OPTOSKY
Spectroscopy Solutions

DataSheet

Online Rotary Scan Hyperspectral Imaging System

ATH3010OL

Features:

- High-sensitivity hyperspectral imager
- 360° full-angle scan, adjustable pitch Angle
- A variety of focal length objective lenses are available to adapt to different focusing targets
- Optical design with high image quality at the full target surface, and the spot diameter is less than 0.5 pixels
- 5-megapixel visible light camera with integrated spectrum
- With automatic wiper, keep Windows clean, automatic heater, window defrost and defog, and shade hood
- Sets several preset bits and an automatic scan trajectory
- The objective interface is standard C-mount, allowing you to change the objective according to user requirements, and the focal length of the lens ranges from 16 to 140mm
- Maximum spectral range: 400-1000nm, 900-1700nm, 400-1700nm
- Maximum FOV Angle: 31.7°

Application:

- Monitor Agriculture: plant diseases and insect pest, disaster, categories
- Forestry: Tree categories identification, Phytomass, nutrient elements, forest health etc.
- Water Environment: Water quality parameters, water waste spatial distribution and migration analysis
- Soil pollution: heavy metal waste
- Minerals: Mineral mapping, ingredients explore, metallogenic prognosis etc.
- City : Urban planning, road monitoring, landscape vegetation monitoring, environmental protection

Description:

ATH3010OL is an online rotary scan hyperspectral imager. In addition to waterproof and dustproof, online monitoring, ATH3010OL has the characteristics of high spatial resolution, high spectral resolution, wide imaging range, etc.

ATH3010OL consists of two parts: hyperspectral imager and fully automatic motorized rotating stage, where the high spectrometer is based on high-efficiency transmission grating technology and has good aberration characteristics.

ATH3010OL uses 2048×1088 or 2048×2048 pixel high performance CCD imaging device, imaging clearly, less noise; Internal integration of the original high compression ratio image compression algorithm.

ATH3010OL is mounted on a pole and adds automatic calibration devices, weather monitoring sensors, etc., to enable long, large area scanning of the target, unattended operation, and continuous operation for several months.

Model	Features
ATH3010OL	Online hyperspectral, Spectral Range: 400-1000nm, Unattended
ATH3010OL-17	Online hyperspectral, Spectral Range: 400-1000nm, Unattended
ATH3010OL-4-17	Online hyperspectral, Spectral Range: 400-1000nm, Unattended

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Fig 1 ATH3010OL Working principle

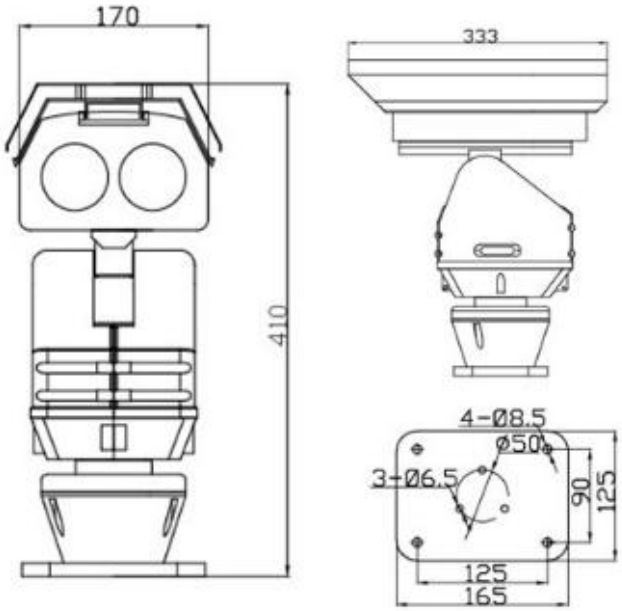

Fig 2 ATH3010OL Dimensions

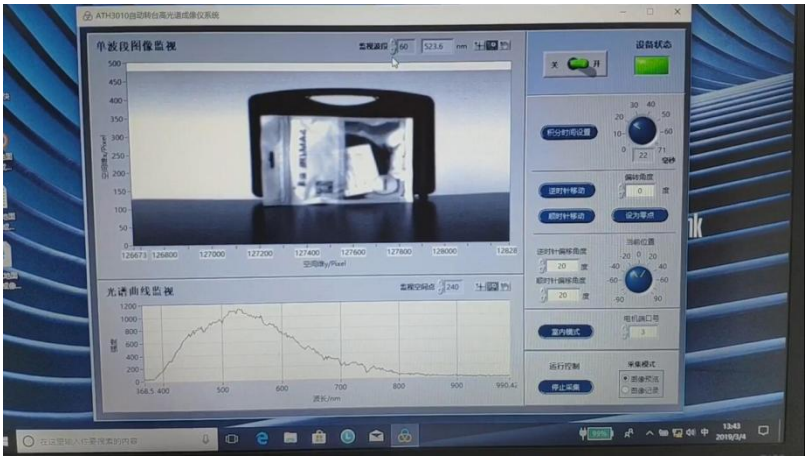

Fig 3 ATH3010OL Interface diagram

Performance parameters:

Items	ATH3010-OL	ATH3010OL-W	ATH3010OL-17	ATH3010OL-4-17
Spectral Range	370-1010nm	370-1010nm	900-1700nm	400-1700nm
Spectral Resolution	＞1.5nm	＞1.5nm	＞3.5nm	＞1.5nm@650nm ＞3.5nm@1500nm
Sampling Interval	0.31nm	0.31nm	1.56 nm	1.56 nm
F-number	F/2.6	F/2.6	F/2.6	F/2.6
Detector	CMOS/CCD	CMOS/CCD	InGaAs CCD	CMOS / InGaAs CCD
Detector Interface	USB3.0	USB3.0	USB3.0	USB3.0
Supply Power	USB，3.4W	USB，3.8W	12V，15W	12V，30W
Detector Target Size	11.26 x 5.98mm	11.26 x 11.26mm	9.6mmX7.68mm	11.26 x 11.26mm 9.6mmX7.68mm
Detector Original Resolution	2048 × 1088	2048 × 2048	640X512	2048 × 2048 640X512
Detector Original pixel size	5.5 μm x 5.5 μm	5.5 μm x 5.5 μm	15X15 μm	5.5 μm x 5.5 μm 15X15 μm
Bit Depth	12 bits	12 bits	14 bits	12 bits 14 bits
Slit Width	25 μm or customization	25 μm or customization	30μm or customization	25 μm or customization 30μm or customization
Recommended Way To Merge Cells	4x4 or 2x4	4x4 or 2x4	No merge or 1×2	According to the front row
Number Of Spatial Channels	480 or 960	2048 or 1024	640	2048 or 640
Number Of Spectral Bands	300 or 600	512, 1024 or 2048	512	512, 1024 or 2048, 512
Focal Length	16-140mm			
FOV	15.2°@f=35mm	15.2°@f=35mm	15.2°@f=35mm	15.2°@f=35mm
IFOV	0.7mrad@f=35mm	0.7mrad@f=35mm	0.7mrad@f=35mm	0.7mrad@f=35mm
Max Frame Rate	340 fps	140 fps	70Hz	70Hz
Size	340mm x 340mm x 180mm	340mm x 340mm x 180mm	340mm x 340mm x 180mm	440mm x 340mm x 280mm
Weight	＜2850g	＜2850g	＜3800g	＜7500g
Operating Temp	-20 - 50°C	-20 - 50°C	-20 - 50°C	-20 - 50°C
Storage Temp	-30-70°C	-30-70°C	-30-70°C	-30-70°C

