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Retraction

Retracted: Path Planning of Energy Robot Based on Improved Ant Colony Algorithm

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] B. Zhu, J. Zhang, J. Li, L. Chen, J. Wu, and Z. Farisi, "Path Planning of Energy Robot Based on Improved Ant Colony Algorithm," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 3216045, 9 pages, 2022.

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Research Article

Path Planning of Energy Robot Based on Improved Ant Colony Algorithm

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In order to optimize robot road planning, automation will increase production efficiency and reduce production costs. An improved ant colony algorithm based on a two-dimensional flat path planning study divided the three-dimensional space into planes, rasterized each plane, and replaced the original shape by storing a pheromone at the intersection. The pheromone storage space along the route will be reduced, and a three-dimensional space route planning study will be gradually conducted. As complex 3D environments and landscape features change, obstacle avoidance strategies have increased, road heuristics have improved, and new heuristic features have emerged. The initial value of the road node pheromone increases the efficiency of early ant search because of the uneven distribution of starting point, target point location information, and forward direction. After each iteration, the stuck ants that did not reach the target point are discarded according to the high-quality ant renewal rules, the iteration threshold is set, and the pheromone fluctuation coefficient is adjusted as the algorithm tends to merge. Compared with the basic ant colony algorithm, the convergence iteration times of the improved ant colony algorithm in this paper are reduced by about 40%, and the optimal path length is shortened by about 10. The duration of the algorithm increases. In terms of algorithm performance, it takes some time to improve the ant colony algorithm. Because of the complexity of the algorithm, some search strategies are added to the algorithm. The contribution of this article is the basis for the mobile robot to walk accurately from the initial position to the working position and perform various tasks independently.

1. Introduction

With the rapid development of robot technology, it has developed from a heavy robot that can only perform a single repetitive action to a lightweight intelligent robot with certain artificial intelligence and can complete a series of complex actions. Over the years, robots have been widely used in all walks of life. They can not only improve production efficiency and reduce production costs but also replace humans to work in some inaccessible or dangerous areas, which has greatly promoted social development and progress, especially in today's industrial manufacturing, the demographic dividend gradually disappears. With the increasing trend of human labor cost, it is an inevitable trend for robots to replace humans in some posts with low repetitive operation technology [1]. Nowadays, with the continuous integration of informatization and industrialization, the intelligent industry represented by robot technology is booming, which is also the key development field of scientific and technological innovation in various countries [2].

Because the mobile robot can move, it is not limited to the static work area, which improves the efficiency of the robot. It is the most widely used and widely used in many areas. Technology planning is the key technology in the mobile robotics industry. This not only guarantees its freedom to perform multiple tasks but also provides all the

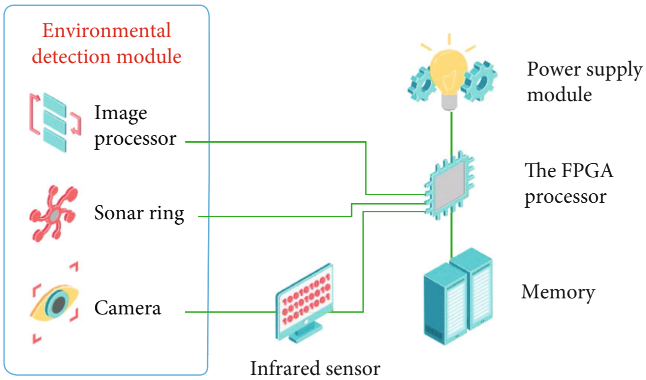

Figure 1: Robot path planning.

prerequisites for every mobile robot to do intelligent research. As shown in Figure 1, road planning is planning the safety according to one or more parameters such as the shortest route, the best time, and the lowest power consumption, to avoid distractions from the point of the mobile robot to the office. The environment for different applications also varies. Not all planning algorithms are appropriate for every situation and include many factors affected by the site. How to plan the safety process quickly and efficiently is the key to completing the project [3]. Currently, a lot of research has been done in the field of mobile robot planning at home and abroad, and good results have been achieved. Different solutions are offered for different applications. However, planning the way in a difficult environment is still difficult. Therefore, the research on this topic in this paper contains special theoretical and important concepts [4].

