Artificial Intelligence Path Planning for Marine Environment

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Abstract. Artificial intelligence path planning and its optimization method is an important topic of the times, but the research of path planning for marine environment is less. Under the background of the popularization of offshore operation platform and the urgent development of marine resources, it is very important to analyze the artificial intelligence marine path planning and study the multi strategy path planning optimization algorithm. In view of this, this study proposes a multi strategy optimization ant colony algorithm (ACA-Mso), and realizes the artificial intelligence path planning of marine environment by updating the population pheromone strategy, implementing the preview strategy of local forced exchange optimization, and the symmetric path optimization strategy. Its main advantage is that it not only overcomes the shortcomings of the basic ant colony algorithm, such as long convergence time, too many iterations of the optimal solution, and the limitations of fuzzy symmetric path selection rules, but also ensures the enhancement of pheromone among nodes, the optimization of local search path potential, and the improvement of search ability of path planning algorithm, so as to realize the comprehensive path planning of marine environment Optimization.

Key words: marine environment; artificial intelligence; path planning; ACA-Mso

1. Introduction
The marine environment is rich in material energy, and China's ocean area is huge, so the promotion and protection of marine resources is one of the important tasks of China's strategic development. As an important basis for the sustainable utilization of marine resources, the research methods of path planning for marine environment are gradually increasing. Compared with the limitations of traditional basic ant colony algorithm, the multi strategy optimization ant colony algorithm is proposed to realize the comprehensive optimization of marine environment path planning.

2. Description of path planning in marine environment
Compared with the land environment path planning, the marine environment has the advantages of less obstacles and small real-time changes. However, compared with the land environment path planning, the marine environment oriented path planning needs to pay more attention to safety and efficiency. That is to say, to realize the comprehensive optimization of marine environmental path planning, the first thing is to ensure the real-time operability, safety and efficiency of marine
environmental path planning. Among them, the specific obstacles that affect the path planning of marine environment include reefs, islands, and coastal targets, and the wave heights of different ocean regions are also significantly different. Therefore, artificial intelligence path planning for marine environment is easily affected by wave height, and then it is difficult to achieve the optimal choice of marine environment path planning. In view of this, how to realize the path planning of marine environment under the changing factors of wave size, wind speed and ocean current has become the key to realize the sustainable utilization of marine resources in China[1].

3. Algorithm selection of marine environment path planning

3.1 Basic ant colony algorithm path planning principle

Through the analysis of various factors affecting the path planning of marine environment, including sea level wave height, current, wind speed and other factors, the ant colony algorithm can improve the scientificity of marine environment change and marine path planning on the basis of adapting to the changes of marine environment and natural path planning. In view of this, the basic ant colony algorithm is a typical method to study the path planning of marine environment. The remarkable feature of the algorithm is to determine the probability ratio of pheromone and path selection. The positive feedback mechanism of pheromone and probability ratio guides ant colony to realize the shortest path selection.

The ant colony algorithm has the characteristics of global convergence and self-organization, which can be used in biological simulation. Although the basic ant colony algorithm has obvious advantages and simple operation, it still needs to be improved for the specific environment. The main disadvantages of basic ant colony algorithm in marine environment are: firstly, ant colony algorithm is easy to fall into the dilemma of local optimization; secondly, the convergence speed is too slow; thirdly, the accuracy of optimal solution in complex environment is low. In view of this, the artificial intelligence path planning of marine environment needs to optimize the basic ant colony algorithm to achieve the efficient optimization ability of the marine environment.

3.2 Dilemma and limitation of basic ant colony algorithm

Combined with the research status at home and abroad, the optimization of basic ant colony algorithm has made relevant progress and good results, such as pheromone update strategy, convergence strategy in the iterative period, etc., which has important reference significance and guiding role at the theoretical node level. On the whole, facing the complex and changeable environment, the basic ant colony path planning algorithm has many defects, such as the result of pheromone updating strategy is not stable, the iterative learning content gradually decreases, and the accuracy of optimal solution for complex tasks is not high. To solve the problem of basic ant colony path planning algorithm in complex marine environment, it is necessary to optimize the strategy. The basic ant colony path planning algorithm flow chart is shown in Figure 1.
The initial pheromone was initialized to determine the ant starting point. All initial nodes are put into taboo list.

Start

- **Output results**
  - Y
  - Maximum number of iterations
    - N
    - Serial number equals quantity
      - N
      - Adjusting pheromone concentration of ant path
  
  - Y
  - Is the node the end point
    - N

The initial pheromone was initialized to determine the ant starting point.

- All initial nodes are put into taboo list
  - NC+1

- M+1, send out new ants
  - Press P to select the next node

**Figure 1.** Flow chart of basic ant colony algorithm

It can be seen from Figure 1 that pheromone is easily limited to the local optimal solution in the update process, resulting in the global optimal solution can only be found in subsequent iterations. Therefore, the global optimal solution of artificial intelligence path planning in marine environment is difficult to meet the basic requirements. At the same time, because the optimal solution can only be found in the later stage of the iteration, the iterative learning content is often reduced, which affects the overall efficiency of path planning. In addition, the basic ant colony algorithm also has the problem of slow convergence speed [2]. In a word, the artificial intelligence path planning of marine environment needs to optimize the basic ant colony algorithm, so as to achieve the efficient optimization ability of marine environment.

