A Ship Route Design Method Based on Adaptive Niche Genetic Algorithm

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ABSTRACT

This paper uses the data collected during the voyage of a 20000-ton bulk carrier from Zhoushan to Zhangjiagang and the meteorological data obtained from the ECMWF as a data set. Based on the correlation analysis results of the data set, the ship's engine fuel consumption model is established based on BP neural network. As the neural network training progresses, the parameters of the ship's engine fuel consumption model will be corrected continuously. In order to solve the problem of conflict between the two objectives of reducing the navigation time of the ship and reducing the fuel consumption of the ship's engine, this paper divides the navigation area and the navigation time by adding the time axis in the square grid diagram, and establishes a multi-objective optimization model for ship routes under the influence of actual wind waves. The multi-objective model is solved by an adaptive niche genetic algorithm to obtain the Pareto optimal solution set, thereby obtaining the optimal route scheme.

KEY WORDS: Correlation analysis, BP neural network, adaptive niche genetic algorithm

INTRODUCTION

As one of the most important means of transportation, ships are moving towards automation and intelligent high-speed development. Reducing navigation costs and ensuring navigation safety are especially important for ships. Reasonable routes can make ships reduce navigation costs while ensuring navigation safety. The problem of route design is essentially a problem of route planning. The problem of ship route planning refers to the search for a route from a known starting point to an end point in an environment where static and dynamic obstacles coexist, and taking sailing time, fuel consumption, sailing risk and other indicators as optimization goals. In response to the hot issue of route planning, many experts and scholars from various countries have also launched a series of studies. Song et al used the grid method to model the environment and adopted an improved ant colony algorithm to plan the path of the unmanned boat (Song, CH, 2014). Kang used heuristic genetic search algorithm based on rolling time domain to find the optimal route (Kang, MH, 2012). Wu applied ocean dynamics information to the feasibility analysis of the route, and solved the shortest route based on this (Wu, L, Wen, Y and Wu, D, 2014). Kim proposed a route planning method based on a finite angular rate in a grid map (Kim, H, Kim, D and Shin, J, 2014). Zhang et al based on the AIS trajectory turning points, determined the connectivity of the turning points according to the ship trajectory, constructed a directional route network, and used the ant colony algorithm to plan the ship route (Zhang, SK, Shi, GY and Liu, ZJ, 2018). Chen Xiao et al used Maklink diagrams to construct polygon boundaries and route networks of obstacles, and used Dijkstra's algorithm to generate the shortest path, and then optimized the path based on ant colony algorithm (Chen, X, Dai, R and Chen, C, 2017).

The above researches still has the following problems: (1) The actual navigation process environment is complex and changeable, and the collected navigation data also has a lot of noise, which is biased compared to the theory. (2) The actual route design is affected by multiple factors, and a single optimization goal cannot be extended to the actual situation. (3) Traditional route planning methods, such as the grid method, are difficult to effectively consider the dynamic changes in the marine environment, making them less applicable. For the above problems, this paper considers the actual ship navigation environment, and proposes a ship route planning method based on a priori information. The application of this method was discussed by taking a direct sea-sea ship as an example, and obtained an effective route planning scheme.

BUILD THE MODEL

The ship's navigation environment is very complicated. Based on the data collected during the actual voyage, it is more practical to carry out route planning. The specific process is shown in Fig.1. Firstly, the massive navigation data collected is preprocessed to obtain a data set that can be analyzed. Aiming at the limitations of the grid method, the environment is modeled by adding a time axis to the grid map. Based on the sailing history data, the main engine power model of the ship is established, and then a mathematical model for multi-target route