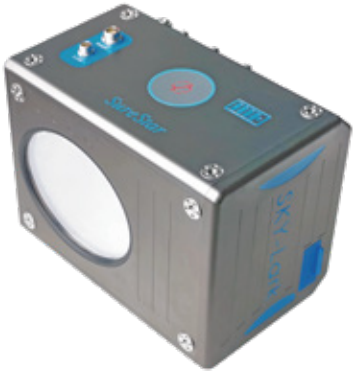
SureStar

Skylark

Lightweight UAV LiDAR System

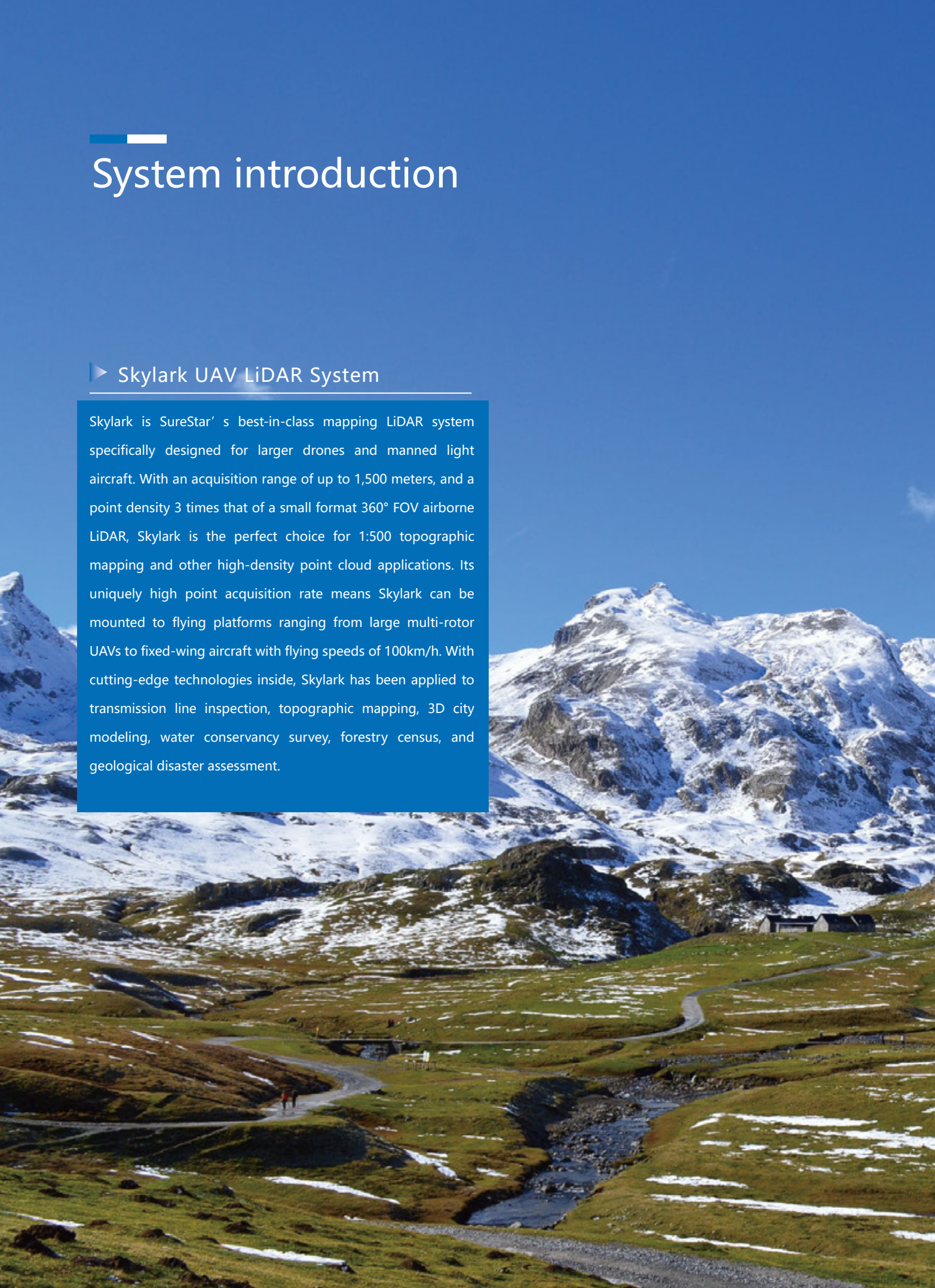
Efficient | Precise | Flexible | Compact



System introduction

Skylark UAV LiDAR System

Skylark is SureStar' s best-in-class mapping LiDAR system specifically designed for larger drones and manned light aircraft. With an acquisition range of up to 1,500 meters, and a point density 3 times that of a small format 360° FOV airborne LiDAR, Skylark is the perfect choice for 1:500 topographic mapping and other high-density point cloud applications. Its uniquely high point acquisition rate means Skylark can be mounted to flying platforms ranging from large multi-rotor UAVs to fixed-wing aircraft with flying speeds of 100km/h. With cutting-edge technologies inside, Skylark has been applied to transmission line inspection, topographic mapping, 3D city modeling, water conservancy survey, forestry census, and geological disaster assessment.