2. Literature Review

Singh, P. and other scientists have devised intelligent optimization algorithms to follow the diet of ants in nature. Ants release pheromones in food research, and the amount of pheromones is inversely proportional to ants' longevity. At the intersection, ants will choose the path with the larger pheromone. The ant colony algorithm is more robust of the best way in the triangle, but it will eventually be integrated in a better way with more data [5]. To improve the functional performance of Wang Xi's algorithm, the ant colony algorithm is combined with the genetic algorithm [6]. Liu, S. in the three-dimensional space, a mobile robot uses a mechanism to remove and retrieve ants stuck to avoid dangerous obstacles [7]. Song, H. developed a traffic control system to provide a better way by avoiding distractions and increasing the visibility of lights [8]. Seo, M. designs dynamic search models to improve algorithm integration speed and quality [9].

Compared with other developed countries, China's research and development of mobile robot technology is relatively late, and the initial research and development stage is even blank in some key fields. However, with the strong support of the state and the unremitting efforts of many scientific researchers, mobile robot has developed very rapidly, achieved remarkable achievements in the world, and even squeezed into the world's leading ranks in some fields. Zhao, X. studied that the first humanoid robot "forerunner" was born, which can carry out simple operation and walk quickly. Although there is still a large gap with other developed countries in the technical level, the successful development of humanoid robot finally made China a place among the advanced countries in the field of mobile robot at that time [10].

Foroughi, F. believes that China launched the Lunar Rover "Jade Rabbit" and successfully landed on the moon, equipped with some advanced scientific exploration instruments for the lunar surface exploration and survey mission. Before that, only the former Soviet Union and the United States successfully launched and landed the lunar rover. At the American consumer electronics exhibition, which gathers the world's advanced technology, alpha robot II came on stage. Compared with the first-generation alpha robot, the second-generation alpha robot has better human-computer interaction experience and intelligence, is flexible and changeable, can complete many complex actions, is equipped with a variety of APP learning software, and has the functions of independent analysis and intelligent decision-making. The successful development of the second-generation alpha robot makes the robot truly known as the close partner accompanying our life. Its success also marks the significant progress and technical breakthrough in the development of intelligent mobile robots in China [11].

Wang, J. believes that environmental modeling is a necessary condition for its autonomous movement. Only by establishing the environmental model first, allowing the mobile robot to perceive the surrounding environment, analyze the current workplace and know where it is, can it make and take reasonable decisions in time to realize safe and collision-free autonomous movement and path planning. Abstract the surrounding environment with a set of data, establish a two-dimensional or three-dimensional workspace, and obtain the environmental data that the mobile robot can understand and analyze so that it can analyze the current environmental information [12]. Xiao believes that path search refers to using corresponding algorithms in the environmental model to find a walking route for the mobile robot. According to the known or unknown global information, it can be divided into two ways: global planning and local planning. Each way has its own advantages. According to different adaptive fields, selecting an appropriate way or combining the advantages of the two ways can maximize the efficiency of path planning. According to the known environmental information, that is, the way to search a route in the mode of offline map is global path planning. This method is simple and easy to implement, but its portability is poor. Once the environment changes, the offline map also needs to be redesigned and changed. Local planning refers to that mobile robots rely on sensor detection to obtain the surrounding environmental information, and calculate and analyze the current environment according to the data information detected in real time. This method has higher requirements for real-time performance and is more difficult. Moreover, relying only on the local information obtained by various sensors is easy to produce local

