Submarine Target Recognition Based on Gps Positioning System

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Abstract. With the development of transportation and the rapid spread of travel tools, economic exchanges around the world have become more frequent. The Global Positioning System (GPS) is an all-weather, high-precision, wide-coverage electronic navigation device that plays an important role in identifying submarine targets. The key technology of GPS is the real-time accurate extraction of targets, and the essence of target extraction is image segmentation. In order to achieve the purpose of seabed target recognition, a simple and effective method is proposed. In this paper, image points of active target image features are calculated by image processing to achieve positioning of the target. The neural network is used to establish the coordinate correspondence of the target from the image space to the GPS positioning system space to locate the submarine space moving target. Based on the positioning principle of GPS technology, the navigation technology of submarine target recognition is studied. A multi-target detection experiment for submarine target location was carried out. The results show that the multi-target recognition and positioning system based on GPS positioning system combined with sonar image design, the target recognition accuracy rate is over 93%, which meets the technical requirements of the detection system. Improving the identification of submarine targets is important.

1. Introduction

GPS technology is widely used in various fields such as military and aviation, but it has to achieve various purposes [1-3]. It must have three elements of GPS terminals, transmission networks and monitoring platforms. These three are indispensable, and the GPS terminal must be able to accept GPS signals as well as be able to process and output. As people's activities on the ocean become more and more important, the ocean is increasingly showing important economic value and national defense value, so the understanding of strengthening the ocean has become more and more urgent [4]. Since the 1990s, countries around the world have increased their investment in marine research, and sonic is currently the only energy source that can be used for long-distance transmission in seawater. Therefore, sonar technology came into being [5]. This is an important means of detecting and identifying sensitive military targets. The detection and identification technology of underwater targets is also one of the important directions for ship and ocean engineering research in the future. Sonar technology is
not only used in land detection, underwater weapon guidance and confrontation, underwater navigation and other military fields, but also has great commercial value in detecting fish and shrimp groups and conducting resource exploration [6-8].

In the research of target recognition related technologies, target recognition and localization technology is an important research field [9]. Image recognition based recognition and localization technology is a hot topic in the field of robot research in recent years. Image information has a wealth of information and a comprehensive description of the scene. It is an important source of target recognition and perception environments, so real-time image perception is in target recognition. Navigation technology plays an important role [10, 11]. In recent years, with the rapid development of image processing technology and computer processing capabilities, visual recognition and positioning has become one of the main development directions in the field of robot recognition and positioning [12]. In actual off-shore operations, due to the large sea-sweeping area of the sonar, if the target is detected and identified by hand, there will be problems of high complexity, large workload, and increased detection and identification time. Staff members will report suspicious targets in a false or false state under fatigue.

This paper introduces the submarine target recognition based on GPS, and summarizes the latest progress in the study of submarine sediment classification using side scan sonar images. It proposes a submarine bottom that combines the phase spectrum containing the details of the image structure with the gray level co-occurrence matrix. Use texture representation and extract feature vectors by applying principal component decomposition. The organic integration of statistical and structural information increases the accuracy of identification. In the submarine target detection, the side scan sonar image is severely disturbed by the seabed reverberation. The spectral peak size of the dual spectrum in the high-order spectrum is proposed as a method for judging whether the target exists in the image. Using higher order spectra suppresses uncorrelated noise in the background of the image and enhances the high-order correlation of the target. It can effectively detect the presence of targets in images of different parameters in the side scan sonar system.

1.1 Method

1.2 Gps Positioning System

GPS is a new type of military satellite navigation system jointly developed by the US Department of Defense. It is the second generation satellite navigation system in the United States. It consists of a GPS satellite constellation (space part), a ground monitoring system (control section) and a GPS signal receiver (user part). The GPS satellite orbit is 6 aircraft, each aircraft is evenly distributed with 4 satellites, a total of 24 satellites, which is four times the number of meridian satellites, undulates at a height of 20,000 kilometers, and can run continuously on the satellite for about 5 hours. Vision. Each user can receive 4 to 12 GPS satellite navigation signals from anywhere at the same time. In China, 5-8 GPS satellites can be seen all day, which is very convenient for Chinese users, and can be continuously navigated and positioned throughout the day. GPS positioning consists of terrestrial radio signals transmitted to the satellite to form a satellite positioning and navigation system. The principle of radio ranging and rendezvous is used to transmit more than three control points to satellite positions. Otherwise, the spatial location of more than three satellites will be used to receive ground users. In the position of the machine, the positioning principle is the basic principle of triangular positioning.