01/02

Lightweight UAV LiDAR System

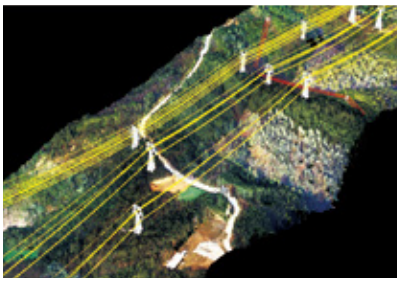
Skylark

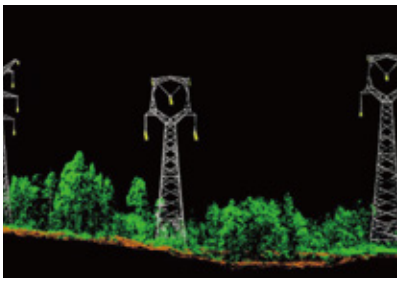
100% pulse capture

Careful flight planning = complete vertical surface coverage

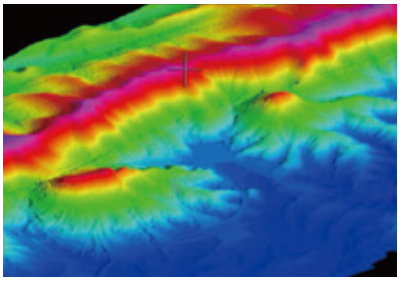
SureStar

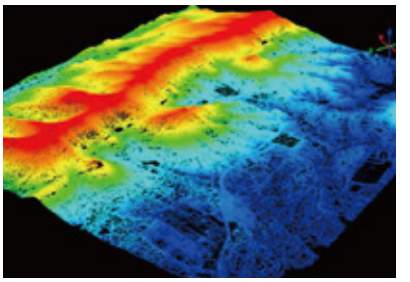
Applications



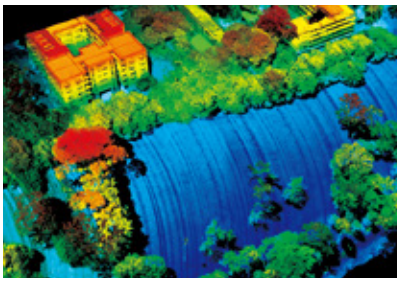


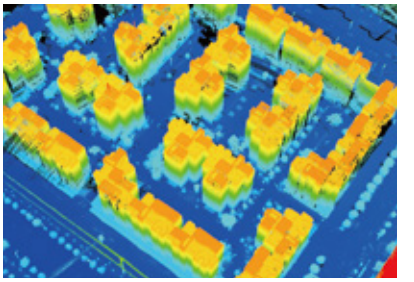
Power line inspection





Topographic mapping





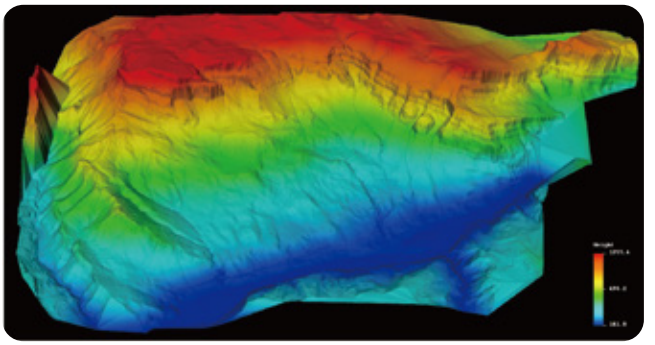
3D city modeling

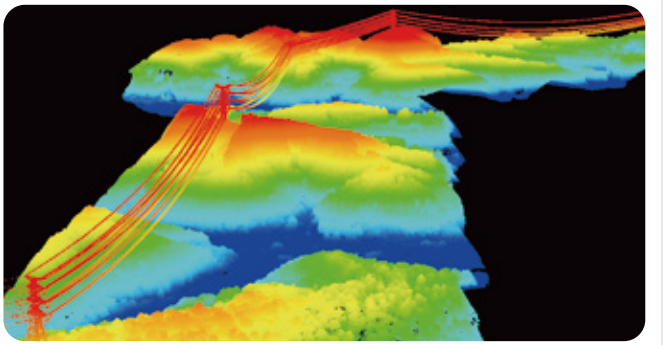
Flight platforms


Electric VTOL fixed-wing UAV

Electric VTOL fixed-wing UAV
60 min endurance with load

High point density	54 pts/m² at 100 km/h
High accuracy	RMS elevation error < 5 cm, good for 1:500 mapping
Long acquisition range	Maximum range of 1500 m, Typical range of 100~700 m
High-efficiency	A single 60 min flight can cover 50 km²

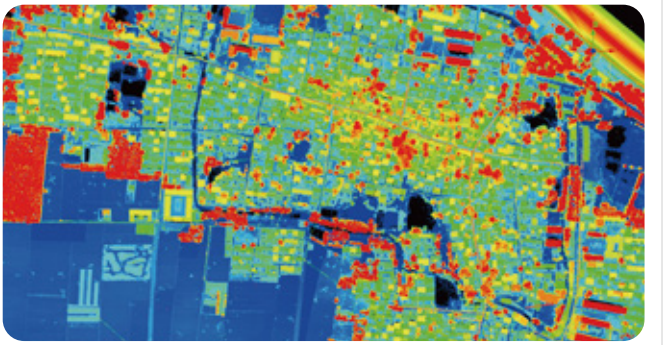




Hybrid-electric VTOL fixed-wing aircraft
240 min endurance with load

High point density	54 pts/m² at 100 km/h
High accuracy	RMS elevation error < 5 cm, good for 1:500 mapping
Long acquisition range	Maximum range of 1500 m, Typical range of 100~700 m
High-efficiency	A single 60 min flight can cover 200 km²


