Research on Water Quality Detection Technology Based on Multispectral Remote Sensing

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Abstract: In view of the characteristics of high cost and limited monitoring points of a river water quality, based on multi-spectral remote sensing technology and image data fusion theory, the river basin is taken as the research object. Using UAV to carry on panchromatic multispectral imaging system to carry out aerial photography of the basin, the data is transmitted to the ground station to process the image data in real time through the data transmission system, and the blue algae, aquatic vegetation and floating garbage in water are realized. The detection of water pollution of farmland and villages around the water body has the function of real time and geographical coordinate positioning. This load has been applied to sea, land and military stations, and has the value of further research and popularization.

1. introduction
Different ground objects have different spectral characteristics, and the radiation energy of the same object is different in different parts, so the images obtained are different. Multispectral remote sensing technology is a kind of photoelectric detection technology which rose in 1980s. It divides the electromagnetic wave of ground object into a narrower spectral section and obtains the information of different bands of the same target in the way of full picture or line sweep. The object of interest is extracted by spectral difference between target and background because of its "map in one" characteristic. In the field of agricultural and forestry monitoring, the essay analyzes the degree of deforestation, crop growth, yield, water regime of cultivated land, distribution, diseases and pests, etc. In terms of environmental monitoring, we can analyze the ecological situation of water quality. Hydrological distribution, chlorophyll distribution and suspended matter concentration, etc., in disaster assessment, the spatial distribution characteristics of building collapse and the relationship between building collapse and strong earthquake can be analyzed and evaluated deeply during the earthquake: the water supply with high sediment content and its flooded area can be quickly identified in flood and waterlogging disaster. In addition, other aspects such as urban planning, anti-terrorist stability, emergency monitoring, power inspection, oil exploration, land and resources, urban construction, etc\textsuperscript{[1]}

Multispectral remote sensor uses imaging technology and spectral technology to obtain image data of several or dozens of spectral bands. This kind of camera has been widely used in aerospace remote sensing\textsuperscript{[2]}. According to the difference of spectrum characteristic between water body and the other land covers, five extraction indexes including B1, B2, B4, NDVI and NDWI were selected, and dedication rules were identified\textsuperscript{[3]}. In order to monitor and evaluate the water quality of Weihe river in
Xi'an using remote sense, the essay used the multi-spectral remotely sensed images and the water monitoring data to establish a linear inversion model of the concentration of chlorophyll-a based on the remote sensing image, and to evaluate the through the single index evaluation method[4]. An adaptive method to extract urban water was proposed based on local iteration using high-resolution remote sensing image[5]. This [6] demonstrates the prototype of a near real-time early warning system using integrated data fusion and mining (IDFM) techniques with the aid of both hyperspectral (MERIS) and multispectral (MODIS and Landsat) satellite sensors to determine spatiotemporal microcystin concentrations in Lake Erie. The large size of Lake Winnipeg (the 10th largest lake in the world) and its susceptibility to algal blooms make satellite technologies indispensable in monitoring the quality of the lake's water. A deliberative control architecture is proposed which features a multi-model classification/regression system for the determination and forecasting of spatial distribution of water pollutants, in particular chlorophyll-a, and a cost optimizing path planner[7]. Multispectral sensors like MODIS offer a high number of spectral bands to detect, identify, classify and describe an oil spill event, and guarantee daily image frequency[8]. An unmanned aerial vehicle (UAV) with a multispectral imagery subsystem would offer the greatest balance of cost and utility for monitoring farmland[9]. According to multispectral high spatial resolution image, a one class support vector data description (SVDD) classifier is first trained. Pixels with anomalous spectrum are detected with this SVDD classifier. These pixels show that there exists pollution[10]. The model uses High-resolution multi-spectral remote SPOT-5 data and the water quality field data, chose four representative water quality parameters, RBF Neural Network is trained and tested, the parameters of RBF Neural Network are optimized by particle swarm optimization algorithms[11].

