

Built-In Push-Broom Portable Hyperspectral Imaging System

ATH6100

Features

- Built-in push-broom structure
- Built-in large-capacity lithium battery, can work in the field
- Max. Spectral range 400-2500nm
- High spectral resolution $\leq 1.3\text{nm}$
- FOV: $23.5^\circ @ f=25\text{mm}$
- Auto focus system (optional)
- Built-in high-resolution visible light camera
- Can be controlled by mobile phones, iPads, laptops and other devices
- Spatiotemporal radiometric intensity correction technology, significantly improving radiometric calibration accuracy
- Linear light-source design matching linear field-of-view to maximize light energy utilization efficiency
- Automatic integration-time recommendation: exposure time suggested according to sample reflectance

Application

- Scanning and restoration of cultural relics, restoration of murals
- Digitization of Calligraphy and Painting
- Textiles: copying of patterns, reproduction of pictures
- Forensic Identification: Document Examination
- Mineral Screening
- Agriculture: Leaf, Tobacco Leaf Scanning
- Research institutions and universities

Description

ATH6100 is a series of ultra-portable hyperspectral imagers independently developed by Optosky with proprietary intellectual property rights, covering the visible to short-wave infrared spectral range. Featuring a built-in scanning mechanism, the ATH6100 enables hyperspectral scanning of targets without large-angle camera rotation. It integrates a lithium-ion battery and CPU, with an optional auto-focus system, and delivers high-resolution, high-quality imaging performance.

ATH6100 can be controlled by terminals including smartphones, iPads and laptops to perform real-time image acquisition, scanning, calibration and result output. While capturing target images, it also obtains spectral data of hundreds to thousands of bands to achieve integrated image-spectrum functionality. Equipped with a high-resolution CCD sensor, the ATH6100 delivers sharp imaging with low noise. It is especially suitable for scanning large-size flat samples such as murals, calligraphy-paintings and textiles.

Lightweight and versatile, the ATH6100 offers excellent battery life and intelligent operation with comprehensive data-processing capabilities. It supports real-time monitoring, calibration and inversion-result output, and fits a wide range of field and laboratory applications. Combining hyperspectral imaging with high-definition photography, the ATH6100 generates datasets with both high spectral and high spatial resolution, enabling full exploration of material-specific spectral and spatial features.



Figure 1 ATH6100 photo

1. Selection Guide

Items	Specification
ATH6100	400-1000nm Spectral Range
ATH6100-17	900-1700nm Spectral Range
ATH6100-25	1200-2500nm Spectral Range
ATH6100-4-17	400-1700nm Spectral Range

2. Technical Parameters

No.	Specification	ATH6100	ATH6100-17	ATH6100-25	ATH6100-4-17
1	Spectral Range	400~1000nm	900~1700nm	1000~2500nm	400~1700nm
2	Spectral Resolution	<1.3nm	<5.5nm	<8nm	Visible: <1.3nm SWIR: < 5.5nm
3	Max. Spatial Channels	1200	512	512	1200
4	Max. Spectral Channels	1920	640	640	2560

Product data information is current as of publication data. Products conform to specifications per the terms of Optosky Standard warranty.

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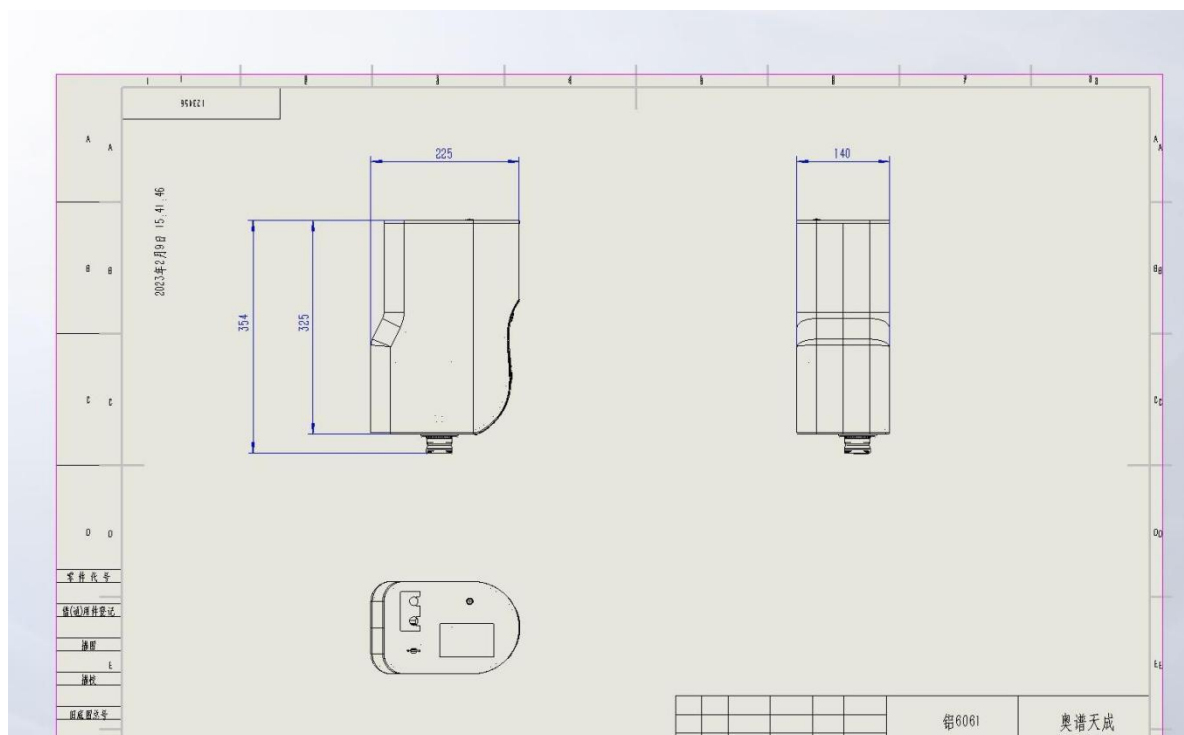
5	Dynamic Range	12bit	16bit	16bit	Visible: 12bit SWIR: 16bit
6	Imaging Lens ^{*1}	Manual Focus (Autofocus Optional)	Infrared Enhanced Lens (Autofocus Optional)	Infrared Enhanced Lens (Autofocus Optional)	Infrared Enhanced Lens (Autofocus Optional)
7	Battery Life	>3h	>2.5h	>2.5h	>2.5h
8	Data Interface	USB3.0			
9	Power Supply	24VDC, 5A			
10	Visible Light Camera Resolution	>8,000,000 pixels			

Note:

*1: The imaging lens is standard with a focal length of 3.5mm, and other focal length lenses are optional;

*2: This product is independently developed by Optosky. The parameters in the table are for reference only, and other parameters can be customized.

3. Product Photos and Dimension Drawing



4. Accessories

No.	Standard	Number
1	USB Drive	1
2	Tripod	1
3	Charging adapter 25V/1.5A	1
4	USB 3.0 to Type-C Data Cable	1
5	USB-B Data Cable	2
6	95% Reflectance Standard	1
7	Halogen Lamp	2
8	User Manual	1
9	Test Report	1
10	Product Certificate	1
11	Warranty Card	1

5. Application Cases of Hyperspectral Camera

5.1 Restoration And Improvement of ancient calligraphy, paintings

As an important cultural heritage of Chinese art and culture, ancient paintings are affected by factors such as natural environments and improper preservation during long-term storage, resulting in stains including mold, water stains, smoke stains, fly feces, oil stains, etc. These stains obscure the information expression of the paintings and reduce the artistic expressiveness of the calligraphy and paintings, thereby affecting their appreciation or collection value. For the removal of stains in paintings, traditional restoration methods mainly include physical and chemical approaches. Physical methods primarily use water cleaning or gentle scraping with a scalpel, which can effectively remove fly feces or mold. The removal of oil stains mainly relies on chemical reagents such as acetone, ether, and potassium permanganate for oxidation and dissolution, which can cause the paper or silk to become brittle or even pulverized, resulting in significant damage to the cultural relics. However, the presence of oil stains obscures the information expression of the paintings and reduces the artistic expressiveness of the calligraphy and paintings. How to effectively extract the hidden information obscured by stains in the paintings without damaging the physical material of the ancient paintings, and to restore and present the original appearance of the paintings as much as possible, has become a difficult problem to solve. In recent years, hyperspectral technology, with its advantages of non-destructive testing, high spectral resolution, and wide spectral range, has been gradually applied to the field of cultural heritage conservation. The high spectral resolution enables fine discrimination, and a series of studies on pigment identification and analysis have been conducted, achieving certain research progress. In addition, the wide spectral range enhances the detection capability for blurred information in cultural relics.

The ground color of the painting *On the Dao* has turned dark yellow due to the long-term aging of the Xuan paper. The entire work is outlined with ink lines to depict mountain and stone scenery and human figures. Since the color of the lines and the background color are not significantly different, the human eye's ability to distinguish the painting and to discern and read the image information is reduced. Through image processing, it

was found that the grayscale image of the MNF 2nd band highlights the ink line information in the painting, lightens the color of the paper, and improves the resolution of the script, making it easier to identify. The effect comparison before and after processing is shown in the figure. (Excerpted from: Wu Wangting et al., Research on Information Extraction of a Qing Dynasty Painting Based on Hyperspectral Technology, Sciences of Conservation and Archaeology, Vol. 29, No. 4, August 2017)

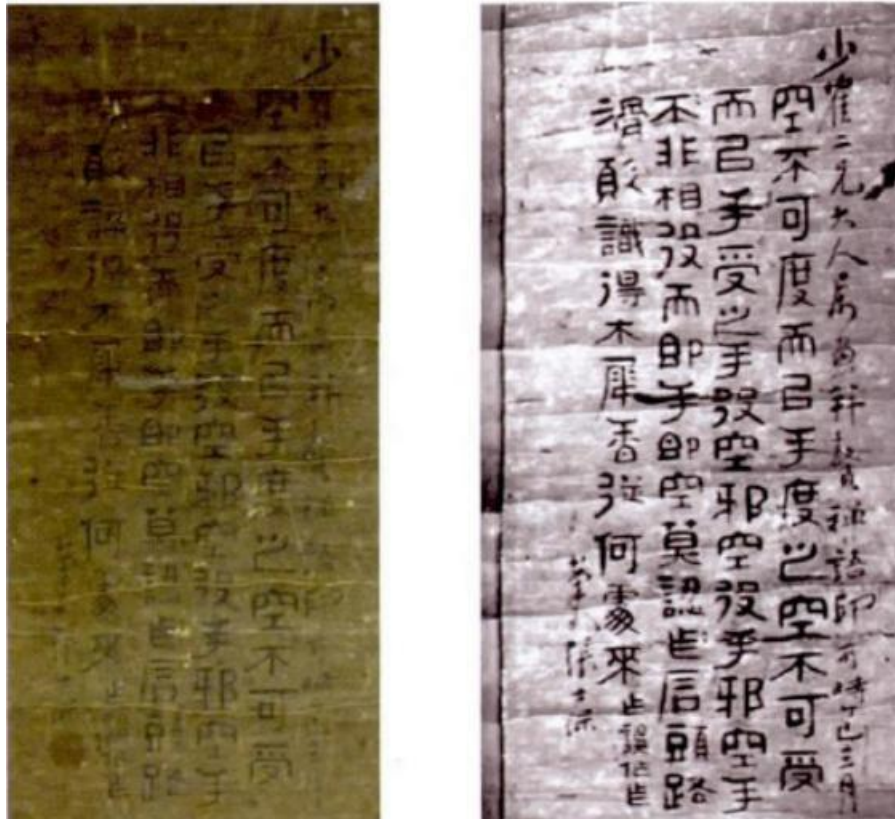


Figure 1 text part image and MNF-Band2 enhancement effect.

There are two seals in the painting On the Dao that are completely illegible (Fig. 5), and their contents can no longer be identified by the naked eye. In contrast, the seal at the lower right corner is relatively clearer, with its outline and contents clearly visible. Image enhancement methods were respectively applied to these two seals to provide a certain reference for their restoration.



Fig. 2 Digital images of the two seals: the center shows the original images of the seals, and the right side shows the seal images after hyperspectral processing.



Figure 3 is the image of the person after hyperspectral enhancement, the left is the original image, and the right is the image after hyperspectral processing.



Figure 4 shows a person image enhanced with hyperspectral technology, with the original image on the left and the hyperspectral processed image on the right.

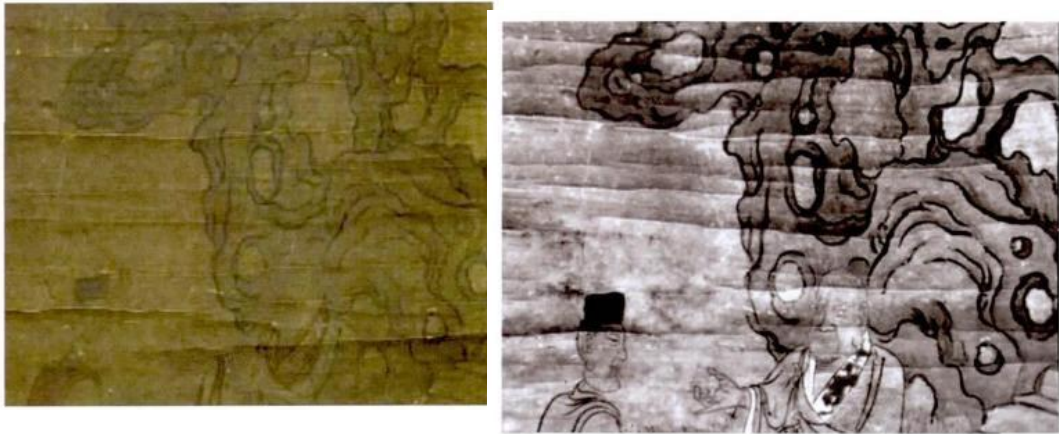


Figure 5 is the image of the rockery enhanced by hyperspectral, the left is the original image, and the right is the image after hyperspectral processing.

