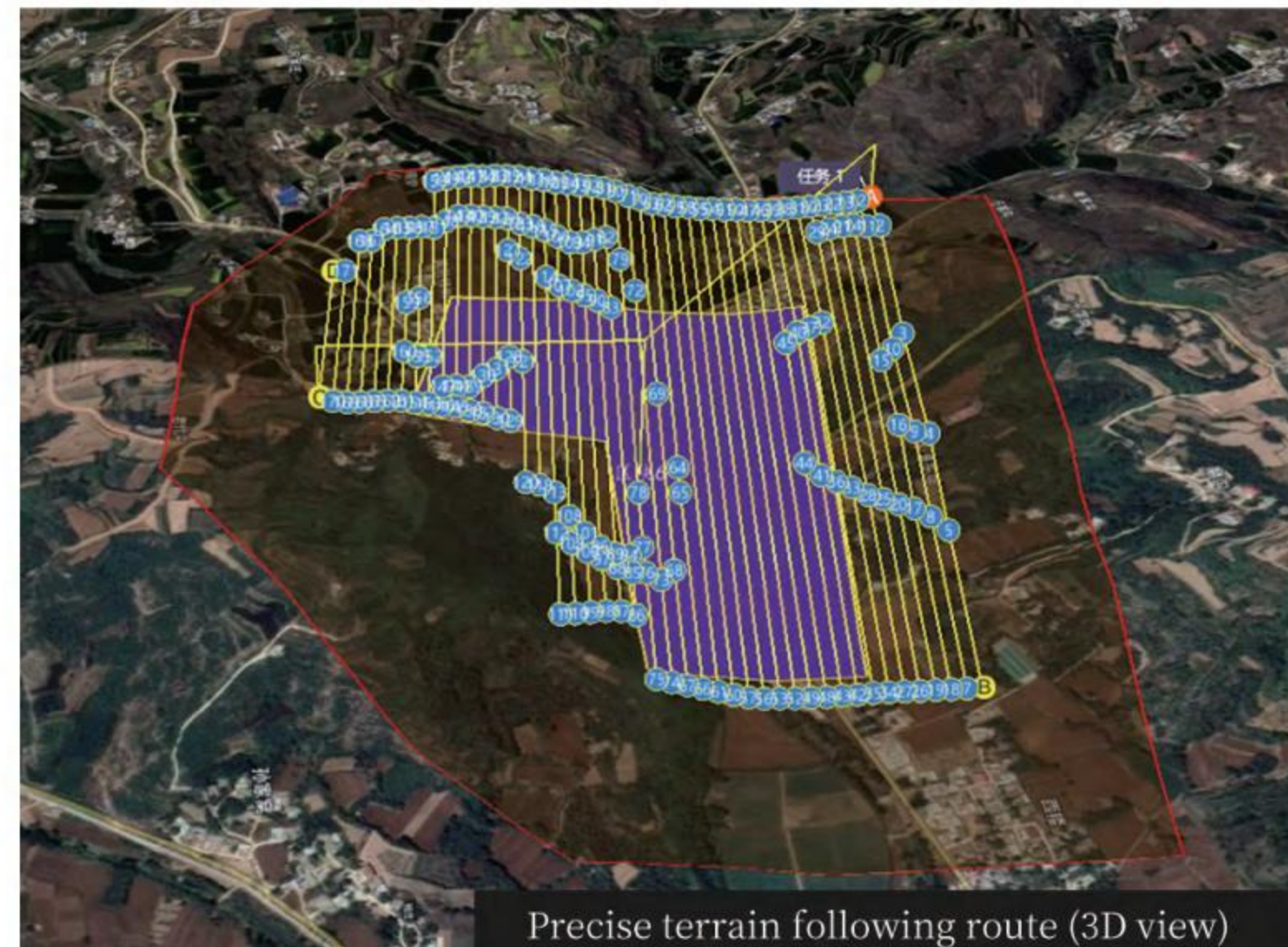
Survey area: 0.33 km²
 GSD: 1.5 cm
 Forward overlap: 80%
 Side overlap: 80%