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Scanning	External push-broom measurement
Data Interface	GBE
Control Interface	RS485
Communication Protocol	Pelco-D or Pelco-P
Preset Pan Speed	100°/S
Pitch Angle Of Gimbal	+35° ~ -75°
Preset Tilt Speed	80°/S
Manual pan speed	0°~40°/S
Manual Tile Speed	0°~20°/S
Level Angle	360°infinite rotation
Vertical Angle	+35° ~ -75°
Preset bits with automatic scanning	Supports preset scan start bit and scan speed
Relative Humidity	90%
Protection Grade	IP66
Operating Temperature	-40° ~ +55°
Gimbal Drive Mode	worm gear
PTZ Power Supply	AC24V±20%，40W
PTZ Weight	<15Kg
PTZ Size	265mm×180mm×315mm （L×W×H）
Data Acquisition Software	Flexible setting of exposure time, dynamic display of real-time hyperspectral images and spectral curves
Data Analysis Software	One-click acquisition of cluster analysis, single-band, true and false color, more than 20 kinds of vegetation indices (customizable), 3D cropping of images, target spectrum recognition and other images with one click without third-party software. All the above functions can realize unattended batch processing .
	With powerful hyperspectral vegetation analysis software, it can quantitatively monitor vegetation greenness and health, including red-edge normalized difference vegetation index (RENDVI), normalized difference vegetation index (NDVI), Modified red-edge normalized difference vegetation Index (MRENDVI), Modified Triangular Vegetation Index (MTVI), Modified Chlorophyll Absorption Ratio Index (MCARI), Modified Chlorophyll Absorption Index (MCARI2) and other indicators.
Software Display	Dynamic real-time display of hyperspectral images, scientific light-dark focusing, avoiding manual visualization focusing errors

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1. Application

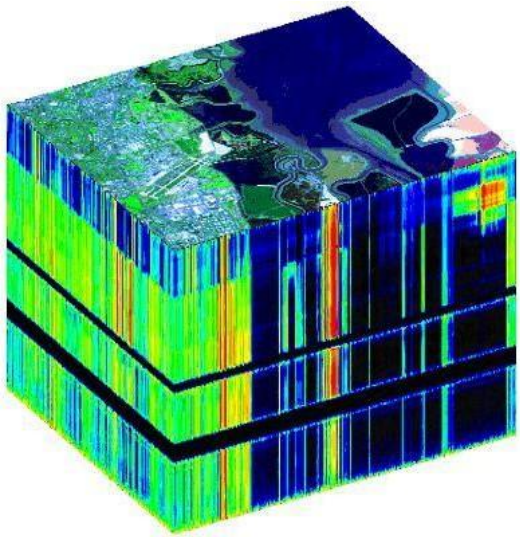

Fig 4 Data cube captured

Fig 5 Drone experiment

Fig 6 Outdoor experiment sceneI

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Fig 7 Outdoor experiment sceneII

Fig 8 Outdoor experiment scene III

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Fig 9 Outdoor experiment scene IV

Fig 10 Outdoor experiment sceneV

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1.1 Industrial Sorting Application

With the development of NIR hyperspectral technology, scientists have tried to use near-infrared hyperspectral technology to detect impurities in cotton. The application of SWIR hyperspectral technology has significantly improved the detection rate of plastic films compared with conventional methods.

Hyperspectral imaging technology is based on a very large number of narrow-band image data technology, which can obtain image information and spectral information of the sample while imaging the sample. Commonly used hyperspectral data processing methods include partial least squares (PLS), support vector machine (SVM) and artificial neural network (ANN).

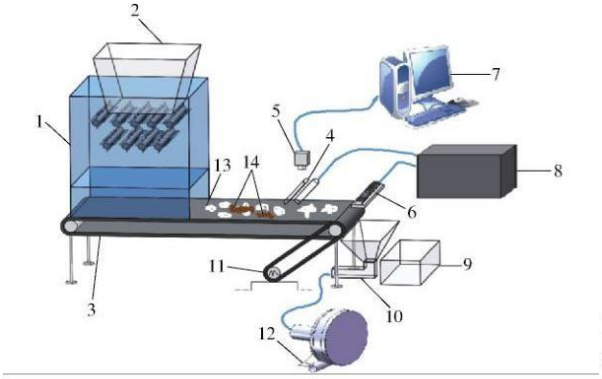
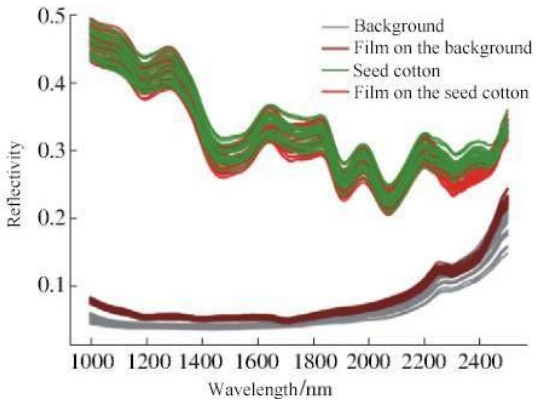
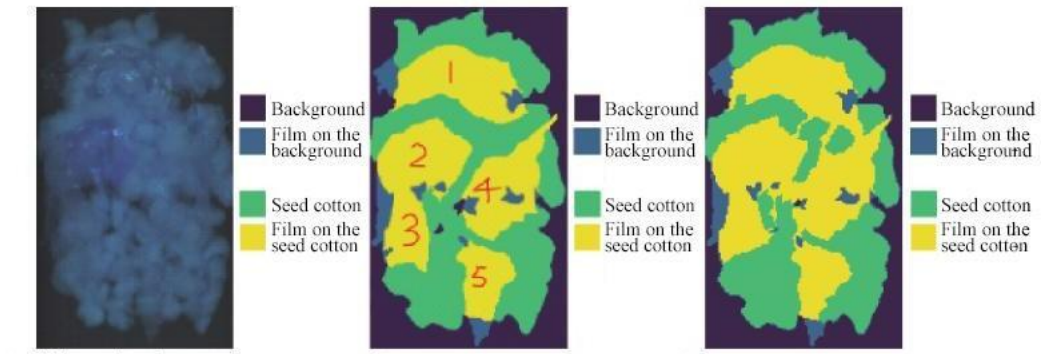


Fig. 2 Schematic of film sorting system of seed cotton

1.Cotton box 2.Cotton inlet 3.Conveyor belt 4.Dome halogen lamp
5.Hyperspectral camera 6.High speed spray valve 7.Industrial PC
8.Industrial PC 9.Seed cotton collection box 10. Waste collection box
11.Servo motor and encoder 12.Fan 13.Seed cotton 14.Film



Cotton seed sorting; (a) System functional composition; (b) reflectance spectrogram of different substances



(a) False color picture of hyperspectral data (b) Manual labeling diagram (c) VW-SAE-PSO-ELM

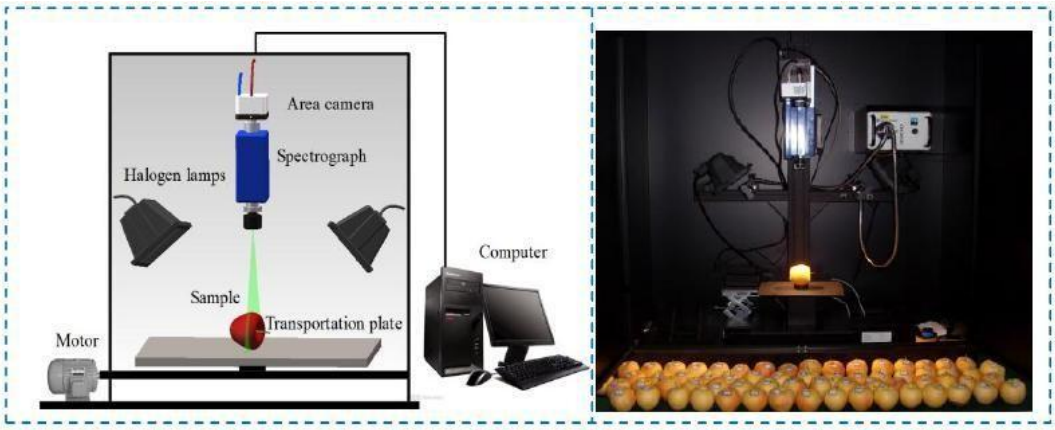
Cotton seed sorting application;

(a) Artificial marking;

(b) Recognition result Apple's external quality is the most intuitive quality feature of Apple, which directly affects Apple's price and consumer preference. Aiming at the difficulties and key points of external inspection of apples, based on machine vision technology, hyperspectral imaging technology and multispectral imaging technology, integrated

image processing technology, pattern recognition method, chemometric method and spectral analysis technology, the external physical quality of apple (shape and size) and detection methods for common defects on the surface.

The detection system and algorithm developed on the basis of the above research laid the foundation for my country's research and development of rapid online inspection and grading equipment for Apple's external quality based on machine vision technology and multi-spectral machine vision technology.



