Research on Computer Image Processing Technology in Navigation and Navigation

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Abstract. In view of the existing navigation systems used on ships, the Baidoo satellite signal access recognition rate is low, and the target recognition accuracy is poor. The paper proposes a computer image recognition method for the positioning target of the ship navigation system based on the Baidoo satellite. In view of the large resource consumption and low calculation rate of the traditional method in the calculation process of the Baidoo satellite signal, the compressed sensing image processing algorithm of single-layer wavelet transform is introduced to perform directional exclusive calculation on the Baidoo satellite signal. The research in the thesis found that the Baidoo satellite ship navigation system positioning target accurate recognition method based on the single-layer wavelet transform-based compressed sensing image processing algorithm can quickly, effectively and accurately lock and identify the set target in the Baidoo satellite navigation.

Keywords. Computer image processing technology, navigation system, bayou navigation system, compressed sensing image processing algorithm, wavelet transformation algorithm.

1. Introduction
With the rapid development of sensor technology, computer technology and information technology, people have higher and higher requirements for the accuracy and reliability of ship positioning and navigation. At present, Global Positioning System (GPS) and Strapdown Inertial Navigation System (SINS) are generally equipped on ships, but GPS and SINS have their own advantages and disadvantages. For example, GPS has high accuracy, but it is controlled by the U.S. ground station and is available at any time. Interruption is possible, and the signal received on the ground is susceptible to interference; SINS is an autonomous navigation system, which is free from external interference and has high relative accuracy, but its error accumulates over time [1]. Therefore, due to the limitations of a single navigation system, it is difficult to meet the needs of modern navigation and warfare. Therefore, the research of integrated navigation based on GPS and SINS has attracted the attention of many researchers.

However, the current GPS-based location service (LBS) technology algorithm, in the process of analysing and calculating Baidoo satellite navigation signals, due to the algorithm analysis logic problem, the satellite signal resolution is insufficient, which causes the consumption of computing space resources to increase, the computing speed to decrease, and the computing Increase in time; directly reduce the signal resolution and reduce the accuracy of target recognition in the navigation map.
phenomenon data. For this reason, finding a method that can effectively improve the accuracy of the Baidoo satellite navigation system's target recognition has become the first task for researchers.

2. Design of accurate recognition method for positioning target of ship navigation system

In the method proposed by scholars, it is considered that the Baidoo satellite navigation signal that needs to be analysed belongs to the image source data signal. Therefore, the parsed image is displayed as a true colour layer, which is formed by combining the R channel, G channel, B channel and Y channel layers [2]. As shown in Figure 1. Since the Gray level difference presented by the edge of the image in the channel directly affects the degree of signal resolution, extracting the channel with the larger Gray level difference as the analysis average value can effectively improve the signal resolution rate.

Figure 1. Baidoo signal analysis and image channel synthesis principle

2.1. Compressed sensing image processing algorithm

Let $x \in \mathbb{R}^N$ be a one-dimensional signal, then it can be expanded by a set of orthogonal bases (such as wavelet basis) $\Psi = \{\psi_1, \psi_2, \ldots, \psi_N\}$, namely

$$x = \sum_{k=1}^{N} \psi_k y_k = \Psi y \quad (1)$$

Among them, $y_k = \langle x, \psi_k \rangle$, the inverse transformation is $x = \Psi^H y$, here, $\Psi^H \Psi = \Psi^H \Psi = I$, $\Psi \in \mathbb{C}^{N \times N}$, $I$ are the identity matrix. When the signal $x$ has only $k = N$ non-zero coefficients $y_k$ on a certain basis $\Psi$, $\Psi$ is called the sparse basis of the signal $x$. For the signal $x$, it can be projected onto a set of measurement vectors $\Phi = \{\phi_1, \ldots, \phi_M\}$ to obtain $M$ linear measurements of $x$, namely