3D model



3D model (enlarged view)



Precise terrain following route (3D view)

Check point error								
Name	Type	Number of photos	Precision (m)	RMSE (pixels)	RMSE (m)	3D error (m)	Horizontal error (m)	Vertical error (m)
3	Full	44	Plane: 0.01 Elevation: 0.01	1.14172	0.0255693	0.0181909	0.0181749	-0.000760934
10	Full	49	Plane: 0.01 Elevation: 0.01	2.67866	0.0526117	0.0552185	0.0528029	0.0161536
6	Full	38	Plane: 0.01 Elevation: 0.01	6.19681	0.100203	0.112961	0.112373	0.0115055
8	Full	37	Plane: 0.01 Elevation: 0.01	1.33593	0.0312324	0.0216895	0.0215939	-0.00203454
9	Full	56	Plane: 0.01 Elevation: 0.01	0.902737	0.0305325	0.0218443	0.0129117	0.0176199
7	Full	55	Plane: 0.01 Elevation: 0.01	2.79058	0.0534523	0.058245	0.0453824	0.0365092
4	Full	50	Plane: 0.01 Elevation: 0.01	1.16516	0.0344242	0.0253396	0.0196105	0.0160475
2	Full	43	Plane: 0.01 Elevation: 0.01	3.80314	0.0716245	0.0809897	0.0525491	0.0616274
1	Full	48	Plane: 0.01 Elevation: 0.01	1.94896	0.0496821	0.0497043	0.0383128	-0.0316645
5	Full	53	Plane: 0.01 Elevation: 0.01	1.35825	0.0323507	0.0366041	0.014034	0.0338069
RMS				2.8059	0.0529691	0.0561178	0.0482179	0.0287096
Median				1.94896	0.0496821	0.0497043	0.0383128	0.0161536

D-OP4000

In another cadastral surveying and mapping project, the houses in the survey area are dense and crisscrossed. The D500 equipped with D-OP4000 was selected and rare image points were utilized, i.e., setting up an image control point every 300 meters or so. After the in situ measurement and verification of the boundary points, the accuracy of the result meets the requirements of China's cadastral surveying and mapping after verification by in situ check points.

Survey area: 0.79 km²
 GSD: 3 cm
 Forward overlap: 80%
 Side overlap: 70%



3D model (enlarged view)



3D model



Layout of image control points (red) and check points (blue)

Boundary Point Check Record				
S/N	Position error /cm		$\Delta z = \Delta 2x + \Delta 2y$	Unit: cm $\sqrt{\Delta 2}$
	ΔX	ΔY		
1	-1.30	0.70	2.18	1.48
2	-1.1	3.7	14.9	3.86
3	-2.7	-1.6	9.85	3.13
4	2.8	-2.2	12.68	3.56
5	3.3	-3.1	20.5	4.53
Check results			$[\Delta \Delta] = \sum \Delta 2$	60.08
			Analyze the mean square error of the point position cm(±)	3.31
Inspection record of side length of boundary point (surface features)				
Number	Measured length d/m	Checked length d'/m	Difference $\Delta d = d' - d$ /cm	Tolerance ΔD /cm
1	9.91	9.89	2	9.60
2	7.43	7.43	3	9.60
3	12.83	12.87	4	10.73
4	10.53	10.51	2	9.81
5	12.83	12.80	3	10.73

