Research on Photogrammetry and Remote Sensing Technology Based on Wavelet Analysis

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Abstract. At present, photogrammetry and remote sensing tech are undergoing the transformation of digitization, intelligence and informatization. Remote sensing and photographic info are continuously developed and utilized more fully, so that the scope and depth of its utilization can be further expanded and strengthened. The utilization of wavelet analysis in remote sensing photographic images has achieved remarkable results. Based on this, this paper first analyzes the concept and principle of wavelet analysis, then studies the connotation of photogrammetry and remote sensing tech, and finally gives the typical utilization of wavelet analysis in photogrammetry and remote sensing tech.

Keywords: Photogrammetry, Remote Sensing Tech, Wavelet Analysis

1. Introduction
With the progress and development of society, especially the accelerating process of urbanization, many fields represented by urban planning, ecological monitoring, environmental protection, agricultural and forestry production and disaster assessment are increasingly inseparable from the assistance and support of photogrammetry, remote sensing and other technologies. Among them, remote sensing tech, as a comprehensive professional field, has been widely and deeply applied in many fields with the support of spatial info discipline in recent years [1]. On the other hand, as an important supporting tech of Earth Science and environmental science, the acquisition of remote sensing info and remote sensing data need to further strengthen the coordination, especially the use of digital tech to integrate the mechanism of photogrammetry and realize the organic integration of multi-channel photogrammetry and remote sensing tech.

As a typical process of reading to obtain info, the core concept of remote sensing tech is to collect and analyze the data of the measured target through various sensors to obtain detailed data info. Remote sensing tech has many utilization advantages as shown in Figure 1 below, so it has been deeply studied and popularized in many fields, and achieved remarkable utilization results. At present, photogrammetry and remote sensing tech are undergoing the transformation of digitization, intelligence and informatization, which makes remote sensing and photographic info more fully developed and utilized, and further expands and strengthens the scope and depth of its utilization.

In addition, photogrammetry and remote sensing tech become more and more complex and systematic with the development of info and intelligent tech, and the data sources are more and more
diversified. Because remote sensing images contain rich info and usually contain a variety of perspectives, it is necessary to further fuse these photographic data, so as to lay a foundation for subsequent image analysis [2]. Wavelet analysis is an important method of multi-source remote sensing photogrammetry. Its utilization in the field of photogrammetry and remote sensing can effectively realize the fusion of target features and decision-making, so as to help realize the understanding and processing of image info. Therefore, it has irreplaceable utilization value in the field of remote sensing and photogrammetry.

In a word, the utilization of advanced mathematical model represented by wavelet analysis in the field of remote sensing and photogrammetry makes remote sensing photogrammetry and data fusion obtain more remarkable results. Multi-source remote sensing photogrammetry and enhancement based on wavelet analysis can obtain good results, and the organic combination of wavelet analysis and transform algorithm further enhances the feature info of photographic and remote sensing images [3]. Different fusion algorithms have different characteristics and utilization advantages. Therefore, studying the applicable conditions of wavelet analysis algorithm has important practical value for further promoting the development of photogrammetry and remote sensing tech.

![Figure 1. Utilization advantages of remote sensing tech](image)

2. Concept and principle of wavelet analysis

2.1. Concept of wavelet analysis
As the continuation and development of Fourier analysis, wavelet analysis is an amelioration of Fourier analysis. The development process of wavelet analysis is an intuitive reflection of the mutual integration of disciplines in the era of big science. Fourier analysis is suitable for dealing with very stable periodic signals, while wavelet analysis is suitable for dealing with rapidly changing highly unstable signals [4]. For the sub stable signal, that is, it can be predicted in a certain period of time, it needs to integrate the characteristics of Fourier and wavelet analysis to process it effectively. In addition, it is not necessary to use wavelet analysis for signals with regular and stable changes for a long time. The traditional wavelet is not necessarily more accurate than STFT in extracting and identifying high frequencies. STFT cannot meet the orthogonality, and its window size is fixed, which lacks the soft adjustability of wavelet analysis window [5].