Hybrid-electric VTOL fixed-wing aircraft



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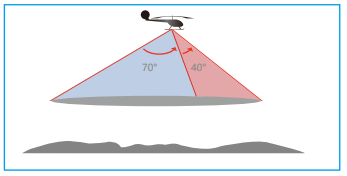
Features

01

Large FOV, long acquisition range

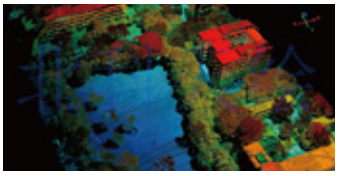
FOV 70°×40°
Swath is 1.4 times the acquisition range
Maximum range is 1500 m
Typical range is 100~700 m



02

High frequency, high point density

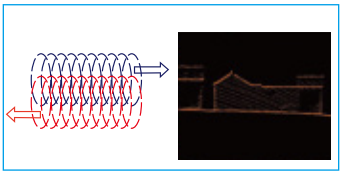
600k pts / sec
Point density better than 100 pts / m^2 @ 200 m range



03

Downward elliptical scanning

100% pulse capture, no wasted points; complete vertical surface coverage with careful flight planning, similar to oblique photography.



04

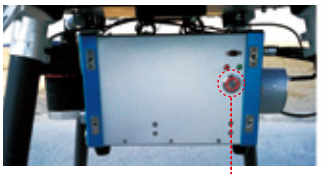
Modular design, flexible configuration

Support for a variety of image sensors
Integrates with optical, hyperspectral, infrared, and ultraviolet sensors

05

One-button start, USB storage

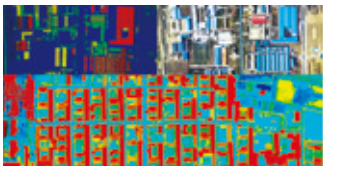
Easy route planning
One-touch power-on startup
Built-in pluggable USB
Easy to copy and transfer data



06

Simultaneous acquisition of images and point cloud

Integrated image sensor data is synchronized with the LiDAR data. This provides automatic exterior orientation and geo-referencing for image fusion and mapping

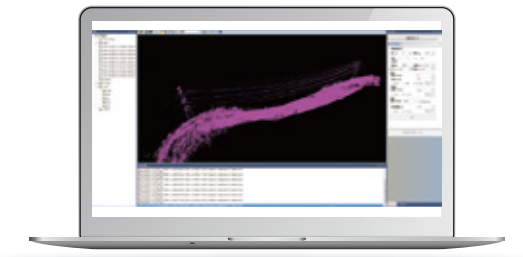


Software

Flight management software SS-NAV

Data pre-processing software SS-LiPre

SS-NAV



SS-LiPre

Fully owned IP rights

Functions of SS-NAV:

01 Route planning	05 Pilot navigation	09 Flexible return
02 System parameter setting	06 Trajectory management	10 Log files
03 Operational status monitoring	07 Camera triggering and monitoring	
04 Point cloud real-time display	08 Flexible route switching	

Functions of SS-LiPre:

01 Point cloud decoding	05 Point cloud display
02 Scanner orientation and position solution	06 Image file production
03 Geo-referencing of point cloud	07 Point cloud format conversion
04 Point cloud filtering and de-noising	

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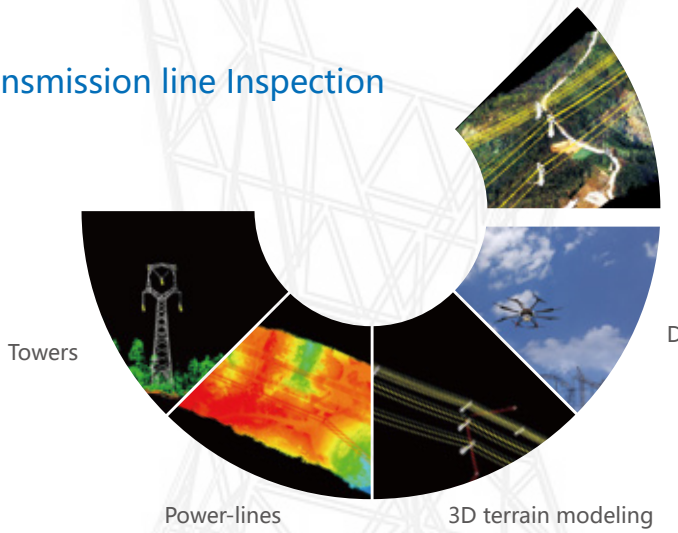
Transmission line inspection

Case

With high quality point clouds critical for transmission line inspection, there exists a strong demand for a reliable, efficient and cost-effective approach to the collection of LiDAR data. Due to its light weight, easy operation and high point density, giving perfect depiction of cables and towers, and excellent vegetation penetration, Skylark has become the gold standard for this application to China’ s 1.2 million kilometers of high voltage power lines.