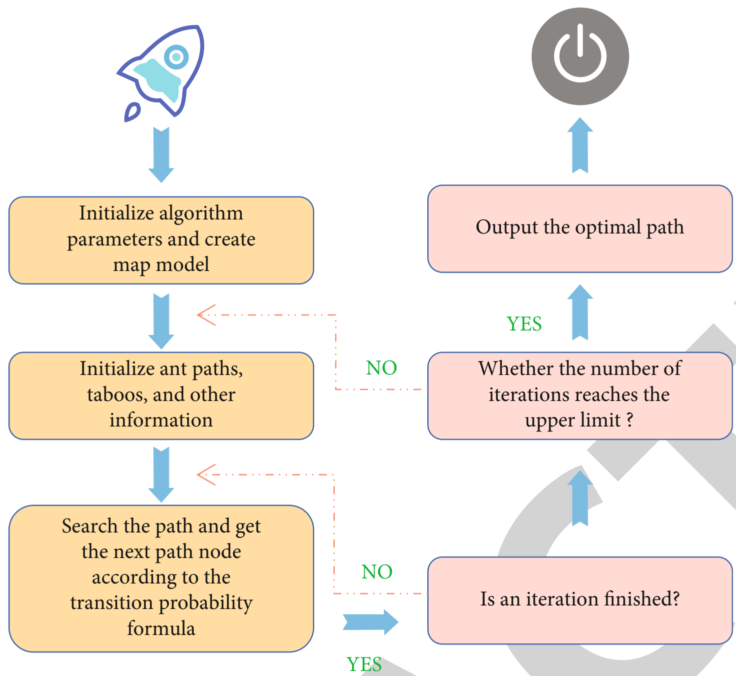

Figure 2: Basic ant colony algorithm path planning flow chart.

poles, which cannot guarantee the final global optimal path [13]. Chen, Y. believes that in practical applications, due to the special working environment, complex terrain, and other factors, the path obtained by searching for the mobile robot through the corresponding algorithm will be found to be not smooth because its route strictly follows the search direction set in advance by the algorithm. That is, there are too many turning nodes in the route. In this case, it is usually necessary to further process the path found by the algorithm to make it a smooth path [14].

According to the current research, this paper is asked to divide the 3D space into planes according to the 2D plan of the research plan and then rasterize each plane. By storing pheromones at the intersection, instead of the old pheromone storage method, reduce the storage space of pheromone, and gradually explore three-dimensional space research and development. Due to the complex 3D environment and changing landscape environment, obstacles to the concept of fashion have increased, heuristic forms have been improved, and new heuristic forces have emerged. Since the initial cost of the pheromone node method is unevenly distributed according to the starting and target point position information and forward, research efficiency of ant first stage is improving; after each iteration, the ants are stuck which does not reach the target. Point is thrown according to the rules to modify ants, set the starting point, and adjust the pheromone volatility as the algorithm tends to integrate. algorithm.

3. Research Methods

3.1. Introduction to Ant Colony Algorithm. The study found that in the foraging behavior of ants, the shortest route will always be found. The reason is that ants secrete pheromones along the way and can be perceived by other ants for decision-making in a small range. The amount of pheromones is inversely proportional to the path length of ants. At first, the ant will randomly search the path, and the pheromone secreted on the path will vary with the length of the path. When another ant makes a decision at the same fork in the road, it will tend to the direction with large pheromone. With the continuous search of a large number of individuals, the whole ant colony can spontaneously gather on the shortest path line [15].

In the t-th iteration, ant k selects the next node j from node i, and the state transition probability of node j is equation (1):

$$p_{ij}^{k}(t) = \begin{cases} \dfrac{\left[\tau_{ij}(t)\right]^{\alpha}\left[n_{ij}(t)\right]^{\beta}}{\sum_{\text{jealow}}\left[\tau_{ij}(t)\right]^{\alpha}\left[n_{ij}(t)\right]^{\beta}}, j \in \text{allow}_k, \\ 0, j \notin \text{allow}_k \end{cases} \quad (1)$$