Schematic diagram and physical diagram developed by Dr. Zhang Baohua of Shanghai Jiaotong University; (a) Schematic diagram; (b) Physical diagram

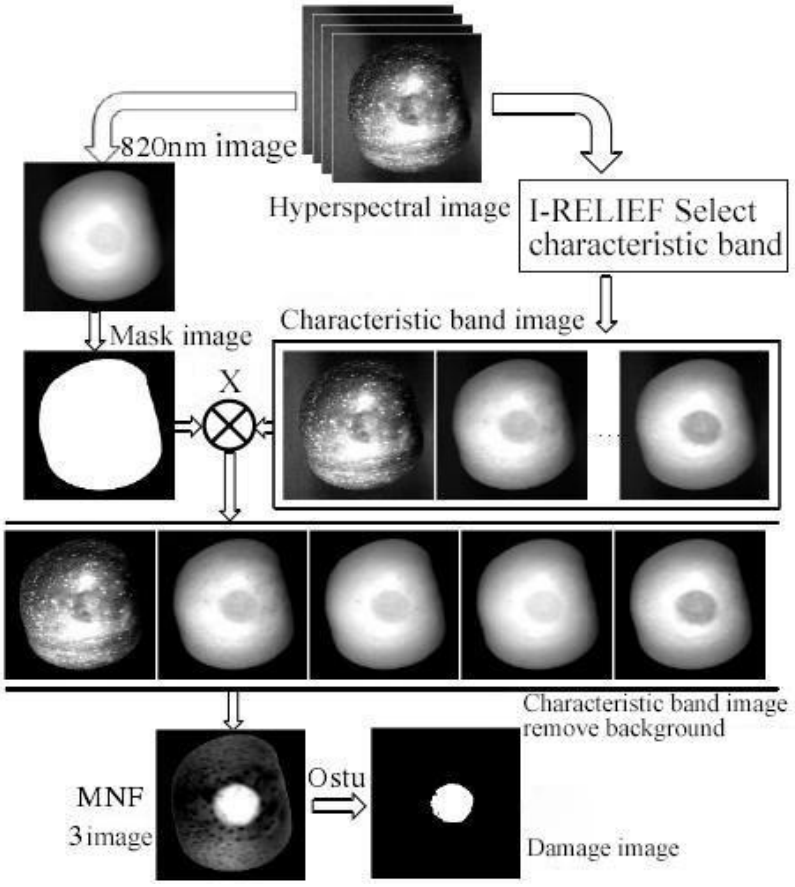


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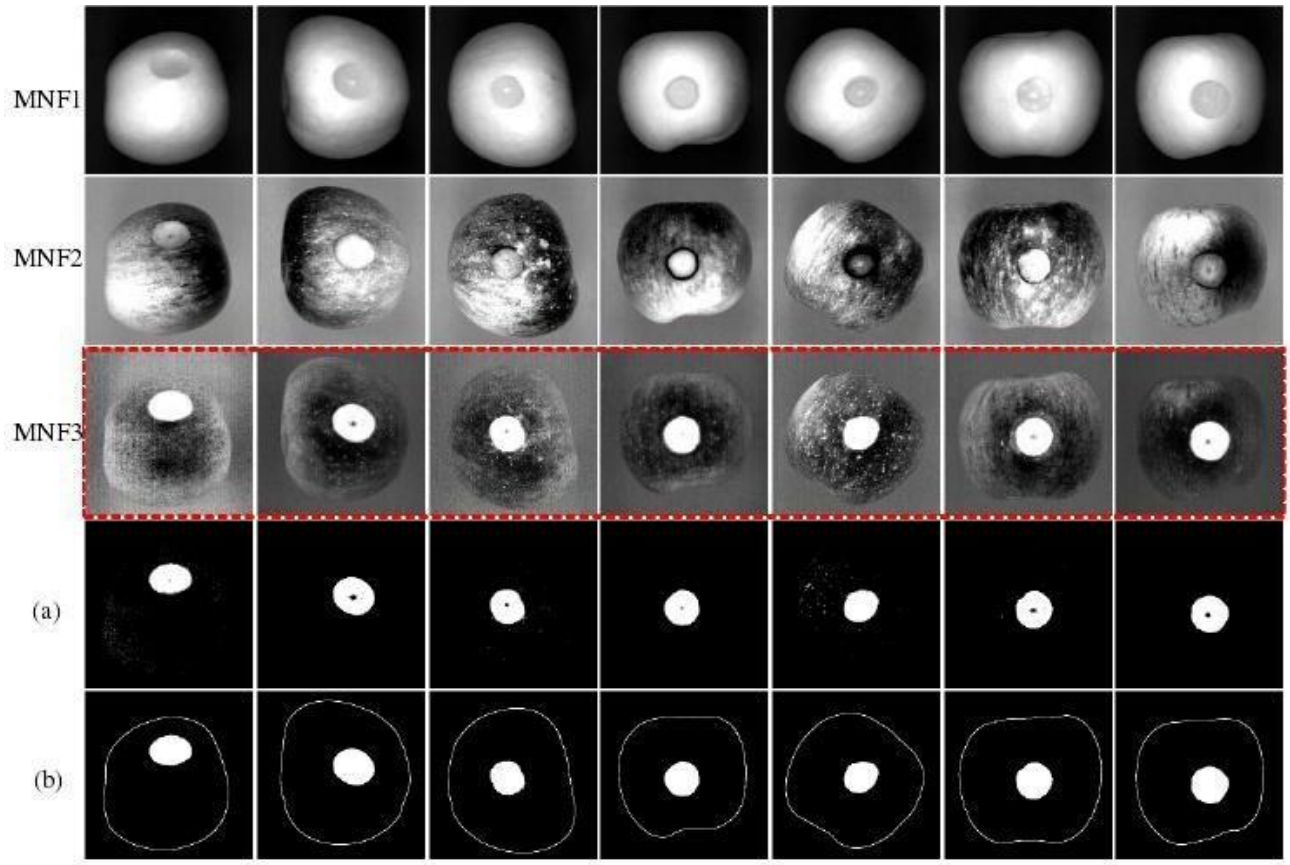
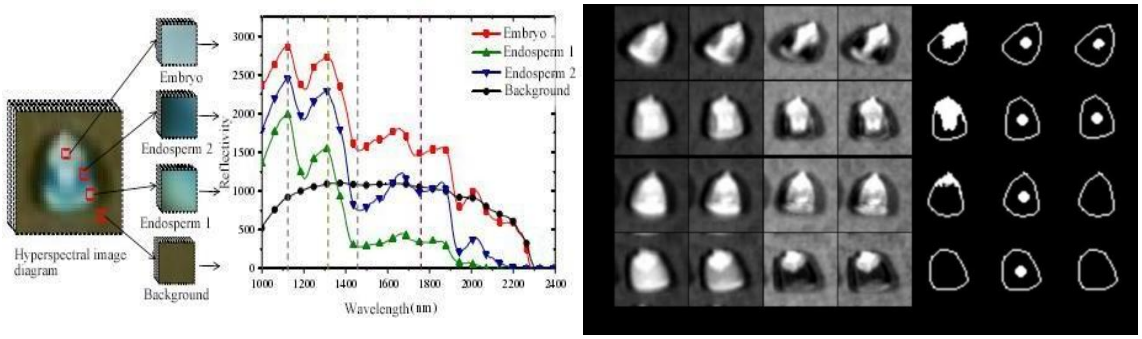
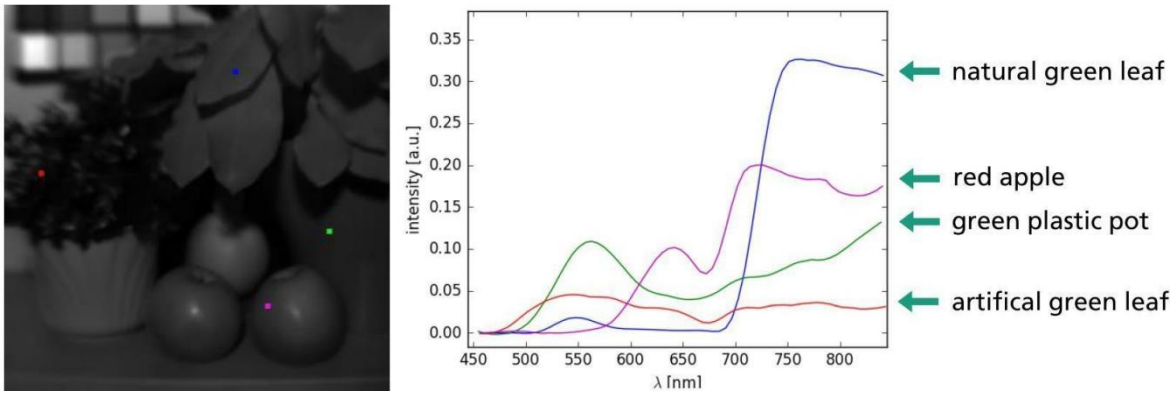
Fig 11 Flow chart of early damage detection algorithm for apple surface



