OPTOSKY
Spectroscopy Solutions

DataSheet

# Rotary Scan SWIR Hyperspectral Imaging System

# ATH3010-17

## Features:

- Spectral Range: 900-1700nm
- Spectral Resolution: 3.5 nm
- High Sensitivity SWIR Hyperspectral Imager
- 13-megapixel visible light camera with integrated spectrum
- High-performance image sensor, high performance-to-price ratio
- Blue light and infrared lighting source, power adjustable
- Optical design with high imaging quality on the entire target surface, the spot diameter is less than 0.5 pixels
- The lens interface is standard C-Mount, and the lens exchangeable
- High-precision electric rotary table

## Description:

ATH3010-17 is a miniature hyperspectral imager with small size and light weight. ATH3010-17 is featured with high spatial resolution, high spectral resolution, and wide imaging range. ATH3010-17 has a built-in stable and blue-light source, and the power is adjustable, so there is no need for additional supplementary light sources.

ATH3010-17 consists of a hyperspectral imager and a fully automatic motorized rotary stage, in which the hyperspectral instrument is based on high-efficiency transmission grating technology and has good aberration characteristics.

ATH3010-17 can be installed on a tripod or a pole, and add automatic calibration devices, weather monitoring sensors, etc., so as to achieve long and large-scale scanning upon the target.

| Model | spectral channels | spatial channels |
|---|---|---|
| ATH3010-17-17 | 512 | 640 |
| ATH3010-17-17H | 1024 | 1280 |

## Application:

- Agriculture： Pest Monitoring, Nutrient Monitoring, Disaster Assessment, Crop Yield Estimation, etc.


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| N/A | Items | ATH3010-17 | ATH3010-17H |
|---|---|---|---|
| 1 | Spectral Range | 900-1700nm | 1000-1530nm (The band can be adjusted, with a total width of 530nm) |
| 2 | Spectral resolution | ≤4.3 nm | ≤3.5 nm |
| 3 | Sampling interval | 1.56 nm | 0.78 nm |
| 4 | F-number | F/2.6 | F/2.6 |
| 5 | Detector | InGaAs | Te-cooled InGaAs |
| 6 | Detector interface | USB3.0 | USB3.0 |
| 7 | Supply power | USB，10W | USB，25 W |
| 8 | Detector target size | 9.6mm x 7.68mm | 6.4 mm x 5.12mm |
| 9 | Detector raw resolution | 640 × 512 | 1280 × 1024 |
| 10 | Detector original pixel size | 15 μm x 15 μm | 5 μm x 5 μm |
| 11 | Bit depth | 12 bits | 12 bits |
| 12 | Slit width | 15 μm | 15 μm |
| 13 | Recommended way to merge cells | 1x2 | 1x2、1x4 |
| 14 | Spatial dimension effective number of pixels | 512 | 1024 |
| 15 | Number of spectral bands | 256 or 512 | 512 or 1024 |
| 16 | FOV | 15.2°@f=35 mm | 14.6°@f=35 mm |
| 17 | IFOV | 2 mrad@f=35 mm | 1.1 mrad@f=35 mm |
| 18 | Max frame rate | 240 fps | 66 fps |
| 19 | Size | 306 mm x 300 mm x 162mm | 306 mm x 300 mm x 162mm |
| 20 | Weight | < 5.8 Kg | < 7.5 Kg |
| 21 | Operating Temp | -10 - 50°C | -10 - 50°C |
| 22 | Storage Temp | -30-70°C | -30-70°C |
| 23 | Max. Spectral channel | ≥512 | ≥1024 |
| 24 | Max.Spatial channel | ≥640 | ≥1280 |
| 26 | Scanning | External push-broom measurement | |
| 27 | Data acquisition software | Flexible setting of exposure time, dynamic display of real-time hyperspectral images and spectral curves | |
| 28 | 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 can be obtained with one click without third-party software. All the | |




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| | | |
|---|---|---|
| | | above functions can realize intelligent batch processing |
| 29 | Software display | Dynamic real-time display of hyperspectral images, scientific light-dark focusing, avoiding manual visualization focusing errors |
| 30 | Communication interface | USB3.0 |
| 31 | Light source | • High stability constant power blue light surface light source<br>• The high-stability constant-power blue-light linear light source compresses and stretches the point light source through the optical lens group to improve energy utilization. |
| 32 | Line light source length (Optional) | ≥220mm@400mm |
| 33 | Line light source width (Optional) | ≤30mm@400mm |
| 34 | Lifespan (Optional) | ≥2000h |

# 1. ATH3010-17 Image






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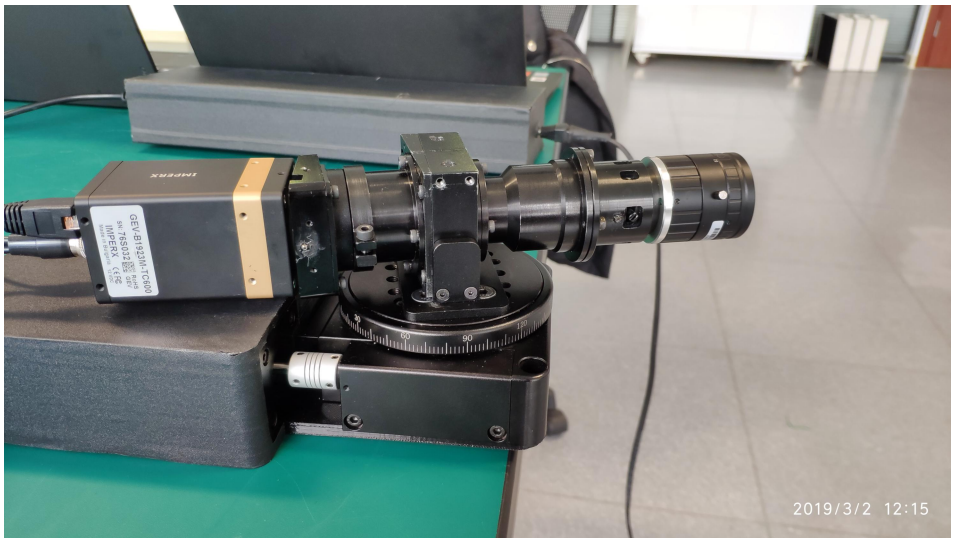
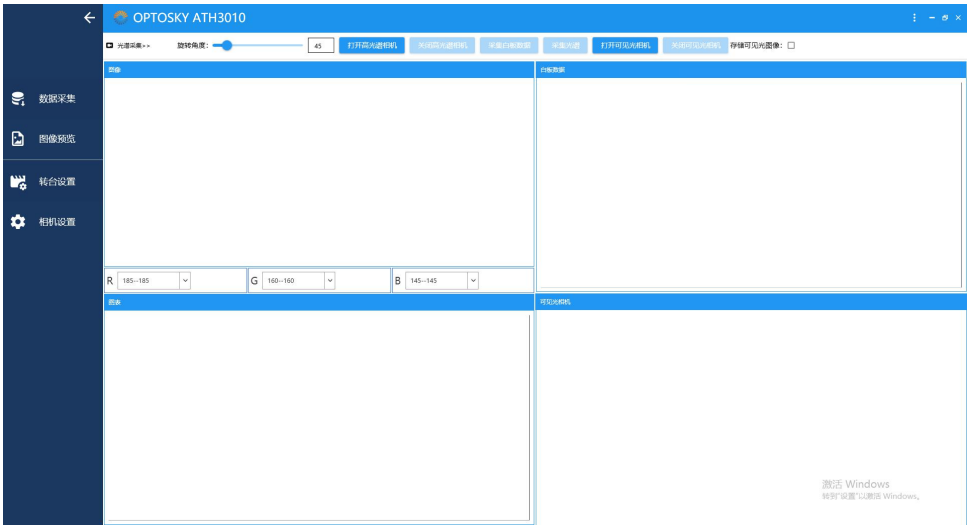