$$s = \Phi x \quad (2)$$

$\Phi \in \mathbb{R}^{M \times N}$, here, each row of $\Phi$ can be regarded as a sensor, which is multiplied by the signal and picked up part of the information of the signal. Based on these $M$ measurements and $\Phi$, the original signal can be reconstructed. Substitute (1) into (2) get

$$s = \Phi \Psi y = \Theta y \quad (3)$$

Where $\Theta = \Phi \Psi$ is the $M \times N$ matrix. It can be seen from this that compressed sensing reduces the signal $x$ from $N$ dimensional to $M$ dimensional observation signal $s$. Since the number of unknowns $N$ in equation (2) is greater than the number of equations $M$, if you directly solve equation (2) to reconstruct
the signal, you cannot get an exact solution. In order to ensure the convergence of the algorithm, $\Theta$ in formula (3) must satisfy the RIP criterion, that is, for any vector $v$ with strict K sparseness, it satisfies

$$1-\varepsilon \leq \frac{\|\Theta v\|_2}{\|v\|_2} \leq 1+\varepsilon$$

(4)

2.2. Compressed sensing algorithm based on single-layer wavelet transform

Since the low-frequency subband of the image after wavelet transform plays a very important role in image reconstruction, only a single-layer wavelet transform is performed on the original image, and then only the high-frequency subband of the first layer is measured, and the low-frequency approximation subband is retained. The coefficients of wavelet decomposition, on the one hand, can effectively reduce the amount of data required to reconstruct the image, on the other hand, it can effectively improve the quality of the reconstructed image [3]. The specific implementation algorithm is as follows:

Step 1: We perform 1-layer wavelet decomposition on the $N \times N$ image to obtain $\{LH_1, HL_1, HH_1, LL_1\}$ four wavelet subband coefficients.

Step 2: We select the appropriate value and construct a measurement matrix of Gaussian distribution. We measure $LH_1, HL_1, and HH_1$ respectively to obtain the measurement coefficient value matrix of the three subbands, while the low frequency $LL_1$ subband coefficient remains unchanged.

Step 3: We use the OMP algorithm to reconstruct the three high-frequency coefficient matrices after measurement to obtain $LH_1, HL_1, HH_1$, and perform wavelet inverse transformation together with the $LL_1$ subband to obtain the restored image.

3. Ship inspection target detection

3.1. Feature extraction

In remote sensing images, from the perspective of geometric shape characteristics, ship targets are generally elongated, with obvious and regular contour characteristics, and the gradient directions on both sides of it are basically strictly symmetrical, and they have a high gradient amplitude along the vertical principal axis [4]. In this paper, combining the inherent characteristics of the above-mentioned ships, the traditional HOG characteristics are improved in the following three aspects. (1) We divide the gradient direction into 8 directional intervals, as shown in Figure 2, which can better describe the symmetry of the ship and highlight the gradient of the ship along the vertical main axis; (2) Along the target main axis, the directions are respectively taken as the top half, bottom half and the whole of the ship as the three statistical area blocks of the gradient histogram, avoiding the influence of different ship sizes; (3) Before statistical direction gradient histogram, first the target performs canny edge detection. According to the edge point information provided by the edge map, only the directional gradient histogram of the edge point is counted, which eliminates the interference of the uneven gradient value within the candidate target area and reduces the computational complexity of the algorithm.
Figure 2. Schematic diagram of E-HOG feature extraction

As shown in Figure 3, it is the extracted E-HOG features of ship targets and non-ship targets. It can be seen from the figure that, for ship targets, whether it is a large ship or a ship with a wake, the E-HOG characteristics are shown in two directions (perpendicular to the main axis) of 1 and 5 in the three area blocks [5]. The histogram statistic of is significantly greater than the histogram statistic of other direction intervals; for non-ship targets, the E-Hog feature does not have this feature.
In this paper, the second-order centre distance is used to find the main axis direction of the ship. Specifically, firstly, statistically record the coordinates of the non-zero-pixel points of the candidate target area in the binary image after the saliency segmentation, set as \((x_1,y_1),(x_2,y_2),\ldots,(x_n,y_n)\), and then calculate the centre of gravity of the area according to the coordinates of these points:

\[
x_c = \frac{1}{n} \sum_{i=1}^{n} x_i
\]

\[
y_c = \frac{1}{n} \sum_{i=1}^{n} y_i
\]