Recognition results of early decay of some apples and intermediate processing (a) rot segmentation results (b) final results



Corn seed sorting application (Dr. Chaopeng Wang, Northwest A&F University)



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The spectrum of natural green plants, artificial green leaves, green plastic, and red apples

1.2 Agriculture growth monitoring

Fig 12 Drone hyperspectral imaging camera, developed and designed by Optosky

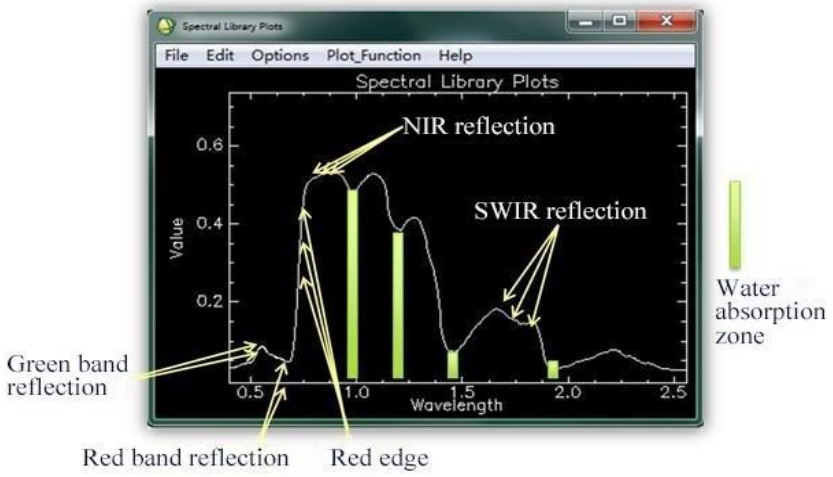

Fig 13 Green plants spectrogram generated by hyperspectral imaging camera

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1) **Crop growth monitoring and yield pre-estimation:** Due to various external factors posed upon crop growth at each stage, there will be certain differences in the internal composition and external morphology of the crop. The major difference is the leaf area index. Leaf area index is a comprehensive index reflecting the individual characteristics and group characteristics of crops.
2) **Crop pest control:** Drone hyperspectral imaging system can monitor pests and diseases during crop growth, track the state of crop growth, analyze and estimate disaster losses, and monitor the distribution and activity of pests, thereby preventing the occurrence of pests.
3) **Drought monitoring of crops:** Drone hyperspectral imaging system monitors crop drought conditions through crop vegetation index and canopy parameters.
4) **Monitoring of soil moisture content and distribution:** to test soil moisture content, under different thermal inertia conditions, the spectrogram generated by drone hyperspectral imager can be quite different. Therefore a mathematical model that analyzes the thermal inertia and soil moisture content can be established, and then the drone hyperspectral imaging system uses this model to analyze soil moisture content and distribution.
5) **Crop nutrient monitoring:** The drone hyperspectral imager monitors the nitrogen content of crops much more accurately than that of other nutrient elements.

Normalized difference spectral index (NDSI), ratio spectral index (RSI) and simple spectral index (SSI) were constructed by using single band and any two bands in the range of 450 ~ 882 nm to calculate the correlation between CGI and spectral index and screen out spectral index with good correlation. Combined with partial least squares regression (PLSR), the inversion model was established.

Using CGI as the index, hyperspectral imager can be used to monitor the growth status of wheat during its high-growth period in 2015. Hyperspectral imager is accurate in inversion CGI, which can monitor the difference of wheat growth.

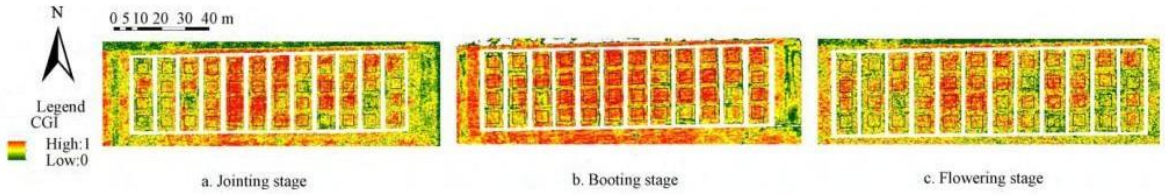

Fig 14 CGI inversion of wheat growth index

1.3 Forest Health monitoring

Used for pest monitoring and forest resource assessment.

Principle: The health of vegetation is related to greenness index, leaf area index, leaf moisture content and light use efficiency;

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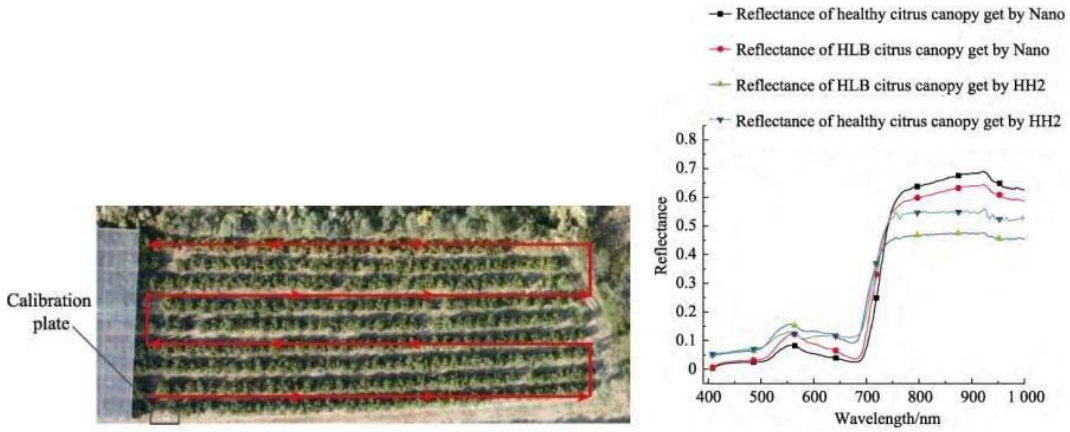


Fig 15 Monitoring and classification of citrus yellow dragon disease plants by hyperspectral imaging camera (designed by Lan Yubin et al., South China Agricultural University)

