Research on Fine Processing of side Scan Sonar Image and Target Recognition Method

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Abstract: As one of the important information sources reflecting the topography and landform of the seabed, the sonar image of the seabed bottom quality has great guiding significance and research value in the field of deep sea exploration. Nowadays, image recognition technology is paid more and more attention. Technical methods such as extracting the features of the target area from the image for target segmentation and feature enhancement, or combining with effective classifiers for feature classification and target recognition are applied to all aspects of real life and production. Obtaining image information and establishing a multi-dimensional objective description of the image has far-reaching significance and value. Based on a comprehensive understanding of the imaging principles and image characteristics of the side-scan sonar bottom quality image, this paper takes into account factors such as the seabed environment, noise characteristics and feature types, and forms a process in accordance with the procedures of denoising enhancement, feature extraction, and recognition and classification. The complete system of sea bottom quality data processing and analysis based on side scan sonar images reveals the characteristic differences and classification criteria of multiple types of sea bottom quality data, and provides theoretical methods and technical support for the accurate identification and correct classification of sea bottom quality information.

1. Introduction

With the rapid development of sonar technology, submarine sonar images can contain richer submarine geomorphology and bottom quality feature information. The inversion of submarine topography and geomorphology based on submarine sonar images is of great significance for submarine exploration, underwater operations, shipwreck salvage, and deep sea protection. The recognition of the bottom quality of the seabed largely relies on the feature parameters extracted from the sonar image, and the classification of bottom quality images is based on this. However, limited by the underwater complex sound field environment and the performance of sonar equipment, sonar images have serious speckle noise interference, blurred edge features, low contrast, and uneven brightness. This is the research on seabed bottom quality sonar image processing and bottom quality classification inversion. Issues that need urgent attention. Therefore, it is necessary to select an appropriate method to remove the interference of ocean noise on the submarine sonar image, extract the main feature information of the image, and select multi-dimensional feature parameters and classification algorithms to achieve bottom quality classification and inversion. In my country, research on side scan sonar systems began in 1970, and side scan sonar systems for multiple needs have been developed so far. The side scan sonar continuously collects the intensity of the seabed echo signal during navigation, which can reflect the changes in the size, shape, and undulations of the underwater topography in a certain area, so that the seabed environment can be more realistically presented. The intensity of the echo received by the side scan sonar is mainly the bottom reverberation. The reverberation formed by the rough bottom surface and various scattering objects near the bottom of the bottom is a random signal, which contains speckle noise that seriously interferes with the image quality. The preprocessing of sonar images including denoising enhancement and other links is an important process for optimizing visual effects, facilitating image interpretation and assisting decision-making. It also lays the foundation for feature extraction and analysis, target recognition, and segmentation

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classification.

2. Sonar Image Processing and Analysis Methods

The sound waves emitted by sonar propagate through the underwater acoustic channel formed by sea water and underwater. The water medium and boundary have extremely complex characteristics. At the same time, it is limited by the underwater complex sound field environment and the working characteristics and performance of sonar. It has the characteristics of low resolution, severe noise interference, and deterioration of edge texture. Therefore, the sonar image needs to be preprocessed before image analysis. Image preprocessing algorithms can be divided into four categories: geometric transformation, pixel gray level transformation, local processing and image restoration. There are different processing methods based on different research purposes. . Taking into account the characteristics of side scan sonar images, image denoising, correction enhancement and edge sharpening are more common preprocessing methods. For image analysis for the research purpose of sediment classification, select the feature value extraction of the preprocessed repaired image to obtain more specific feature parameters, and use one or more methods to extract the image feature parameters to form the image feature The vector is used as the input of the classifier, and the characteristics of different types of bottom quality are learned and trained through the classifier's own learning strategy, and finally an accurate model with recognition and classification functions is obtained to achieve the purpose of classification of bottom quality images.