The signals transmitted by the GPS satellite mainly include a carrier signal, a ranging code and a navigation message, and a correspondence relationship between the transmission parameter N of the signal and the user distance error URA. The GPS receiver receives the tracking signal and edits the station's 3D speed, time and coordinate position. The new GPS receiver is getting smaller and smaller in size and weight. Even when performing accurate relative positioning, even GPS geodetic receivers perform dual relative frequencies. The receiver can have a frequency of 5mm + 1 x 10^-6D and a compatible GPS receiver has been invented. At some point, the user simultaneously receives more than three satellite signals using a GPS receiver to measure the location of the station P. The
intersection method solves the three-dimensional coordinates \((X, Y, Z)\) of the P point. The observation equation is the formula (1):

\[
\rho_i^2 = (X - X_i)^2 + (Y - Y_i)^2 + (Z - Z_i)^2
\]

The formula (1) is not the only way to solve the three-dimensional coordinates. During the GPS positioning process, the satellite continues to run at high speed, and its coordinate values change in different time periods. The principle of satellite ranging mainly includes pseudorange positioning, carrier phase point and differential GPS positioning. The positioning method should adopt the positioning method according to the actual situation.

1.3 Side Scan Sonar Image Feature Extraction and Recognition

Since the side scan sonar system is affected by many factors during the drawing process, manual interpretation methods have been used in the past. The subjectivity of man-made makes the interpretation inaccurate or even incorrect, which brings hidden dangers to marine engineering. If the underwater autonomous operating platform transmits sonar image data to the water and interprets it manually, it will take up limited underwater communication channel bandwidth and will not guarantee real-time operation. Therefore, the development direction of side scan sonar image interpretation is fast and accurate unsupervised automatic recognition. With the development of marine mapping technology, the application of side scan sonar is more and more widespread and popular. At present, the detection and location of large submarine targets, seabed sediment structure detection, offshore oil exploration, waterway drainage, marine environment detection, marine fisheries, etc. have played an important role in this regard, and are indispensable part of underwater intelligent robot sounds. Detection Systems. The high-resolution side-scanning sonar submarine image can well reflect the topographic and texture information of the seabed and can be used for seabed sediment classification. The gray level of the side scan sonar image corresponds to the seafloor echo intensity. The echo intensity is a complex physical quantity related to various factors such as the transmission power, the type of substrate, and the angle of incidence. Different types of substrates may have the same echo intensity, so it is not practical to use a single gray value to characterize the classification of the substrate. The texture of the sonar image with different substrates was found to be different, so the side scan sonar submarine classification mainly uses image texture information indicating the surface roughness of the seabed surface.

The main task of texture analysis is to extract quantitative features that reflect the texture characteristics of the image. After long-term research, a variety of texture feature extraction methods have been proposed, which can be divided into statistical methods, structural methods and model methods. The statistical method is based on the statistical property of the spatial distribution of gray values in the image as a texture feature. Commonly used statistical methods include gray level co-occurrence matrix method, texture energy measurement method, fractal geometry method, local Fourier transform method, high-order statistical method and so on. The disadvantage of the statistical method is the large amount of calculation. The structuring method is to treat texture primitives as a result of repeated repeating texture primitives according to specific rules. The difficulty of the structural method is whether it can effectively extract texture primitives and describe their repetition laws. The model method expresses a texture image by a linear combination of probability distributions or basis functions. The coefficients of the model are used to describe the texture information of the image, mainly including the Markov model and the two-dimensional autocorrelation model. The difficulty of the model approach lies in the choice of the texture image model and the best estimate of the model coefficients.
2. Experiment
In order to verify the validity of the target's spatial position and motion parameter estimation algorithm relative to the seabed, a simulation experiment was carried out on the target state. It can be seen from the above-mentioned ocean space coordinate model that there is a one-to-one correspondence between the coordinates of the target on the image and the coordinates of the target relative to the GPS positioning coordinates. In this paper, the CAN bus is used to implement communication of the main part of the system other than GPS. After the feature matching, the mutual mapping relationship between the feature points of the sea bottom target image can be known, and the corresponding transformation relationship of the sea bottom target image, that is, the region where the target object is located, can be obtained by calculation. The images located in the scene can be calculated. In this paper, the rough positioning of the target is completed according to the homography matrix between the seabed template image and the scene image. However, the calculation result of the homography matrix calculated by the RANSAC algorithm is random, that is, there is a certain error, and the estimation error of the homography matrix will directly lead to the error of the target positioning result. According to the preliminary positioning results, the target segmentation, edge detection and minimum connection rectangle are obtained by using the edge shape information of the target, and finally the centroid coordinates of the target are obtained to achieve more accurate target positioning. Table 1 shows the results of the precise positioning of the target. The positioning error of the target in the X-axis direction is 3 pixels, the positioning error in the Y-axis direction is 2 pixels, and the deflection angle error is 0.2 degrees. Table 1 lists the functional descriptions of the mode registers.