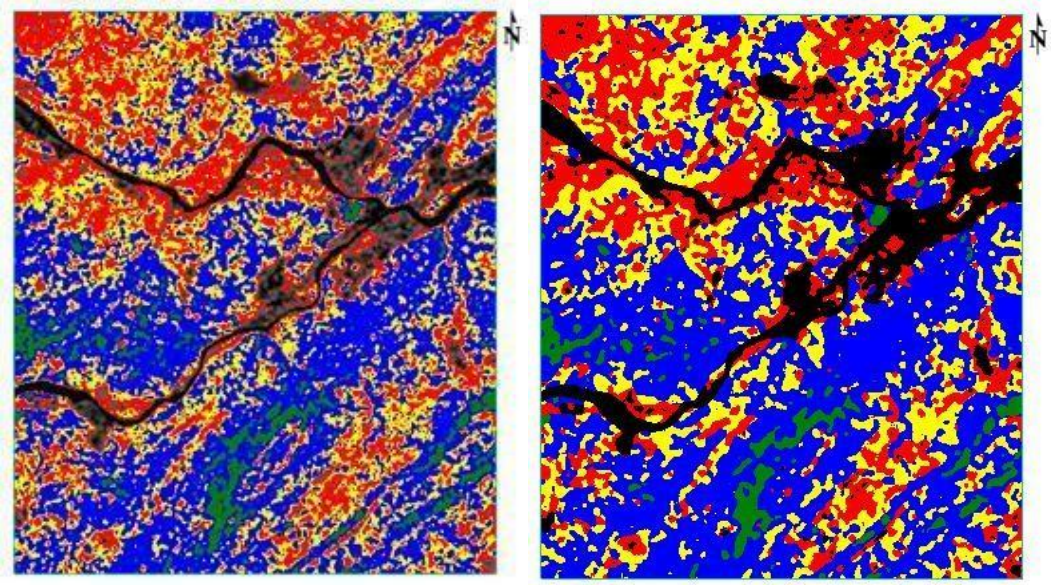
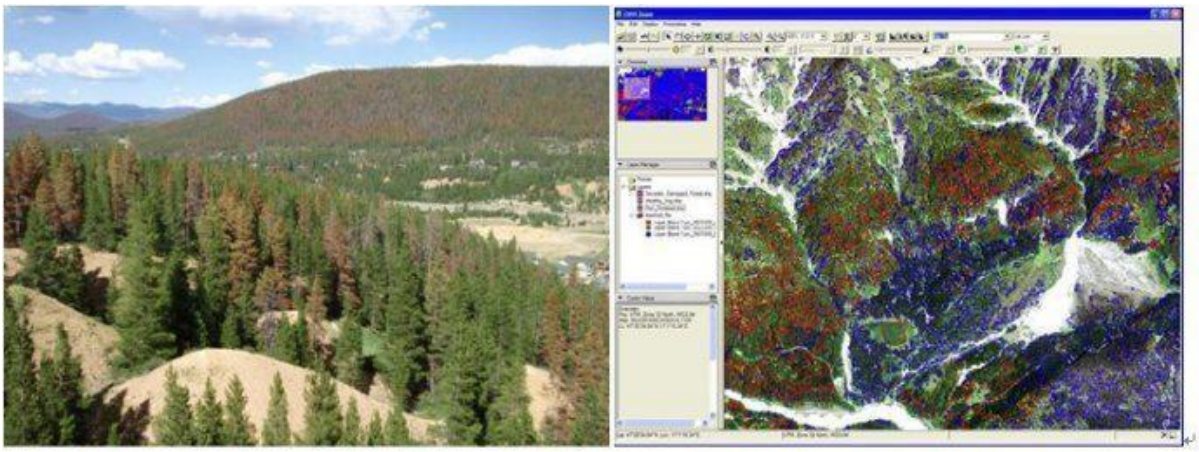


Fig 16 Distribution map of masson pine health condition monitored by hyperspectral camera, by Wang Shuang of the University of Electronic Science and Technology of China



1.4 Geological Prospecting Application

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Hyperspectral imager has evolved from the multi-spectral remote sensing technology represented by Landsat and was developed in the mid-1980s (Goets et al., 1985, Tong Qingxi et al., 2006).

Due to its advantages of high spectral resolution and atlas integration, hyperspectral imager can detect and analyze rock and mineral composition at large scale. It can not only provide a macro image of the ground, but also analyze the variety and abundance of minerals, or even the chemical composition of some minerals (quoted from Wang Runsheng et al., 2010).

In recent years, with the continuous development of hardware, data processing and software, the application of hyperspectral imager in geological survey has been accelerated.

Hyperspectral imager has played an important role in geological mapping, the definition and division of hydrothermal alteration zones, and the delineation and discrimination of mineralization anomalies from large metallogenic areas to medium-scale ore fields (e.g. Bierwirth et al., 2002; Company Changyun et al., 2005; Kruse et al., 2006; Cudahy et al., 2007; Wang Runsheng et al., 2010; Liu Dechang et al., 2011; Yan Baikun et al., 2014; Yang Zian et al., 2015; Graham et al., 2017).

As the theory of metallogenic system (Wyborn et al., 1994) has become the guiding principle of geological prospecting, thematic mineral mapping on the scale of large ore concentration areas and metallogenic belts will provide key regional material composition information for predictive prospecting and exploration.

The spectral wavelength ranges used for mineral mapping include visible light (400-700nm), NIR (700-1000nm), SWIR (1000-2500nm), and thermal IR (7000-15000nm). At present, the most widely used in mining is the short-wave infrared region (1000-2500nm), as its frequency is close to the frequency and combined frequency of the chemical bond vibration in the mineral lattice, the mineral containing water or OH- (mainly layered silicate and clay) as well as some sulfate and carbonate minerals can be observed in the range of short-wave infrared wavelength.

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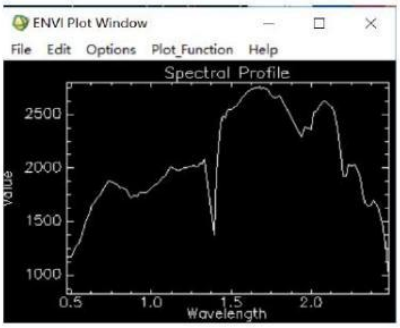
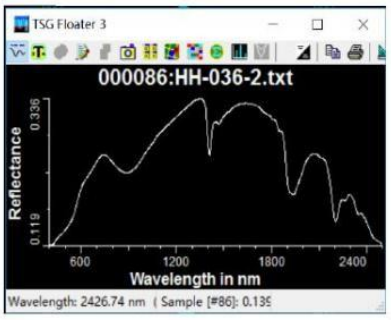
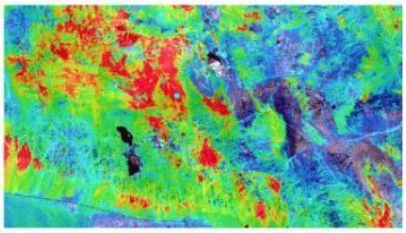


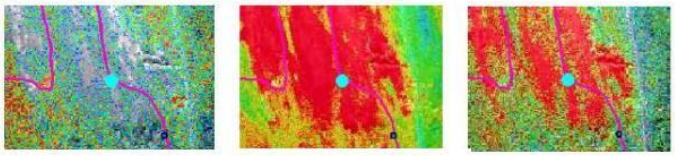
HH036 point image spectrum



HH036 point measurede spectrum

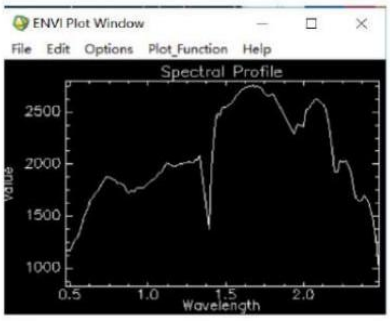


Sericite Filling Results Comparison of known deposit points between HH036 and measured

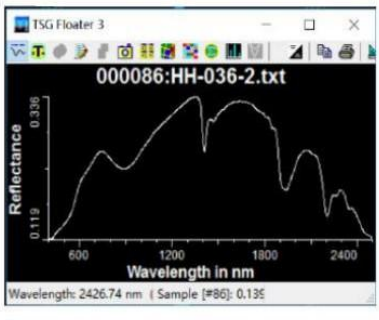


Chlorite extraction results | Sericite extraction results | Feb3+ extraction result

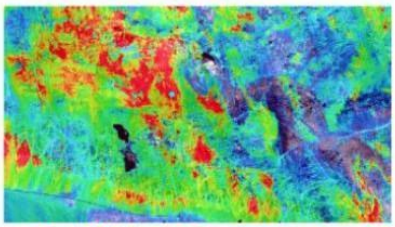
Sampling point photos | Long-range photos of sampling points



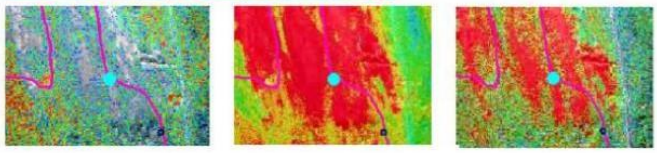
HH052 point image spectrum



HH052 point measurede spectrum



Sericite Filling Results Comparison of known deposit points between HH052 and measured



Chlorite extraction results | Sericite extraction results | Feb3+ extraction result

Sampling point photos | Long-range photos of sampling points

Application of hyperspectral imager in geological prospecting Soil salinization is one of the important ecological and environmental problems in arid and semi-arid areas. Soil salinization causes soil hardening, fertility decline, acid-base imbalance, land degradation and other consequences, which seriously restricts agricultural development in China and affects the

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strategic situation of sustainable development in China at present, hyperspectral imaging system, featuring large scale, wide range, effective and economical, provides a new way for quantitative monitoring of soil salinization phenomenon.