To address the scientific challenges of restoring oil-damaged areas in ancient paintings, this paper proposes a virtual restoration method for oil stains on ancient paintings based on hyperspectral image classification and linear regression. This method mainly deals with the true color pixel values in the stained areas. First, various linear regression equations are established, using the bands less affected by the stains to correct the true color display bands that are more affected. This way, the pigments under the stains can be shown in the true color bands, improving the appreciation and artistic value of the ancient paintings, while avoiding damage to precious artifacts from chemical methods. (Note: Zhou Pingping, Virtual Restoration of Oil Stains in Ancient Paintings Based on Hyperspectral Image Classification and Linear Regression, Geoinformation World, Vol. 24, No. 3, June 2017)

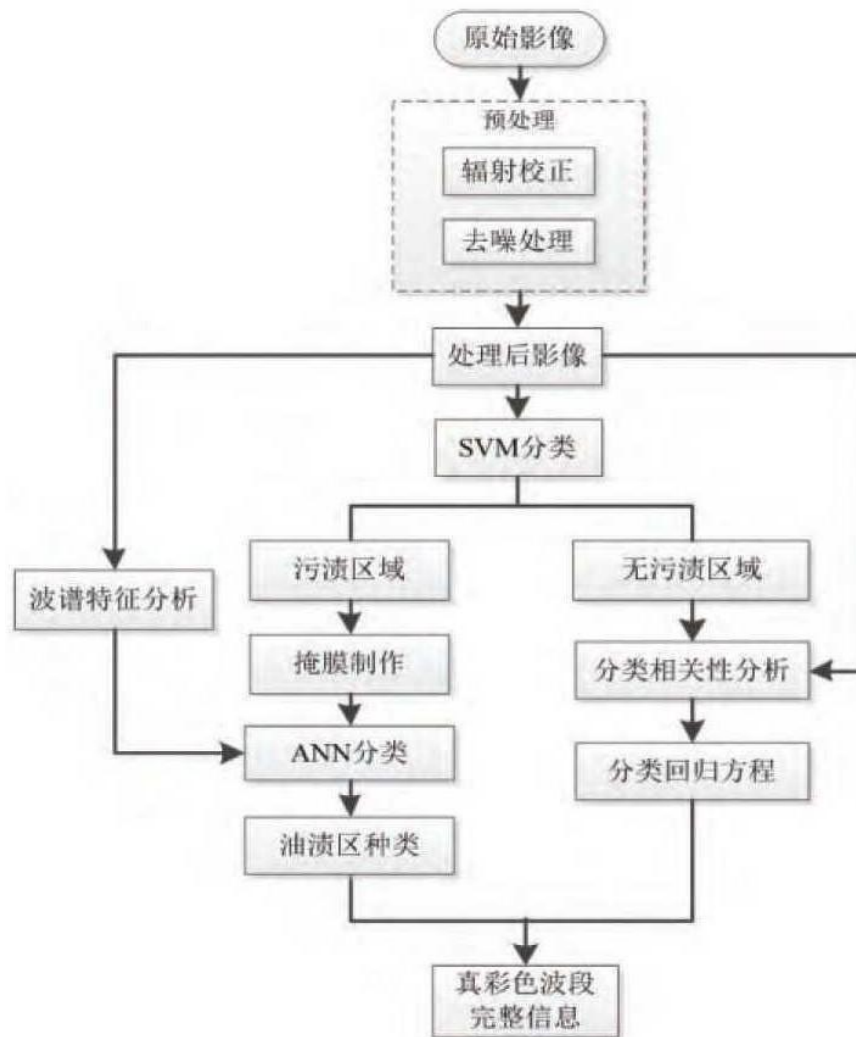
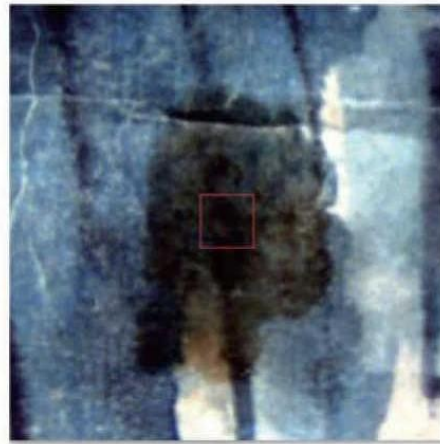


Figure 6 Flowchart of Virtual Restoration of Ancient Paintings Based on Classification Linear Regression

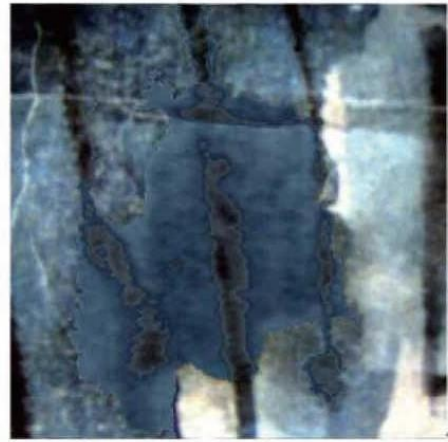
Compared to the original image, the restored image reveals the paint information that was hidden under the stains. The black pigment details in the image are clearly visible, and the leaf vein patterns are well presented. The classification regression processing, which considers the relationship of different substances across various bands, makes the color restoration effect more noticeable, as shown in Figure b. This color restoration effect is even more apparent when looking at the entire painting, as shown in Figure d. Comparing the original image of the stain-damaged artwork in Figure c with the restored image from classification regression in Figure d.

It is obvious that the hidden information under the stains was extracted and displayed, while the color of the stained areas was also well restored. Overall, using classification regression can effectively eliminate the

impact of stains on paintings and calligraphy.



a 原始影像



b 分类回归处理结果



c 原始影像真彩色显示



d 修复后影像真彩色显示

Figure 7: Ancient oil painting restored using hyperspectral imaging

5.2 Application of Drone Hyperspectral Imaging in River Water Quality Inspection

Based on years of professional hyperspectral knowledge and products, AspTek has launched the ATH9010W drone rapid river water quality inspection system. This system consists of a hyperspectral imager mounted on a drone, a wireless data transmission system, a Beidou positioning system, a hyperspectral intelligent big data analysis system, and its supporting equipment.



Figure 8 UAV Rapid River Water Quality Inspection System ATH9010W

This system can inspect 3-5 kilometers of a river in approximately 15 minutes, producing a distribution map of river pollution. Relevant management departments only need to send personnel to areas with higher suspicion of pollution to take water samples for on-site testing, eliminating the need for blind water sampling operations and saving a significant amount of human and material resources.

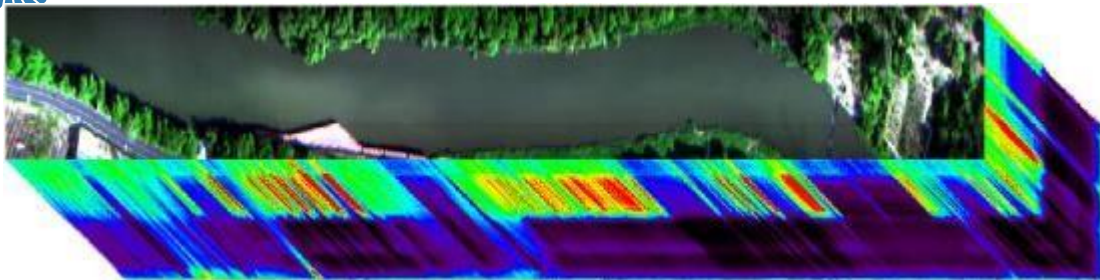


Figure 9 ATH9010W Hyper spectral Image of River Water Quality Obtained from Flight

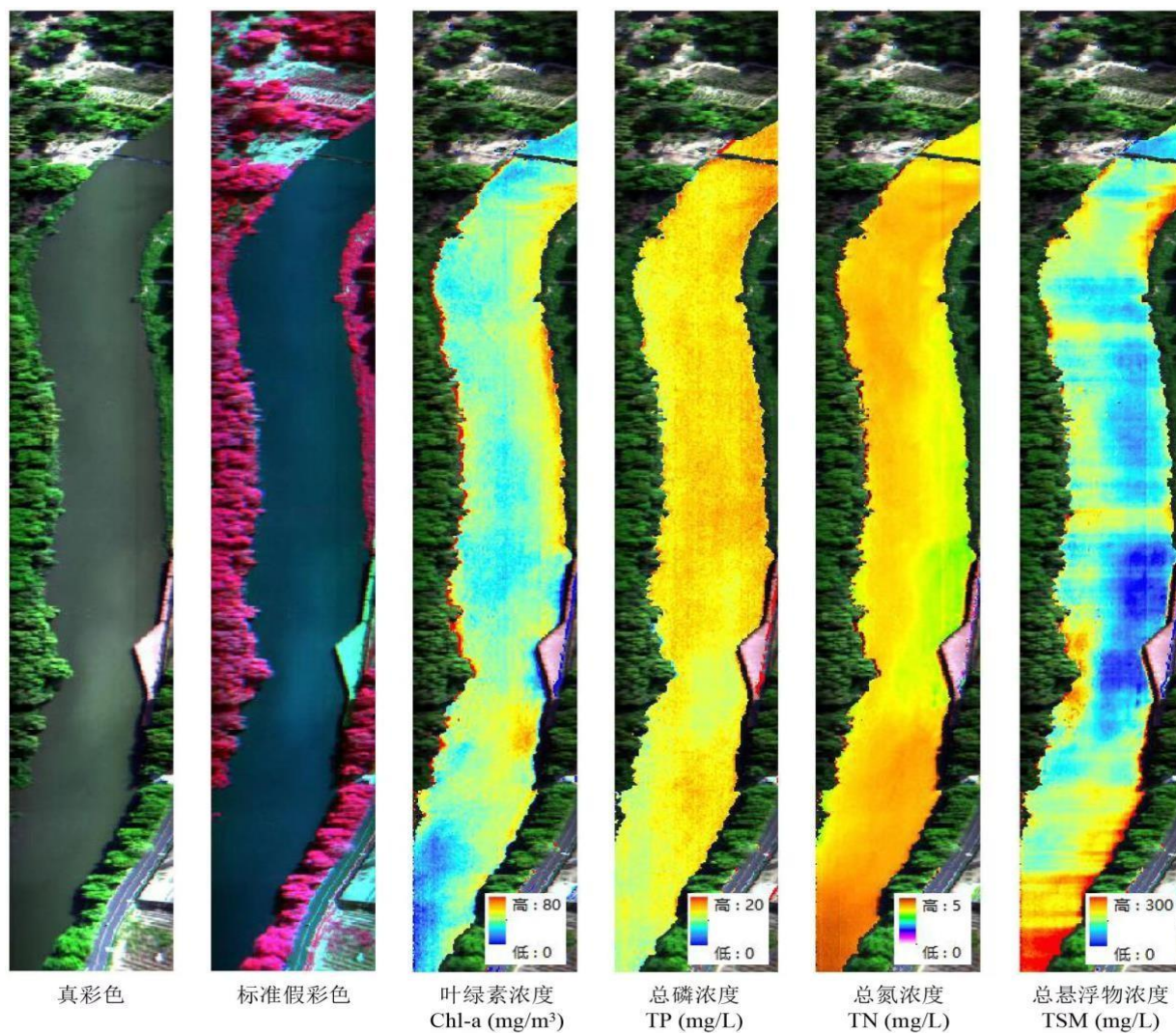


Figure 2 ATH9010W River Quality Inspection Map Obtained From the Flight; Flight Location: Xiamen Fujia; Flight time: March 25, 2022, 10:57am; Flight altitude: 200 meters Flight speed: 5m/s Flight number: 20220325105712



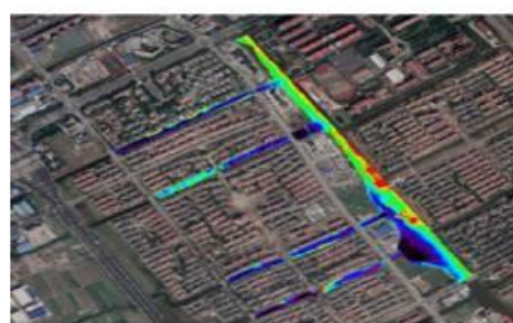
COD



TP (总磷)



TN (总氮)



ABS600

Figure3 Actual detection results of rapid river water quality inspection, Flight Location: KunShan Jiangsu, Flight time: July 25, 2019, 10:57am, Flight altitude: 100 meters, Flight speed: 4.7m/s, sortie number: 20190725103419

Remote sensing possesses notable characteristics such as rapid dynamics, wide coverage, low cost, and periodicity, making it an important technological support. It can track the generation and development of water pollution in real time and has irreplaceable advantages in monitoring water quality dynamics in inland lakes, rivers, and nearshore seas. With the continuous development of remote sensing technology, hyperspectral remote sensing technology, which is characterized by high precision, multiple bands, and large information content, has been widely applied in remote sensing water quality monitoring, significantly improving the estimation accuracy of water quality parameters through remote sensing.

5.3. Application of Hyperspectral Imagers in Early Survey of Pine Wilt Disease





Figure 12 ATH9010SXC Drone Forestry Monitoring and Inspection System

Pine wood nematode is the most serious invasive pest causing losses to China's forest resources and is considered a major national ecological disaster. Its destructive power is extremely strong; once a pine tree is infected, it dies in about 40 days. Currently, there is no effective medication for treatment, and it is referred to as the "cancer" of pine trees. Without effective measures, entire pine forests can die within 3 to 5 years. In recent years, the spread of pine wood nematode disease has been accelerating, and the severity of its damage has been increasing. According to statistics from various regions in the autumn of 2018, the nationwide area affected by pine wood nematode disease was 9.74 million mu, with 10.66 million trees killed, showing a significant increasing trend. At present, this disease is rapidly spreading westward and northward; its westernmost occurrence has reached Liangshan Prefecture in Sichuan Province, and its northernmost occurrence has been reported in multiple counties in northern Liaoning. It has also invaded multiple national scenic areas such as Huangshan, Taishan, and Zhangjiajie, and has appeared in nearly one hundred county-level administrative districts in the Three Gorges Reservoir area and the Qinba Mountains, posing a serious threat to the safety of nearly 900 million mu of pine forests in China.

