

Research on logistics Route Optimization based on AFSA

Ruxue Luo^{1,2}

¹ Graduate University of Mongolia, Ulaanbaatar 999097, Mongolia

² Zhanjiang University of Science and Technology, Zhanjiang 524094, China

Abstract: Based on the characteristics of logistics goods, in the process of logistics to choose a reasonable or optimal path, will save more logistics costs. In the process of using artificial fish swarm algorithm to find the optimal path planning, through the artificial fish swarm algorithm to improve the visual range, congestion factor and other factors, and record and mark the feasible solution, the target point of the fish swarm trajectory, form the feasible solution of the path planning and select the best solution, to achieve the optimal logistics path, reduce the cost of goods logistics.

Keywords: Logistics; Route optimization; Artificial fish swarm algorithm.

1. Introduction

Logistics is the most important link of products. The optimal logistics path is not only conducive to protecting the fast delivery of goods and reducing losses, but also saves costs for goods.

Through the path planning can achieve the shortest time and distance, the minimum cost and effective obstacle avoidance performance, it is also a key component of the navigation system. From the initial state to the target state process, to find an optimal or near optimal path to avoid obstacles in the working space. Aiming at the obstacle avoidance path planning problem of mobile robots, Liu Ningning et [2] al. studied the obstacle avoidance path of mobile robots with improved gray Wolf optimization algorithm on the basis of the basic swarm intelligent algorithm. Li Qing et al. proposed a global path planning strategy for mobile robots based on convergence preserving particle swarm optimization algorithm, which provides a solution for mobile robots to find a shortest path to avoid obstacles in a limited time. Jiang Ming et al. proposed a two-population evolutionary strategy of improved genetic algorithm based on fixed length binary path coding to achieve global path optimization. Guo Wei et al. proposed an improved artificial fish swarm algorithm (IAFSA) and a path planning method based on MAKLINK graph to achieve the global optimal path for mobile robots in a static two-dimensional environment. Tharwat A et al. realized intelligent bezier curve path optimization planning based on chaotic particle swarm optimization algorithm. Zhao Xiao et al. proposed an improved A* algorithm to solve the problems of A* pathfinding algorithm in large scenes, such as high memory cost and long computing time.

Artificial Fish Swarm Algorithm (AFSA) is a new swarm intelligent optimization algorithm that simulates the clustering, random walking, foraging and rear-following behaviors of fish. It has the advantages of fast optimization speed, strong global optimization ability and simple implementation. However, some factors, such as global and local optimal interference, scope of vision and congestion factor, also affect the optimal path. In this study, from the perspective of logistics cost, AFSA was improved to explore the realization of logistics path planning optimization of

electroplating products.

2. Problem Description

(1) Problem description and basic assumptions. Logistics route planning from the perspective of logistics cost, planning the optimal distribution route of electroplating products. Assume that the logistics transportation is the head fish in a school of fish and the formation of the school of fish to find the optimal logistics route.

(2) algorithmic steps. Route planning of electroplating products is carried out based on AFSA. In the planning process, there is no crossing or collision for obstacles. AFSA simulates fish foraging, clustering, rear-ending and random behavior.

3. Parameter and model establishment

(1) Parameter description

Fish school size: N ;

Range of sight: (is the minimum value of visual range, is the maximum value of visual range); $visual_{(\min\sim\max)}$
 $visual_{\min} \quad visual_{\max}$

Crowding factor: (represents δ the number of artificial fish allowed to be accommodated within a unit volume to prevent artificial fish from having local extreme value points), between the value range; $\delta \in (0,1)$

Maximum number of attempt steps: try_number

Crowding factor: $\delta_{(\min\sim\max)}$

Number of iterations: t ;

Maximum number of iterations: M_t ;

Adjust parameters: m .

(2) Model establishment

Due to the global optimal solution and suboptimal solution curve interference problem, the probability of the optimal route planning of AFSA is, and the probability of the optimal route is low. $p = \frac{1}{2^n}, n = 1,2,3,\dots$. In order to achieve the optimal AFSA route planning, when the fish swarm finds the target point, the track of the fish swarm at the target point is

recorded, and the feasible solution of the path planning is formed. In the feasible solution, the shortest path is selected as the best.