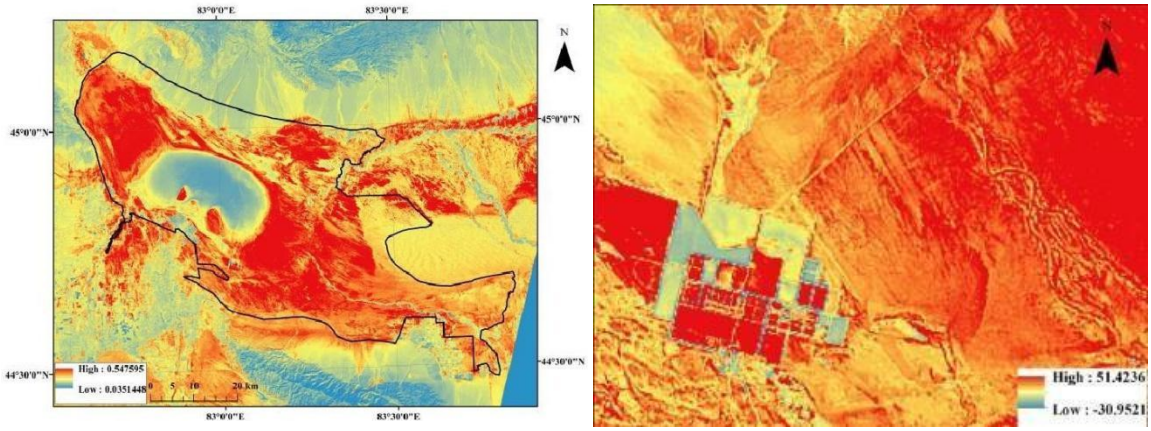
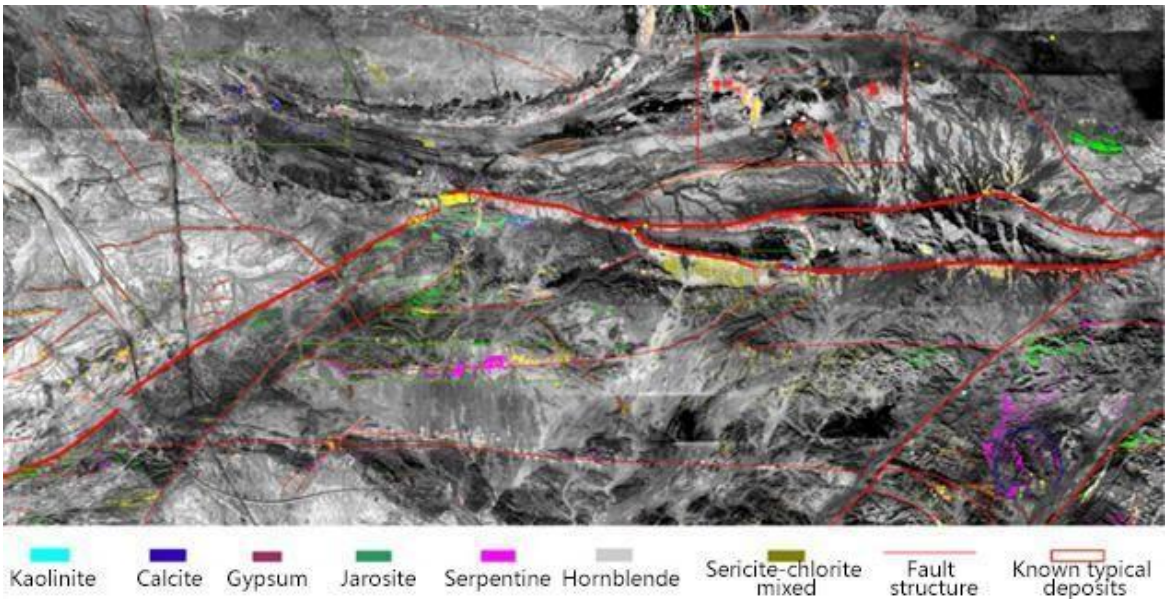


Fig 17 The surrounding area of a salt field



1.5 Public Safety Application

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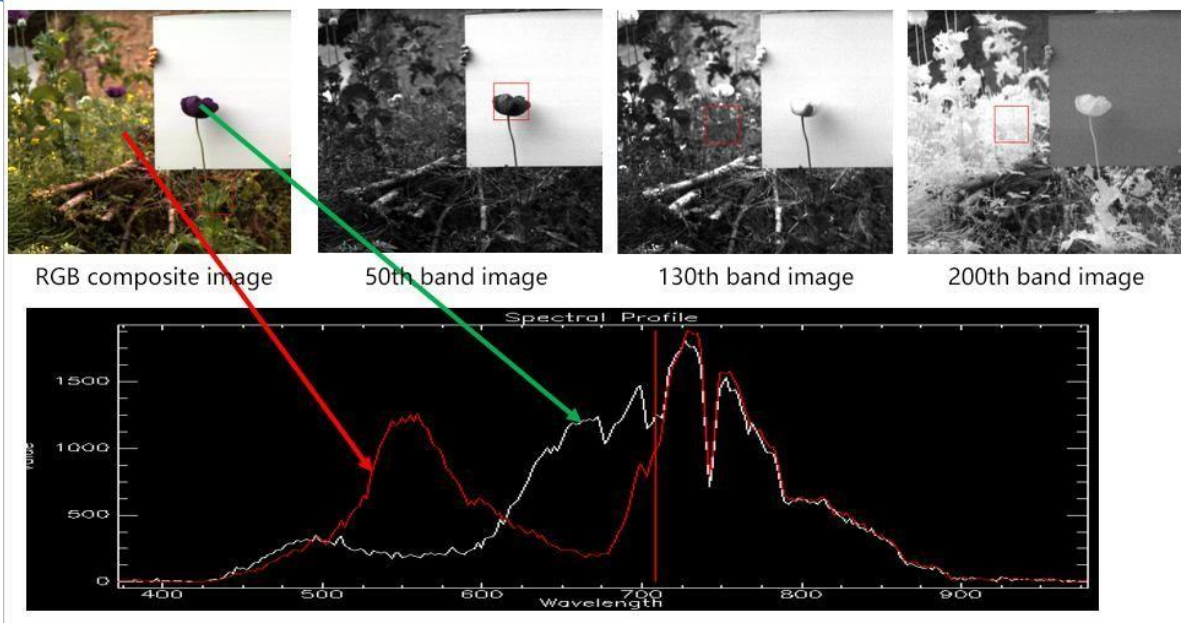

Fig 18 Monitoring illegal poppy cultivation by hyperspectral imager

Fig 19 Document inspection application

1.6 Medical Microscopic Imaging Application

Objective: online detection and navigation positioning during tumor surgery

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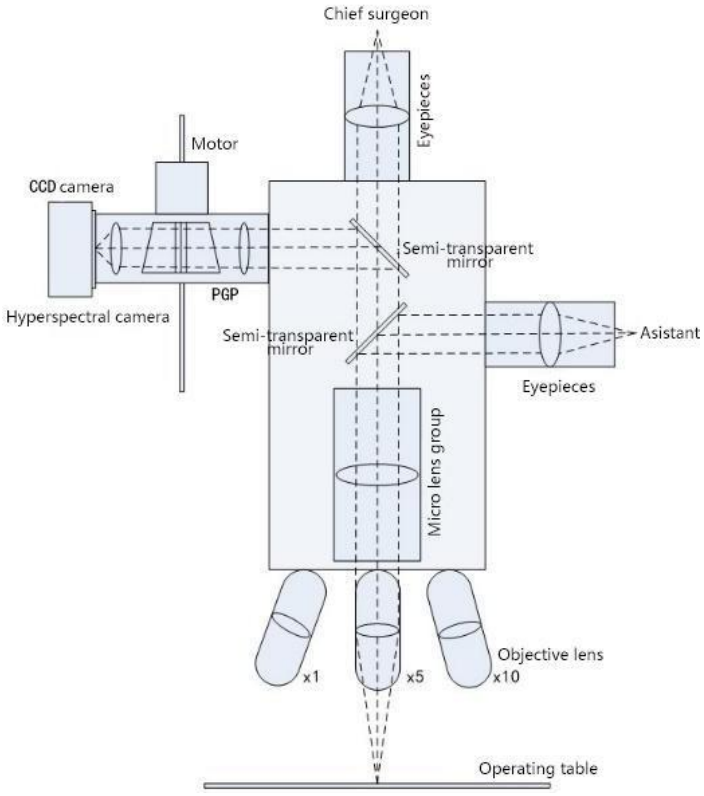