Pine wilt disease has two main characteristics. First, it occurs in a scattered distribution; second, there's a high chance of infected trees around dead trees. These two features guide the field survey and remote sensing monitoring work in this study.

The spectral characteristics of *Pinus massoniana* affected by pests and diseases differ from those of healthy ones. Under different key wavelengths, when the pines are stressed by pests like pine wood nematodes, changes occur in their external color and physiological traits, as well as decreases in internal chlorophyll content and moisture. So, when studying varying levels of pest and disease damage in these pines, looking at changes across all wavelength ranges and the sensitive spectral bands can help. These changing key bands can serve as a basis for determining the severity of pest and disease damage in *Pinus massoniana*.

When green and healthy plants are attacked by pests and diseases, the chlorophyll content in their leaves gradually decreases until it is completely depleted. This results in a reduction in the energy and intensity of the chlorophyll absorption bands in the spectral reflectance curves of green plants, leading to an increase in spectral reflectance within the visible light wavelength range. Compared with healthy leaves, as shown in the figure, the reflectance of affected leaves in the visible light band is higher than that of normal vegetation leaves, while the spectral reflectance in the infrared band is significantly reduced. Based on this knowledge, to monitor the classification status of pest and disease severity in Masson pine over a wide area and on a large scale, it is necessary to extract the spectral feature information that changes in each spectral band of vegetation affected by pests and diseases, particularly the spectral characteristics in the near-infrared band. This enables quantitative analysis of pest and disease damage in terms of leaf pigments, cellular structure, and water content. The spectral response characteristics of normal healthy vegetation leaves are shown in the figure:

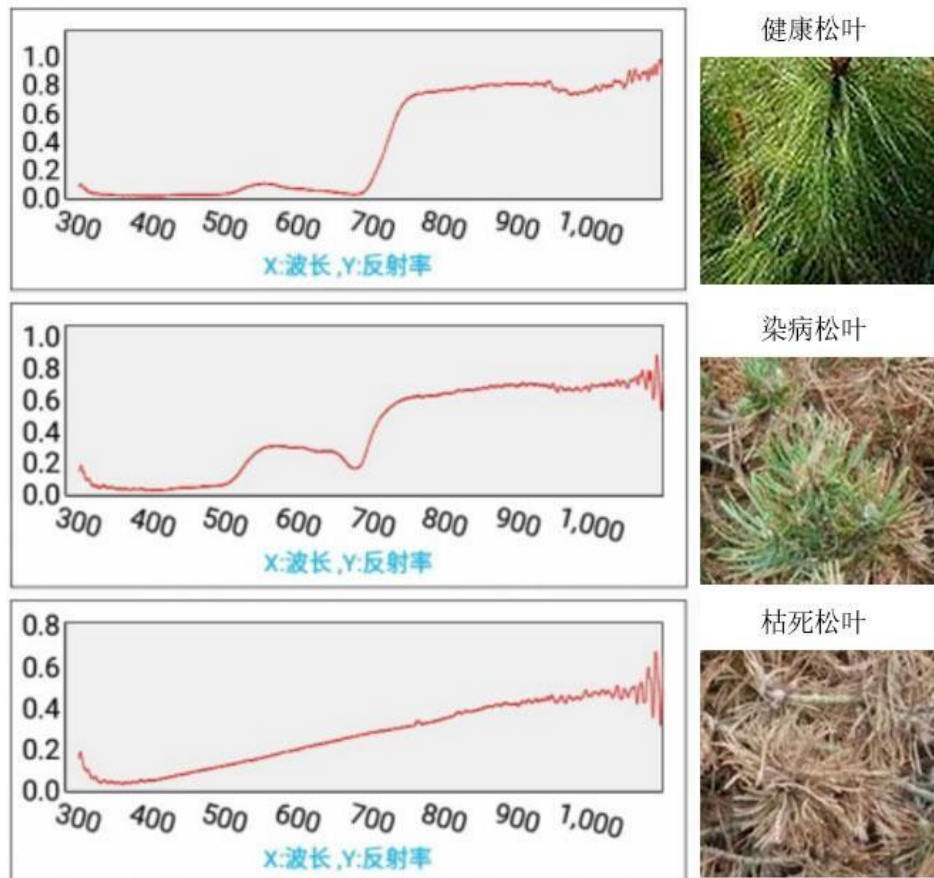


Figure 4 Pine Needle Spectral Curves for Different Health Conditions

Using an experiment with Masson pine needles under different levels of pest and disease stress as an example, we analyzed the original spectra of needles with varying degrees of damage. Next, we can extract sensitive bands and study the application of the red-edge effect in determining the severity of pest and disease in Masson pine. The characteristics of the original spectra of Masson pine under different disease indices are shown in the figure below.

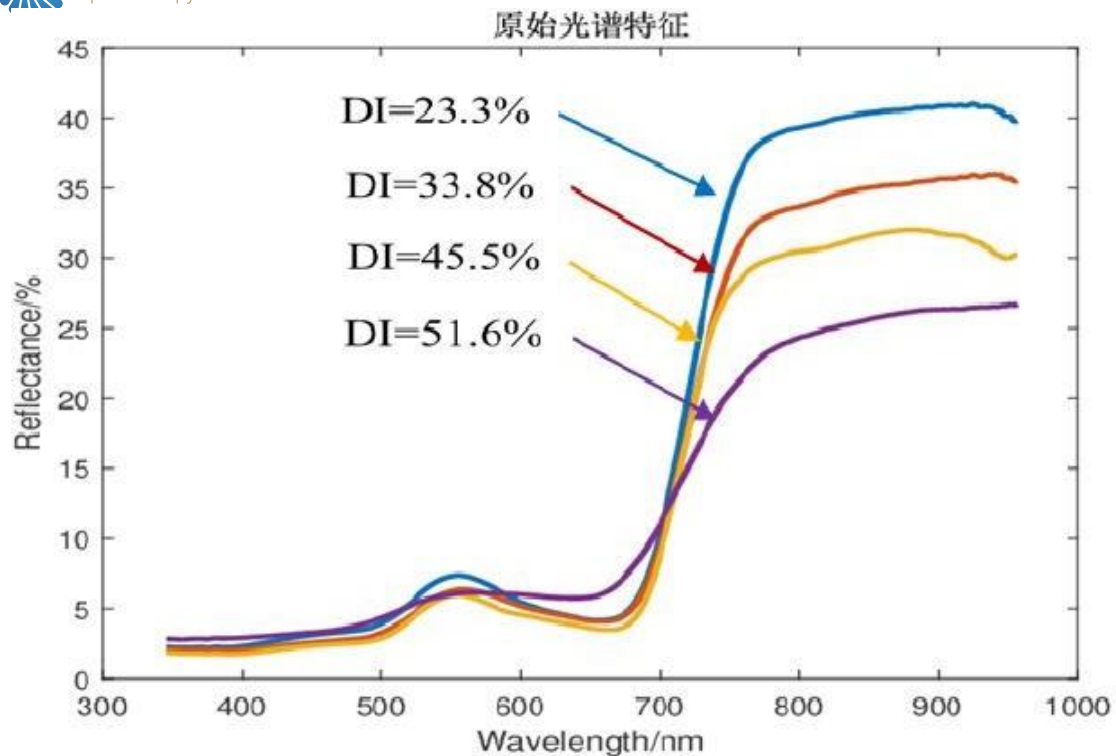
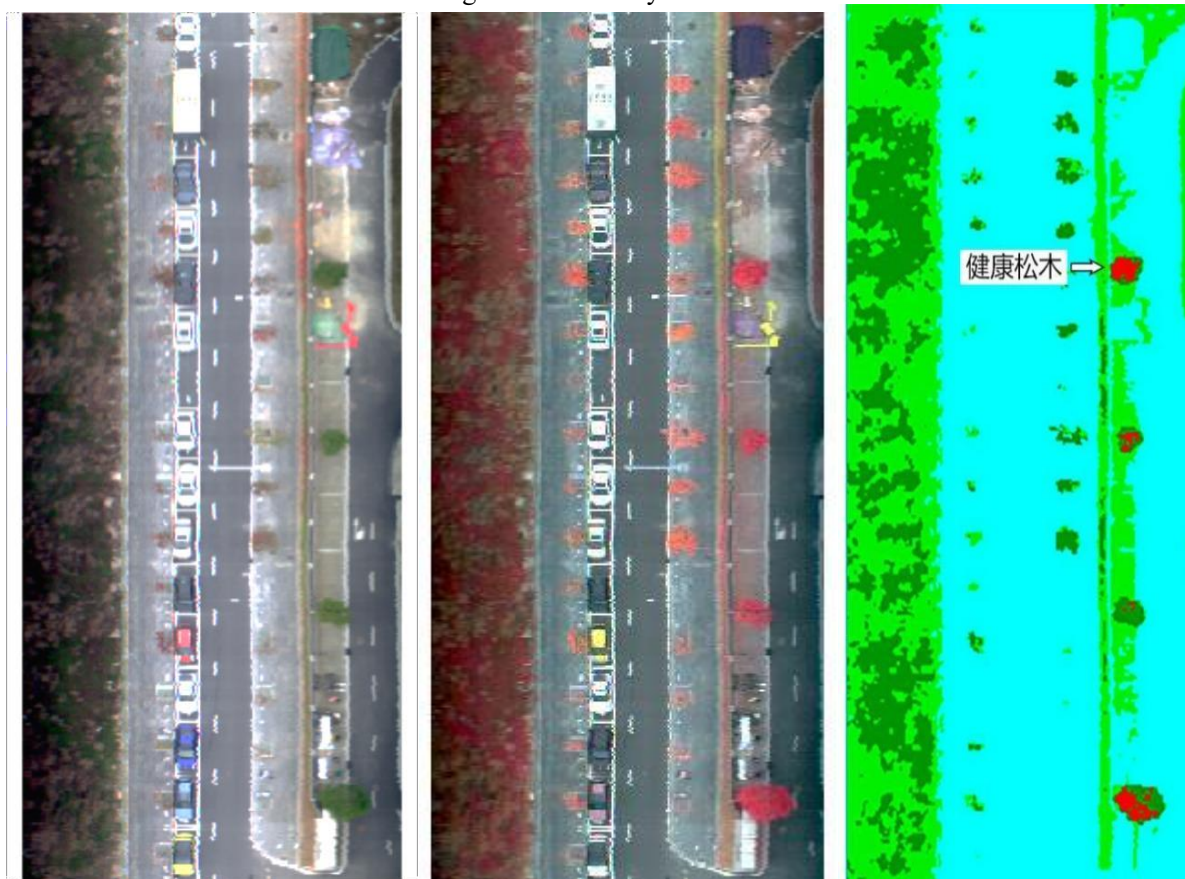


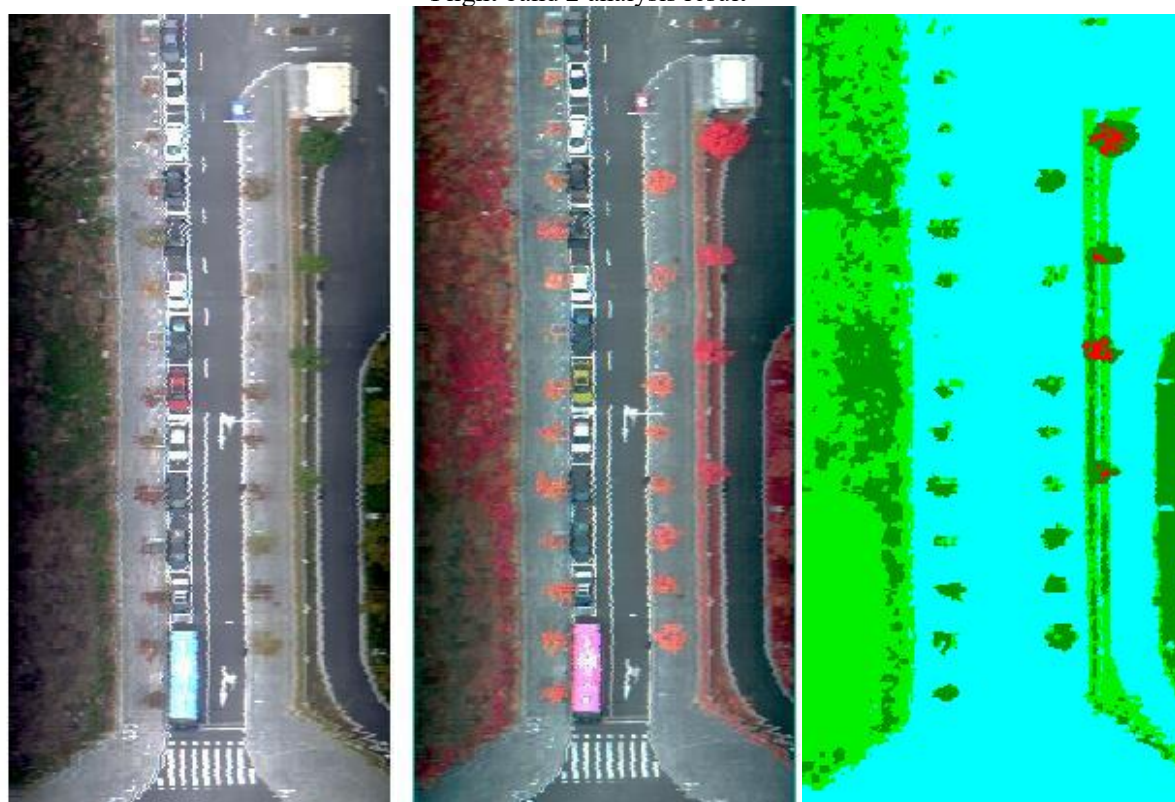
Figure 5 Original spectral characteristics of Masson's pine under different disease indices

From the above figure, we can analyze that as the severity of the disease increases, the spectral data of Masson's pine show obvious spectral feature changes in the visible light range (400-680nm). In the “green peak” between 500-600nm, the lower the severity of pests and diseases, the higher the peak, located at 553.9nm-570nm. In the “red valley” between 650-700nm, the lower the severity of pests and diseases, the more obvious the valley, but there is some overlap between levels, occurring at 665.1nm-641.4nm, gradually flattening until it disappears. As the severity of pests and diseases increases, the steep slope from the red light band to the near-infrared band gradually becomes gentler. However, in the near-infrared band range, the spectral feature shows that the healthier the Masson's pine, the greater the reflectance as the severity of the disease decreases. That is, the less healthy the Masson's pine, the lower the reflectance in the near-infrared region. This is because the original detection results contain some noise and scattered pixels due to disease severity, and optimization is needed. Post-classification tools, including maximum value analysis and clustering, are used to remove small patch noise. The optimized results are shown in Figure 8.