In AFSA, the visual range is small, and the search in a small range is more detailed, which is beneficial to the convergence rate, but it is easy to fall into the local optimal. On the contrary, the wider detection range of fish swarm is conducive to rear-end pursuit and clustering behavior, but it has an important influence on the algorithm stability. Therefore, the visual function of exponential function is proposed to adjust the visual field and give the visual range a range selection, that is, large range search in the early stage and small range meticulous search in the late stage, so as to improve the search accuracy and convergence speed. The algorithm is also easy to implement.

$$\begin{cases} visual = visual_{min} \times (visual_{max} / visual_{min})^\lambda \\ \lambda = 1 / (1 + m \times (t / M_t)) \end{cases} \quad (1)$$

Considering the search ability and convergence speed of the algorithm, the improved crowding factor function is:

$$\begin{cases} \delta(k+1) = del \times \delta \\ del = (1 - \frac{t}{m_t})(\delta max_{min}) \end{cases} \quad (2)$$

4. MATLAB simulation examples

Cargo logistics path optimization example parameter setting, $N=60, visual = 15, \delta = 0.618, try_number = 17, M_t = 110$

The traditional algorithm was defined as AFSA1, and MATLAB simulation was used to obtain the path image as shown in Figure 1 and iteration as shown in Figure 2.

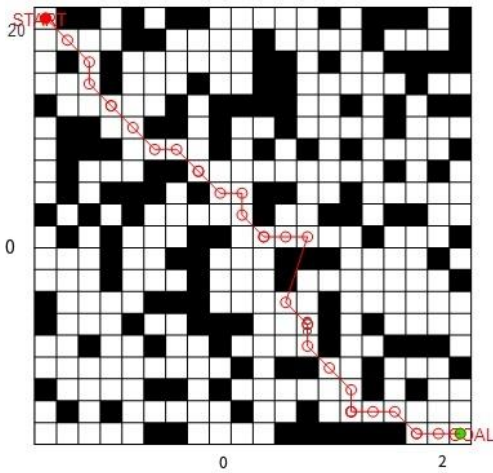


Figure 1. Path diagram

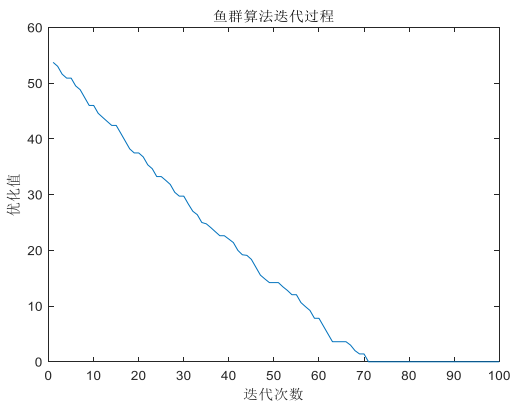


Figure 2. Iteration diagram

In the feasible solution, the optimization algorithm to improve the visual range function and the congestion factor function is AFSA2. Using MATLAB simulation, the path image is shown in Figure 3 and the iteration is shown in Figure 4.

