Research on Ship Track Optimization Based on Big Data Analysis

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Abstract: Ship track is inferred from AIS data, but massive track data will aggravate the storage pressure of ship control center. Based on the characteristics of ship track data, big data analysis technology is applied to sort out and fit ship track data to reduce the pressure of track data storage. This paper pre-processes the ship track data by collecting data and using the three-order difference method of big data analysis technology, and completes the ship track fitting process by segmental fitting, coordinate transformation, curve fitting and other methods. The experimental results show that the ship track fitting can be consistent with the actual ship track without affecting the local trend of the track data, which proves that the fitting effect is better and the ship track fitting results can be obtained with higher precision.

Key words: Big Data Analysis; Ship's Track; Goodness of Fit

1. Introduction

Under the background of economic globalization, the Marine economy has achieved rapid development, which has increased the scale of international trade and transportation. This enlarges the traffic density of ships and increases the risk of accidents, leading to greater challenges for the sustainable development of maritime transport. In this environment, observing and measuring ship track status is of great significance for effective management of water traffic[1]. In this process, due to the large overall scale of ship operations, the ship will also face changes brought by a variety of uncontrollable factors in the actual operation process, resulting in the complexity of the process for the ship control center to obtain track data through AIS, and it is difficult to achieve accurate judgment of the ship track, and multiple sets of data need to be compared. Due to the need for data comparison, the massive data formed in real time by the ship track puts forward higher requirements for the storage capacity of the ship control center, and it is necessary to achieve management optimization through more long-term and effective compression and storage of ship track data. Since the volume of AIS data has reached the level of big data, its processing and application have become the main obstacle to the acquisition of ship track related information[2]. It is an urgent problem in the ship field to provide solutions for how to optimize ship track and how to manage and compress it.

2. Ship Track Fitting Method

2.1 Data Acquisition and Processing of Ship Track

According to the existing research findings, AIS collection of ship tracks is faced with spatial-temporal dimension errors in the actual operation process, and may even lead to data loss in serious cases. Moreover, the original AIS data cannot be used directly, so professional decoding and adaptation are required[3]. In view of this, combining the existing research results and traditional practices, this paper selects the following methods to collect and process the ship track.

(1) Data collection of ship track

Firstly, the ship track data acquisition is based on AIS, and the relative position reference object is selected by radar and the ship position information is compared by longitude and latitude lines. By comparing the relative distance between the random points on the ship track and the reference object, the ship route area is delimited, and the longitude and latitude span of the area is matched with the actual distance, and the overall data collection interval of the ship track trend is obtained. Secondly, the dimensional difference of ship navigation corresponds to the actual sailing distance, and the navigation Angle of ship track trend is determined. Multiple groups of random points of track are combined with the

navigation Angle, and then the AIS node of ship track is obtained by referring to them one by one. Finally, the ASCII code is used for receiving and decoding verification, and the corresponding AIS node is decoded after passing, and the AIS original data is output.

(2) Data processing of ship track

AIS original data include ship identification code, latitude and longitude, speed and course, AIS data collection time, etc.[4]. Affected by force majeure factors, AIS data need to be processed before practical application, so as to ensure the accuracy of ship track fitting. Before the actual processing, the possible points of major errors are identified, including the following aspects. Ship identification code (MMSI total 9 characters, greater than or less than the error), latitude and longitude (longitude range [0,180°], latitude range [0,90°], out of range or negative value is the error), speed and course (speed is positive, course range [0,360°], Negative speed and course greater than 360° are errors), AIS data collection time (there is a specified time interval, not in the time range is an error). According to the above comparison, the wrong data is eliminated and the missing data is interpolated, so as to ensure the integrity and accuracy of AIS data and prepare for the follow-up track fitting. In order to measure the unified index, all parts of AIS data are processed without dimension.