Flight Band 1 Analysis Results



Flight band 2 analysis result



True Color Image

Fake color Image

Extraction result

Figure 15 Results of Healthy Pine Area Detection

As the severity increases, the chlorophyll content in the needles of Masson's pine gradually decreases, and the cellular structure is progressively damaged, causing a noticeable drop in reflectance in the near-infrared band. Therefore, the sharp change from the red light band to the near-infrared band in the vegetation reflectance spectrum plays an important role in estimating plant health.

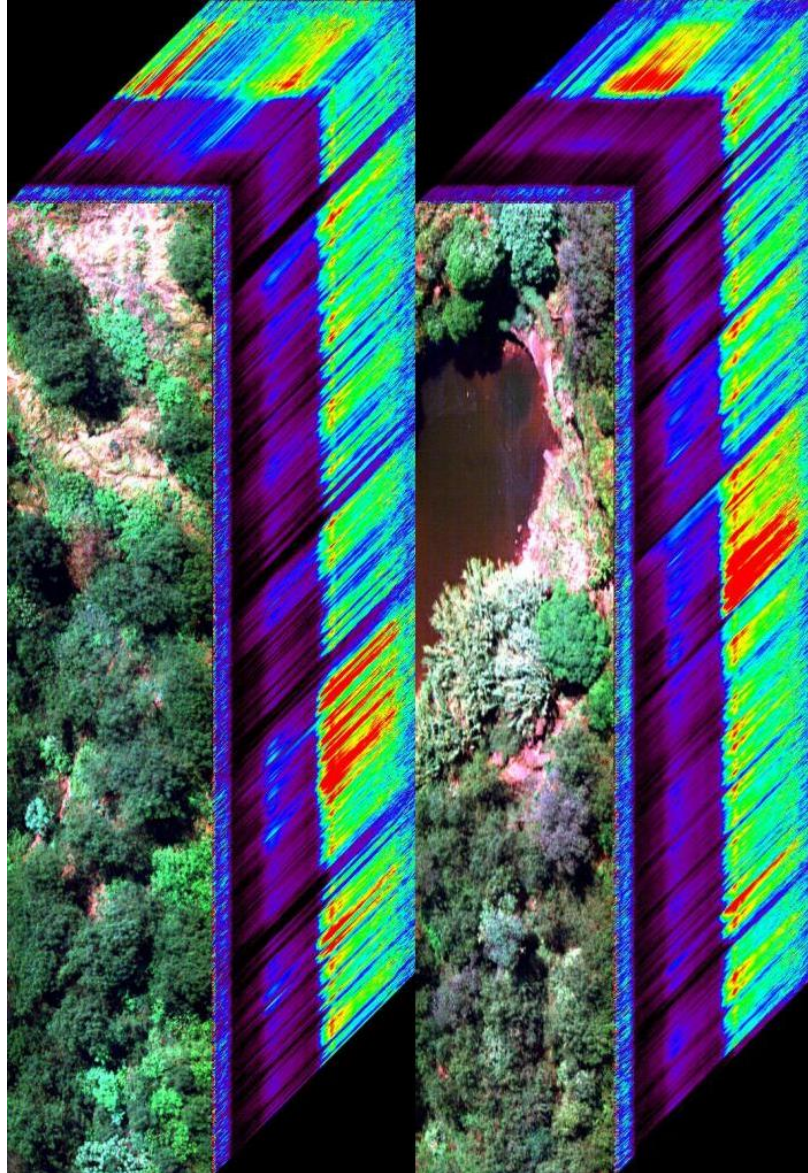


Figure 16 ATH9010SXC hyperspectral image of pine nematode infestation during inspection

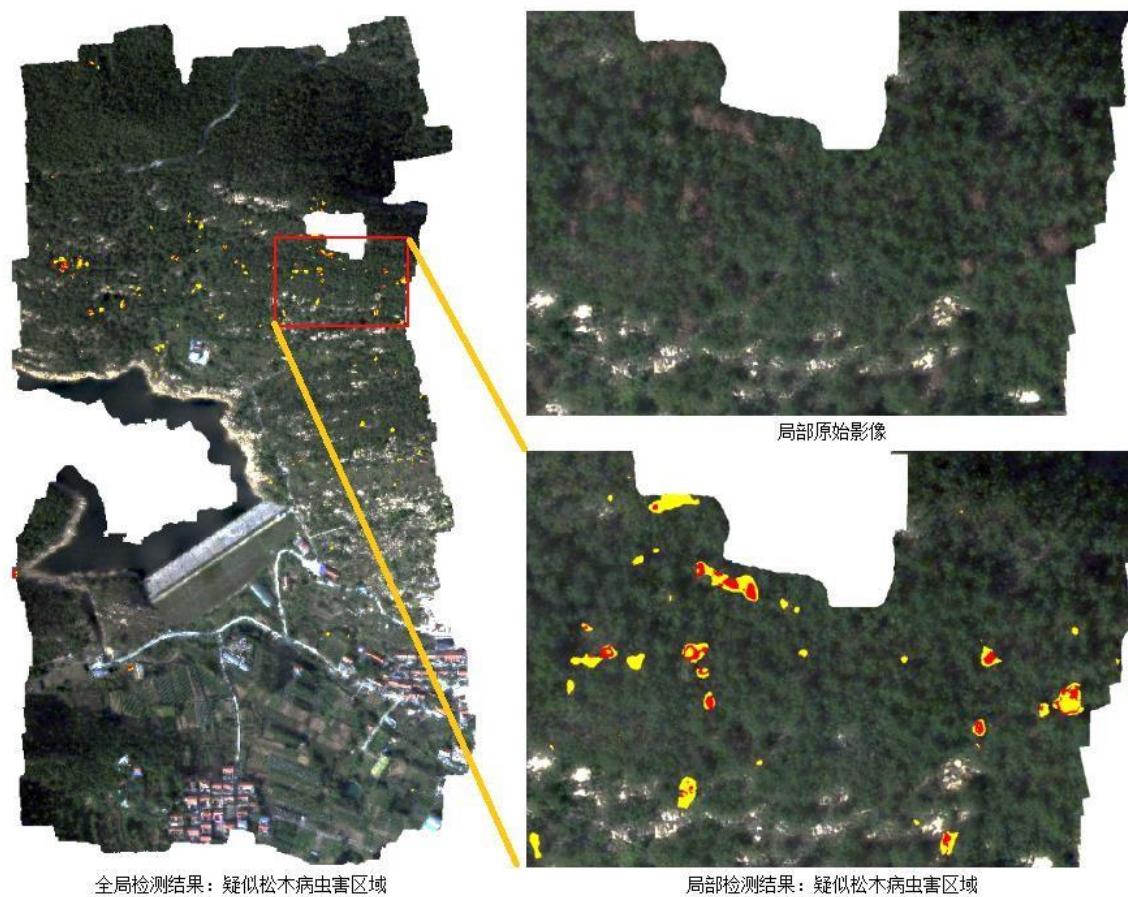


Figure 17 shows the distribution result of pine caterpillar infestations surveyed by the ATH9010SXC. Aircraft model:ATH9010SXC-FW. Flight altitude:500 Meters, Flight speed:20m/s, Flight location: ZhangZhou Fujian Province

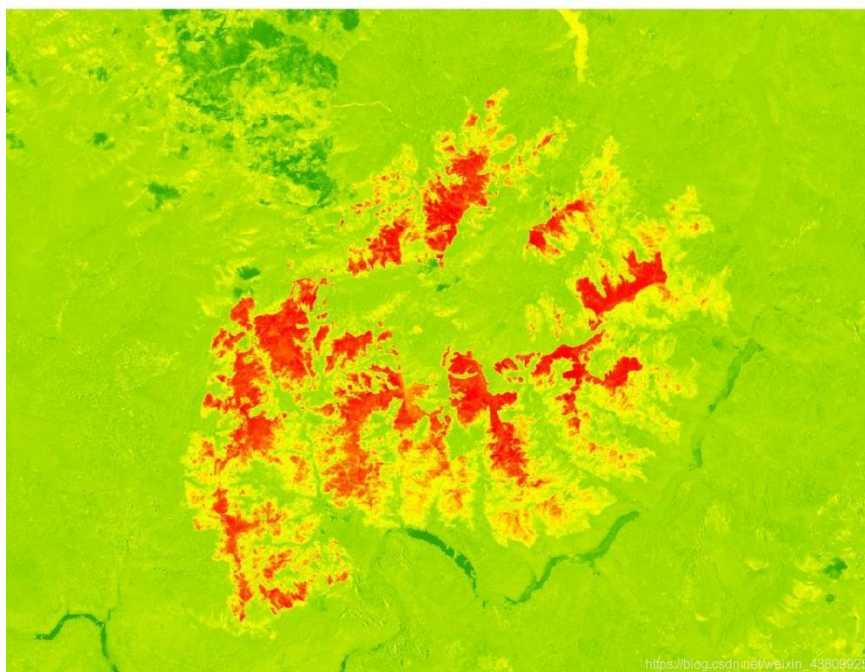


Figure 18 shows the distribution results of pine nematode infestations inspected by ATH9010SXC. Aircraft model: ATH9010SXC-FW, flight altitude: 500 meters, flight speed: 20 m/s, flight location: Sanming City, Fujian Province.

5.4 Application of Hyperspectral Imager in Identification and Grading of Corn Drought Disaster

Corn ranks among the world's most vital food crops and is China's top grain crop. Northern China serves as the major corn-producing region. Fluctuations in temperature and precipitation make drought a key factor restricting corn yield in these zones. With growing demands for refined agricultural management, accurate and efficient identification and grading of corn drought stress are of great practical importance.

Traditional crop drought identification mostly relies on satellite multispectral remote sensing images to calculate vegetation indices for drought evaluation. Nevertheless, satellite imagery is constrained by weather conditions, satellite transit cycles and low spatial resolution, leading to unsatisfactory timeliness and precision. The advancement of unmanned aerial vehicles (UAVs) enables convenient, flexible acquisition of ultra-high-resolution remote sensing data, offering new approaches to address various agricultural challenges in recent years. Meanwhile, the development of deep neural networks, especially fully convolutional neural networks, has greatly improved the accuracy of semantic segmentation for remote sensing images.

Liu Chang from Jilin University adopted the Optosky ATP9000 UAV-mounted hyperspectral imager (renamed ATH9010 at present) and developed a deep learning semantic segmentation algorithm to identify and classify drought damage in corn.

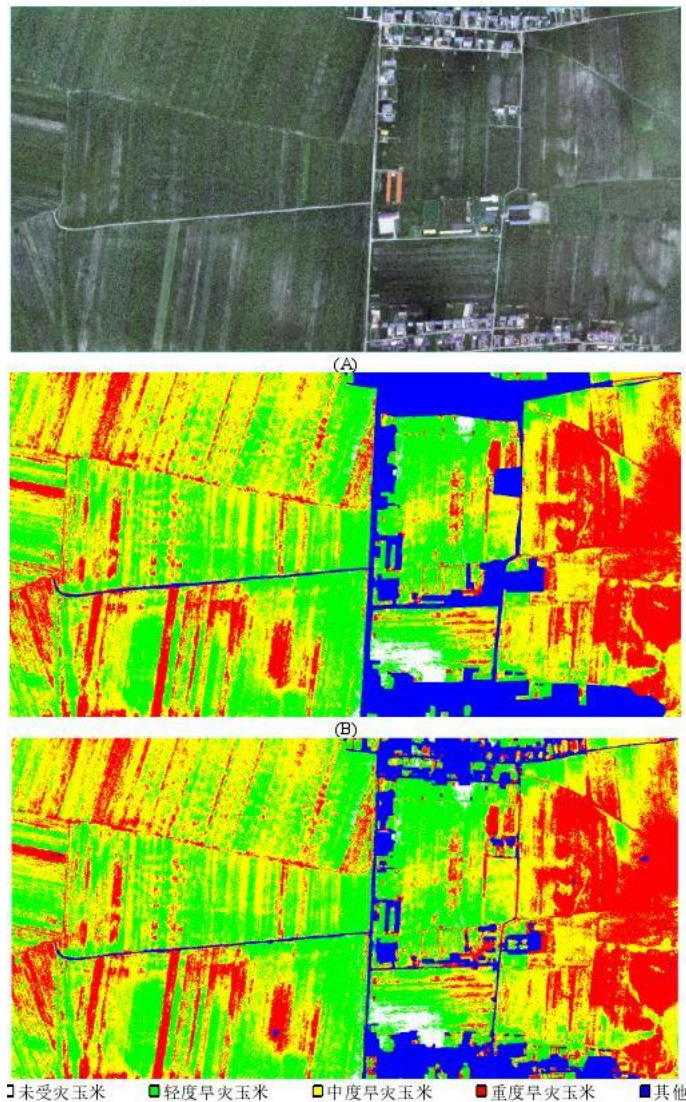


Figure 14 Liu Chang from Jilin University carried out research on corn drought grading with a hyperspectral imager. The Optosky ATP9000 UAV hyperspectral imager (currently renamed ATH9010) was adopted in the study.