Last Generation of Rotary Scanning Imaging Spectrometers




ATH3010-17 software interface

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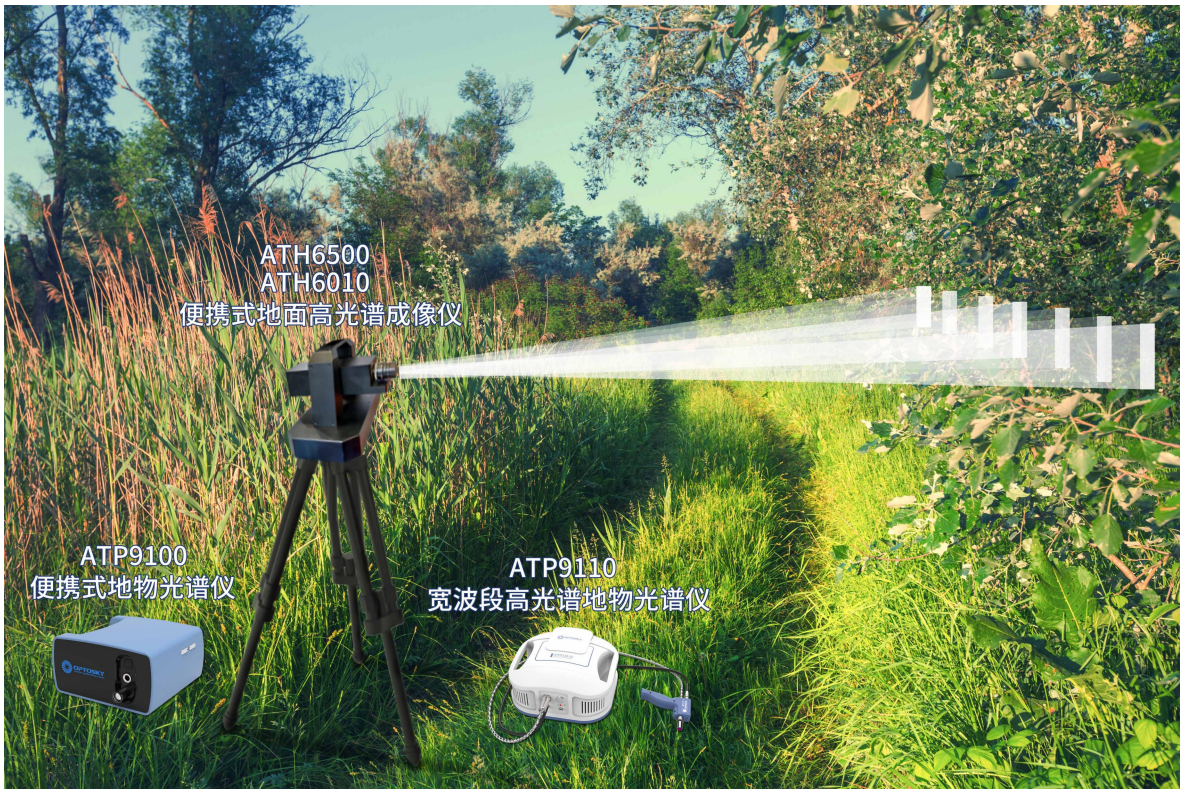
# 2. Application Scenarios




Hyperspectral imager and Field spectrometer


ATH3010-17OL Field Online Continuous Hyperspectral Observation System

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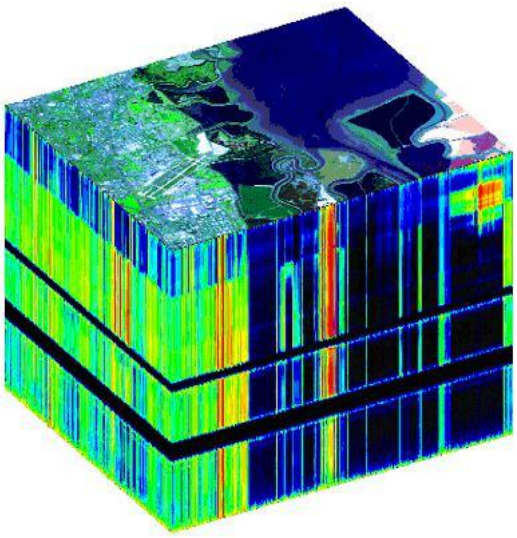
# 3. Application



Data cube captured

Drone experiment

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Outdoor experiment scene Ⅰ

Outdoor experiment scene Ⅱ

Outdoor experiment scene Ⅲ




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Outdoor experiment scene Ⅳ

Outdoor experiment scene Ⅴ




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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).

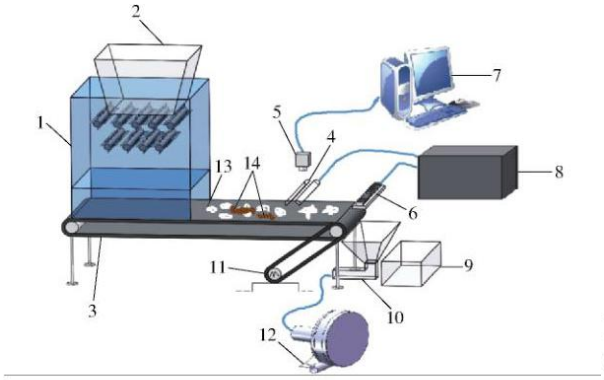
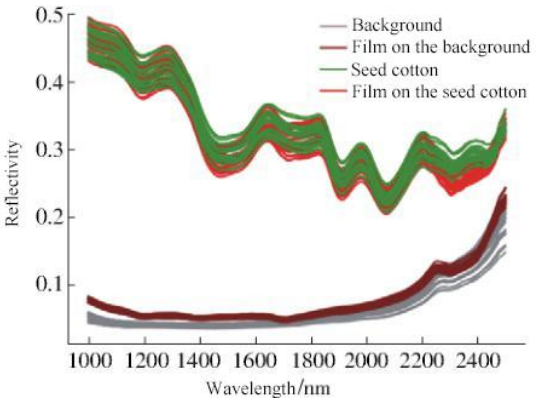



Fig. 2 Schematic of film sorting system of seed cotton

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

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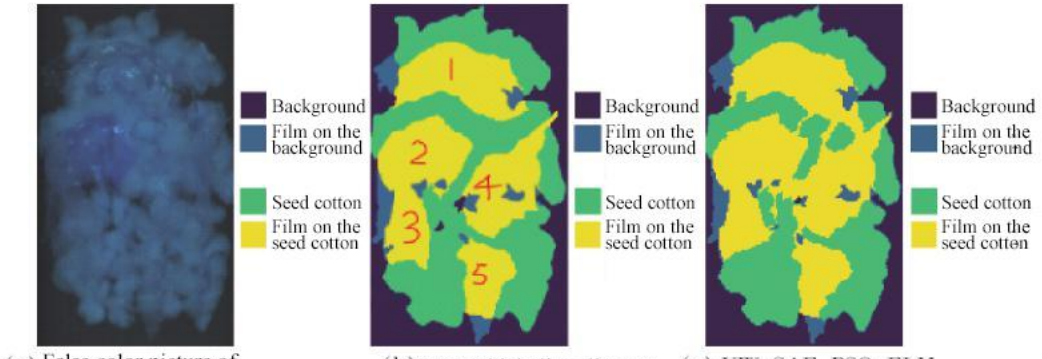
Cotton seed sorting; (a) System functional composition; (b) reflectance spectrogram of different substances