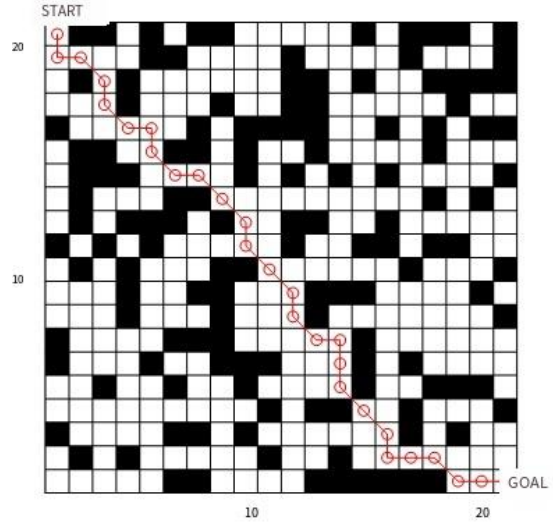


Figure 3. Path diagram

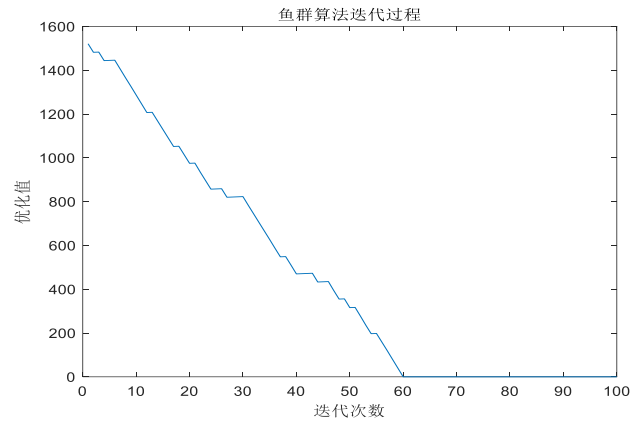


Figure 4. Iteration diagram

The above two algorithms take 60 groups of random initial values for the experiment, recording the shortest and longest path. The path planning results show that AFSA2 optimizes the path, as shown in Table 1.

Table 1. Comparison table of optimization results

Model	Shortest path	Longest path	Average	t/s
AFSA1	73.1	83.9	78.5	63.4
AFSA2	71.0	75.0	73	62.5

Figure 1, Figure 3 and comparison Table 1 show that traditional AFSA1 path planning is prone to be unreasonable, with many recorded values crossing obstacles. However, if visual range parameters and crowding factor are fixed values like traditional artificial fish swarm algorithm, the path cannot be optimized. By adding improved visual range function and congestion factor function to the feasible solution recording method, AFSA2 can effectively adjust itself with the number of iterations, avoid global and local curve interference, and obtain the optimal and stable logistics path.

5. Epilogue

By using the AFSA improvement method, it can be seen from the results in Table 1 that the improved planned goods path is shorter, the planned goods path is reasonable and optimized, and the logistics cost will be less, which indicates that the cost of goods logistics can be reduced through route optimization.

Acknowledgment

Fund Project: Zhanjiang University of Science and Technology Brand Promotion Project: PPjhcZ-2022278, Zhanjiang University of Science and Technology Featured Major Project: Engineering Management Major.

References

- [1] Zhu Daqi, Yan Mingzhong. [2010].Review of Path Planning Technology for Mobile Robot. Control and Decision, 25(07), 961-967.
- [2] LI Qing, XU Yinmei, ZHANG Dezheng, Yin Yixin. [2010]. Global Path Planning Strategy for Mobile Robot Based on Particle Swarm Optimization.Journal of University of Science and Technology Beijing, 32(3), 397-402.
- [3] JIANG Ming, Wang Heng, Zhang Hua, Xie Xingzhe. [2011].Application of Improved Genetic Algorithm in Global Path Planning of Mobile Robot. Computer Applications and Software. (08), 113-116.
- [4] Guo Wei, Qin Guoxuan, Wang Lei, Sun Rijie.[2019].Robot Path Planning Based on Improved Artificial Fish Swarm Algorithm and MAKLINK Graph. Control and Decision.(6),1-8.
- [5] Tharwat A, Elhoseny M, Hassanien A, Gabel T, Kumar A.[2018].Intelligent bezier curve-based path planning model using chaotic particle swarm optimization algorithm[J].Cluster Computing, 3,1-22.
- [6] Zhao Xiao, Wang Zheng, Huang Chengkan, Zhao Yanwei.[2018].Path Planning of Mobile Robot Based on Improved A* Algorithm. Robot, (06),903-910.
- [7] WANG Hui, HUANG Yiqing, Liu Xiaofeng.[2019].Path Planning of Mobile Robot Based on Detection Operator Experiential Learning Fish Swarm Algorithm. Journal of Anhui Institute of Technology,34(01),13-20.
- [8] Chen T B, Zhang P, Gao S , Zhang Q S.[2018].Research on the dynamic target distribution path planning in logistics system based on improved artificial potential field method-fish swarm algorithm[C]. 2018 Chinese Control And Decision Conference (CCDC). Shenyang: IEEE,7,4388-4391.
- [9] Zhang Mingxing, Wang Peng, Bai Yanping, Hou Yuchao.[2019].Array Signal DOA Estimation Based on IAFSA-MUSIC Algorithm. Mathematics in Practice and Cognition, 49 (22) ,163-170.
- [10] YU Zhuoxi, JIN Yujia.[2018].Parameter estimation of regression Model based on improved artificial fish swarm Algorithm. Statistics and Decision,34(22),75-77.
- [11] Luo Ruxue, Chen Miaona, Lin Jican. [2020] Path Planning of Robot Based on Improved Artificial Fish Swarm Algorithm. Science Technology and Engineering,20(23),9455-9449.