With different algorithms, UAV hyperspectral imagers can detect more complex types of disasters, including waterlogging, pest infestation and hail damage. All these disasters trigger crop yield reduction and economic losses.

5.5 Application of Hyperspectral Imagers in Industrial Sorting

With the development of near-infrared hyperspectral technology, Jiang et al. adopted near-infrared hyperspectral technology to detect impurities in cotton. Particularly, short-wave near-infrared

hyperspectral technology greatly improves the detection rate of plastic films compared with

conventional methods. Hyperspectral imaging technology generates image data across numerous narrow wavebands, capturing both visual and spectral information of samples during imaging. Common hyperspectral data processing algorithms include Partial Least Squares (PLS), Support Vector Machine (SVM) and Artificial Neural Network (ANN).

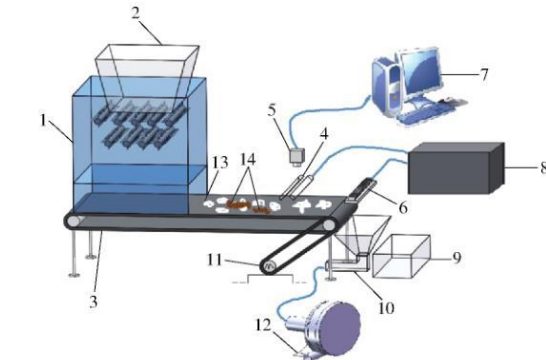


图2 籽棉地膜分选系统示意图

Fig.2 Schematic of film sorting system of seed cotton

1. 配棉箱 2. 进棉口 3. 输送带 4. 穹顶卤素灯 5. 高光谱相机 6. 高速喷阀 7. 工控机 8. 驱动箱 9. 籽棉收集箱 10. 废料收集箱 11. 伺服电机与编码器 12. 风机 13. 籽棉 14. 地膜

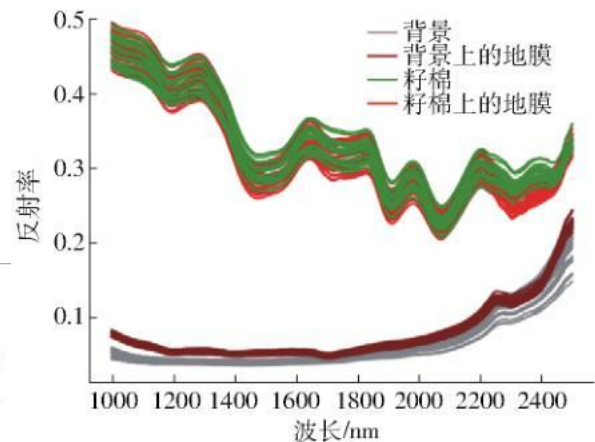


Figure 15 Application of hyperspectral imager in seed cotton sorting; (a) Functional composition of the system; (b) Reflectance spectral curves of different substances

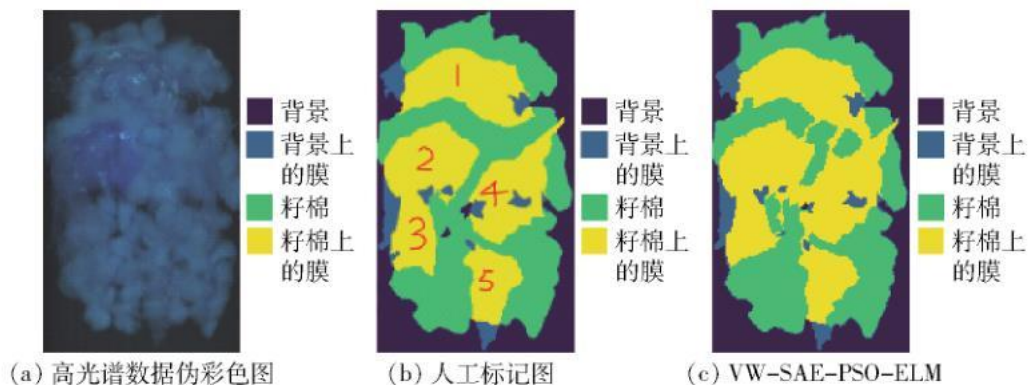


Figure 16 Application of hyperspectral imager in seed cotton sorting; (a) Manual labeling; (b) Identification results of hyperspectral imager

The external quality of apples is the most intuitive indicator, which directly affects fruit prices and consumer preferences. Focusing on difficulties and key points in apple surface inspection, detection approaches for apple external physical properties (shape and size) and common surface defects are explored based on machine vision, hyperspectral imaging and multispectral imaging technologies, combined with image processing, pattern recognition, chemometrics and spectral analysis.

The inspection systems and algorithms developed from above research lay a foundation for developing domestic rapid on-line sorting equipment for apple exterior quality using machine vision and

multispectral machine vision.

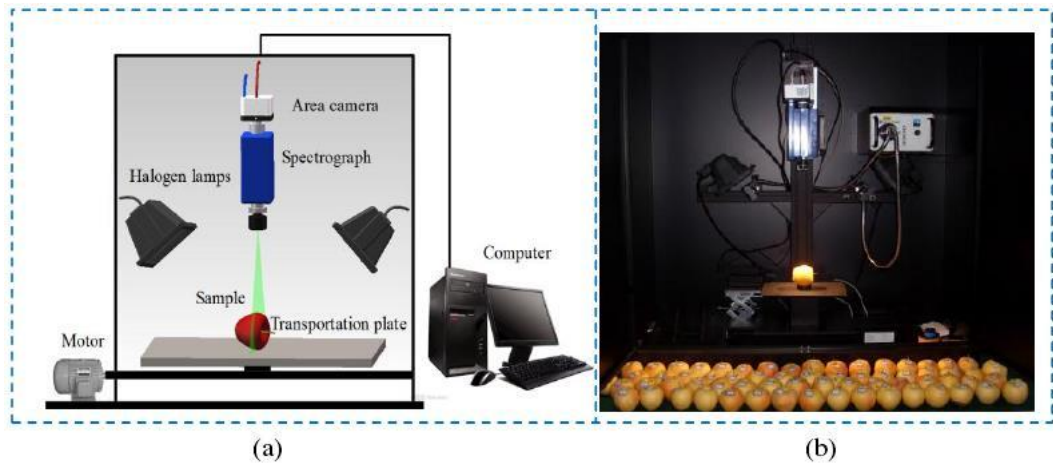


Figure 17 Schematic diagram and physical photo of the hyperspectral imaging system developed by Dr. Zhang Baohua from Shanghai Jiao Tong University; (a) schematic diagram; (b) physical photo

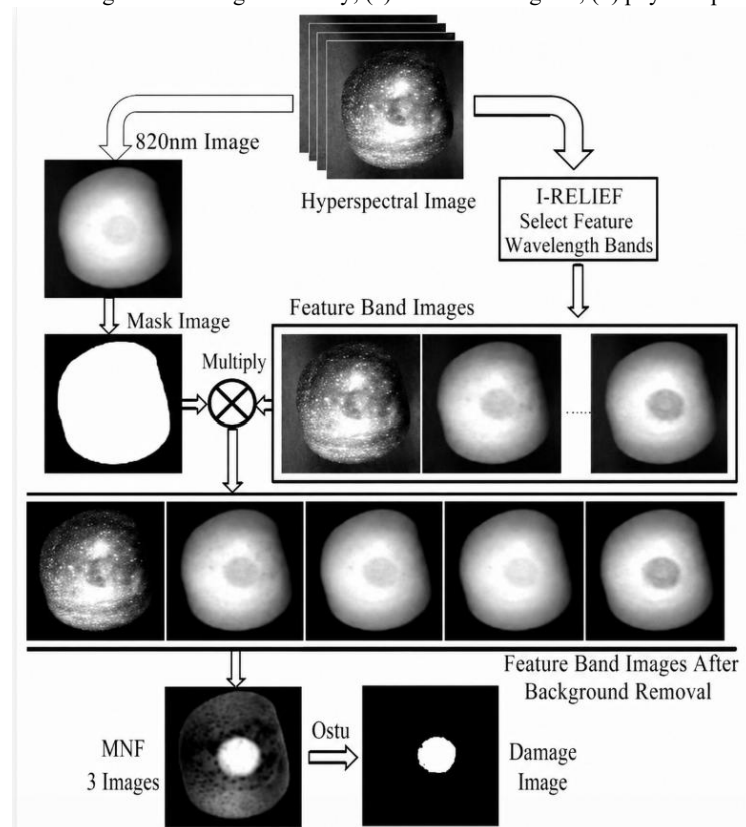


Figure 18 Flow chart of the algorithm for detecting early damage on apple surfaces

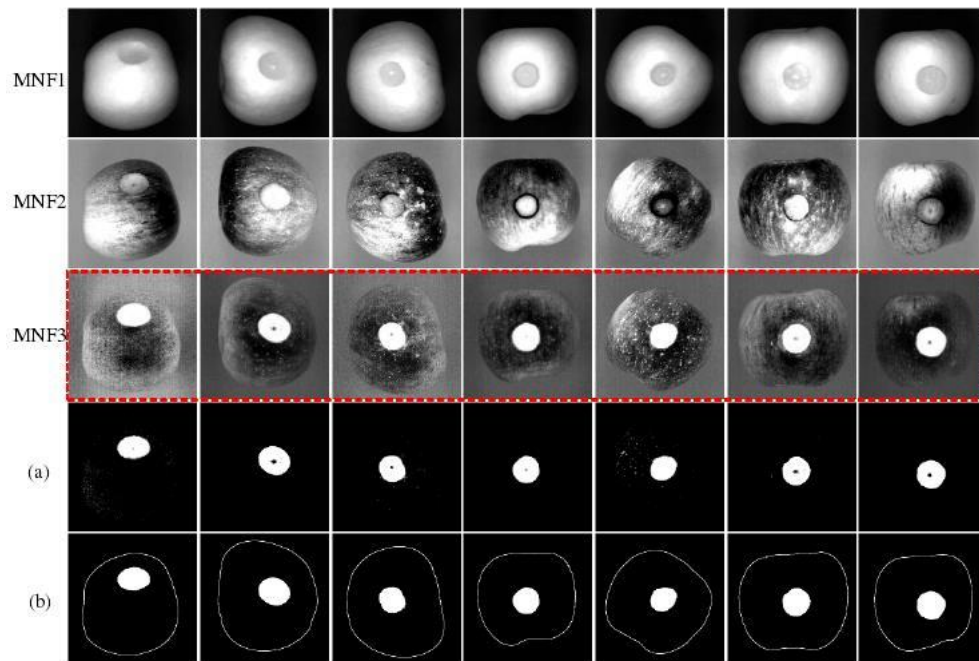


Figure 19 Recognition results of early apple rot and intermediate processing; (a) Rot segmentation result; (b) Final detection result

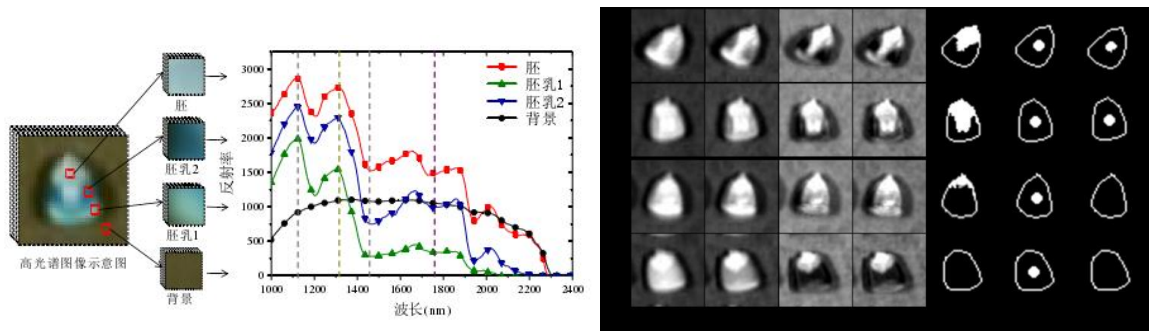


Figure 20 Application of 1000-2500 nm hyperspectral imager in corn seed sorting (Dr. Wang Chaopeng, Northwest A&F University)

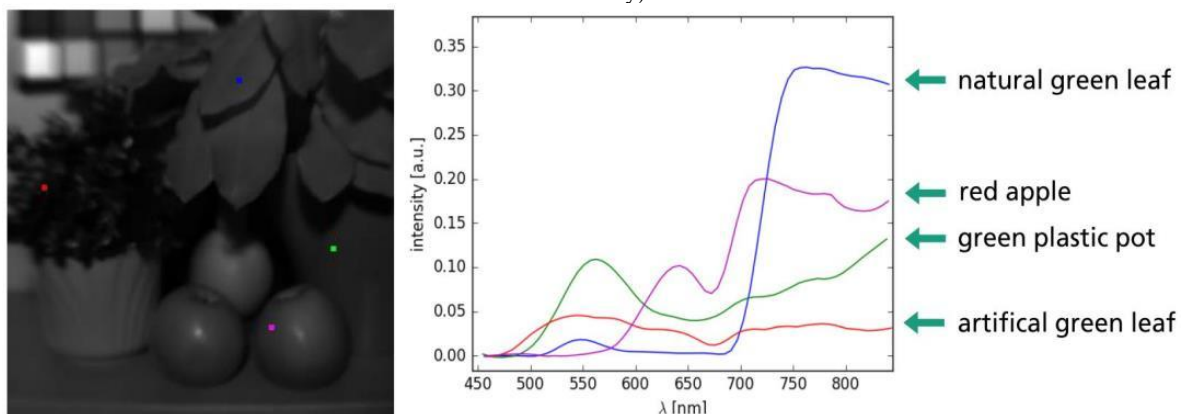


Figure 21 Spectrograms of natural green plants, artificial green leaves, green plastics and red apples