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

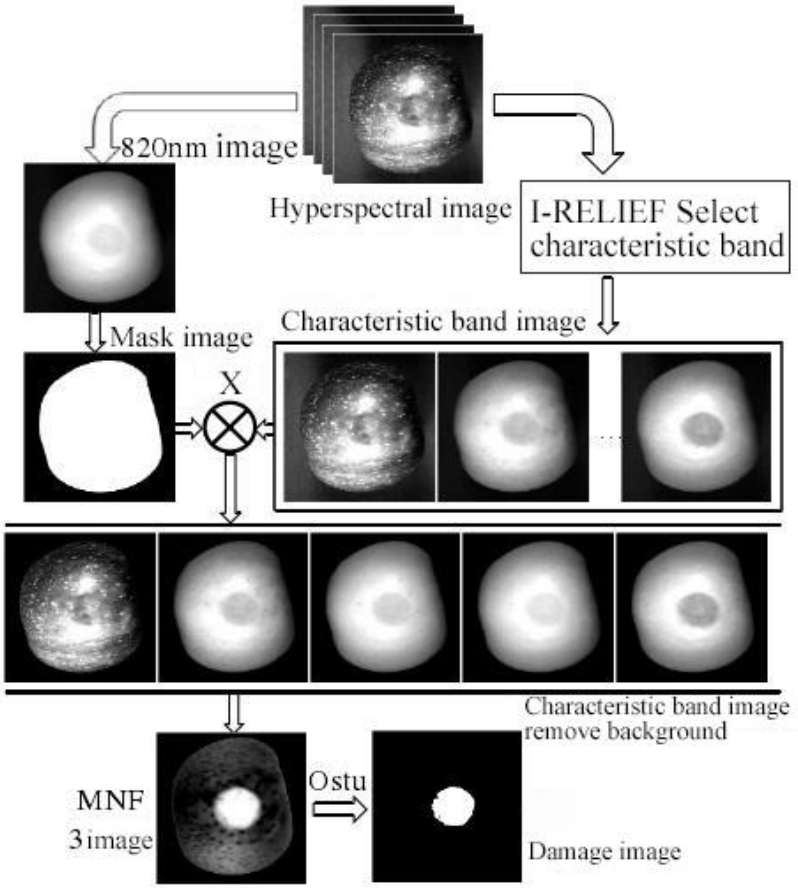
Cotton seed sorting application; (a) Artificial marking; (b) Recognition result

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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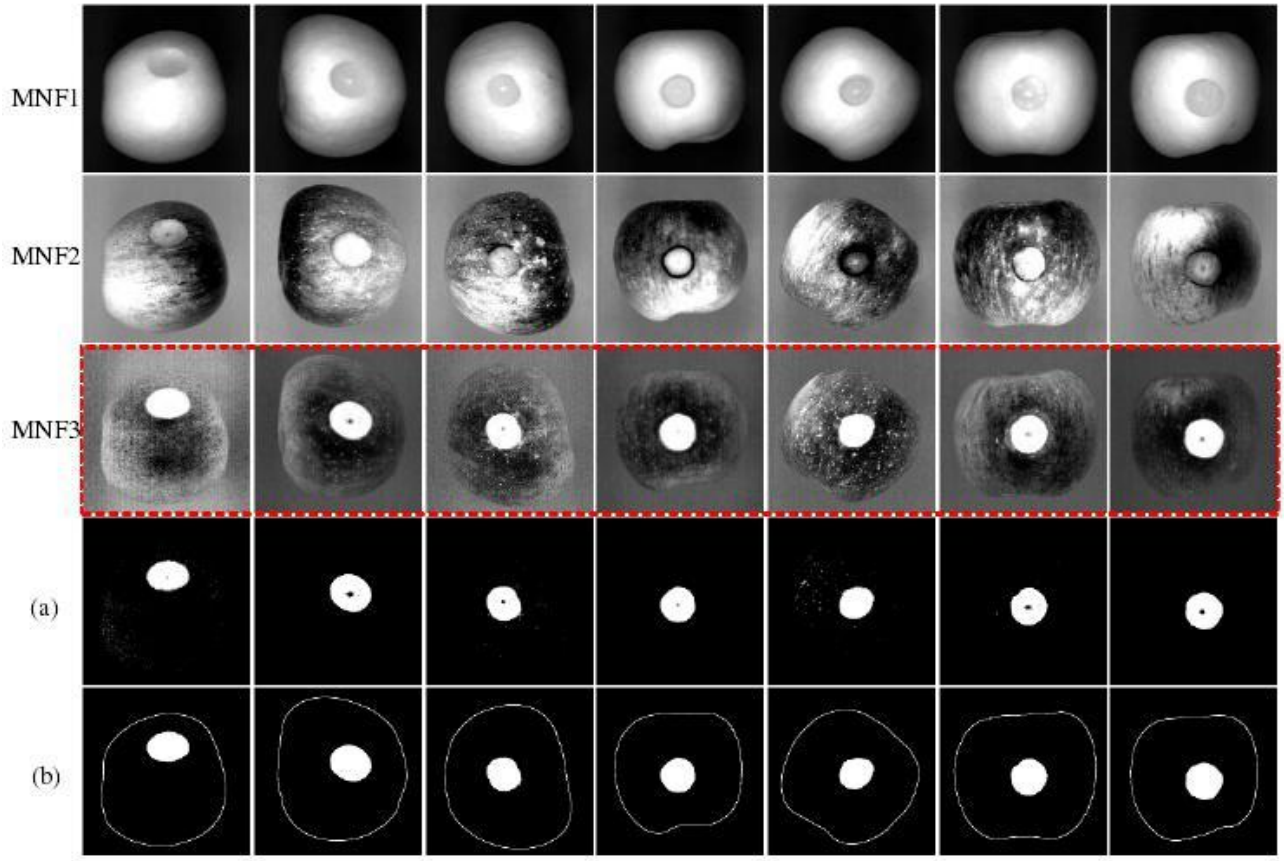
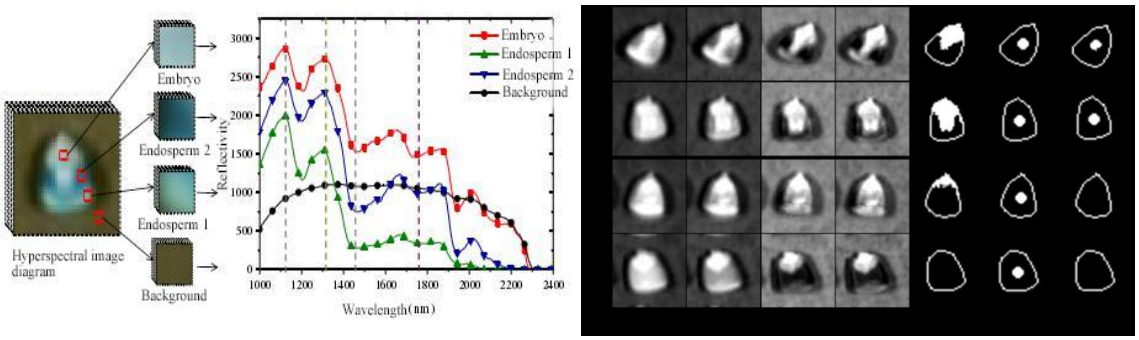
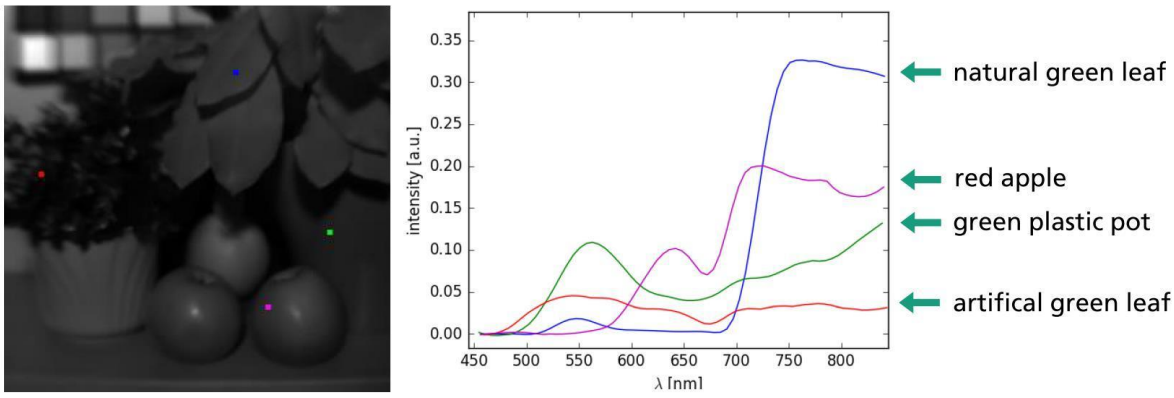
Flow chart of early damage detection algorithm for apple surface




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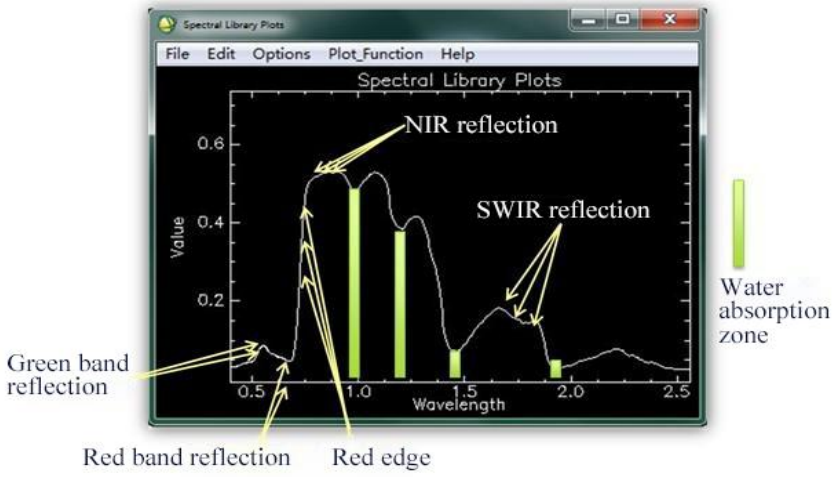
The spectrum of natural green plants, artificial green leaves, green plastic, and red apples

## 1.2 Agriculture growth monitoring

Drone hyperspectral imaging camera, developed and designed by Optosky




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.