D-LiDAR2000

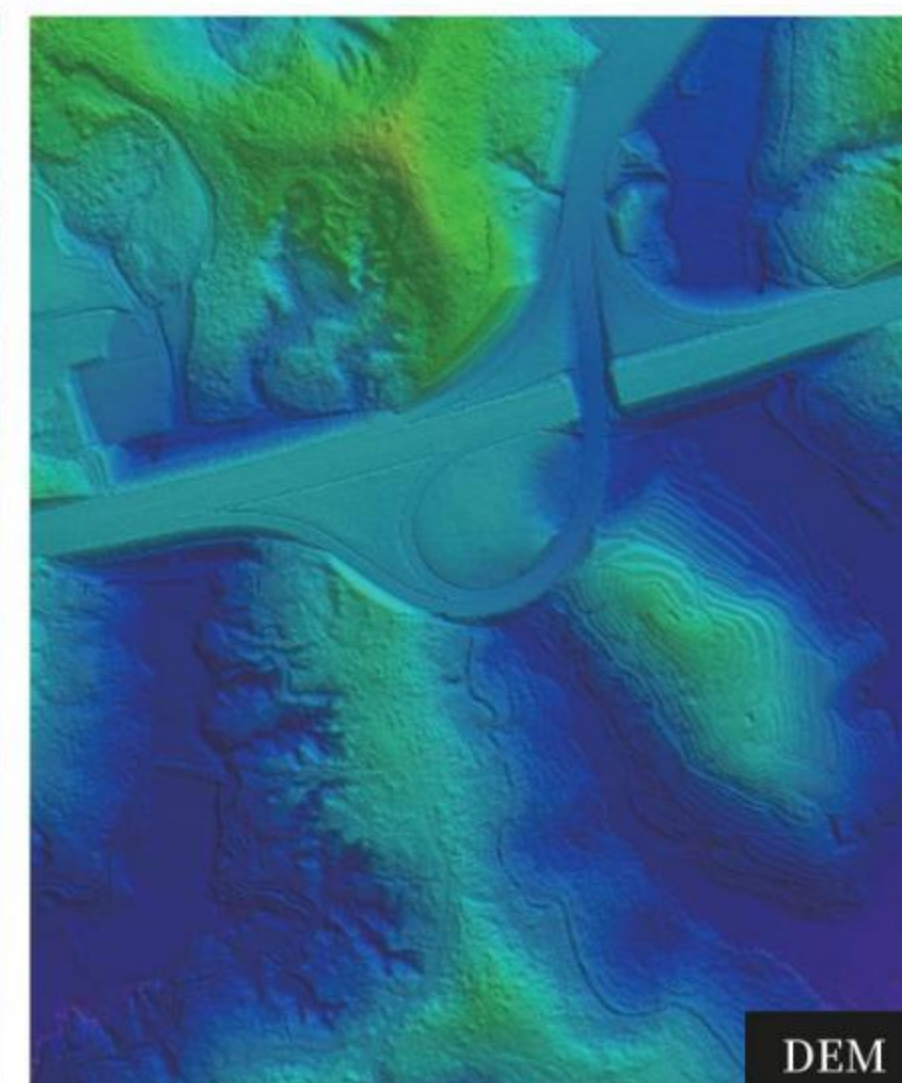
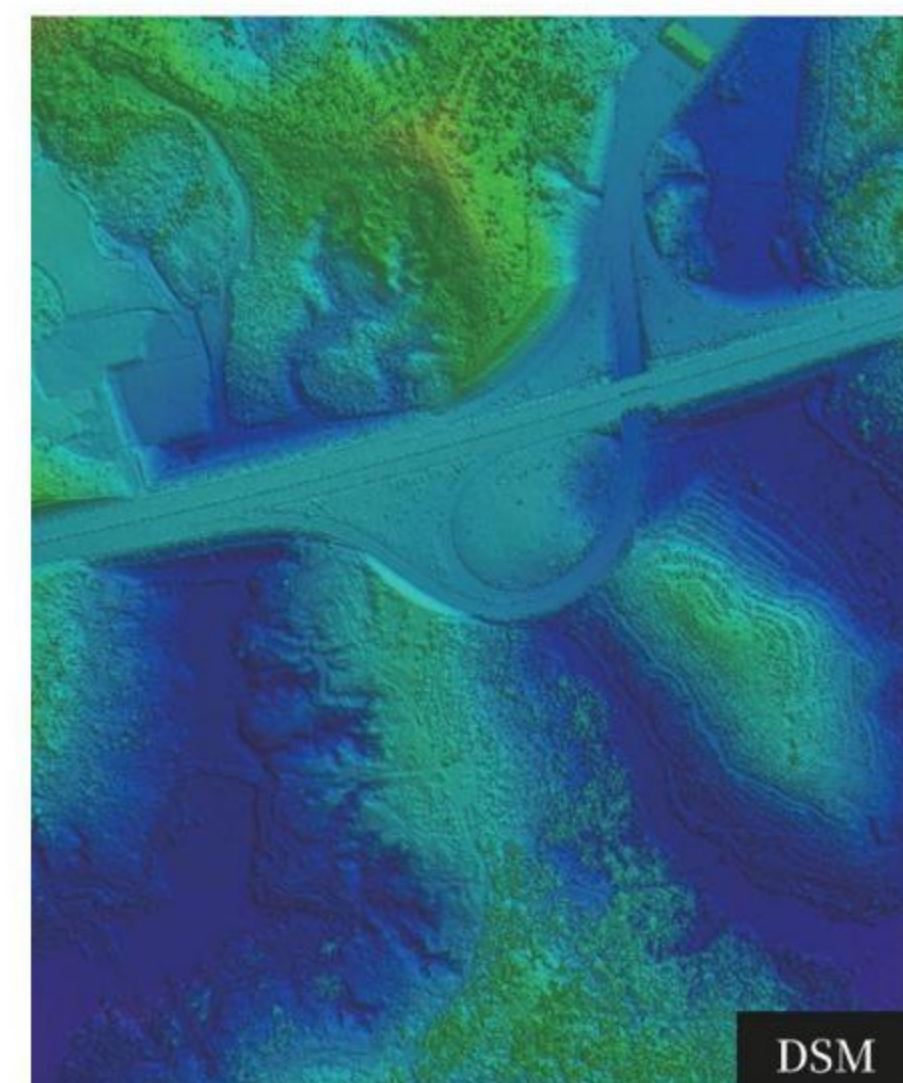
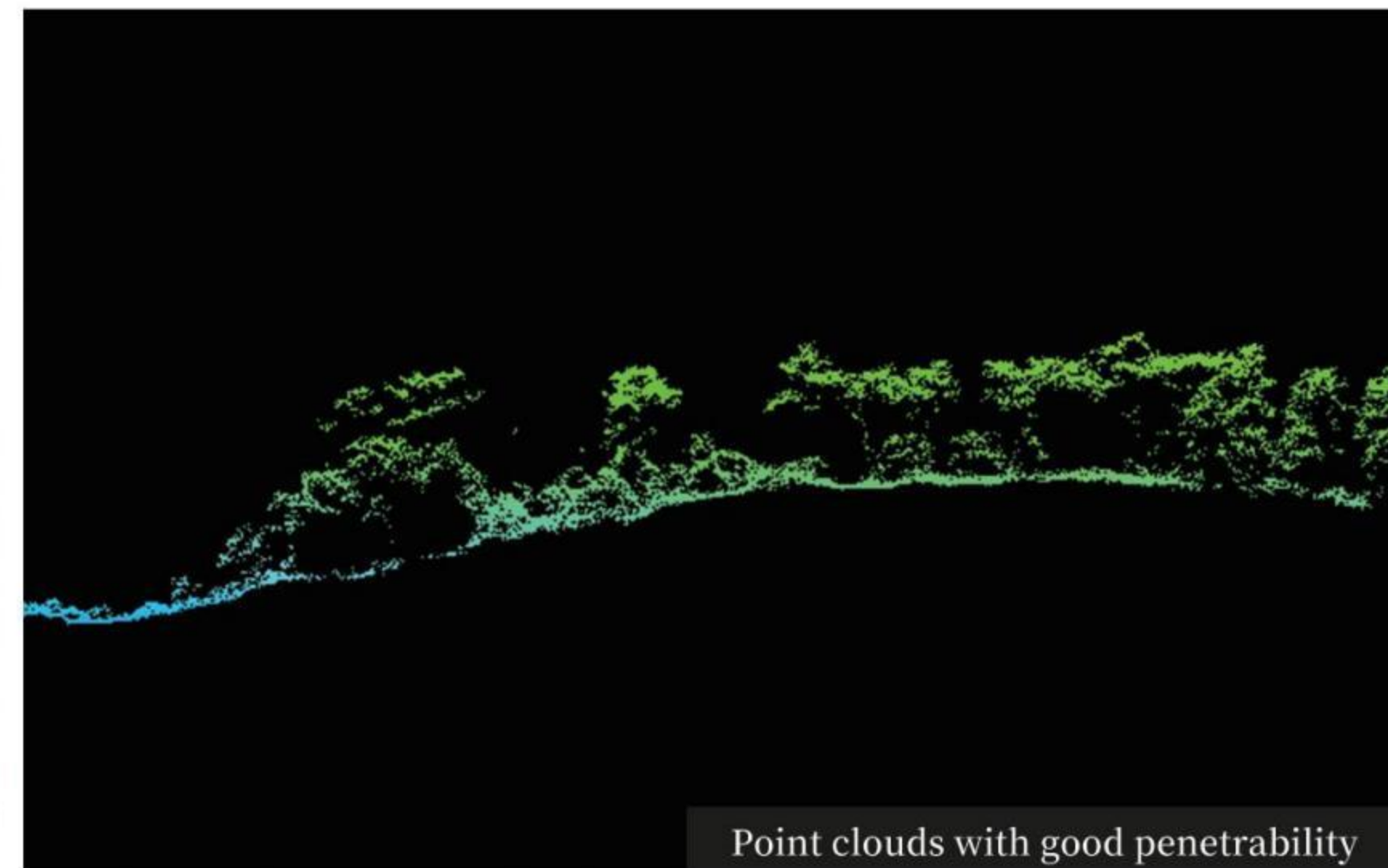
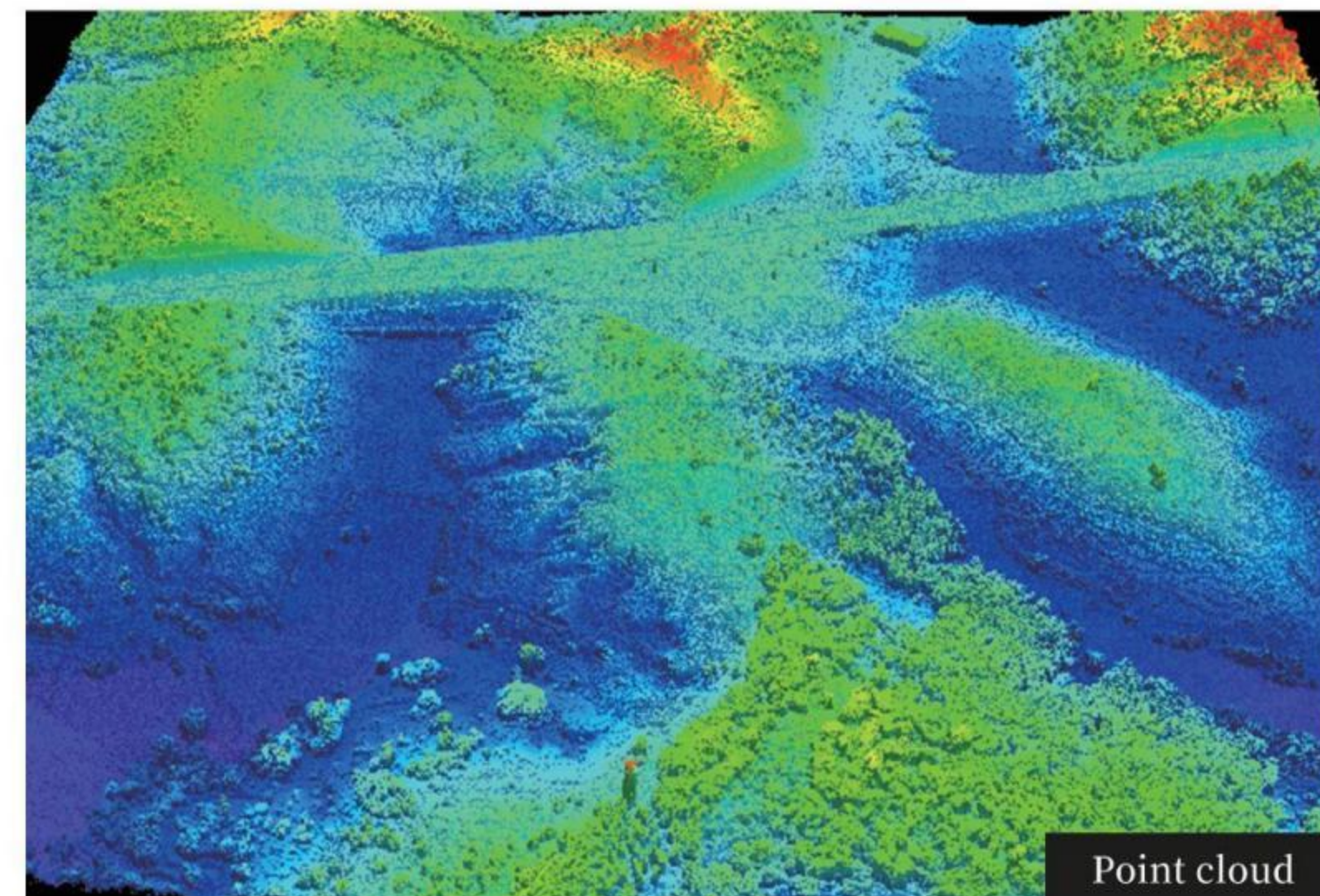
D500 is equipped with D-LiDAR2000 to carry out point cloud data acquisition in a dense forest area in Guangdong Province, China. The point cloud result shows a good ground point penetration, which can better fit the terrain. Through point