Fig 20 Medical microscope imager optical path schematic diagram

Fig 21 Medical microscope imager figure

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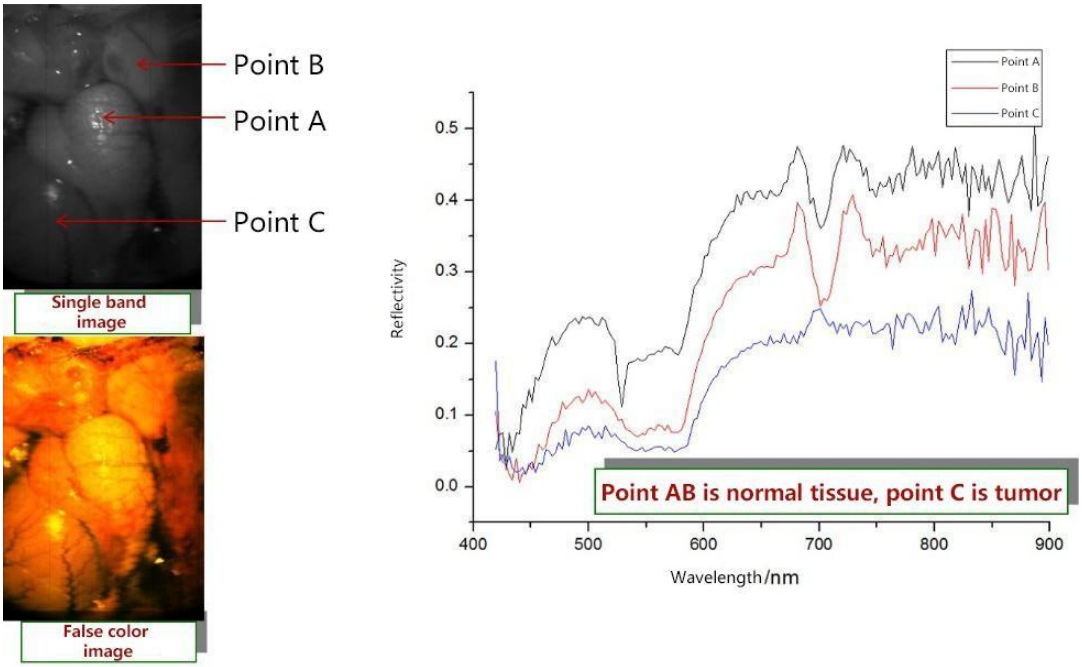

Fig 22 Data collect by medical microscopic imager

1.7 Drone Hyperspectral Imager

1.8 Optosky Drone Hyperspectral Imager

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Introduction: The drone hyperspectral imager is composed of SpecVIEW-VIS, stable platform and POS modules.

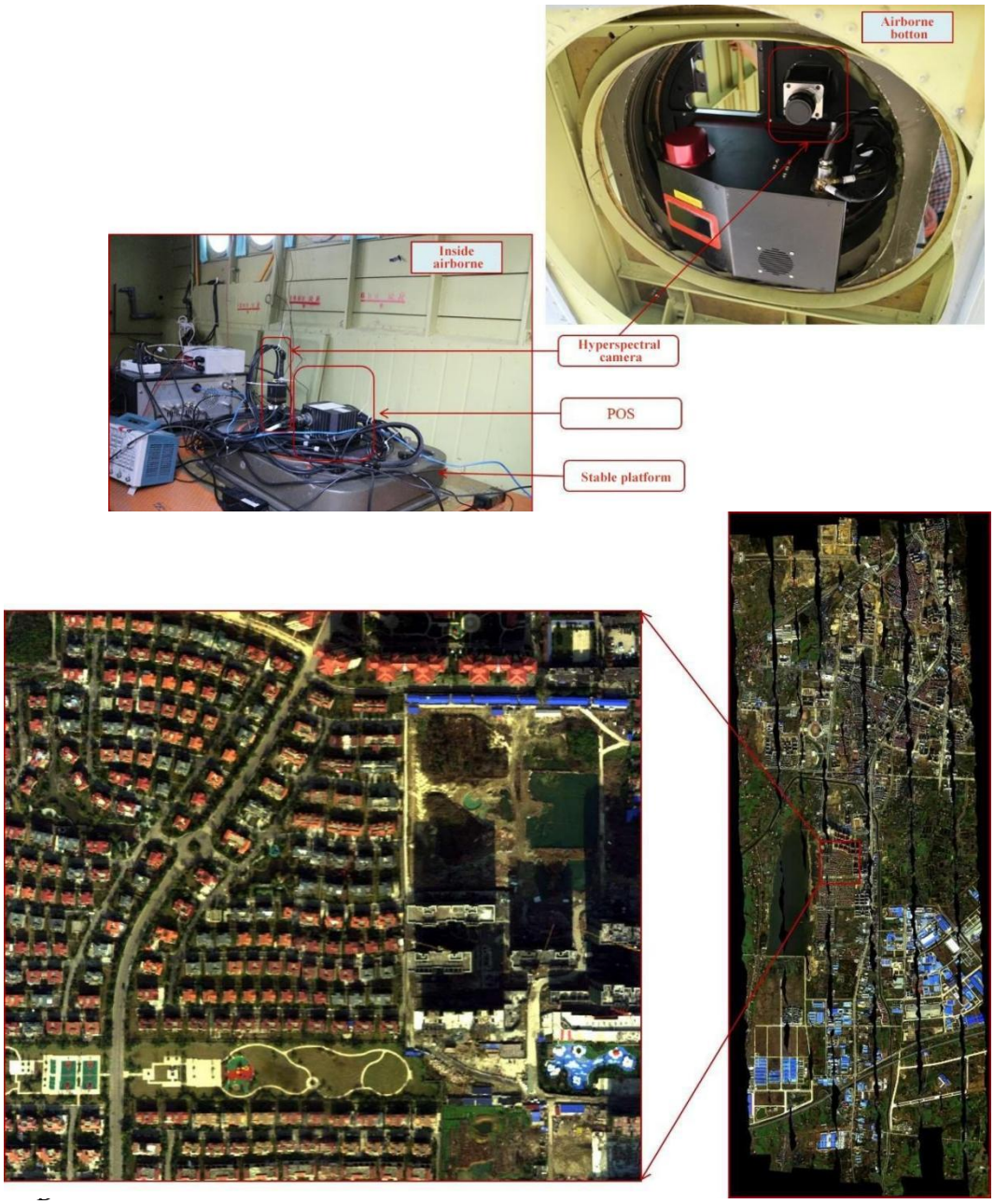

Fig 23 Drone Hyperspectral Imager pseudo color image

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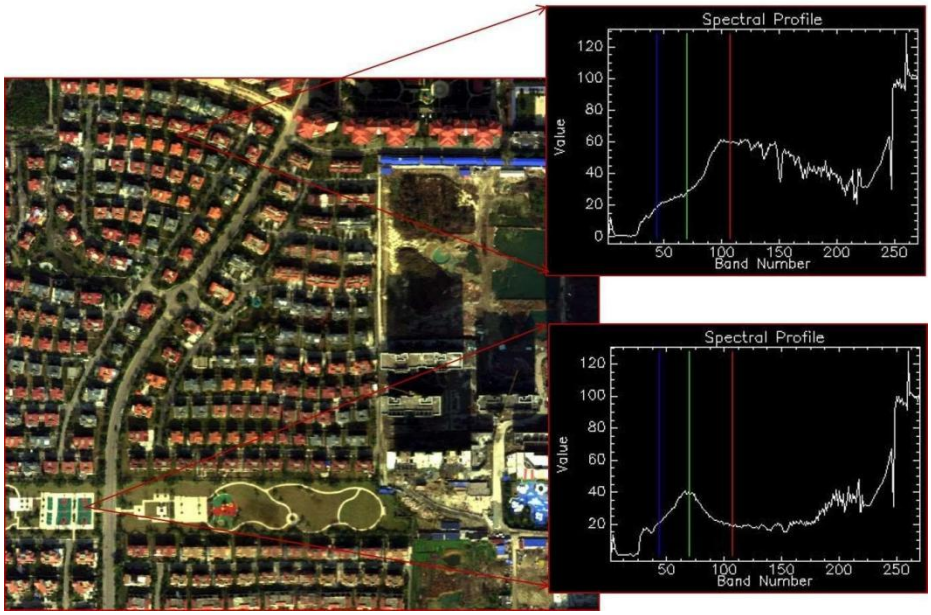