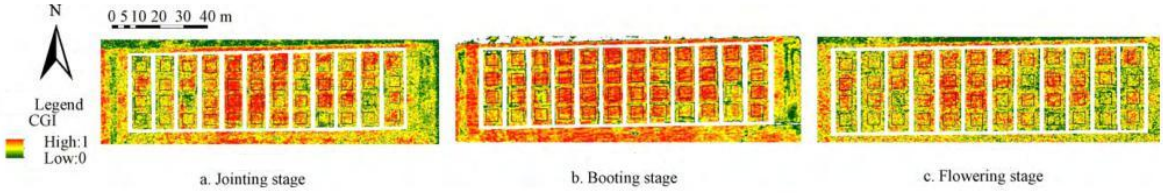


Figure 18 CGI inversion of wheat growth index

## 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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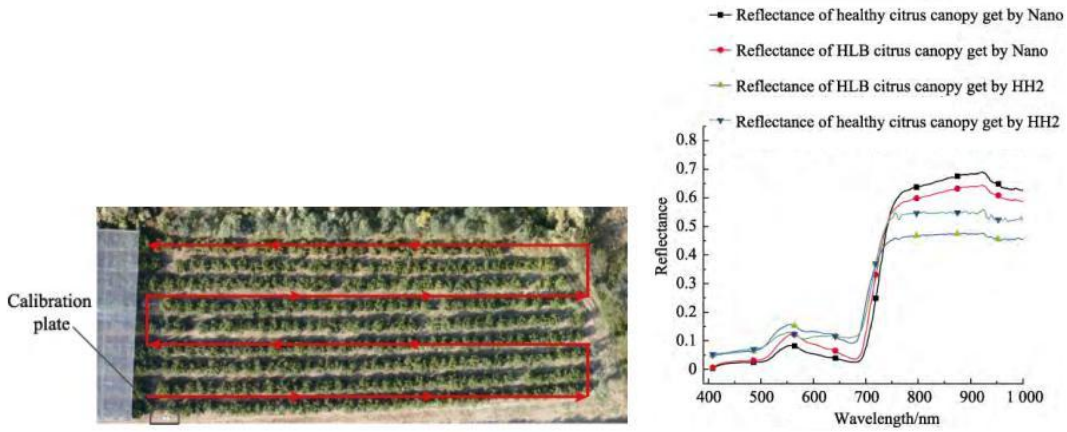
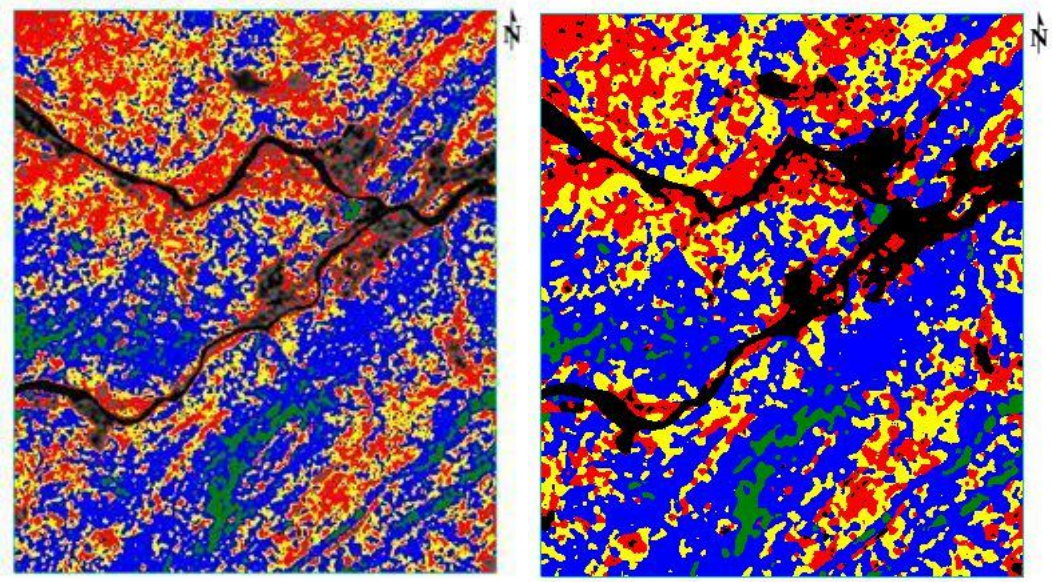
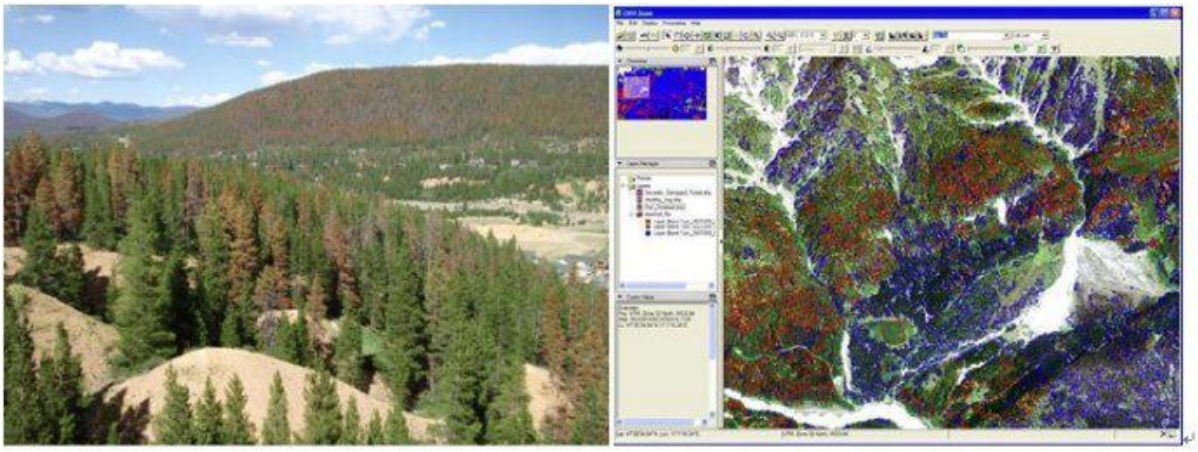



Monitoring and classification of citrus yellow dragon disease plants by hyperspectral imaging camera (designed by Lan Yubin et al., South China Agricultural University)




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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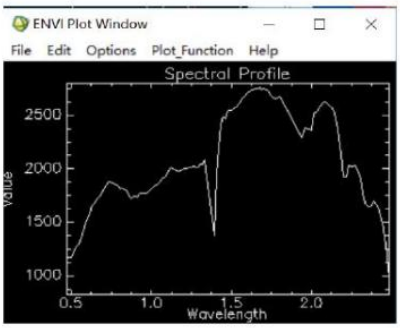
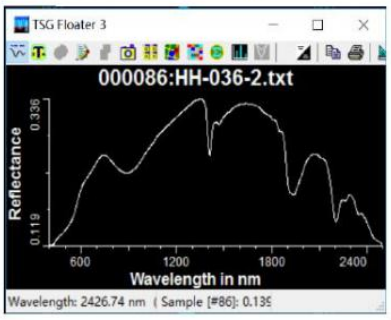
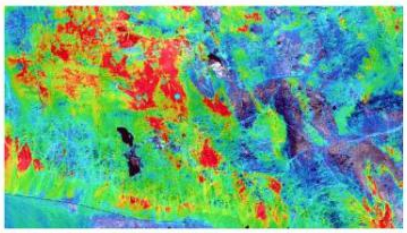