cloud filtering and editing, the accuracy of the final point cloud result is 3.8 cm.

Relative flight height: 120 m

Survey area: 0.502 km²

Flight time: 27 mins

Cruising speed: 8 m/s



ID	X	Y	Z	dH
0513ld-47	563326.710000	2507055.588000	63.851000	-0.061989
0513ld-48	563300.378500	2507122.747000	64.324000	0.000445
0516ld-156	563014.435200	2507283.217000	72.924000	-0.015671
0516ld-157	562568.468800	2507239.843000	85.684000	-0.030962
0516ld-158	562822.249200	2506895.790000	84.745000	-0.037361
0516ld-162	562315.280300	2506946.055000	86.124000	-0.048069

Points in calculation: 6 RMSE: 0.038196 Accuracy report

D-LiDAR3000

D500 is equipped with D-LiDAR3000 to carry out power channel data collection on high voltage power lines. The relative flight altitude is 90 meters, the flight speed is 13.5 m/s, and the point cloud density is set to be 105 pts/m². The lowest point of the ground line of the power line is about 45 meters above the ground, and about 45 meters away from the absolute height of the UAV. The point cloud result shows that the structures of power lines and towers are complete in all directions, and the details are clear, reflecting the characteristics of D-LiDAR3000's high precision, high precision, and high density.