5.6 Application of Hyperspectral Imaging Technology in Precision Agriculture



Figure 22 UAV hyperspectral remote sensing system manufactured by Optosky

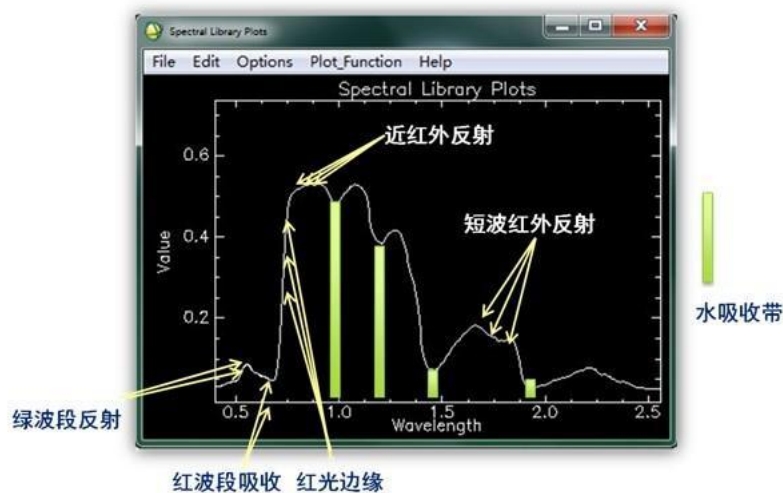


Figure 23 Spectrogram of green plants measured by hyperspectral imager

- 1) **Crop growth monitoring and yield prediction:** At different growth stages, crops differ in internal composition and external morphology due to varied external conditions. The leaf area index serves as the most prominent difference, a comprehensive index reflecting individual and group growth status of crops.
- 2) **Pest and disease control of crops:** Remote sensing can monitor crop damages caused by diseases and pests, track crop growth conditions, assess disaster losses, and detect the distribution and activity patterns of pests to realize early pest prevention.
- 3) **Crop drought monitoring:** Remote sensing monitors crop drought conditions based on crop

vegetation indices and canopy parameters.

- 4) **Monitoring of soil moisture content and distribution:** Spectral signals captured by remote sensing show obvious discrepancies under different thermal inertia. Therefore, a mathematical model linking thermal inertia and soil moisture content can be constructed. Remote sensing applies this model to analyze soil moisture content and its spatial distribution.
- 5) **Crop nutrient monitoring:** Remote sensing achieves higher accuracy in detecting nitrogen content in crops compared with other nutrient elements.

Normalized Difference Spectral Index (NDSI), Ratio Spectral Index (RSI) and Simple Spectral Index (SSI) were established using single bands and arbitrary two bands within 450–882 nm. The correlation between CGI and spectral indices was calculated, and indices with strong correlation were selected. An inversion model was built combined with Partial Least Squares Regression (PLSR). Taking CGI as the evaluation indicator, UAV hyperspectral images were adopted to monitor wheat growth across multiple growth stages in 2015. UAV hyperspectral data delivered high CGI inversion accuracy, enabling identification of overall wheat growth variations and providing references for wheat growth monitoring.

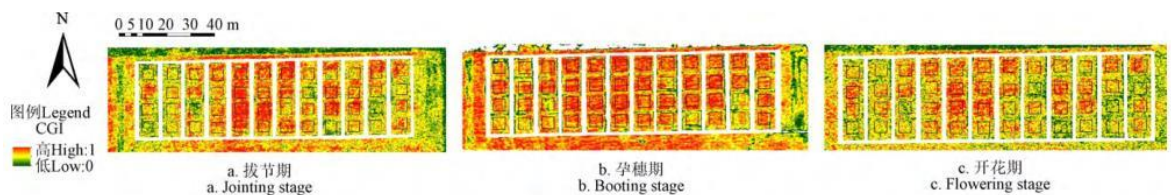


Figure 24 Inversion of wheat growth indicator CGI

5.7 Application of Hyperspectral Technology in Forest Health Assessment

It is applied to pest monitoring and forest resource evaluation.

Principle: Vegetation health is correlated with greenness index, leaf area index, leaf water content and light use efficiency.

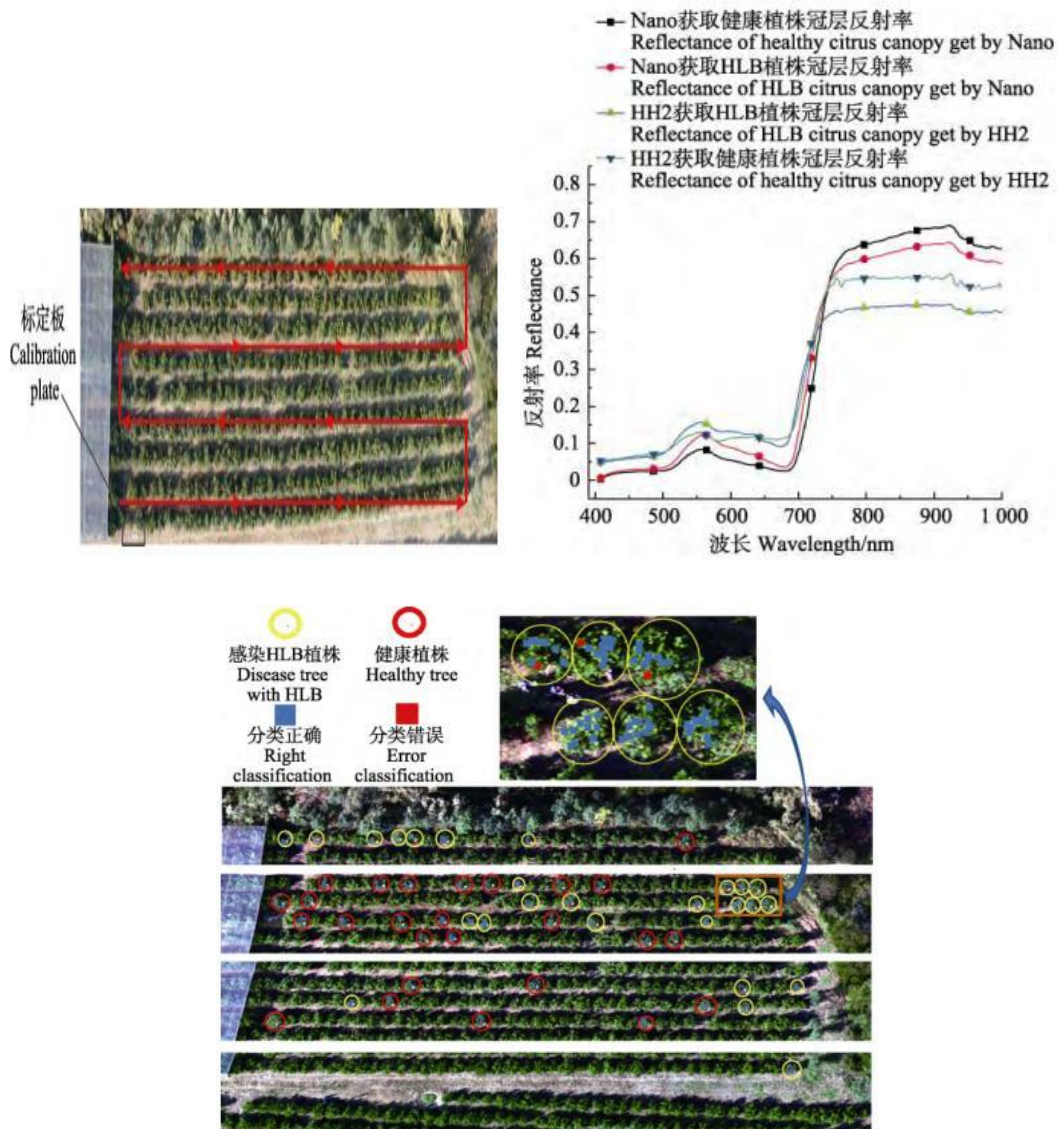


Figure 25 Monitoring and classification of citrus huanglongbing plants based on UAV hyperspectral remote sensing (designed by Lan Yubin et al., South China Agricultural University)

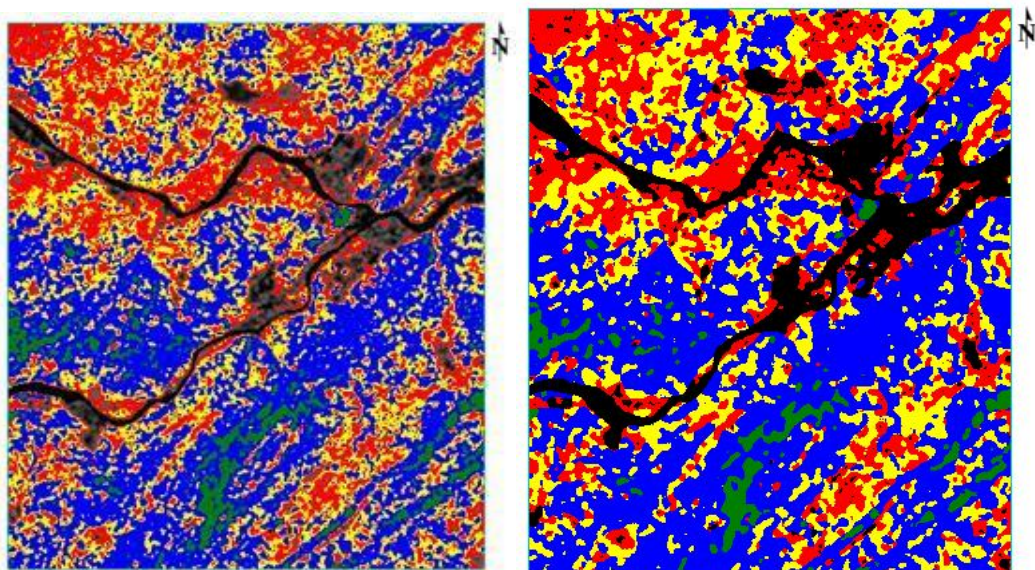
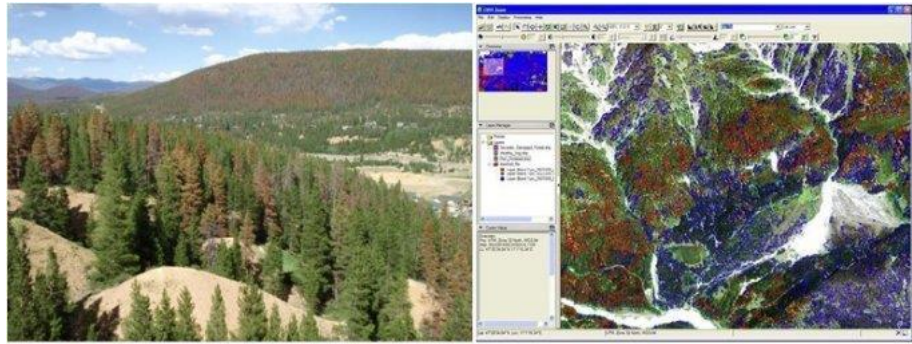


Figure 26 Distribution map of masson pine health studied by Wang Shuang from University of Electronic Science and Technology of China with hyperspectral imager

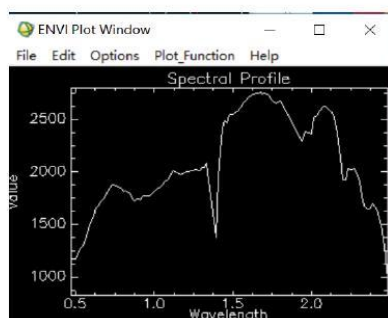
5.8 Application of Hyperspectral Imagers in Geological Exploration

Evolved from multispectral remote sensing technologies represented by Landsat, hyperspectral remote sensing initially took shape in the mid-1980s (Goets et al., 1985; Tong Qingxi et al., 2006). Benefiting from high spectral resolution and integrated mapping-spectrum features, hyperspectral remote sensing enables precise detection and analysis of surface rock and mineral compositions over large spatial scales. It not only delivers macroscopic ground images but also identifies mineral types, abundance and even chemical compositions of certain minerals within geological bodies at the pixel level (Wang Runsheng et al., 2010). In recent years, continuous advances in hardware, data processing algorithms and software for imaging spectrometers have accelerated the adoption of hyperspectral remote sensing in geological

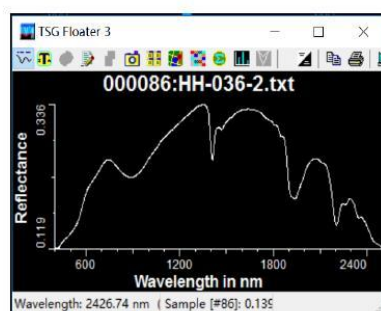
surveys. The technology plays a vital role in geological mapping, delineation of hydrothermal alteration

zones, and identification of mineralization anomaly zones across major metallogenic belts and medium-sized ore fields (Bierwirth et al., 2002; Lian Changyun et al., 2005; Kruse et al., 2006; Cudahy et al., 2007; Wang Runsheng et al., 2010; Liu Dechang et al., 2011; Yan Bokun et al., 2014; Yang Zi'an et al., 2015; Graham et al., 2017). As metallogenic system theory (Wyborn et al., 1994) further guides mineral prospecting, targeted mineral mapping covering large ore concentration areas and metallogenic belts provides critical regional compositional data for predictive mineral exploration.