where allow_k represents the set of all reachable path nodes in the next step, and α is the information heuristic factor. The larger the value, the stronger the guiding role of pheromone. β is the expected heuristic factor. The larger the β, the greater the influence of path distance information on ant decision-making, and greedy for the current effect. τ_{ij} is the pheromone concentration of path (i, j), n_{ij} is the heuristic function, and d_{ij} is the Euclidean distance between current node i and node j to be selected. The smaller d_{ij} is, the larger n_{ij} is, and the larger p_{ij}^{k} is, as shown in formula (2):

$$n_{ij} = \frac{1}{d_{ij}}. \quad (2)$$

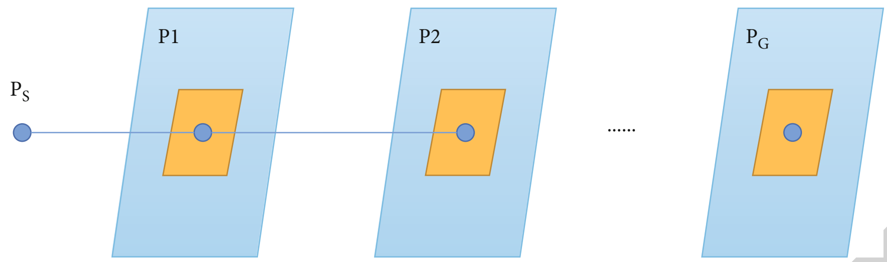

Figure 3: 3D space search mode.

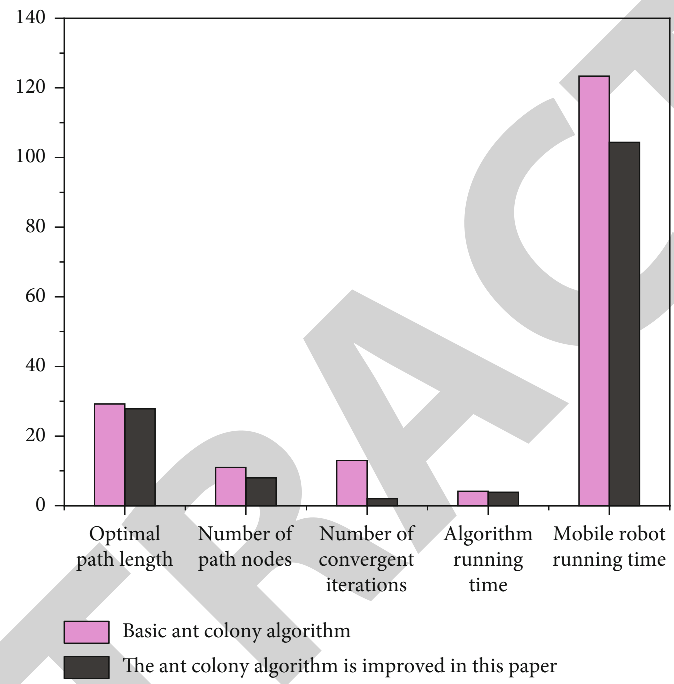

Figure 4: Experimental results in 20mx20m environment.

Because the algorithm is only determined by the comprehensive influence of path distance and pheromone, and the positive feedback characteristic makes the pheromone increase continuously. It is conceivable that when it reaches a certain time, the pheromone value on the path will become large, which will weaken or even completely eliminate the role of heuristic function. In order to avoid this situation, it is set that after the ant colony completes one iteration, that is, at time $t+1$, the pheromone on path (i,j) is updated according to equations (3) and (4).

$$\tau_{ij}(t+1) = (1-\rho)\tau_{ij}(t) + \Delta\tau_{ij}(t, t+1), \tag{3}$$

$$\Delta\tau_{ij}(t) = \sum_{k=1}^{m} \Delta\tau_{ij}^{k}(t), \tag{4}$$

where ρ is the pheromone Volatilization Coefficient, which aims to weaken the pheromone on the path, and set the value range of ρ as $\rho \in (0,1)$. $\Delta\tau_{ij}(t)$ represents the pheromone increment of the ant on the path (i, j), and the initial time $\Delta\tau_{ij}(0) = 0$.