2.2. Definition and principle of wavelet analysis
Wavelet is a function defined at finite intervals and the average value is zero. Let the function \( \psi(t) \) be a wavelet function. If it satisfies the following equation 1, it is called the parent wavelet function. By stretching and translating the \( \psi(t) \) function, the following equation 2 is obtained, in which variable \( a \) is the scale function and variable \( b \) detects the translation position along the \( t \) axis. \( \psi_{a,b}(t) \) constitutes a set of orthogonal wavelet bases of \( L^2(R) \), which is called wavelet function, or wavelet for short. If
wavelet is properly selected so that $\psi(t)$ is limited in time domain and $\hat{\psi}(\omega)$ is concentrated in frequency domain, WT can have the ability to characterize the local characteristics of signals in time and frequency domain.

$$\int_0^{+\infty} \frac{|\hat{\psi}(\omega)|^2}{\omega} d\omega < +\infty$$  \hspace{1cm} (1)

$$\psi_{a,b}(t) = |a|^{-\frac{1}{2}} \psi\left(\frac{t-b}{a}\right) \quad a,b \in \mathbb{Z} \hspace{1cm} (2)$$

2.3. Utilization of wavelet analysis

The advantage of wavelet analysis is that it is a universal analysis tool and has achieved remarkable results in many fields. Numerous wavelet functions provide a broad space for the free selection of wavelets. Wavelet analysis has a wide range of utilizations, including but not limited to many disciplines in the field of mathematics, AI, classification & recognition, seismic exploration data processing, fault diagnosis of large machinery, etc [6]. In mathematics, wavelet analysis is mainly used in numerical analysis, constructing fast numerical methods, constructing curves and surfaces, solving differential equations, cybernetics and so on. In image processing, image compression, classification, recognition and diagnosis, decontamination, etc.

3. Research on photogrammetry and remote sensing tech

3.1. Concepts of photogrammetry and remote sensing

As the predecessor of remote sensing tech, the goal of photogrammetry is based on photo measurement and interpretation. It is a science and tech to study and determine the shape, size, position, nature and relationship of the subject using the images taken by optical or digital cameras. Photogrammetry carries out measurement and interpretation on the image without contacting the measured target object itself, and strictly establishes the geometric relationship between the image point and the corresponding object point at the moment of image acquisition.

Remote sensing measures the geometric and physical properties of objects through non-contact sensors. Remote sensing tech is mainly composed of remote sensing image acquisition tech and remote sensing info processing tech [7]. Photogrammetry and remote sensing record measure and interpret the images and their digital expressions obtained by non-contact sensor system, so as to obtain reliable info of natural objects and environment.

3.2. Fundamentals of digital photogrammetry

Image digitization and image re-sampling are the measurement process of discretization of the actual continuous function model. The core of digital photogrammetry is to automatically identify the image points with the same name between two images, and complete the image correlation by means of computer numerical calculation of digital images [8]. The calculation principle of the image matching method represented by covariance is shown in equation 3-4 below. Calculate $(l-n+1) \times (m-n+1)$ covariance differences. When the covariance value is the maximum, the midpoint of the corresponding correlation window is the image point with the same name of the undetermined point.

$$\begin{align*}
\sigma_{gg'}(k,h) &= \frac{1}{n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} g_{ij} g_{i+k,j+h} - \overline{gg'} \overline{gg'}^t
\end{align*}$$  \hspace{1cm} (3)
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In addition, the polynomial

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parameters is used to force

the complex deformation

surface. Through the least

square fitting, the difference

between the deformation value

at the control point and the actual

value is minimized. The adjustment

solution is used to calculate the

coefficients of the polynomial correct the coordinates and eliminate the influence of the error.