The spectral wavelength bands applied in mineral mapping cover visible light (400~700 nm), near-infrared (700~1000 nm), short-wave infrared (1000~2500 nm) and thermal infrared (7000~15000 nm). Currently, the short-wave infrared band (1000-2500 nm) sees the most extensive use in mining industries. This wavelength range matches the overtone and combination frequencies generated by chemical bond vibrations within mineral crystal lattices. Therefore, minerals containing water or hydroxyl ions (dominantly phyllosilicates and clays), as well as specific sulfates and carbonates, can be detected in the short-wave infrared region.



HH036 点影像光谱



HH036 点实测光谱

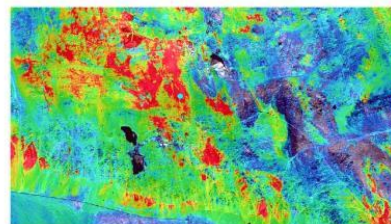
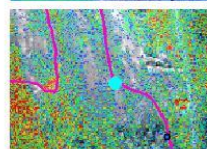
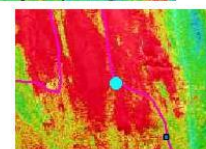


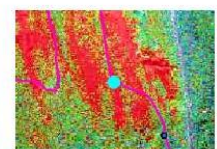
图 3-20. 绢云母矿物填图结果
HH036 点影像和实测光谱对比
已知矿床点



绿泥石提取结果



绢云母提取结果



Fe3+提取结果



采样点照片



采样点远景照片

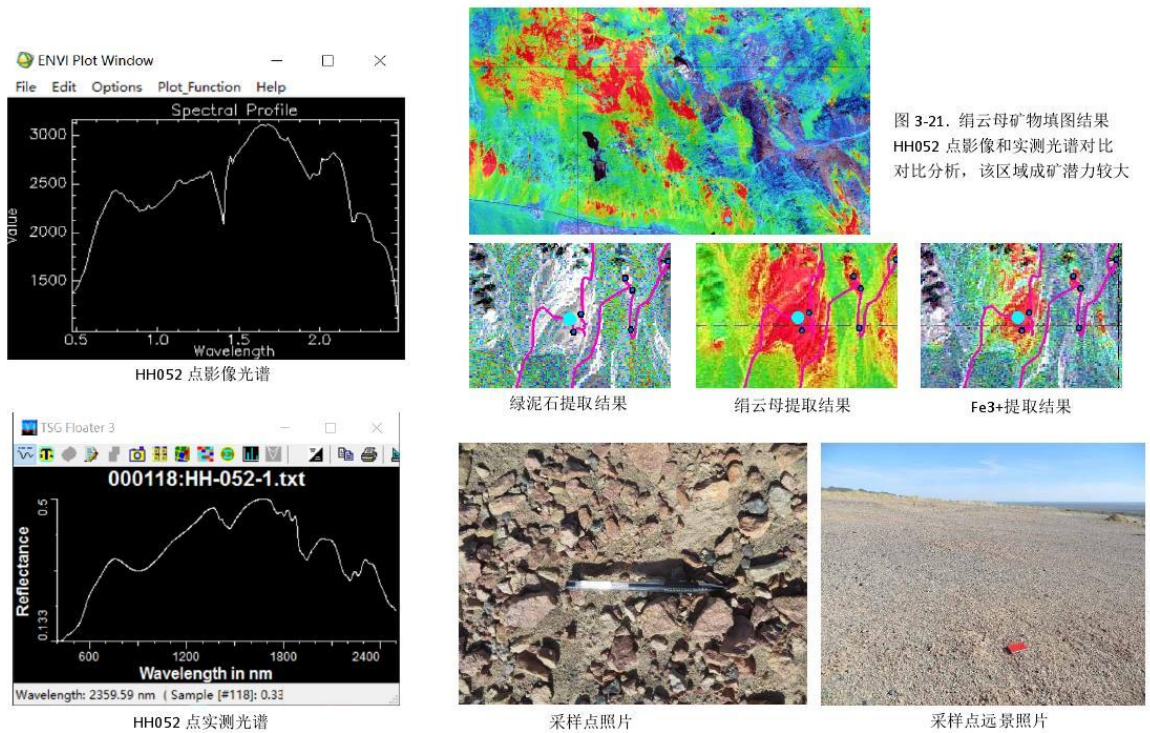


Figure 27 Application of hyperspectral imager in mineral exploration

Soil salinization is one of the major eco-environmental problems in arid and semi-arid regions. Soil salinization causes soil hardening, fertility reduction, pH imbalance and land degradation, which severely restrict agricultural development and undermine the overall sustainable development strategy of China. With the advantages of large monitoring scale, wide coverage, high timeliness and low cost, remote sensing makes up for the defects of traditional soil salinization monitoring methods and offers a new approach for quantitative monitoring of soil salinization.

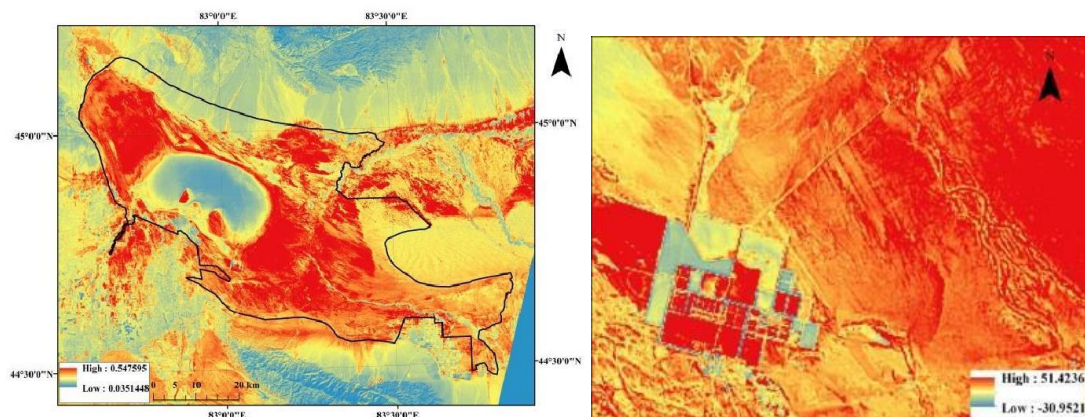


Figure 28 Areas surrounding a salt field

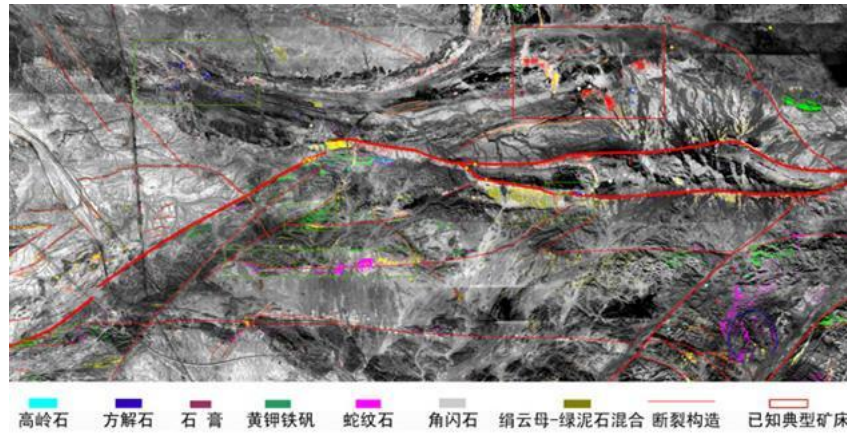


Figure 29 Survey map of a mining site

5.9 Applications of Hyperspectral Imaging in Public Safety

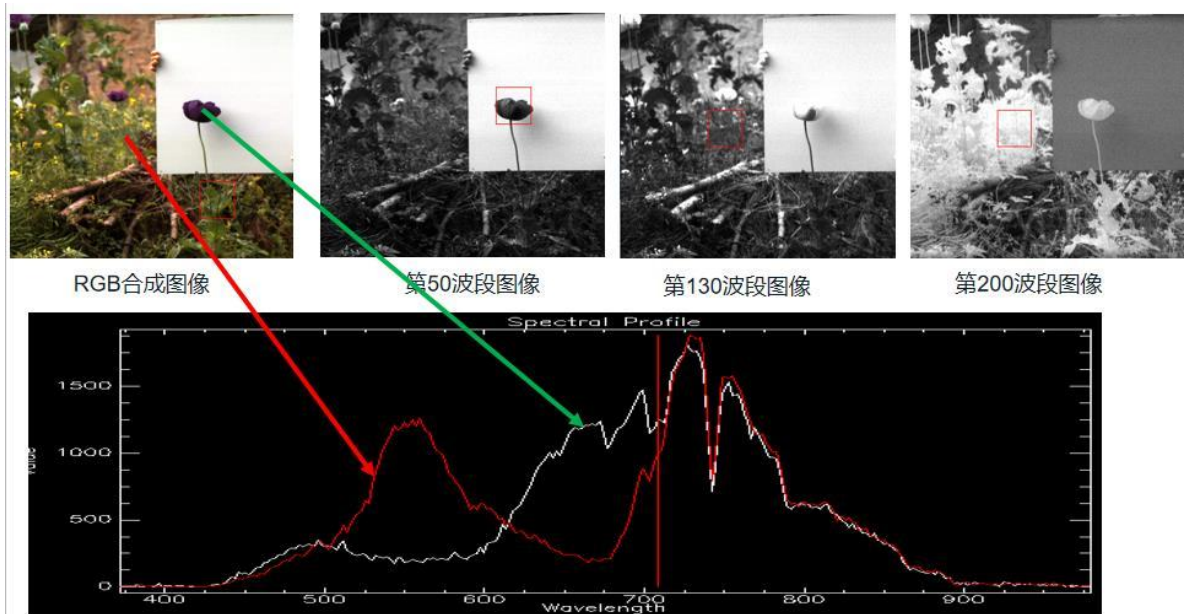


Figure 30 Application of hyperspectral imaging in detecting illegal opium poppy cultivation

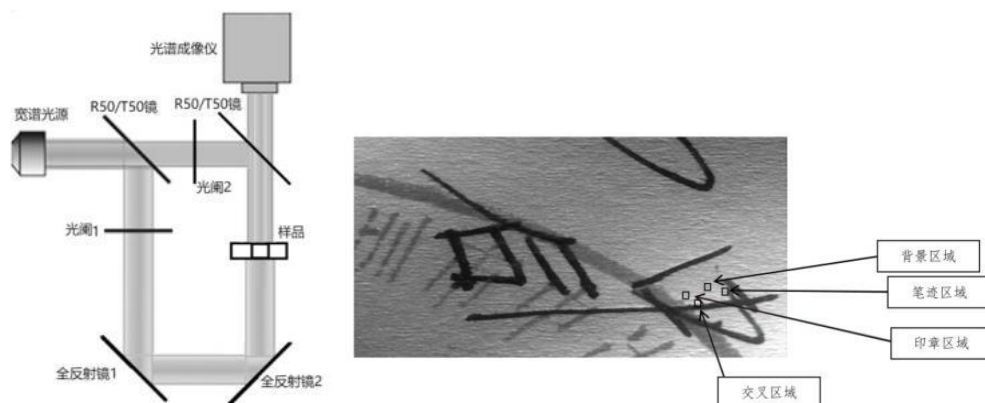


Figure 31 Application of hyperspectral imager in document inspection

6. Optosky Hyperspectral Cameras

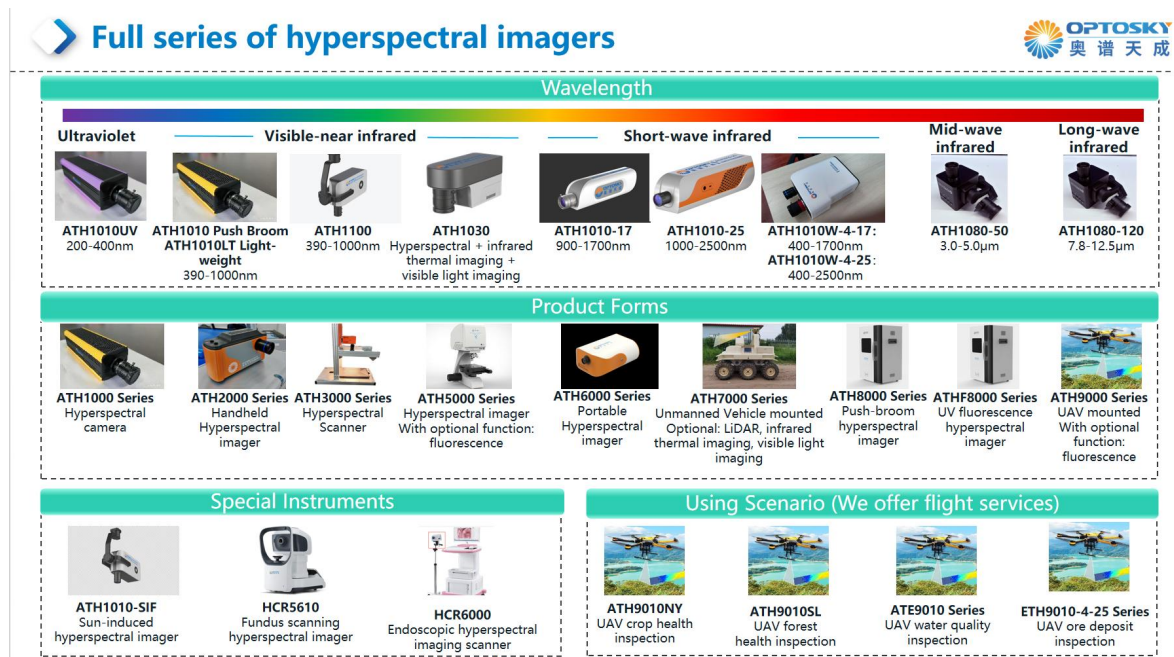
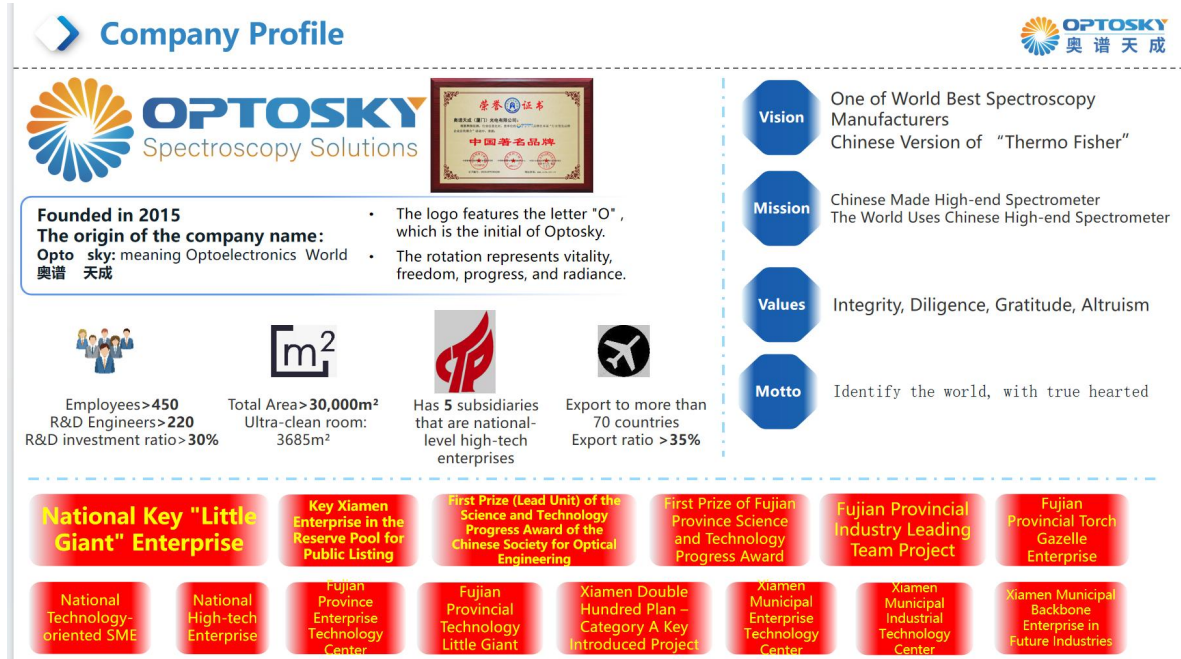