This paper selects the ant cycle basic ant colony algorithm model of $\Delta\tau_{ij}(t)$, as shown in formula (5).

$$\Delta\tau_{ij}^{k}(t, t+1) = \begin{cases} \dfrac{Q}{L_k}, \text{ if ant } k \text{ passes through path } (i, j) \text{ in this cycle} \\ 0, \text{ others} \end{cases}, \tag{5}$$

where Q is the pheromone intensity and L_k is the total length of the path taken by ant k.

3.2. Route Planning. This communication means that the environment is a network of cells of small size, which is ideal for overcoming problems and storing and managing information. This is the best way in modern design. Because the modeling method is simple and easy to use, a grid model guide is selected in this document. The planning method of the simple ant colony algorithm is shown in Figure 2 [16].

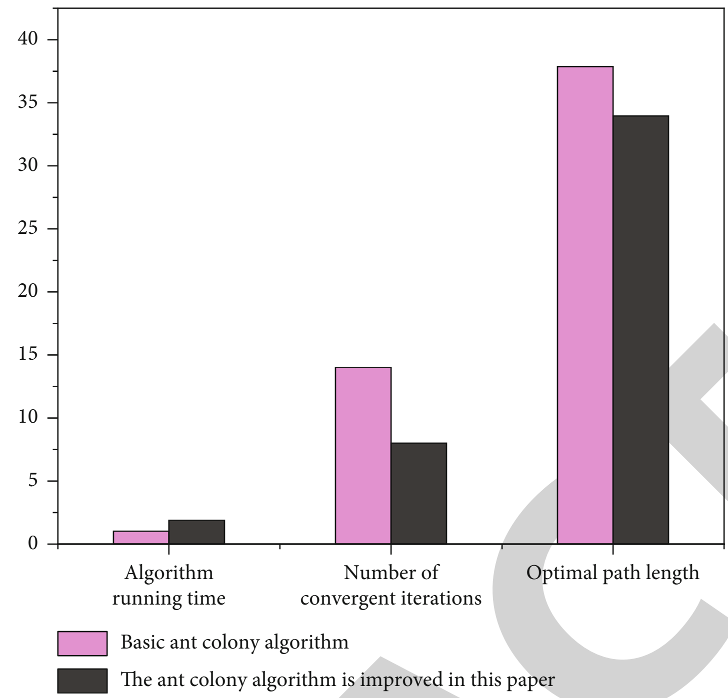

FIGURE 5: Simulation experiment I.

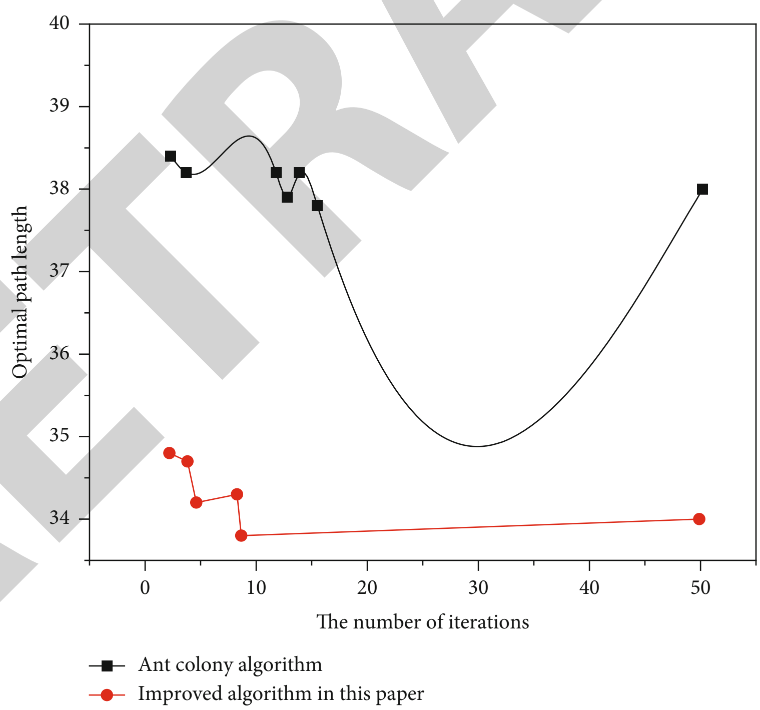

FIGURE 6: Convergence of two algorithms.