Table 1 Mode Register Function Description

| MOD.0 | MOD.1 | MOD.2 | MOD.3 |
|-------|-------|-------|-------|
| RR    | RIE   | TIE   | EIE   |
| MOD.4 | MOD.5 | MOD.6 | MOD.7 |
| OIE   | Reserved | Reserved | Reserved |

3. Discuss
The specific process of determining the target in this paper is to use the matching tracking algorithm for the submarine signal to analyse the time-frequency of the signal. A filtering method fits the polarization mode of the wave to verify the presence of ocean waves. If there is a submarine wave, the wavelet is extracted according to a statistical method, and the seabed target is determined according to the wavelet frequency. In the experiment, 54 and 49 test data were collected for target 1 and target 2, respectively, and the ship was identified by wavelet extraction. Among them, the number of correctly identified target 1 is 49, and the probability of correct recognition is 90.7%. The number of correctly identified targets 2 is 42 and the probability of correct recognition is 89.4%, as shown in Table 2. In general, the correct recognition rate of target 1 and target 2 is very high, especially the probability that the target 1 ratio is higher than target 2.

Table 2 Proper Identification Of Seabed Target Probability

| Submarine target | Number of experiments | Correct recognition times | Correct recognition of probability |
|------------------|-----------------------|--------------------------|----------------------------------|
| Target 1         | 54                    | 49                       | 90.7%                            |
| Target 2         | 49                    | 42                       | 89.4%                            |

This paper uses GPS to locate the submarine wave frequency to determine the target. The main purpose of GPS positioning and water body and formation separation of sonar images is to separate regions of larger variation in the image. In actual ocean exploration, sonar is not only a necessary condition for detecting objects in water, but also a necessary condition for detecting objects in the formation. Due to the large difference between the water body and the formation environment, the
noise of the ocean is usually small, the target is easy to detect and distinguish, and the reverberation of
the formation is more serious, which makes the detection of the target extremely difficult. Since the
environment in seawater is relatively simple, the difference between the target and the water body is
obvious, and it is easier to detect whether the target exists. The interior of the formation is complex,
especially the interface between the formation and the water body is affected by reverberation and
chaos. The background image has a serious impact on the target area, which is not conducive to
judging whether the target exists or not, and is not conducive to the quantitative analysis of the target.
Therefore, by segmenting the entire sonar image, the image of the water body portion and the image of
the formation portion can be separated, and then the mathematical morphology operation is performed
on the features of the segmented binarized image to reduce noise and reverberation interference. In
order to obtain a more accurate interface between the water body and the formation, it is convenient to
locate and identify the water body and the formation later. The simulation verifies the feasibility of the
method. The seismic tracking signal is processed by a matching tracking algorithm, and the wave
determines the presence of the target by polarization characteristics. The column target sample
recognition results are shown in Figure 1.

Figure 1 Column Target Sample Recognition Results

![Figure 1 Column Target Sample Recognition Results](image)

It can be seen from Figure 1 that among the 40 classification results, the sonar target recognition
error of GPS is 1, and the remaining 39 results are correct, and the recognition accuracy is 97.5%. The
traditional model identifies 4 errors with a correct rate of 36 and an accuracy rate of 90%. The sonar
target recognition of GPS is much better than the traditional method.

4. Conclusion
In the current research field of seabed, the detection and identification of sonar image targets is a
prominent problem and challenge. Due to the complex underwater environment, sonar images have
many features, such as high noise and low resolution. It is very difficult to detect and identify the
target of the sonar image. This paper takes the submarine target as the research object and applies it to
target recognition. After a series of processing and analysis of the collected signals, the target shape of
the sonar image will be more. The presence of a target is detected by identifying the flow along the
signal based on GPS positioning and characteristics of the waves generated by the submarine target. In
this paper, the multi-channel statistical method is used to extract the wavelet of the seabed seismic
signal, and the target ship is determined according to the difference of the wavelet frequency value,
which provides a new method for the realization of seabed target recognition.
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