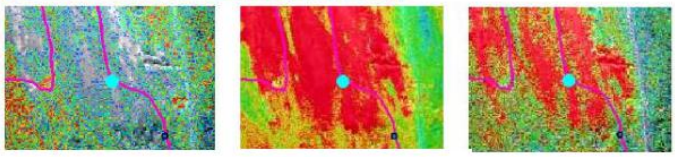

HH036 point image spectrum




HH036 point measurede spectrum

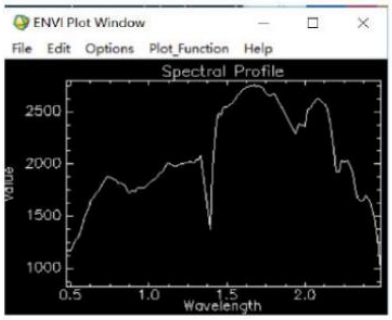


Sericite Filling Results Comparison of known deposit points between HH036 and measured

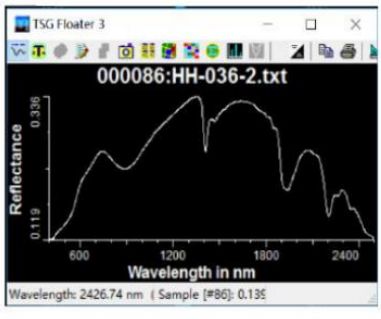


Chlorite extraction results | Sericite extraction results | Feb3+ extraction result

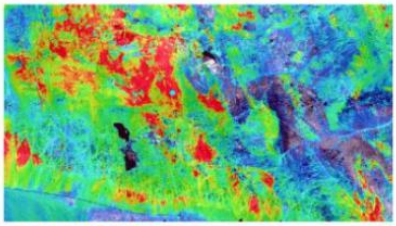
Sampling point photos | Long-range photos of sampling points



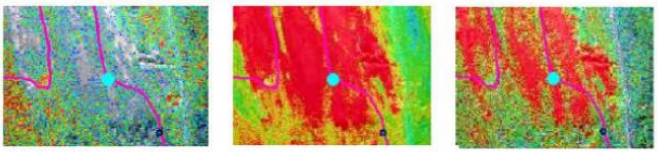

HH052 point image spectrum




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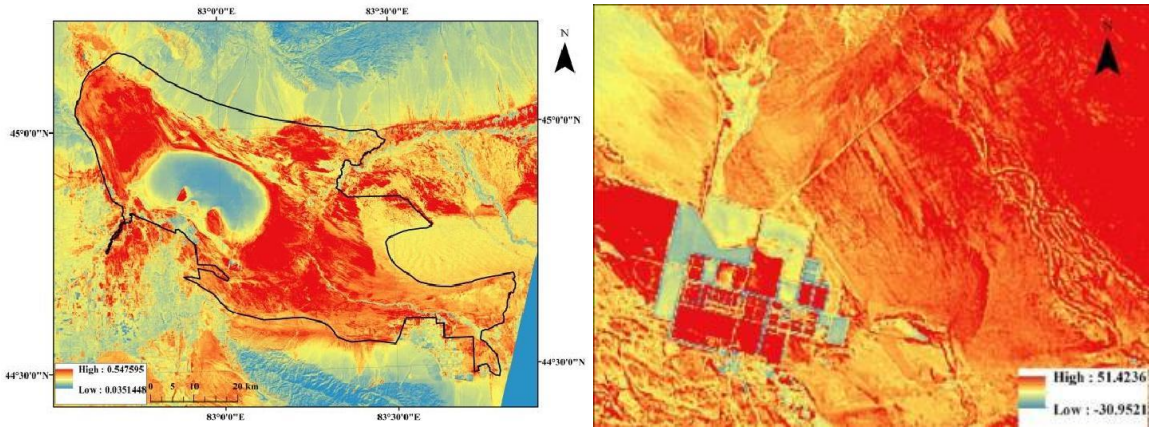
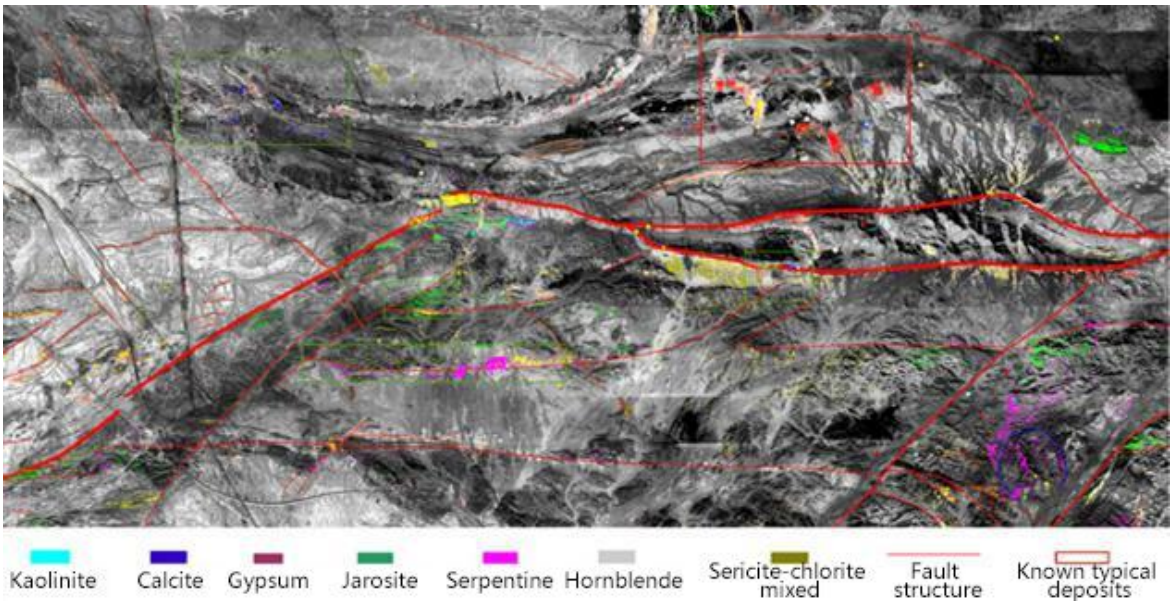
strategic situation of sustainable development in China at present, hyperspectral imaging system, featuring large scale, wide range, effective and economical, provides a new way for quantitative monitoring of soil salinization phenomenon.