4. Photogrammetry and remote sensing tech based on wavelet analysis

4.1. Image edge feature extraction based on wavelet analysis

With the rise of remote sensing tech, photogrammetry has made remarkable progress. The combination of photogrammetry and remote sensing, especially the high-precision geometric positioning and geometric correction of remote sensing images, accelerates photogrammetry to realize multi temporal, multi-sensor and multi-resolution composite and geometric registration [10]. Remote sensing image edge feature extraction plays a very important role in image info interpretation and processing. Wavelet transform has a good detection effect on all kinds of signal mutation points, which can ensure that all mutation points in the image can be detected. Using the multi-resolution characteristics of wavelet and first-order differential operator, various image edges can be extracted effectively. The process of image edge extraction based on wavelet transform is shown in Figure 2 below.

\[
\overline{g} = \frac{1}{n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} g_{ij} \\
\overline{g}^k_h = \frac{1}{n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} g_{i+k,j+h} 
\]

3.3. Photogrammetry and remote sensing processing system

The functions of photogrammetry and remote sensing processing system are image digitization, image preprocessing, coordinate measurement, image orientation, automatic aerial triangulation, image matching, establishment of digital ground model and its editing and automatic contour drawing [9]. Secondly, the coordinates of the common points of the adjacent model in the image space auxiliary coordinate system should be equal, the scale reduction coefficient is calculated, and the coordinates of the model points in the unified navigation belt image space auxiliary coordinate system are obtained. In addition, the polynomial composed of undetermined parameters is used to force the complex deformation surface. Through the least square fitting, the difference between the deformation value at the control point and the actual value is minimized. The adjustment solution is used to calculate the coefficients of the polynomial correct the coordinates and eliminate the influence of the error.

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the affected edge in the process of eliminating remote sensing image noise. Finally, the combination of wavelet theory and ANN can significantly ameliorate the accuracy of remote sensing image interpretation.

5. Conclusion
In summary, wavelet analysis is an important method of multi-source remote sensing photogrammetry. Its utilization in the field of photogrammetry and remote sensing can effectively realize the fusion of target features and decision-making, so as to help realize the understanding and processing of image info. Through the analysis of the concept and principle of wavelet analysis, this paper studies the definition and principle of wavelet analysis. Through the analysis of photogrammetry and remote sensing tech, the value of photogrammetry and remote sensing processing system is analyzed, and the typical utilization of wavelet analysis in remote sensing photogrammetry is further studied.

References
[1] Yili Hamu Yarmaimai, Xie Lirong, Kong Jun. remote sensing remote sensing photogrammetry method based on PCA transform and wavelet transform [J]. Infrared and laser engineering, 2014 (07): 2335-2340.
[2] Yuan Hua, Zhang Wanqiu. Research on remote sensing remote sensing photogrammetry tech based on wavelet transforms [J]. Computer knowledge and tech, 2011 (02): 421-423.
[3] Gao Xiaofeng, Zhang Jianfeng, remote sensing image processing and analysis based on MATLAB and wavelet analysis [J]. Microcomputer info, 2016, 22 (3): 25-26.
[4] Gong Jianzhou, Liu Yansui, Xia Beicheng, Chen Jianfei. Response of fusion quality of multi-source remote sensing images combined with IHS and wavelet transform to the number of wavelet decomposition layers [J]. Chinese Journal of image and graphics, 2010 (08): 1269-1277.
[5] Liu Chunping. A multi-source remote sensing image classification method based on info fusion [J]. Computer utilization, 2017, 27 (8): 11-12.
[6] Li Yinqing, Li Lingling, quantitative evaluation method of remote sensing photogrammetry quality [J]. Chinese Journal of inertial tech, 2017, 15 (6): 6-8.
[7] Lian Jing, Wang Ke, utilization of multi-scale image edge detection tech in vehicle recognition [J]. Highway traffic tech, 2017, 24 (9): 6-17.
[8] Hisham Othman, Shen-En Qian, Noise Reduction of Hyperspectral Imagery Using Hybrid Spatial-Spectral Derivative-Domain Wavelet Shrinkage [J].Geoscience and Remote Sensing, 2016,44(2):11-12.
[9] Lv Ruilan, Wu Tiejun, Yu Ling, performance analysis of threshold denoising method using different wavelet generating functions [J]. Spectroscopy and spectral analysis, 2014, 24 (7): 11-12.
[10] Li Xuchao, Zhu Shan'an, overview of image denoising in wavelet domain [J]. Chinese Journal of image graphics, 2016, 11 (9): 5-6.