3.3. Three-Dimensional Path Planning. The emergence of mobile robots is widely used in all walks of life, such as deep-sea exploration, coal mine exploration, aerospace, and other fields. These applications are not only in the two-dimensional environment but also in the three-dimensional environment, and working in the three-dimensional environment is closer to people's daily real life. Therefore, from the perspective of practicability and future development trend, the research of path planning in the three-dimensional environment is very important. At present, most of the research on path planning is based on the two-dimensional plane environment. There are some limitations for the three-dimensional space with complex environment and large scale. Moreover, due to the influence of the

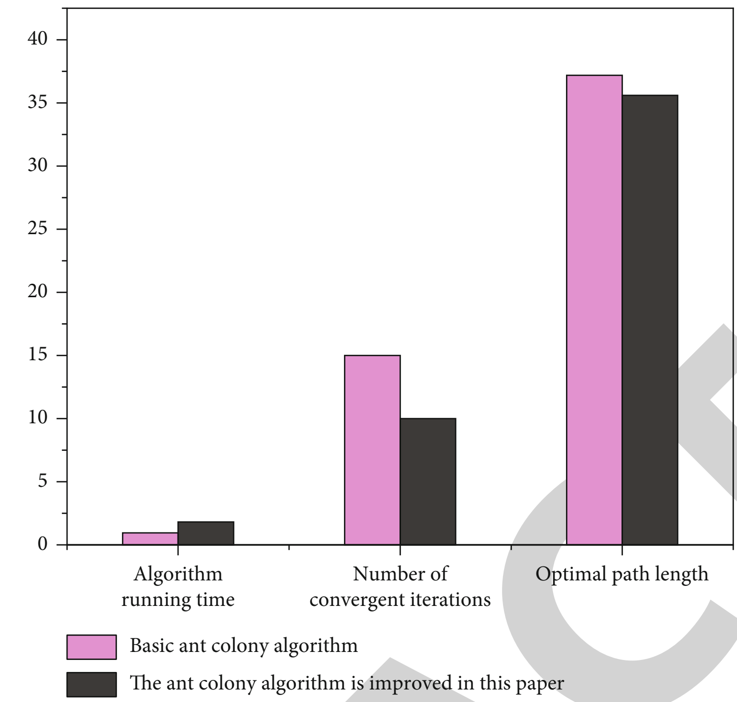

Figure 7: Simulation experiment II.