Transmission line Inspection



LiDAR inspection versus image inspection

01 Different purposes: Image inspection is to find existing defects, LiDAR inspection is to find potential threats and obtain true 3D data for sag assessment, vegetation clearance and other spatial issues.

02 Different capabilities: Images cannot give accurate 3D information of the power line corridor, LiDAR can.

Skylark’ s advantages

01 Cost efficient
02 High accuracy
03 High point density
04 Easy to operate
05 Operator safety

— Operational speed over 80 km / h, no need for reference points

— Point cloud with elevation accuracy of 5 cm at 300m range

— 100% pulse capture = no wasted points, point density of 45 pts / m² at 300 m range

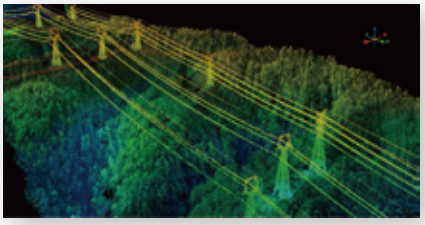
— Independent operation requires only three hours of training for novice users.

— Offset flight paths ensure high levels of security of the infrastructure and safety for the operator

Equipment preparation

Data collection

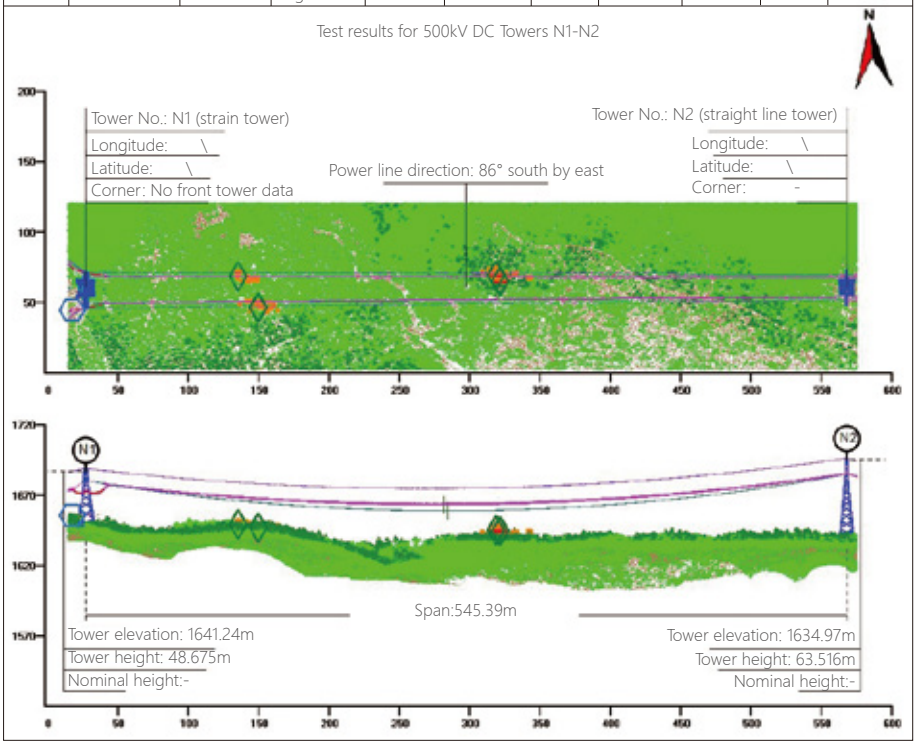
Point cloud visualization



Inspection report (threats analysis)

Distance Defect Report for 500kV DC Transmission Line.

Tower interval	Distance from first tower	Coordinate point	Defect type	Radius to defect	Measured distance			Safe distance		
					Horizontal	Vertical	Clearance	Horizontal	Vertical	Clearance
N1-N2	294.10	\	High vegetation	2.88m	3.80m	15.02m	15.49m	-	-	16.00m



Skylark
100% pulse capture
Careful flight planning = complete vertical surface coverage

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Water conservation survey

Case

Scope of survey:

An irregular shaped catchment 10 km in length containing dykes and sluice gates. The altitude difference is about 150 m.

Task:

- Produce a plan of the catchment and extract cross sections and long section of the intercepting trenches to be built.
- The plan scale is 1:500. The cross-section scale is 1:200 with section spacing 50 meters. The longitudinal section scale is 1:500.

Data format:

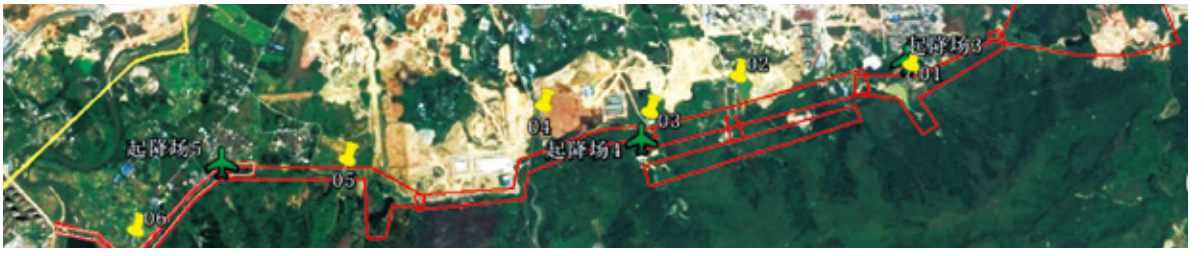
DWG files, blueprints, editable survey data, surveyors' diaries, field photos.