Fig 24 Drone Hyperspectral Imager data-spectral curve

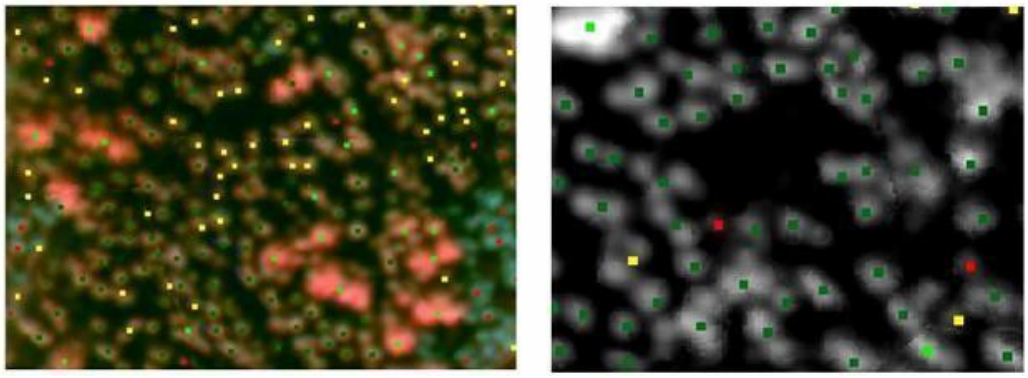

Fig 25 Drone Hyperspectral Imager monitors forest disease and pest

1.9 Water Quality and Environmental monitoring

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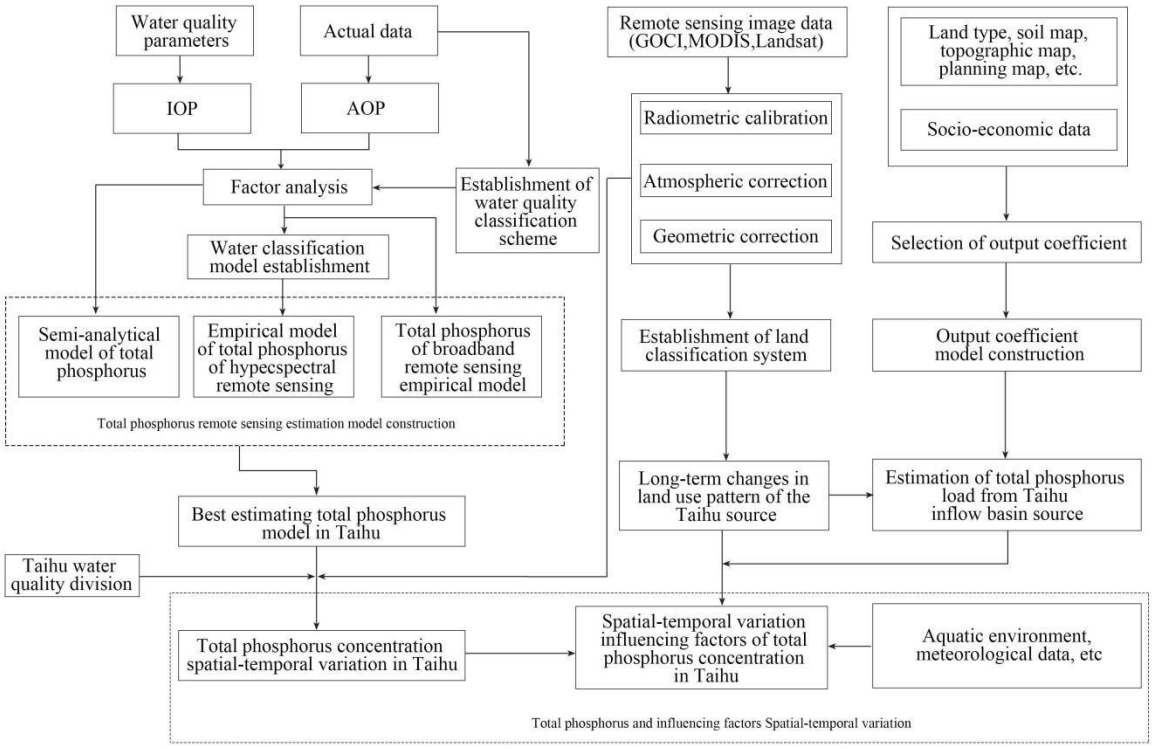
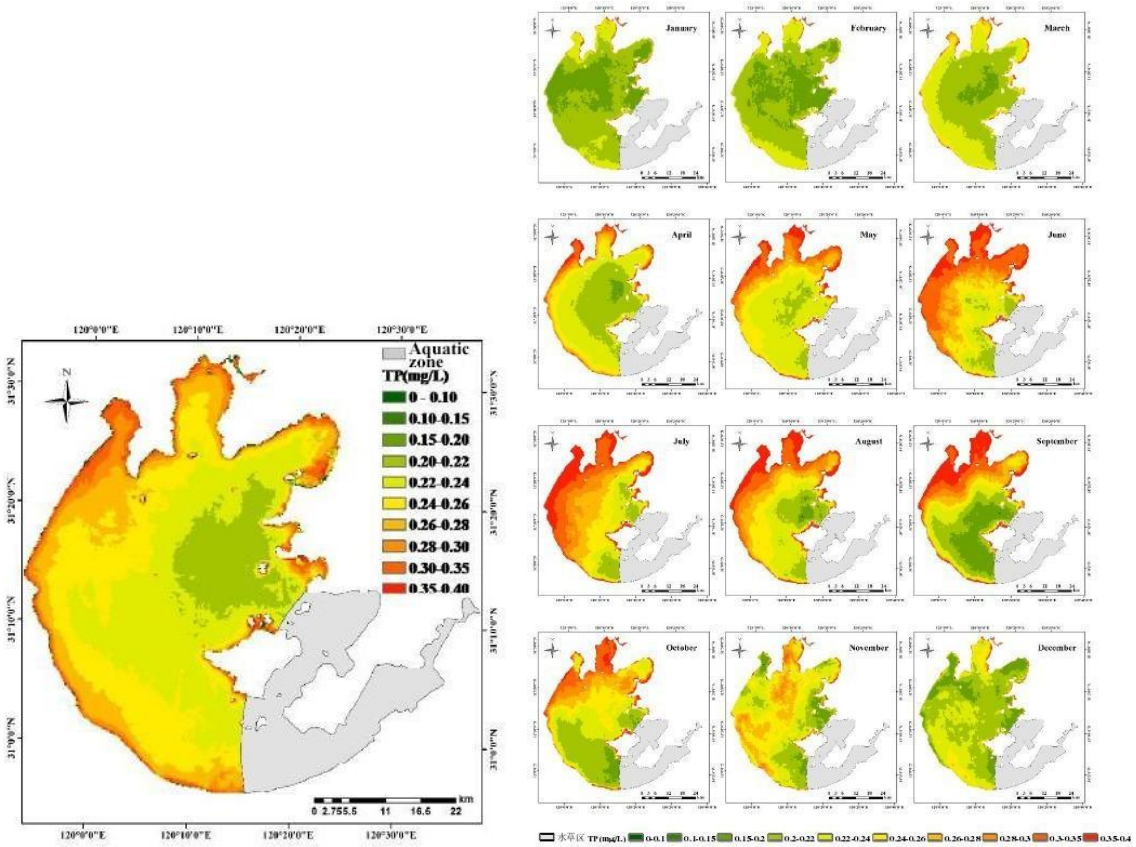


Fig 26 Inversion algorithm flow of hyperspectral data



Spatial distribution of total phosphorus concentration in Taihu Lake. The spatial difference of total phosphorus concentration was obvious, with the highest value of 0.38mg/L and the lowest value of 0.06mg/L.

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Monthly variation of total phosphorus concentration in different lakes.

The lake area also generally reaches its maximum phosphorus concentration between June and September. The total phosphorus concentration in Zhushan Bay, Meiliang Bay and the west bank of Taihu Lake was higher than the mean value of the whole lake from March to October of the year, and was significantly higher than that in the rest of Taihu Lake. The total phosphorus concentration in Gonghu Bay was higher than that in the whole lake only in June, and the total phosphorus concentration in the south bank of Taihu Lake and Great Taihu Lake was relatively low throughout the year.

The distribution of dissolved oxygen and chlorophyll concentration in Zhelin Bay, eastern Guangdong, taken by drone hyperspectral imager