The surrounding area of a salt field




## 1.5 Public Safety Application

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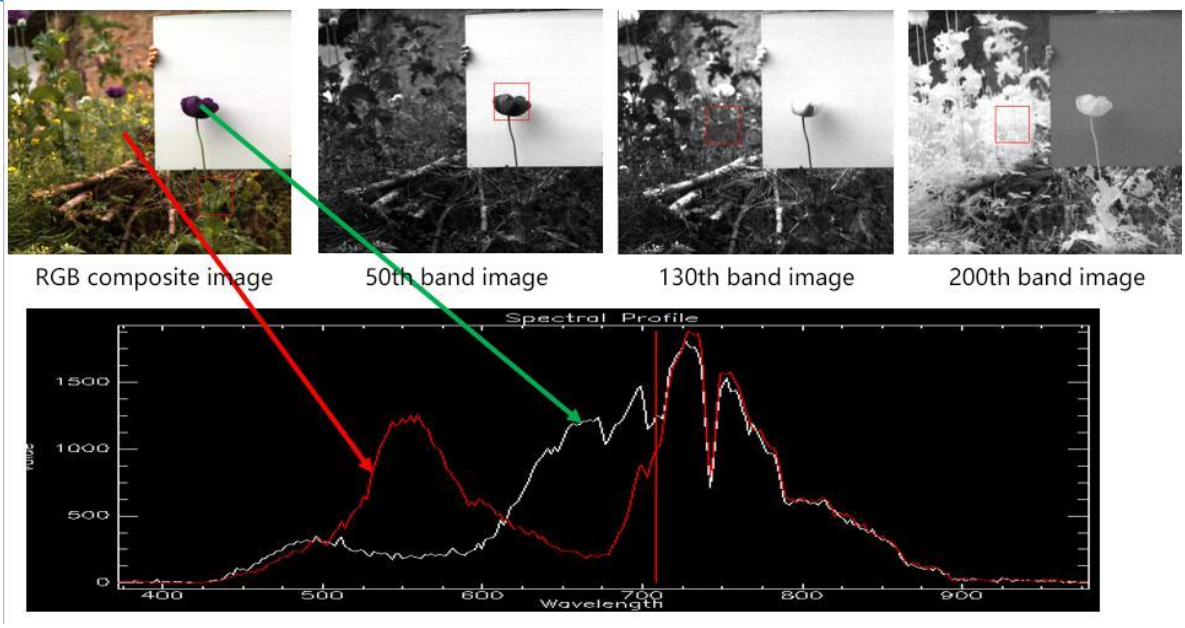
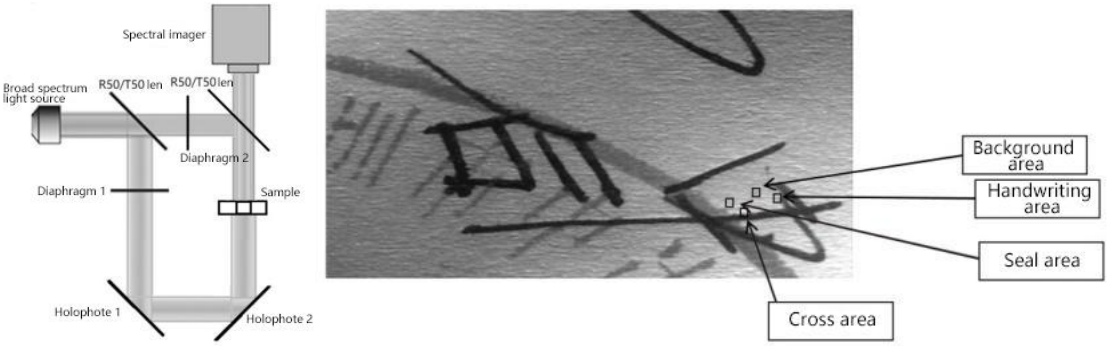



Monitoring illegal poppy cultivation by hyperspectral imager




Document inspection application

## 1.6 Medical Microscopic Imaging Application

Objective: online detection and navigation positioning during tumor surgery

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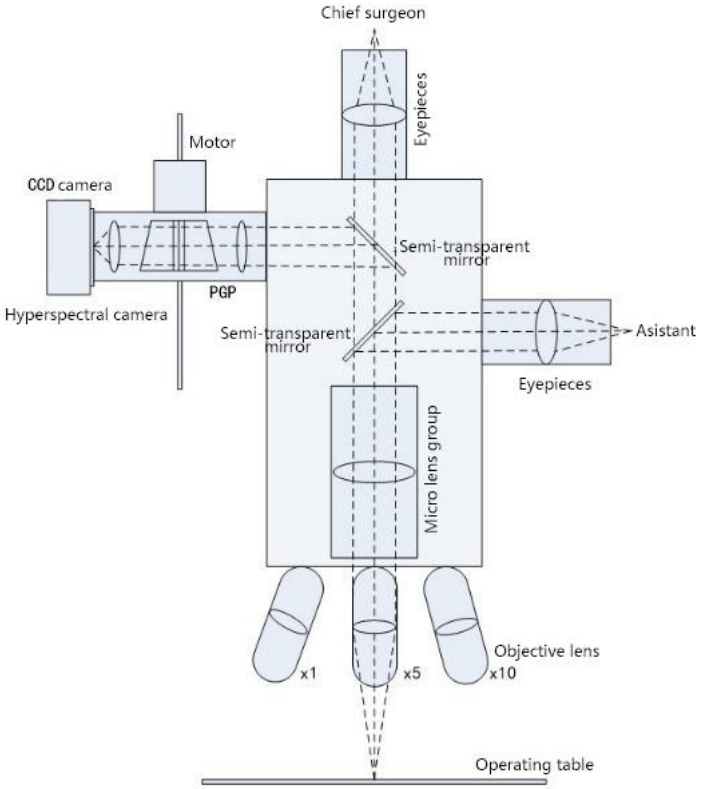
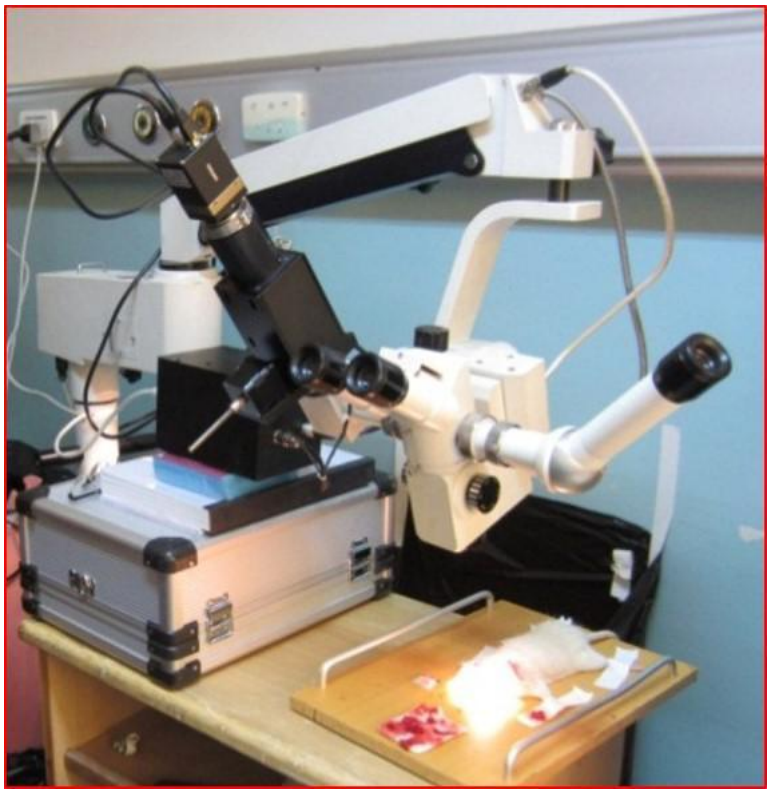



Medical microscope imager optical path schematic diagram



Medical microscope imager figure

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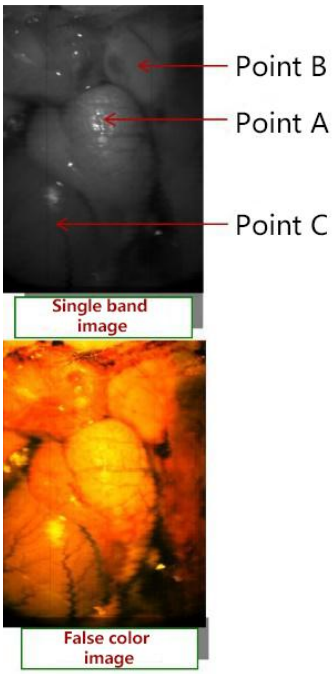
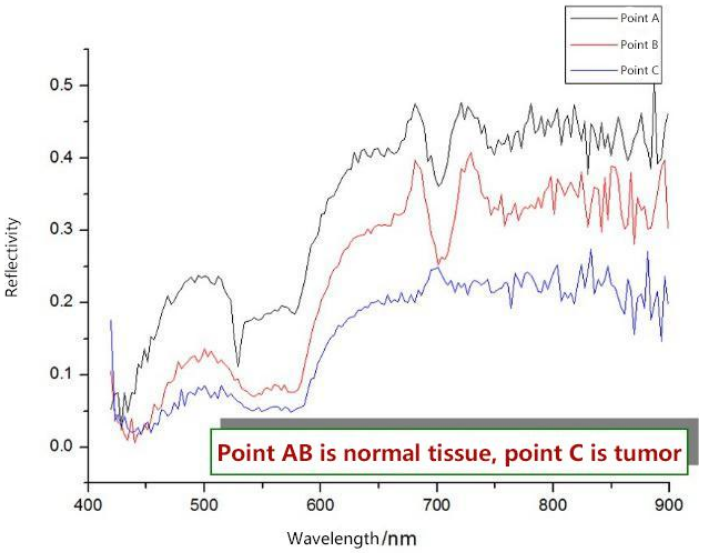