2. general planning

The airborne panchromatic multispectral imaging system is divided into two parts: aircraft and ground. According to the function module, it can be divided into multi-spectral imaging equipment, ground image processing subsystem, ground control and detection subsystem and so on. The multispectral imaging equipment includes multispectral camera subsystem, integrated management control subsystem, large capacity storage subsystem, distribution subsystem and stable platform subsystem.

![Fig 1. The system composition](image)

The integrated design scheme of airborne panchromatic multispectral imaging system with multi-spectral camera and stable platform is modular. The multispectral camera adopts multi-channel detector and multi-lens imaging mode, and the CMOS imaging device is selected. The shutter mechanism of the camera can be saved and the camera can be miniaturized. 5 groups of lenses are equipped with different spectral filters. The incident light is simultaneously separated into the corresponding detector. Five detectors are exposed simultaneously by the integrated management control subsystem, and five channels of image data are stored by five large memory. The airborne
panchromatic multispectral imaging system has an external communication interface and can be connected to wireless data transmission equipment for telemetry and remote data transmission.

Fig 2. The system function module

The ground image processing subsystem consists of off-line mode, that is, the correction, splicing, fusion, retrieval and display of the image data in the camera image memory in the ground workstation. The main functions include image correction, image stitching, target location, etc. Format conversion, etc. The image processing subsystem is divided into two kinds of workpiece modes: conventional and emergency. The difference between them lies in the difference of processing precision and speed. In the normal working mode, the main flow is as follows: reading image data, system radiation correction, image mosaic and fusion, format conversion, retrieval and display. Emergency working mode is a kind of working mode designed to facilitate and quickly view image information and provide decision basis for decision making method. In this mode, when an image is artificially selected for viewing, the system skips correction and splicing mitigation and immediately reads the image for viewing.

3. System composition

3.1. optical design
As an important part of camera optical system, optical window is very demanding for optical performance. In order to ensure the window has high optical performance in the atmospheric environment, it is required that the window structure is reasonable, the material matching, the processing and assembling errors are small, and the window should have good adaptability to the environment at the same time. The optical window assembly consists of optical window glass, window glass frame and window glass ring. According to the configuration of the camera and the requirements of the optical system, we ensure that the effective light is not occluded under the premise of ensuring the effective aperture of the optical lens. The three-dimensional model of the optical window glass design is shown in figure 3.
3.2. Architectural design
The multispectral imaging equipment consists of a multispectral imaging subsystem and a stable platform subsystem. The multi-spectral imaging subsystem mainly completes the multi-spectral imaging and data storage of the target, and the stable platform subsystem mainly completes the attitude adjustment of the multi-spectral imaging subsystem.

3.3. Electronic design
Multispectral imaging equipment is mainly divided into the following parts:

1) The stable platform control circuit stabilization platform can play an auxiliary role in shooting, eliminate aircraft disturbance, and limit angular displacement. The effect of attitude change and vibration on imaging quality is reduced. The stable platform is able to move horizontally and tumbles, enabling the multispectral camera to have vertical and squint imaging functions. The stabilization platform uses a two-axis and two-frame structure with an external inertial navigation module to provide the position and attitude information of the camera, which is convenient for attitude control and post-image processing.

2) The high precision synchronization of the control system of the integrated management and control subsystem of the management control circuit, including five groups of simultaneous exposure of the back, image acquisition, data acquisition with flight assistance, and stable platform control; Control camera parameters and working mode, control back image data transmission.

3) The large capacity storage subsystem is used to store images and flight auxiliary data. The memory contents include: storing image data, camera parameter information, task information, aircraft position, attitude, time, etc. Sheet number and other auxiliary information.

4) The secondary power supply circuit converts the 12V DC power supply provided by the UAV platform to the voltage needed for the operation of the system modules. The output voltage of the secondary power supply circuit is multispectral camera, stable platform, management control circuit and large capacity storage circuit.