Figure 34: The hyperspectral product series produced by Optosky

7. OptoSky—Company Profile

OptoSky was founded in 2015 with group headquarters in Xiamen, a picturesque coastal city. It is a national-level key "Little Giant" enterprise featuring specialization, refinement, differentiation and innovation, dedicated to the R&D, production and sales of high-end spectral analysis instruments. The enterprise was initiated by Dr. Liu Hongfei, an international specialist in spectral instruments, who is an academican of the Russian Academy of Natural Sciences, leading talent of the National Ten-Thousand Talents Program, beneficiary of the Ministry of Science and Technology Innovation Talent Promotion Program, Class A talent under Xiamen Double Hundred Talent Program, PhD holder from Shanghai Institute of Technical Physics, Chinese Academy of Sciences and postdoctoral fellow of Xiamen University. The company devotes itself to developing globally advanced spectral analysis instruments and aims to be a top-tier international supplier of spectral instruments, evolving into a domestic pacesetter in the spectral instrument sector.

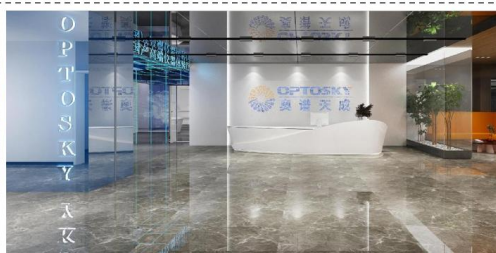


more than 500 intellectual property rights, among which over 100 are invention patents including two US invention patents. Currently, it undertakes more than 20 national, provincial and municipal research projects such as a major industrialization special project sponsored by the State Oceanic Administration with total funding of 30 million RMB. Meanwhile, OptoSky presides over and participates in formulating over 20 national, industrial and association standards. Standards led by the company: Near-infrared Terrestrial Object Spectrometer, Rapid Water Quality Detector Using Spectroscopy, Technical Specification for Multispectral Imaging in Smart Agriculture, Handheld Fruit Quality Detector, Technical Requirements for Medical Near-infrared Spectrometer, Portable Rapid Water Quality Detector Using Spectroscopy, etc. Standards participated in formulation: Technical Specification for Raman Spectrometer, Hazardous Chemical Detector Based on Raman Spectroscopy, Online Rapid Water Quality Detection System Using Spectroscopy, Technical Specification for Ecological Environment Monitoring System Based on Mobile or Fixed Buoys, Determination of Benzophenone Ultraviolet Absorbers in Textiles, Determination of Antifungal Performance of Textiles Part 1: Fluorescence Method, Plant Phenotype Chlorophyll Fluorescence Imaging Analysis Equipment, Technical Requirements for Plant Monitoring Using UAV Hyperspectral Remote Sensing, etc. OptoSky keeps guiding the formulation of spectral technical standards and industrial upgrading.

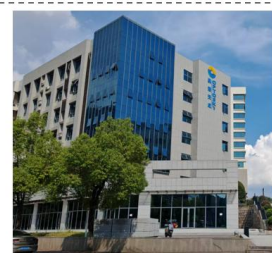
Our Offices



Optosky Technology Park (Xiamen North Station) – Under Construction



Xiamen Headquarters Base (Approx. 3,000 m², Self-owned Property)



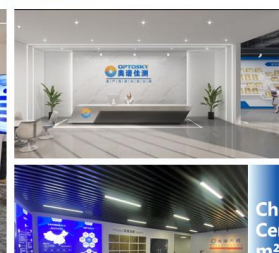
Changsha Head office (>10,000 m²)



Wuhan R&D Center (>2,000 m²)



Taizhou Manufacturing Base (>4,000 m²)



Xuzhou R&D Center (>2,000 m²)



Chengdu R&D Center (>1,300 m²)

Figure 37 Optosky National R&D Center/Smart Manufacturing Base

Product data information is current as of publication data. Products conform to specifications per the terms of Optosky Standard warranty.

主持和参与制定的多个国家标准



Figure 38: Leading and participating in multiple national standards

Relying on its exclusive technologies including opto-mechatronics integration, spectral analysis, weak photoelectric signal processing and cloud computing, OptoSky has built a full-spectrum product portfolio with Raman spectrometers as flagship products, covering fiber spectrometers, hyperspectral imagers, field spectroradiometers, infrared spectrometers, fluorescence spectrometers, spectrophotometers and LIBS instruments. These products are widely adopted in scientific research, semiconductor, new energy, biomedicine, chemical pharmacy, public security, smart agriculture, military industry and other fields, ranking among the world's top tier in both product performance and brand influence. Its products are sold to more than 70 countries and regions worldwide. OptoSky is the top Chinese optical instrument brand in Russia, among the top three high-end optical instrument brands in the Middle East, and one of the fastest-growing Chinese brands in Europe and America. The company has realized domestic substitution and export breakthroughs for high-end spectral instruments.

Product Lines

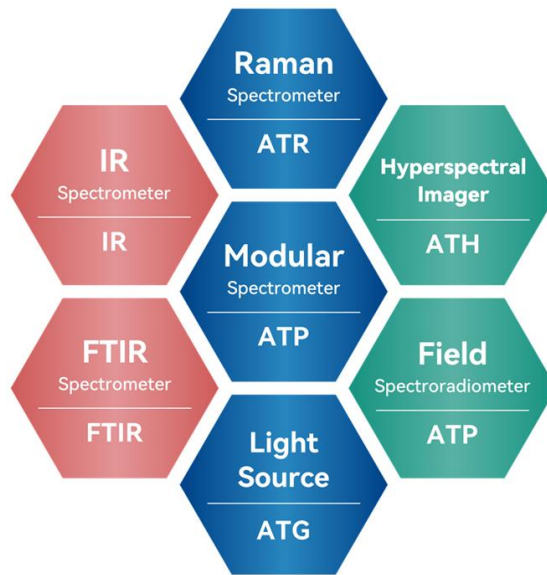


Figure 39: Main Product Series and Application Areas

OptoSky bases its development on technology, follows market demands and prioritizes customers, delivering outstanding solutions and high-quality products and services for numerous industries. Widely recognized by governments at all levels and the industry, the company has acquired more than 300 innovation patents, software copyrights, qualification certifications and domestic and international honors in total.

The enterprise holds multiple accreditations and honors including National Key Specialized, Sophisticated, Unique and Innovative Little Giant Enterprise, Key Pre-listing Enterprise of Xiamen, Leading Industrial Talent Team of Fujian Province, Xiamen Industrial Technology Center, Fujian Gazelle Enterprise, Class A key introduction project of Xiamen Double Hundred Talent Program and National High-tech Enterprise. It has also been awarded Xiamen Specialized, Sophisticated, Unique and Innovative Enterprise, Xiamen High-tech, High-growth and High-value Key Enterprise and Xiamen High-tech Enterprise.

Partial Honors Obtained by OptoSky:

- August 2025: Won the first prize in the final of the New Generation Information Technology Industry Group, Sichuan Division, the 14th China Innovation and Entrepreneurship Competition 2025
- July 2025: Approved as a Postdoctoral Innovation and Entrepreneurship Practice Base
- July 2025: Listed as a national-level key Specialized, Sophisticated, Unique and Innovative Little Giant enterprise
- March 2025: Approved for the Changsha Expert Workstation
- September 2024: Selected as a national-level Specialized, Sophisticated, Unique and Innovative Little Giant enterprise
- June 2023: Named a key pre-listing enterprise of Xiamen
- May 2023: Included in the Leading Industrial Talent Team Program of Fujian Province
- 2023: Accredited as Xiamen Industrial Technology Center
- 2022: Dr. Liu Hongfei elected an academician of the Russian Academy of Natural Sciences

- 2022: Recognized as a Fujian Torch Gazelle Enterprise
- 2022: Certified as a Fujian technology-based small and medium-sized enterprise
- December 2021: Its Raman spectrometer won the Second Prize of Fujian Provincial Science and Technology Progress Award
- 2021: Dr. Liu Hongfei selected for the National Ten-Thousand Talents Program organized by the Central Organization Department 2021: OptoSky awarded Fujian Provincial Science and Technology Little Giant Enterprise
- 2020: Dr. Liu Hongfei included in the Innovation Talent Promotion Program of the Ministry of Science and Technology
- 2020: Led the formulation of the national industrial standard Visible and Near-Infrared Field Spectroradiometer
- 2020: Dr. Liu Hongfei certified as Class B high-level talent of Fujian Province 2019: Certified as a national high-tech enterprise
- 2019: Honored the Independent Innovation Gold Medal issued by China Instrument and Control Society
- 2019: Recognized as a Specialized, Sophisticated, Unique and Innovative micro and small enterprise in Xiamen
- 2018: Won Excellent Enterprise Award in the National Final of the 7th China Innovation and Entrepreneurship Competition
- 2018: Received the second prize in Xiamen Division, the 4th China Innovation and Entrepreneurship Competition
- 2018: Won Silver Award in Fujian Division and Bronze Award in National Final of the 5th World New Materials Innovation and Entrepreneurship Competition
- 2016: Included in Class A key high-level talent introduction project (highest tier), the 8th Xiamen Double Hundred Talent Program
- Listed on Strait Equity Exchange Market, Stock Code: 865147
- Certified compliant with ISO9001:2015 Quality Management System

- Participated in formulating national standards Raman Spectrometer and Hazardous Chemical Detector Based on Raman Spectroscopy Technology
- Undertaken the major marine economic collaborative innovation project Research, Development and Industrialization of Marine Three-Dimensional Monitoring Sensors and Systems sponsored by State Oceanic Administration with total funding of RMB 30 million
- Established strategic partnership with School of Electronic Science and Engineering, Xiamen University since 2017
- Served as undergraduate internship base and joint postgraduate training institution of Xiamen University of Technology since 2016
- Served as undergraduate internship base and joint postgraduate training institution of Jimei University since 2017
- Member unit of Fujian Young Entrepreneurs Association; director unit of Xiamen Young Entrepreneurs Association
- Implementation entity for industry-university-research cooperation projects of Xiamen
- Member unit of Xiamen Emergency Association

8. Contact Us

Company Name: Optosky (Xiamen) Optoelectronics Co., Ltd.

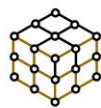
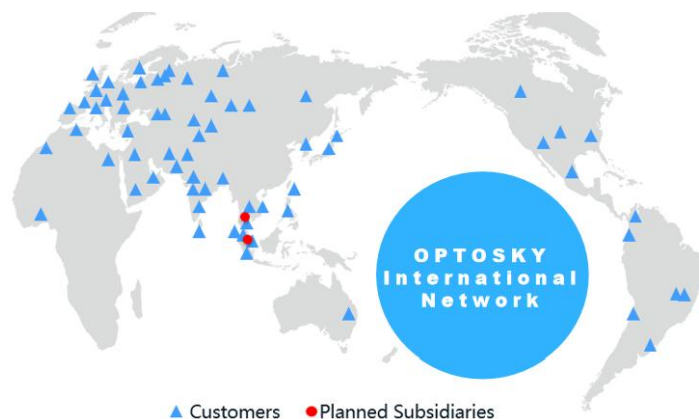
Address: 5th Floor, Building F02, Phase III of Xiamen Software Park, Jimei District, Xiamen

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China market and Global Distributors



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>70 countries



>260
Distributors



36%
share

=====The Essence of Exploration • Dedication to Authenticity=====

=====End of Article=====