4. Algorithm optimization of marine environment path planning

4.1 path planning principle of optimized ant colony algorithm

In view of the difficulties in the basic ant colony algorithm for marine environment path planning, this study proposes a multi strategy optimization ant colony algorithm (ACA-Mso). Its main advantages are that it not only overcomes the shortcomings of the basic ant colony algorithm, such as the long convergence time of the basic ant colony algorithm, the dilemma of too many iterations of the optimal solution, and the fuzzy limitation of symmetric path selection rules, but also ensures the security between nodes. In order to improve the practical applicability of the algorithm, the overall time-consuming of the algorithm is effectively reduced. The flow chart of ACA-Mso algorithm is shown in Figure 2.
The initial pheromone was initialized to determine the ant starting point. All initial nodes are put into taboo list. Start NC+1, send out new ants. The pheromone increment of the optimal path and each path pheromone are updated according to the node passing times. Press P to select the next node. Is the node the end point? If yes, output results. Maximum number of iterations. The optimal path is simulated and the symmetric path is optimized. The pheromone concentration of ant path is adjusted. Serial number equals quantity?

Figure 2. Flow chart of ACA-Mso algorithm

As shown in Figure 2, ACA-Mso path planning optimization algorithm updates the pheromone increment of the optimal path, and then updates the global path of node passing times. Through the preview strategy optimization and symmetric path optimization of the optimal path, the ACA-Mso path planning optimization algorithm realizes the screening of the optimal path facing the marine environment [3]. It can not only effectively shorten the convergence time and overall operation time, but also effectively improve the practical accuracy and applicability of ACA-Mso path planning optimization algorithm in complex and changeable marine environment.

4.2 Improvement strategy of optimized ant colony algorithm

The path planning of marine environment based on ant colony algorithm has some problems, such as convergence time process, difficult to achieve the global optimal path selection and so on. This paper optimizes from three aspects: pheromone update strategy, local optimization preview strategy and symmetric path analysis strategy. Among them, at the pheromone update strategy level, the traditional basic ant colony algorithm adopts the global pheromone update method, and its main defect is that pheromone is easy to accumulate quickly on the short-circuit path, which affects the search ability of the algorithm, and is ultimately limited to the selection of the local optimal path, so it is difficult to realize the path selection of the global optimal solution [4]. In view of this, ACA-mso path planning optimization algorithm fully improves the performance of the optimization algorithm in marine environment path planning by effectively combining the pheromones of nodes and node edges. It effectively avoids the problem that the iterative learning content is too small, resulting in the
pheromone on the optimal path is too strong. At the same time, it enhances the amount of information of the optimal path and its related nodes, and improves the global search efficiency of the algorithm. In this way, the accumulation of pheromones is allocated and the local optimum is avoided.

The preview strategy level of local forced exchange optimization. Due to the complex and changeable marine environment, how to effectively reduce the overall running time of marine path planning has become a key factor in this study. Therefore, in the ACA-Mso path planning optimization algorithm, the preview strategy makes a reasonable judgment on the nodes, and uses the current node as an important benchmark to predict the future nodes, thus greatly improving the efficiency of the optimal path selection [5]. Since not all nodes will perform preview operations, the balance of the strategy is ensured. After the above operations, the preview strategy determines the more potential and better path in the local search, and then by deleting the bad path and advancing according to the optimal path, it can better solve the adverse factors caused by greedy selection of nodes, improve the local optimization ability of the algorithm, and ensure the high quality of the optimal solution in the algorithm search.

Symmetrical path analysis strategy level. According to the characteristics of the marine environment, there are two kinds of symmetrical paths: one is that there are no obstacles between the starting point and the end point of the symmetrical path, and the scope is large; the other is that there are obstacles between the starting point and the end point of the symmetrical path, and the symmetrical path to be found is on both sides of the obstacles. For the first case, the search range is large, the number of symmetrical paths is large, the calculation cost is large, and the time is long, so it is not suitable to explore one by one, and the effective path can be selected by the state transition probability, so the strategy is not applicable to this; for the second case, the surrounding nodes select obstacles as the starting point of the symmetric path, and finally determine the closure point of the symmetric path. Path discovery builds new paths. For the sea area with large velocity difference between the two sides of obstacles, finding symmetrical path can not only improve the search ability of the algorithm, but also effectively improve the path optimization ability with the help of special environment.

5. Conclusion
The basic ant colony algorithm for marine environment path planning, there are convergence time process, difficult to achieve global optimal path selection and other issues, this study from the pheromone update strategy, local optimization preview strategy, and symmetric path analysis strategy three levels of optimization. It overcomes the difficulty that the basic ant colony algorithm is easy to fall into the local optimum, the defects of long convergence time and overall running time, and the limitation of insufficient search ability of basic ant colony algorithm. In short, the ACA MSO path planning optimization algorithm proposed in this study can not only effectively improve the accuracy and applicability of path planning, but also fully realize the global optimization of marine environment path planning, and then have reference significance for path planning in complex and changeable environment.

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