Flight planning after field reconnaissance:

The area was divided into 7 zones for drone take off and landing.

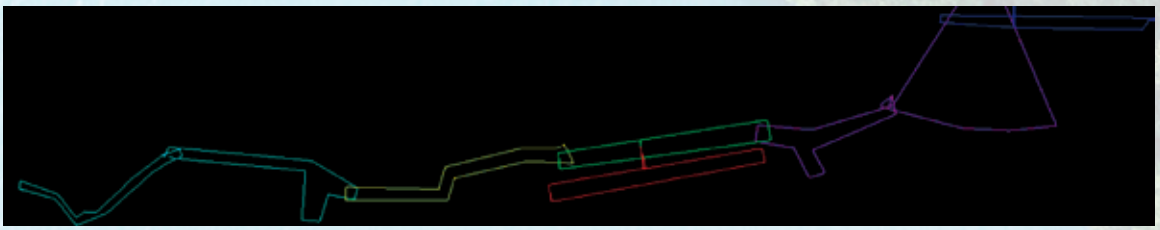
Control point layout and measurement:

Multiple check points were established from the existing control network.



Flight plan and data acquisition:

01 Number of take-offs: 8	02 Flight altitude: 150-250 m	
03 Point density: better than 100 pts/m²	04 Image acquisition: yes	05 Flight path length: 10 km



Flight trajectory file

Accuracy check results:

100 elevation checkpoints throughout the survey area were measured using TerraSolid software and compared to the known values. The results were:

Elevation accuracy:

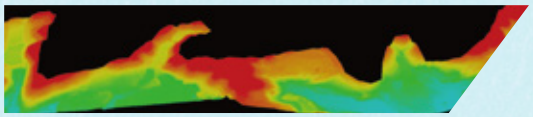
- 01 Root mean square: 5.7 cm
- 02 Standard deviation: 4.8 cm
- 03 Average error: 3.2 cm

Use	Number	Easting	Northing	Known Z	Laser Z	Dz
☒	g146	241330.72	2515962.54	24.360	24.507	+0.147
☒	g153	241252.44	2515942.33	24.850	24.816	-0.034
☒	g155	241215.72	2515943.09	25.074	25.041	-0.033
☒	g162	241093.24	2515944.59	25.773	25.870	+0.097
☒	g156	241197.98	2515943.15	25.171	25.138	-0.033
☒	g150	241299.73	2515940.88	24.556	24.528	-0.028
☒	g148	241309.62	2515960.95	24.526	24.617	+0.091
☒	g154	241233.80	2515942.56	24.961	25.041	+0.080
☒	g157	241180.07	2515942.92	25.265	25.251	-0.014

Average magnitude	0.0454	Average dz	+0.0320
Std deviation	0.0485	Minimum dz	-0.0340
Root mean square	0.0573	Maximum dz	+0.1470

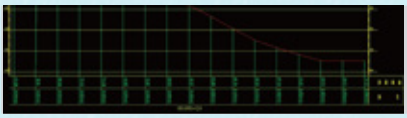
Outputs

DEM



DEM (partial model)

DLG



Cross sections

DOM

SureStar

Topographic mapping

Case1

Skylark turned a tough survey into an easy task

The daily life of many topographic surveyors is use RTK or total stations to measure the terrain point-by-point. Data collection for some large projects may take several months and expose survey crews to the dangers of nature.

With Skylark, the need to continuous transport equipment from point to point is removed, significantly more terrain points are obtained thus increasing the data fidelity, and field crew safety is enhanced.

A major benefit of Skylark is its ability to penetrate densely vegetated areas and access otherwise inaccessible terrain.

Location: Changsha
Landform: Mountainous area
Altitude difference: 380 m
Ground conditions: Remote area covered by dense vegetation.

Field photo

Skylark installed on a multi-rotor drone

Photo of the survey area

The Skylark solution

Field data collection:

01 Flight planning with "SS-NAV" software - flight altitude: 600 m; flight speed: 17 km/h
02 Install Skylark onto the eight rotor drone (1 minute)
03 Base station setup (5 minutes)
04 GNSS and IMU static initialization in open area (5 minutes)
05 Flight and data collection. (15 minutes)
06 Post-flight static state (5 minutes)

Data preprocessing:

01 Trajectory solution: including attitude and position computation
02 Point cloud solution: produce WGS84 point cloud in LAS format
03 Coordinate transformation: Transform the WG84 point cloud into the client' s coordinate system

Topographic mapping

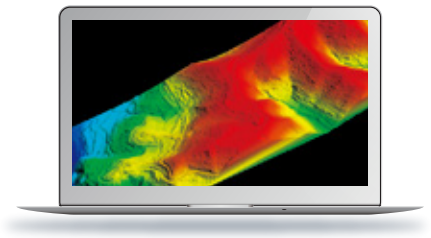
Case1

Data post-processing:

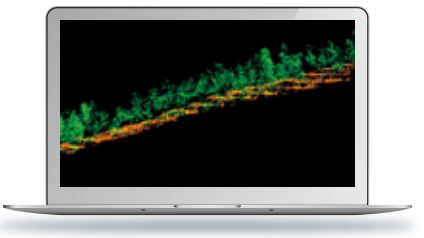
Point cloud de-noising, classification and tiling