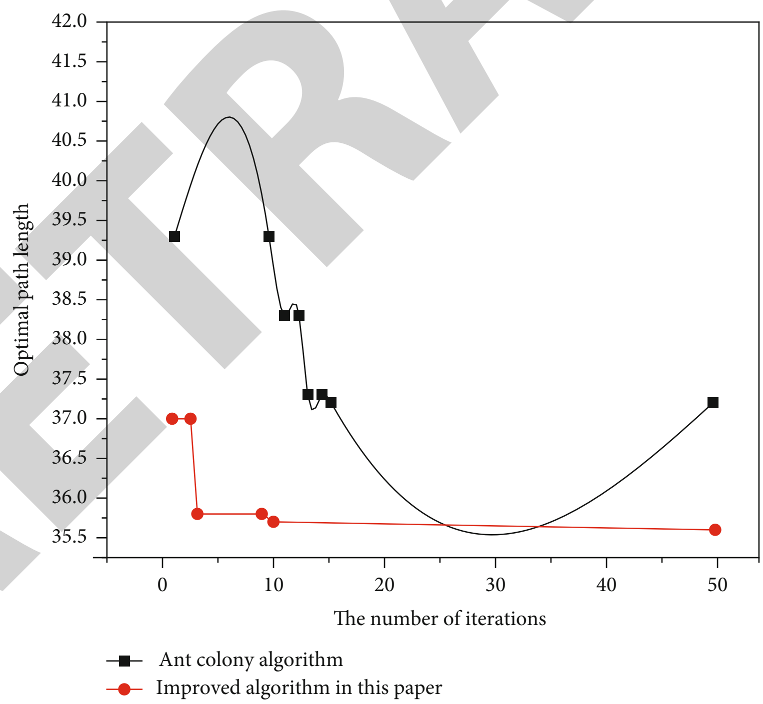

Figure 8: Convergence of two algorithms.

special landform of the three-dimensional environment, the difficulty of path planning also increases.

In the three-dimensional space, due to the expansion of the selection range of nodes, the algorithm search becomes extremely complex, and a large number of path nodes traversal in the three-dimensional space will be prone to ant deadlock. Therefore, a search mode combining layered forward and grid plane method is adopted in three-dimensional space, as shown in Figure 3. Set the mobile robot to start from the starting point P_s and follow the X direction as the main forward direction. Specify that the maximum horizontal movement distance of the mobile robot is $y_{\max}$ and the maximum vertical movement distance is $x_{\max}$ each time, that is, set the ant to search the next path node, and there is a visual area to avoid the ant colony from traversing each node in three-dimensional space. Firstly, starting from the starting point P_s, the ant searches for the feasible node $p_1(x_1, y_1, z_1)$ in the first plane, and then searches for the second feasible node $p_2(x_2, y_2, z_2)$ in the second plane. The ant selects the path nodes in each plane in turn until the search ends at the target point P_G, and then it can search for an optimal path [17].

Heuristic function is an important part of the whole ant colony algorithm. Its function is to guide the mobile robot to choose the shortest path by using distance information, which directly affects the convergence, stability, and optimality of the algorithm. In the early stage of algorithm search, they blindly select the node and ignore the obstacles around the node, which is easy to fall into a deadlock state. Therefore, the obstacle avoidance strategy is added to construct a new heuristic function. The transition probability formula is shown in formula (6):

$$P_{a,a+1} = \begin{cases} \dfrac{[\tau_{a,a+1}]^a [H_{a,a+1}]^\beta}{\sum [\tau_{a,a+1}]^a [H_{a,a+1}]^\beta}, \text{feasible point}, \\ 0, \textit{other} \end{cases} \quad (6)$$

$$H_{a,a+1} = D1^{w1} \times D2^{w2} \times S_{a,a+1}^{w3}, \quad (7)$$

$$D1 = \frac{1}{\sqrt{(i_a - i_{a+1})^2 + (j_a - j_{a+1})^2 + (k_a - k_{a+1})^2}}, \quad (8)$$

$$D2 = \frac{1}{\sqrt{(i_G - i_{a+1})^2 + (j_G - j_{a+1})^2 + (k_G - k_{a+1})^2}}, \quad (9)$$

$$S_{a,a+1} = \frac{N - N_{a+1}}{N}, \quad (10)$$

where $\tau_{a,a+1}$ is the path pheromone. $H_{a,a+1}$ is heuristic function information; $D1$ is the reciprocal of the distance from the current node to the next node; $D2$ is the reciprocal of the distance from the next node to the target point; i_a, j_a, k_a is the current node coordinate; $(i_{a+1}, j_{a+1}, k_{a+1})$ is the coordinate of the next node; i_G, j_G, k_G is the target point coordinate; N is the total number of nodes in the exploration area of the current node; N_{a+1} is the number of infeasible nodes in the exploration area of the current node; w_1, w_2, w_3 is the corresponding weight. By introducing the obstacle avoidance strategy and improving the heuristic information function, the global search ability of the algorithm can be effectively improved [18].