Traditional image denoising methods are divided into spatial domain image denoising and frequency domain image denoising. Spatial domain denoising includes methods such as mean filtering, median filtering, Wiener filtering, etc. The basic idea is to obtain the mean or median of the sonar image pixel gray level to achieve the purpose of noise reduction. With the in-depth study of spatial denoising methods by scholars, new improvements have been proposed to traditional spatial denoising methods. For mean filtering, weighted mean filtering, K-neighbor averaging, gradient reciprocal weighted smoothing, etc. are proposed; for median filtering Proposed weighted median filtering, multi-level median filtering, adaptive median filtering and recursive median filtering methods. Frequency domain denoising uses the different distributions of noise and signal in the frequency domain for filtering processing to obtain them by frequency division. In general, the main information of the image is stored in the low frequency part, and the details, edges and noise of the image are stored in the high frequency part. When high frequency denoising, it is necessary to consider the maximum preservation of edge details and other information, which is called sonar image denoising the key is also difficult. While the traditional low-pass filtering method filters out high-frequency components, it also loses high-frequency detail information, which makes the image blurry, and brings difficulty to the identification of image feature information. In order to overcome the disadvantages of traditional denoising methods, people use wavelet transform technology for image denoising processing. Wavelet transform technology is a mathematical transformation method that uses wavelet functions to analyze the signal in the time and frequency domain. It can be regarded as the original signal and the scale. The stretched wavelet function family and scale function are convolved, and wavelets with different time-frequency widths are used to fit each part of the original signal to realize the localized analysis of the signal. From the perspective of filters, wavelet transform can be regarded as the original signal filtered by wavelet bandpass filters of different scales, and the signal is decomposed into different frequency bands. It has better time resolution in the high frequency band of the signal. The low frequency band has better frequency resolution, so that effective information can be extracted from the signal.

3. Research on the Preprocessing of Submarine Bottom Sonar Image

In order to analyze the impact of non-original sonar images as input data on this research, this experiment is specially designed to explore the noise and feature differences between the original image and the PDF generated image, and to reproduce the process of extracting bottom quality sonar images from the literature for experimental research . In order to get closer to the most obvious visual texture features of the bottom quality image, the desert image was selected for experimentation. The size of the sonar image used in most research institutes is about 100×100, and the image of this size is also used for experimentation here. One of the processes that is easy to generate interference information is the process of synthesizing the original image into a PDF file, that is, the process of generating documents from the original document; the other process is the process of intercepting the bottom quality image, that is, the process of obtaining the bottom quality image from the document. The actual operation sequence is opposite to the theoretical process. First, verify the impact of the screenshot process, and then verify the impact of the generated file, design experiments and verify the above two processes. 1) The process of capturing the image The original desert image is Image1, and the image is captured to Image2. Because the process of capturing may cause changes in the grayscale and brightness of the image, the main purpose of the process is to explore the impact of the process of capturing the image on the grayscale. Perform gray-scale conversion on the two images in Matlab, and change the RGB image to gray-scale image. In order to minimize the error caused by the inaccurate edge of the screenshot, take a sub-image composed of 100×100 pixels in the center of the image for experiment. The digital matrix dimensions corresponding to the gray-scale sub-images are the same, and algebraic operations can be performed. Performing the difference calculation on the two, the result is that the maximum grayscale difference is 8 and the minimum value is 0, which is equivalent to 3.1% grayscale error in 256 grayscale levels, including screenshot misalignment. The error is considered to be within the acceptable range.

The above experiment can prove that the effect of the screenshot process on the gray level of the image is within the allowable range, and the gray level related features of the image can be extracted. The process also proves that taking screenshots from the PDF file will not cause excessive interference to the image displayed in the PDF file. The original desert image is Image1. The PFD file is intercepted to obtain the image Image3, and the gray scale conversion is also performed. In order to explore the generation of electronic noise in the synthesis file and screenshot process, the wavelet transform that can better reflect the image information and noise is selected for the two images. The image undergoes wavelet three-layer decomposition to obtain the energy ratio of each scale channel. Observe the noise generation through the high frequency energy ratio in each direction, and use Gaussian filtering, median filtering and wavelet transform to denoise the screenshots.