3.4. Image design system
Architecture design refers to the relationship between the system and the external system and the logical structure of the system.
Image processing software is the software that performs fast processing task after completing the flight task, reads the file from the storage device, takes the self-defined TIFF data (including POS data, camera parameter data, image data, etc.) as the input, automatically recognizes the image format, and so on. All functions of the software are realized by custom TIFF files, and the functions other than geometric correction and route browsing are accomplished by common images. The results of image processing are displayed as images on the display device and can be stored in a specified location. The software needs the manual interaction of the user interface to confirm the input and reference of the function module. The user can use one of the single function modules independently and tie them together to form a logical process.

4. Ground quantitative test

There is a high correlation between chlorophyll content and cyanobacteria concentration in a river. It is feasible to detect cyanobacteria qualitatively using near infrared band for chlorophyll sensitive characteristics, see fig. 6, the correlation coefficient is over 99%.

The vegetation index and other discriminant indexes can be constructed by setting the camera spectrum segment. The increase or decrease of the index has a strong correlation with the change of cyanobacteria concentration, as shown in figs. 7 and 8. By constructing the ratio extrapolation, the correlation between the index and the change of cyanobacteria concentration is over 90%. The correlation between normalized vegetation index and cyanobacteria concentration was close to 93%.
The ground test verifies that according to the current spectrum setting, the quantitative relationship between the experimental group and the camera gray value is established by constructing the normalized vegetation index, ratio index and other models. Good results have been obtained. At present, in the application of remote sensing quantification, it is mainly faced with the problem that the quantitative model constructed in a specific environment can not be applied to other environments accurately. However, this experiment still proves that the camera spectral section setting has a good sensitivity to the concentration change of algae in water, and has the potential to develop the correlation application.

5. Scene imaging test

5.1. Experimental verification of ground photography
By imaging the cyanobacteria on the ground, it is determined that the camera has a good extraction ability for the coverage of cyanobacteria.

![Surface cyanobacteria extraction](image)

In fig. 9, (a) is true color fusion image of cyanobacteria water area, (b) is color infrared false color fusion image, (c) is spectral information segmentation and classification image, (d) is superimposed image and true color image after classification. Due to mineral ions, the water color itself is green. In the true color image, Shui Hua of cyanobacteria is not obvious, such as (a); Using the characteristics of high sensitivity to chlorophyll in near infrared band, the composite color infrared false color packet image was synthesized. It was found that cyanobacteria were clearly visible and bright red, which was clearly separated from water body, such as (b); The spectral information difference is used to segment the image, and after classification, the coverage area of cyanobacteria is obtained. For example, the (c); overlay the extracted coverage area with the true color image. The real area covered by Shui Hua, such as (d), can be observed.

5.2. Aerial test verification
The aerial images of this system have good sensitivity to aquatic vegetation and algae such as cyanobacteria Shui Hua and Enteromorpha and can be used to quickly distinguish the coverage of Shui Hua and distinguish the different concentrations of Shui Hua as shown in Fig. 10.
6. Conclusion

The airborne panchromatic multispectral imaging system is proved to be capable of detecting Shui Hua and aquatic vegetation by ground quantitative fitting, ground photography and aerial test. The technology is ability to judge the non-point source pollution sources such as agricultural fields (pesticide non-point source pollution sources), villages (domestic sewage sources) and other pollutants around the water body, the ability to distinguish pollutants such as floating garbage, etc. The three-dimensional point cloud reconstruct ability of water body surrounding topography and geomorphology and buildings (such as water conservancy facilities).

Airborne panchromatic multispectral imaging system has a good imaging resolution, clear imaging, the ability of mass production of true color image and color infrared image, which is easy to read; It has high accuracy and controllable cloud head, and has the ability of vertical view and tilt photography, so it has high application value in remote sensing application field of water basin.

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