Ground points are obtained from the classification which is followed by DEM construction and contour line extraction

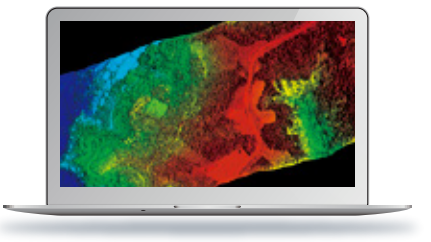
Deliverables



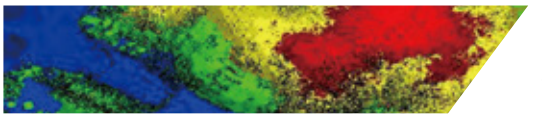
Digital elevation model (DEM)



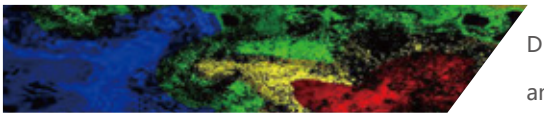
Classified point cloud
(yellow: ground points, green: vegetation points)



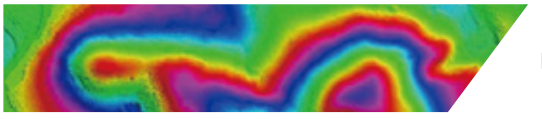
Digital surface model (DSM)



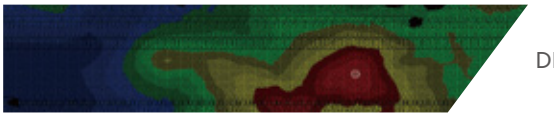
De-noised point cloud sampled to 75 points per/m^2



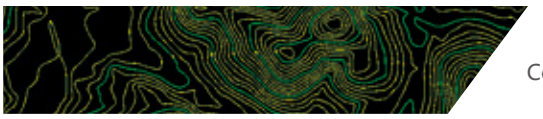
DEM with classified vegetation removed and sampled to 8 points per/m^2



DEM generated from all ground points



DEM sampled onto a 1m mesh



Contour lines

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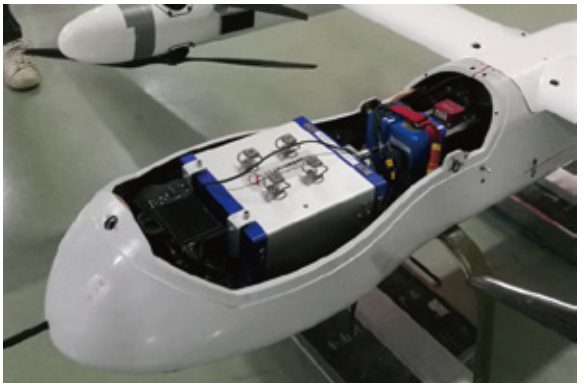
Topographic mapping

Case2

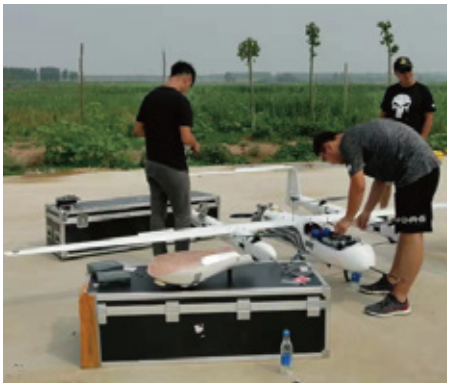
Pre-flight preparation

Skylark mounted on a SD-60B drone

The mounting and brackets and upper hanging plate are installed in the payload bay with damping brackets which allows Skylark to be easily installed and removed; the GPS antenna mount sits on top of the mounting bracket and the antenna is installed last.



Quick assembly
Overall damping equipment debugging



Skylark operation verification

Flight overview

- Flight area: 28 km^2
- Flight height: 300 meters above ground
- Flight line interval: 230 meters
- Flight time: 1 hour and 40 minutes
- Flight speed: 110 km / h
- Route length: 120 km

Topographic mapping

Case2

Achievement

Data quality statistics:

Point density: 17 pts/m²

Image resolution: 0.05 m

Elevation accuracy: 0.06 meters

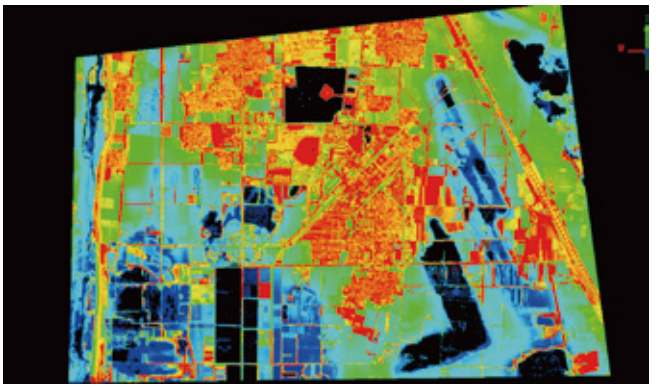
Working efficiency: 60km² / flight

CHT8024-2011 Airborne Lidar Data Acquisition Technical Specification

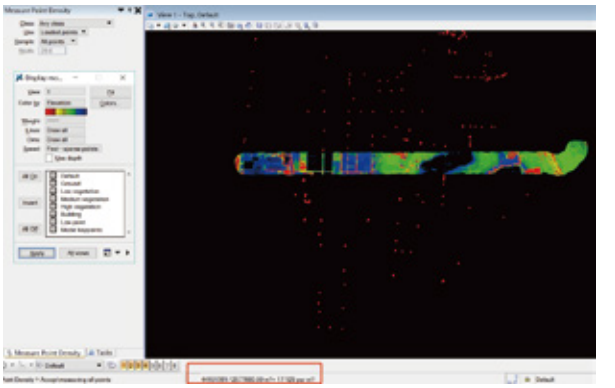
"Requirements:

- 1:500 scale map, point density ≥ 16 points / m²;
- 1:1000 scale map, point density requirement ≥ 4 points / m²;
- 1:2000 scale map, point density requirement ≥1 point / m²;

Satisfy 1:500 mapping requirements



Raw point cloud



Point density 17 points / m²

Image-rendered point cloud figure 1

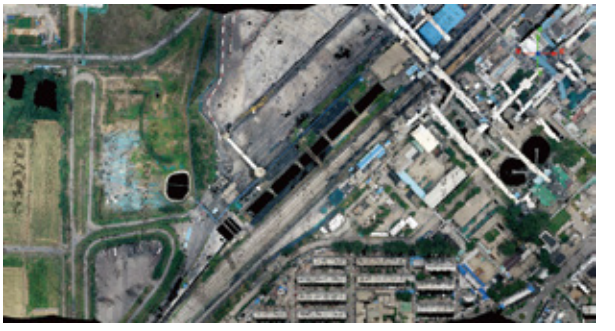


Image-rendered point cloud figure 2

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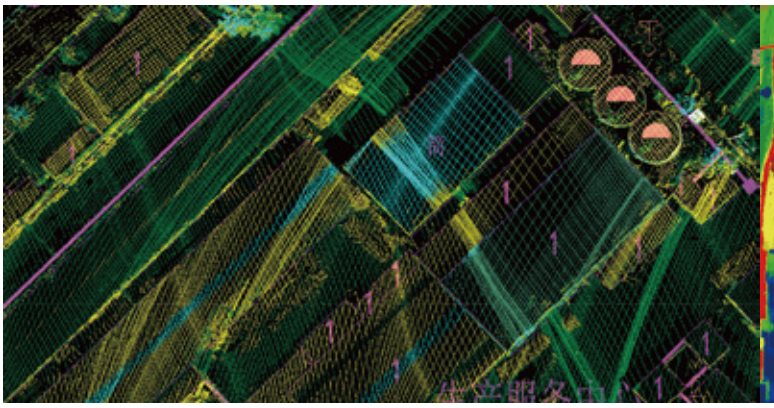
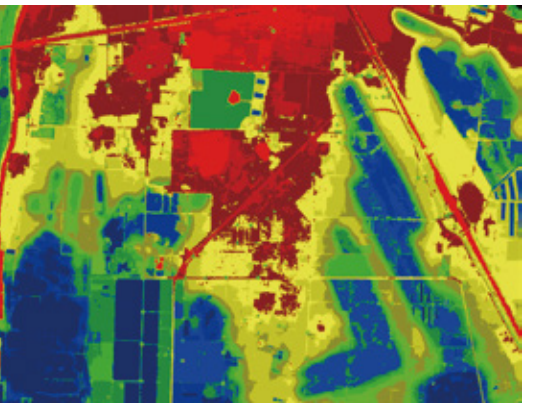
Topographic mapping

Case2

Orthophoto: 0.05 m ground sample distance (GSD)



Planimetric accuracy better than 10 cm



DEM

Table of elevation errors

Point number	Actual coordinates			LiDAR elevation	Elevation error
	Easting	Northing	KnownZ	LaserZ	Dz
20	4878.606	39266.811	41.402	41.5	0.098
21	4877.145	39266.738	41.759	41.83	0.071
22	4877.946	39266.879	42.261	42.26	-0.001
23	4877.242	39266.046	42.651	42.59	-0.061
24	4877.26	39266.762	42.543	42.65	0.107
25	4877.975	39266.119	43.005	43.09	0.085
26	4877.883	39266.837	43.081	43.07	-0.011
27	4877.878	39265.961	43.8	43.78	-0.02
810	4837.002	39281.264	43.957	43.87	-0.087
811	4838.157	39284.839	45.886	45.88	-0.006
812	4838.559	39288.215	46.052	45.99	-0.062
813	4839.921	39294.174	46.835	46.83	-0.005
814	4839.911	39298.509	46.917	46.91	-0.007
815	4839.976	39299.798	46.861	46.82	-0.041
816	4839.318	39299.274	47.044	46.98	-0.064
RMSE: [VV] =0.079=±Sqrt([VV]/(n)) =± 0.060(m)					