4. Research on Multi-Feature Extraction of Bottom Texture Images

The gray-scale changes of sonar images of different types of bottom quality show randomness in a local area, and a certain regularity in a large area, forming a spatially repeated and visually perceptible texture feature, which makes the image The different regions in the can be identified based on texture features. For example, the rocky seafloor has undulating ridges and joints, strong gray scales and stripes, and the sandy gravel ripples show directional light and dark stripes. The overall brightness of the muddy seafloor is low and there are local blocky bright spots undulating, fine sand The whole is flat, showing uniform and small bright spots, the overall gray scale of the vegetation is low, and there is a certain crown shadow undulation. Affected by many factors, the analysis based on the gray level information of a single pixel has great limitations, and the analysis based on the average gray level information of the entire area may not get accurate results. Usually, it is necessary to analyze the bottom quality. Consider direct statistical features and spatial features of pixels. In actual research, one type of image feature cannot fully express the characteristics of the bottom quality or serve as the only classification standard for multiple types of bottom quality. Therefore, this paper intends to adopt a variety of feature analysis methods to establish multi-scale, multi-directional, and multi-dimensional feature vectors to fully capture the diversity, direction and roughness of sonar image feature changes, and to maximize the accuracy of submarine bottom quality classification. rate.

The submarine sonar image is a gray-scale image. The sonar system converts the received echo intensity into the image gray value. The difference in the reflection coefficient of the submarine bottom causes the image to have a certain brightness change, so the gray-scale information can reflect to a large extent Draw out the differences of different types of sediments. The gray level co-occurrence matrix is a very classic and practical texture analysis method based on the second-order joint conditional probability density function of the image. It analyzes the local pattern and arrangement rules of the image, because it has good performance in image feature analysis. It has been widely used in related research at home and abroad. The gray-level co-occurrence matrix describes the probability correlation between pixels and gray levels separated by a certain distance in the image and at a certain inclination angle. It describes the comprehensive information of the image gray level with respect to the direction, adjacent interval, change range, etc., and reveals the image brightness Compared with the frequency content described by the Fourier transform, the gray-level co-occurrence matrix has a more intuitive advantage in describing the gray-level distribution characteristics of the bottom texture image of the seabed. The extraction of the characteristic parameters of the seabed bottom quality image through the gray level co-occurrence matrix is mainly completed in two steps: firstly, the moving window is selected to generate the gray level co-occurrence matrix; and then the statistical feature quantity is calculated for each gray level co-occurrence matrix.

5. Conclusion

Based on the understanding of the imaging principles and image characteristics of the side-scan sonar seabed bottom quality image, this paper considers the image content of the seabed environment, noise characteristics and feature types, and summarizes the bottom quality sonar image research methods from many aspects. Propose a complete system of bottom quality sonar image processing and analysis including denoising enhancement, feature extraction, recognition and classification, and reveal the characteristic differences and classification criteria of multiple types of bottom quality data, so as to accurately identify and correct bottom quality information. The classification provides theoretical methods and technical support, and also proves the application prospects of this complete system. The work and results of this paper are as follows: Introduce an image denoising method with stronger edge preservation. When performing preprocessing including denoising and enhancement on the bottom quality side scan sonar image, consider the extraction of image features in the subsequent steps, and introduce the sorting adaptive median filter algorithm. Compared with the traditional median filter, the edge information and the Noise is treated differently: median filtering is performed on the noise, and the gray value of the edge information is kept unchanged. This method has less damage to the edges, softer processing of the edges and noises of the same gray transition part, and has achieved better results than median filtering, which guarantees the subsequent extraction of seabed bottom quality parameters. . At the same time, spatial and frequency domain methods are used to pre-process the image.

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