Data collect by medical microscopic imager

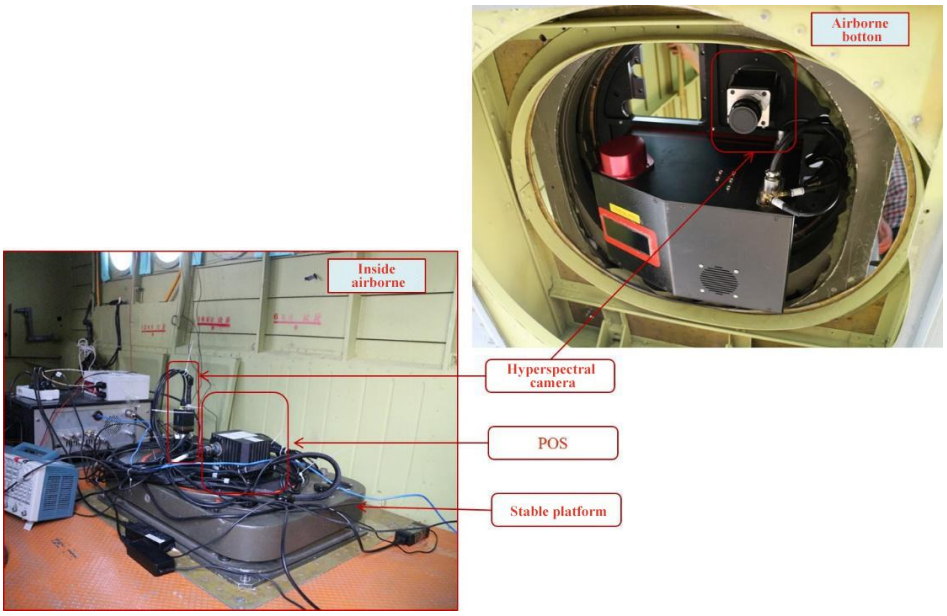
## 1.7 Drone Hyperspectral Imager

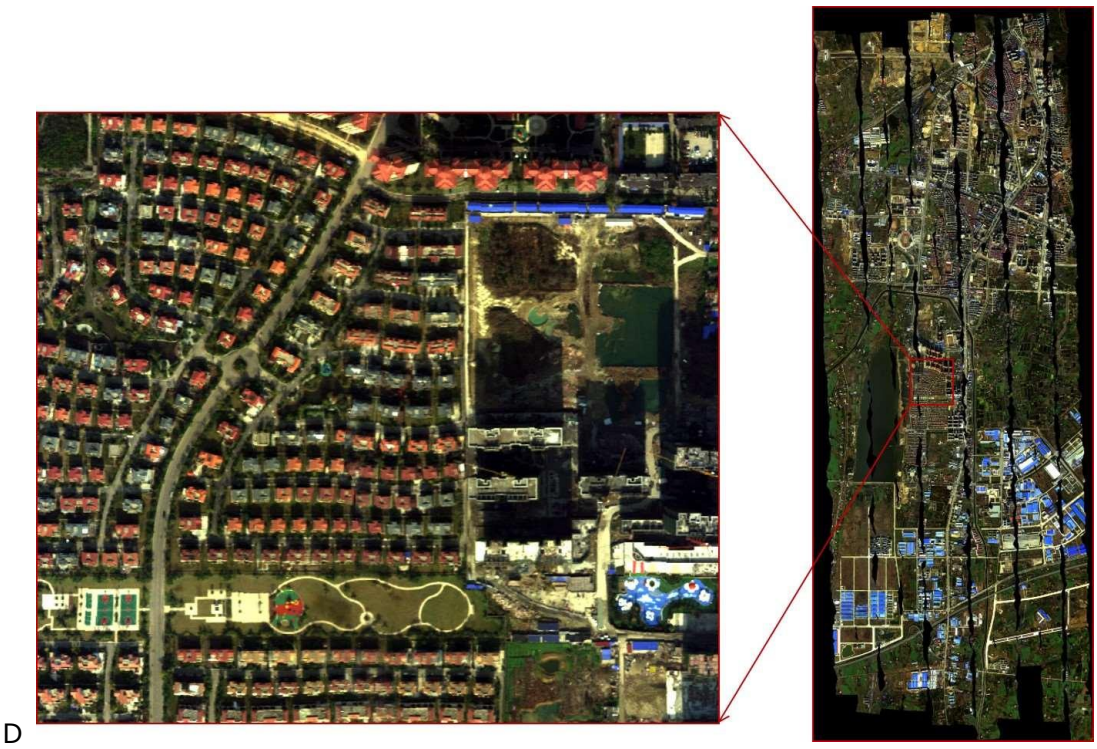
### 1.8 Optosky Drone Hyperspectral Imager




Floor 22th, Creative Bld., 1300 Jimei Ave, Jimei, Xiamen, 361005, China
Tel: +86-592-6102588

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



D

Drone Hyperspectral Imager pseudo color image

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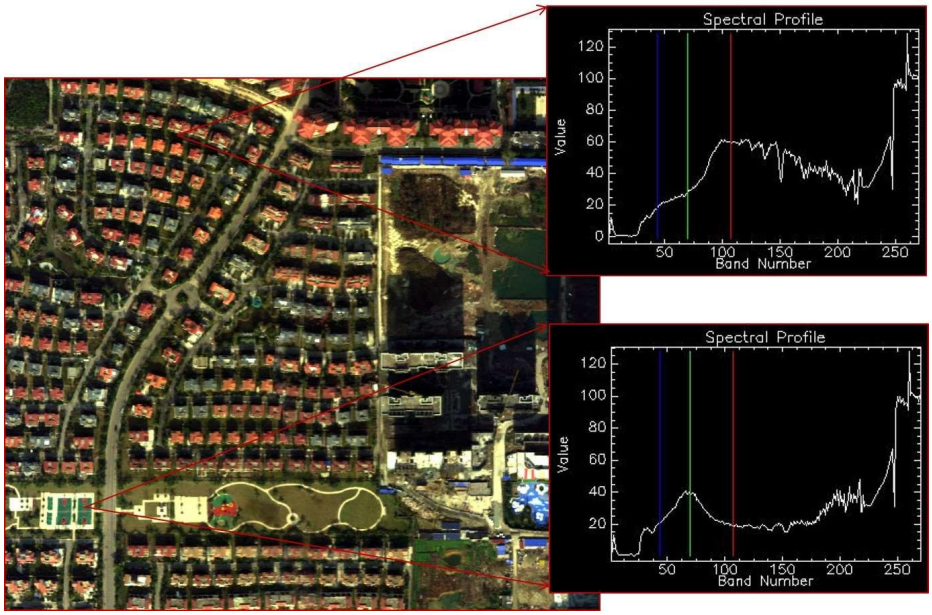
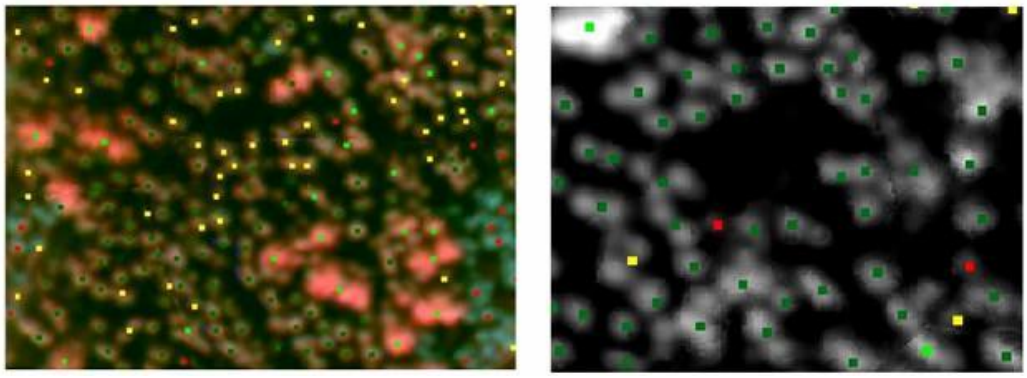