RMS elevation error 6 cm

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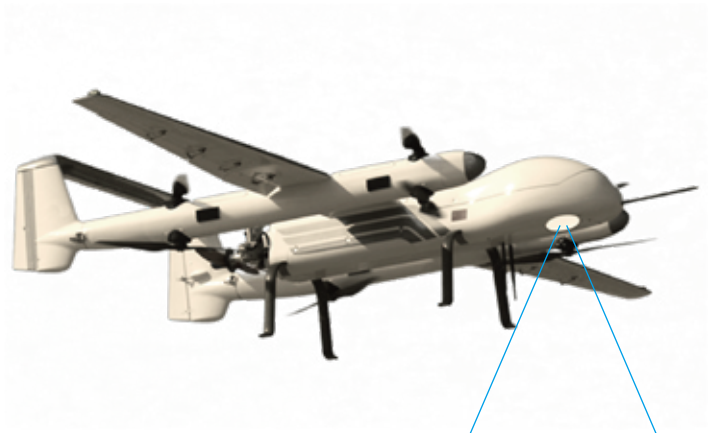
Lightweight UAV LiDAR System

Topographic mapping

Case3



Skylark’ s first test on Pisces Island

Topographic mapping

Case3

Flight parameters

Flight altitude: 200 m

Motor speed: 3000 rpm

Flight speed: 108 km/h (30 m/s)

Strip width: 280m

Pulse frequency: 250 kHz

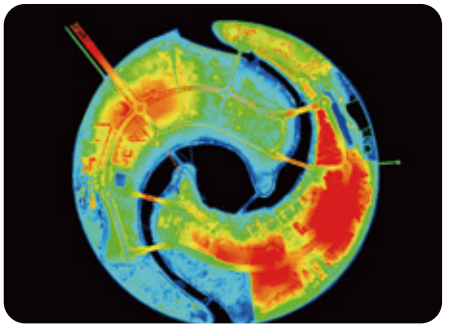
Camera parameters: 42.2 mpix sensor, fixed focus 28 mm lens, 44 m exposure interval

Route planning

Prepared for takeoff

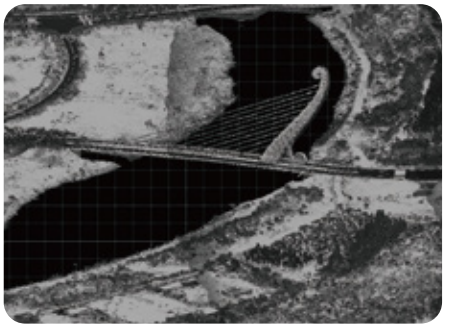
Data processing

Surestar’ s SS-LiPre software was used to solve the trajectory, generate the georeferenced point cloud, transform the point cloud coordinates, denoise and classify the point cloud, thus ensuring the users to acquire the perfect data.

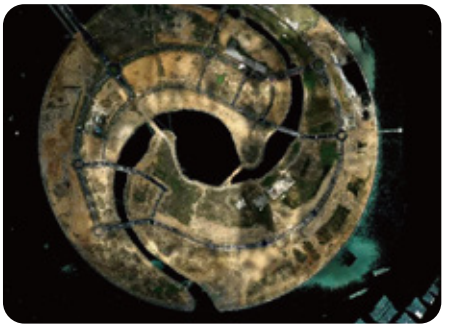


Elevation-colored point cloud

Orthophoto



Return pulse intensity



Color rendered point cloud

Specifications

Component	Element	Skylark
Features	Typical range	100 - 700 m
	Flight platforms	Drones, manned light aircraft
	Elevation accuracy Plane accuracy	< 5 cm < 10 cm
	No ground control mapping scale	1:500、1:1000、1:2000
	Time synchronization accuracy	<1 μs, including LiDAR, GNSS, IMU, and digital camera
	Data storage removable USB, data source	LiDAR, GNSS and IMU
	Operating mode	one-button start
	System weight	3.9 kg /4.8 kg (+camera)
	Operating temperature	-20℃~55℃
AK-series laser scanner	Minimum detection range	3 m
	Maximum detection range	AK-1500: 900 m @ 20% reflectivity / 1500 m @ 80% reflectivity AK-1000: 600 m @ 20% reflectivity / 1000 m @ 80% reflectivity AK-600: 300 m @ 20% reflectivity / 600 m @ 80% reflectivity
	Pulse frequency	50~600 kHz
	Laser safety class	Class I
	Scanning FOV	70°*40°
	Scanning mode	Oblique ellipse scanning
	Scanning frequency	50~200 KHz
	Range accuracy	10 mm@100 m(5 mm+50 PPM)
	Angular resolution	0.001°
	Laser echo	multiple
	Intensity resolution	12 bits
	Scanner weight	<4 kg
Navigation components	IMU type	high precision IMU
	IMU refresh rate	200-1024 Hz
	GNSS antenna line	1-2
	Satellite systems	GPS L1/L2、GLONASS L1/L2、BDS B1/B2
	Position accuracy (post-processing)	plane: 0.01m (locked) / 0.3m (GNSS signal loss of lock for 60 seconds) Vertical: 0.02m (locked) / 0.1m (GNSS signal loss of lock for 60 seconds)
	Heading (HDG) accuracy (post-processing)	0.009° (locked) 0.010° (GNSS signal loss of lock for 60 seconds)
	Pitch accuracy	0.005° (locked) 0.006° (GNSS signal loss of lock for 60 seconds)
	Roll accuracy	0.005° (locked) 0.006° (GNSS signal loss of lock for 60 seconds)
Camera	Camera model	AFD C42 / Sony a7R2 / Canon 5D (optional)

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