2.2 Ship Track Data Preprocessing Based on Data Analysis

In the actual operation process, the ship track is susceptible to various force majeure, which makes it difficult to effectively complete the forecast behavior, and the effect of the ship track shows strong volatility[5,6]. Due to the sailing purpose and actual benefits of ships, the start and end points of ship routes are related to the periodic change rules of ship tracks, and their tracks show similar periodic change characteristics, that is, the start and end points of ship tracks are similar. Due to the spatio-temporal difference of ship track data, the cubic spline interpolation method is used to preprocess the relevant data of ship track. The time node of the ship track is divided into several intervals, each interval is assigned a function value, and the following polynomials are constructed for the relationship:

$$\mathrm{A}_i(\theta) = \alpha_i\theta^3 + \beta_i\theta^2 + \gamma_i\theta \quad (1)$$

Among them, α_i 、 β_i and γ_i are the undetermined coefficients of each node of the ship's track 。 It is worth noting that, to ensure $\mathrm{A}(\theta)$ 、 $\mathrm{A}'(\theta)$ $\mathrm{A}''(\theta)$ have uninterrupted characteristics, determine the coefficients of all cubic spline equations, and construct equations based on these characteristics:

$$\begin{cases} \mathrm{A}(\theta_i - 0) = \mathrm{A}(\theta_i + 0) \\ \mathrm{A}'(\theta_i - 0) = \mathrm{A}'(\theta_i + 0) \\ \mathrm{A}''(\theta_i - 0) = \mathrm{A}''(\theta_i + 0) \end{cases} \quad (2)$$

Based on the global architecture of equations, the global interpolation function is generated. In the process of determining the interpolation, the interval data are introduced into the equations for calculation.

2.3 Ship Track Fitting Framework

The linear fitting method and the least square curve fitting method are used to fit the ship's track in segments and obtain the accurate ship's track. The data processing amount of ship track is reduced by fitting, and the longitude and latitude data are converted into ship track node coordinate information by Gaussian projection conversion method. Considering the spatial fit of the ship's track, the three dimensional curve fitting is selected, and the ship's track is divided into two stages: straight line and curve, and the linear fitting and least square curve fitting are used for fitting calculation respectively. The output parameters in the fitting process are the combination of the first ship track point and curve parameters, and the ship track length is determined by the fitting error calculation, which realizes the accurate control of ship track information.

3. Test Results and Analysis

In order to verify the practical application performance of ship track optimization method in big data environment, this paper first prepared ship track experiment, and selected relevant materials to analyze ship track. Secondly, on the basis of preparing the experiment, the ship track data is fitted and tested by relevant methods. Finally, the concrete research results are obtained through calculation.

3.1 Preparation for Ship Track Test

In the preparation stage of ship track test, it is necessary to ensure that the measurement instruments related to track data are well equipped, and the practical application of ship track fitting analysis through inspection big data is done. Track data acquisition is realized through AIS equipment, and a certain model of long-sailing ship is selected for research. In order to carry out the test smoothly, safe waters should be selected for the experiment, the maneuverability and accuracy of the experiment should be improved as much as possible, the relevant reference markers of the test route should be designed in advance, the weather and tide conditions of the test day should be determined, effective planning and deployment should be made with the test personnel involved, and the ship should be inspected and maintained before the actual operation to ensure that the test preparation can be effectively implemented. It should be noted that the reference object used in the ship's track test should be set in a position that is easy to observe, easy to measure and does not affect the track test, so as to avoid the error of data measurement in the track test as far as possible.

3.2 Ship Track Data Fitting Test

The data extraction of track fitting requirements will be affected by the difference of ship track sending frequency, and the data time of ship track is also uncertain. Therefore, time delay should be extracted to reflect the pre-processing of ship track fitting requirements. Under normal circumstances, the shorter the time delay of ship track fitting data extraction, the higher the data analysis efficiency of the ship track fitting method, and the longer the time delay of ship track fitting data extraction, the lower the data analysis efficiency of the ship track fitting method. In the course of specific experiments, the method used in this paper is used to test the above design content. The results show that the gap between the track fitting results and the actual ship track delay limits is small, some nodes have numerical errors, but the whole is consistent, indicating that the fitting test meets the requirements of ship track fitting.

4. Conclusion

With the rapid development of intelligent transportation, the scale of ship navigation data is constantly expanding, thus forming complex and high-dimensional features. Due to the large burden of the channel, it is necessary to predict the navigation track information of the ship and plan the navigation route reasonably. In order to meet the high requirements of ship traffic safety due to the rapid development of Marine economy, the ship trajectory is analyzed based on big data technology. In this process, the ship track optimization method is optimized based on big data technology, and then the goodness of fit method is used to analyze and process the obtained ship track data before fitting. The experimental results show that the proposed method can accurately fit the track data, meet the requirements of data extraction and track fitting error terms, and achieve better data compression and track precision.

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