Drone Hyperspectral Imager data-spectral curve



Drone Hyperspectral Imager monitors forest disease and pest

## 1.9 Water Quality and Environmental monitoring

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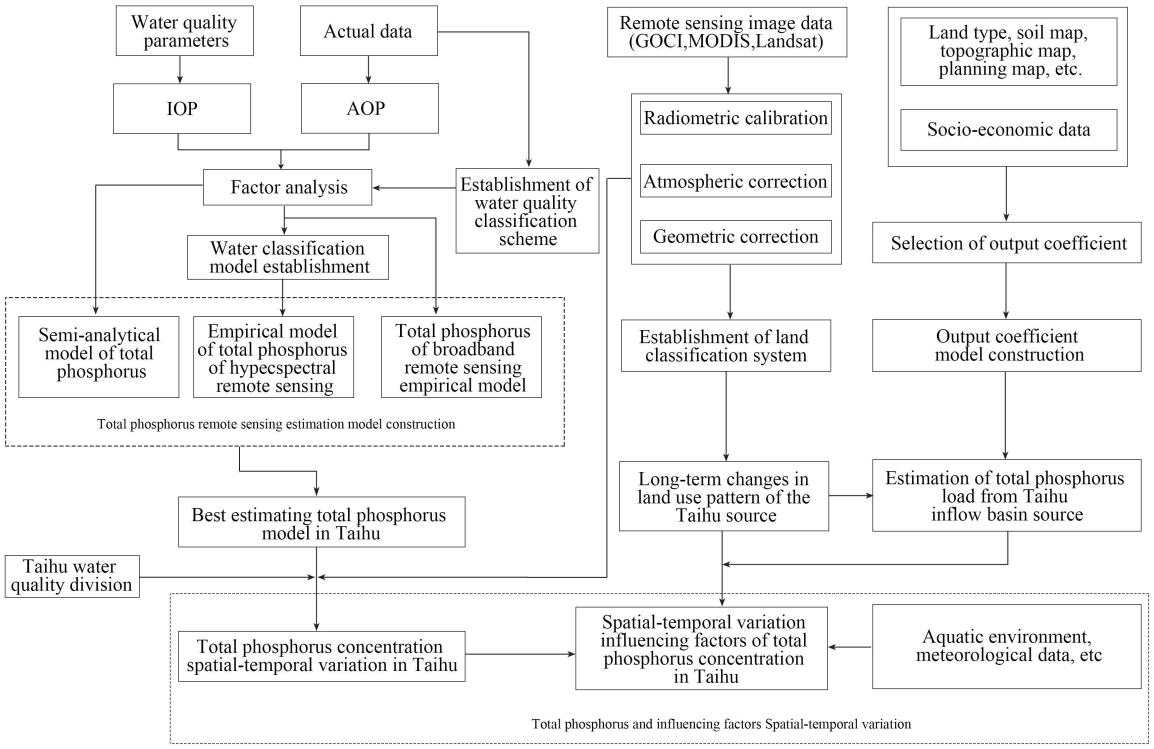
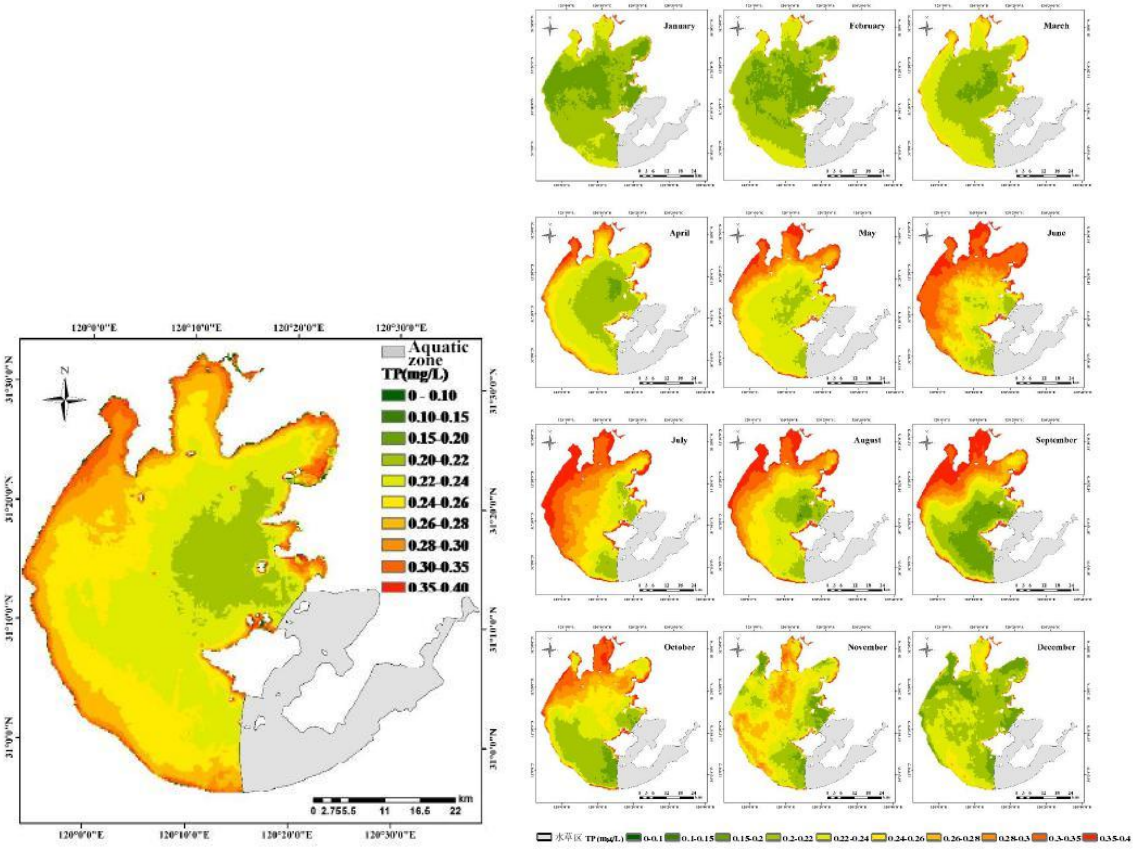



Inversion algorithm flow of hyperspectral data




(a) Spatial distribution of total phosphorus concentration in Taihu Lake. The spatial difference of total phosphorus concentration was obvious, with the highest value of

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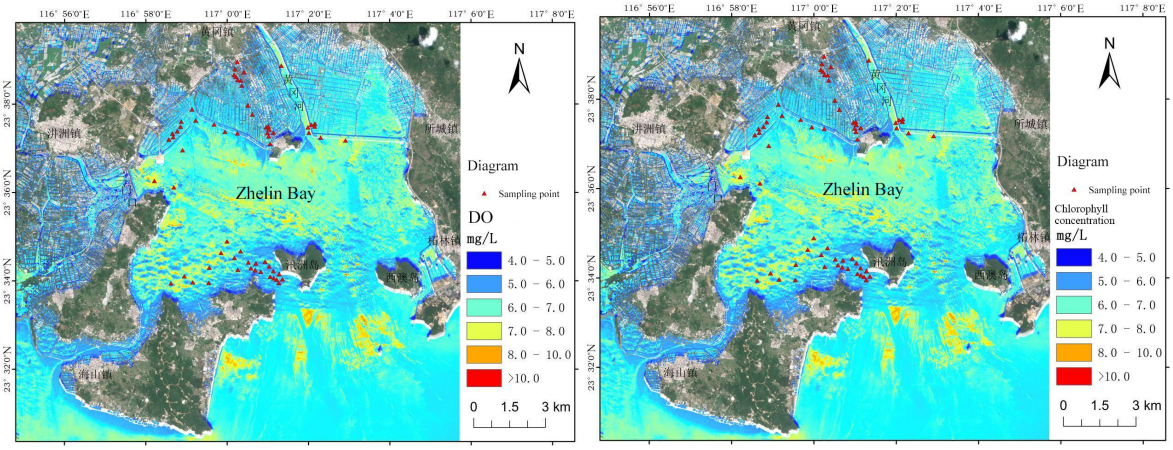
Tel: +86-592-6102588

0.38mg/L and the lowest value of 0.06mg/L. (b) 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

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