4. Result Analysis

4.1. Path Planning Experiment of Improved Ant Colony Algorithm. The improved ant colony algorithm is divided into two path planning, in which the first time uses the eight directions of front, back, left, right, and adjacent diagonal corners to specify the mobile robot's movement route, and the second time optimizes the map model and adjusts the movement direction [19]. In order to increase the application effect description, set the grid size as 1mx1m and the average speed of the mobile robot as 0.5 m/s. Considering safety factors, set the deceleration required for the mobile robot to reach each node as 0.2 m/s. In addition, it takes 2 s to turn at each node. The results are shown in Figure 4.

4.2. Simulation Experiment. Randomly designed31m ∗ 31m ∗ 31mround structure. In order to avoid adverse effects, the ant colony algorithm and the ant colony algorithm were developed for comparative experiments using the shortest method as a measurement method [20].

4.2.1. Design Experiment 1. Set the starting point (1,15,8) and the target point (31,16,9). Well planned. The test data are shown in Figures 5 and 6. Compared to the normal ant colony algorithm, the number of iterations of the improved ant colony algorithm was reduced by 43% and the length by 10%. Experiments have shown that improving the ant colony algorithm can reduce the time and delay of integration in a three-dimensional environment [21].

4.2.2. Simulation Experiment II. Set the starting point as (1,1,5) and the target point as (31,8,5). The experimental data are shown in Figures 7 and 8 [22–23].

The result is that a simple ant colony algorithm obtains the best path in the world after 15 iterations, the number of iterations is 37.1920 m, an improved ant colony algorithm obtains the best path in the world after 10 iterations, and the number of iterations is 35.5997 m[24–25].

5. Conclusion

This project explores the way in which mobile robots are designed based on the bug colony algorithm, which can not only design the path of mobile robots in the office but also create walking time, short and shortest. Since the power consumption of a cell phone is low, it is important to choose the appropriate algorithm to improve performance. This paper compares several experimental and analytical test data to get more accurate and better algorithm improvement. The main roles are as follows.

An ant colony optimization algorithm is ready. The distribution of the first pheromone concentration unevenly based on the starting point and target position information on the global map, which improved the research of early ants; and added a safety barrier to prevent multiple pedestrians from crossing. Due to blind research, the pseudo-random migration strategy controlled by the weak is true, and the updated content of the pheromone vaccine is effective. Discuss how to connect the network path to 3D space modeling and change the search mode and pheromone storage mode, thus using the 3D environment to plan the way, add protection block, establish heuristic new functions, improve pheromone update policies, and modify. exchange coefficient. Curable.

In order to optimize robot road planning, automation will increase production efficiency and reduce production costs. An improved ant colony algorithm based on a two-dimensional flat path planning study divided the three-dimensional space into planes, rasterized each plane, and replaced the original shape by storing a pheromone at the intersection. The pheromone storage space along the route will be reduced, and a three-dimensional space route planning study will be gradually conducted. As complex 3D environments and landscape features change, obstacle avoidance strategies have increased, road heuristics have improved, and new heuristic features have emerged. The initial value of the road node pheromone increases the efficiency of early ant search because of the uneven distribution of starting point, target point location information, and forward direction. After each iteration, the stuck ants that did not reach the target point are discarded according to the high-quality ant renewal rules, the iteration threshold is set, and the pheromone fluctuation coefficient is adjusted as the algorithm tends to merge. algorithm. The simulation results show that compared to the basic ant colony algorithm, the number of iterations of the improved ant colony algorithm in this article is reduced by about 40 percent, the optimal path length is shortened by about 10 percent, and the run time is reduced, shortened by about 10 percent. The duration of the algorithm increases. In terms of algorithm performance, it takes some time to improve the ant colony algorithm. Because of the complexity of the algorithm, some search strategies are added to the algorithm. The contribution of this article is the basis for the mobile robot to walk accurately from the initial position to the working position and perform various tasks independently.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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