Finally, the main axis direction angle \(\theta\) of the area is obtained as:

\[
\theta = \frac{1}{2} \arctan(2m_{12} \times m_{20} - m_{10} \times m_{21})
\]

### 3.2. Target confirmation

After we extract the E-HOG features, we choose the AdaBoost classifier to make the final judgment and confirmation of the candidate targets. AdaBoos is an iterative algorithm. Its core idea is to train different weak classifiers or basic classifiers for the same training data, and then combine these weak classifiers into a strong classifier [6]. The AdaBost classifier is a classifier that is simple to implement, does not overfit, and has a very high accuracy. It has achieved good classification results in many applications.

### 4. Algorithm simulation

In this paper, we intercepted 321 remote sensing images with 2m resolution from the Google Earth database for experiments. The size of these images ranged from 2000 pixel \(\times\) 2000 pixel to 8000 pixel \(\times\) 8000 pixels. 517 positive samples and 624 negative samples were intercepted from 272 experimental images for use in the training of the AdaBoost classifier. The size of the positive samples ranges from 20 pixels\(\times\)10 pixels to 200 pixels\(\times\)120 pixels, including different sizes and types of ship targets. The samples are non-ship targets such as clouds, islands, coastlines, waves, and floating objects at sea, and the size is also from 20 pixel \(\times\) 20 pixel to 200 pixel \(\times\) 120 pixels. For the remaining 49 experimental images, we intercepted 102 sub-images with a size of 1024pixel\(\times\)1024pixel for the detection experiment [7]. These sub-images contained a total of 426 ship targets of different sizes and types, and the background included a calm sea surface. The sea surface with thin clouds, the sea surface with waves, the sea surface with many small islands and parts of the port, and other complex sea backgrounds. The detection results are shown in Figure 4 below. From left to right, the detection results of ships under
four sea backgrounds are shown from left to right: It can be seen from the figure that the algorithm in this paper can accurately detect ship targets under various complicated sea backgrounds.

![Figure 4. Experimental results of ship image detection](image)

It can be seen from Table 1 that the average difference of the simulation test of the proposed method is smaller than that of the traditional method, which proves that the proposed method has high accuracy of positioning target recognition [8]. It can be seen that the traditional method of positioning target recognition coordinate trajectory and the simulated positioning target coordinate trajectory have a larger overlap distance; the proposed method of positioning target recognition coordinate trajectory and the simulated positioning target coordinate trajectory have a smaller overlap distance; the comparison between the two methods suggests The accuracy of positioning target recognition coordinates is significantly better than that of traditional methods.

| Method                  | Simulated mean square error |
|-------------------------|-----------------------------|
| Traditional method      | 0.9543                      |
| Method of this article   | 0.4297                      |

5. Conclusion
In this paper, the Baidoo ship navigation system has been studied. Aiming at the limitation of the measurement matrix and other dimensions of the integrated navigation algorithm based on the traditional weighted fusion of measured values, a single-layer wavelet transform-based compressed sensing image processing method is proposed. The specific derivation process of the algorithm is given in the article, and the effectiveness and superiority of the new algorithm are proved through algorithm analysis and computer simulation. Compared with the traditional method, the computer image processing method has a wider application range, while maintaining the simple and easy-to-operate characteristics of the original method and the high estimation accuracy of the traditional centralized dimension expansion and fusion. The navigation system will have very good application prospects. But theoretically, the proof of the equivalence of fusion with centralized dimension expansion needs further study.
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