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Intelligent Robot Functions and Personality Rights under Ant Colony Optimization Algorithm in the Background of Anti-Discrimination

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ABSTRACT. *This paper is to analyze the intelligent robot functions under the ant colony optimization (ACO) algorithm in the background of anti-discrimination and to further study its personality rights. In this study, the ACO algorithm is used to improve the path planning ability of the intelligent robot, and it is simulated to analyze the personality rights of the intelligent robot. The results show that in the analysis of the iteration times, it is found that the path length of the intelligent robot in the grid map will be almost unchanged after the iteration is greater than 40 times, which is the global optimal path planning. Further analysis of its personality rights can find the inevitability of giving the robot personality rights after it becomes more intelligent. And the application of intelligent robots with strong artificial intelligence will also make people's lives more convenient and efficient. Therefore, through the research in this paper, it is necessary for intelligent robots to plan the global optimal path while making the robot more intelligent to give them personality rights. It provides an experimental basis for related research in the field of later intelligent robots.*

KEYWORDS: *Intelligent robot, Aco algorithm, Personality right, Path planning, Ethics*

1. Introduction

With the rapid development of science, the application of artificial intelligence technology is becoming more and more widespread. As an application of machine intelligence, intelligent robots have also been gradually invented. As an important part of the robot field, intelligent mobile robots have been continuously innovating since the birth of the 1960s. It is increasingly applied to more fields, such as education, economics, national defense, and life. Also, its role cannot be ignored [1, 2]. The rapid development of intelligent robots has brought great convenience to human life and society. But it has brought many social problems. How to investigate the infringement caused by the robot's activities in real life and the ownership of the copyright of works generated by intelligent robots are issues that need to be thought [3]. Then, whether to give certain rights and obligations to intelligent robots has become the focus of scientific researchers in related fields.

As one of the important issues in the research of science and technology ethics, the personality rights of intelligent robots have attracted the attention of many worldwide scholars in recent years. Research on the personality rights of robots can deepen people's understanding of human-machine relationships, the self-alienation trend of intelligent robots, human-machine subjectivity, and human-machine rights [4]. On the one hand, it can restrict and regulate the social problems it may cause from a technical perspective, thereby making the legal and ethical issues of intelligent robots more complete. On the other hand, it can provide a reference for the development of intelligent robots and implementing corresponding ethics, making the development of the entire robotics field more rapid [5]. When analyzing the personality rights and ethics of intelligent robots, the improvement of the functions and technologies of robots is also very important. Robots must be able to move flexibly when performing tasks, thus, rational planning of their paths becomes the first problem to be solved. Usually, the path planning of a mobile robot is mostly performed in an environment with obstacles, that is, to find a feasible path for safe avoidance of collision between the starting point and the ending point. Common path planning algorithms include simulated annealing algorithm, genetic algorithm (GA), particle swarm optimization (PSO) algorithm, ant colony optimization (ACO) algorithm, artificial neural network algorithm, and the greedy algorithm. However, each algorithm has its shortcomings and cannot well solve the path planning problem [6, 7]. ACO, as an intelligent planning algorithm with good relative performance, is a random search simulation of ant foraging process in nature. Compared with other algorithms, it is a cluster intelligence algorithm, which often has better robustness. At the same time, the ant colony algorithm, as a population-based evolutionary algorithm, allows multiple ants to continue searching during operation, which has parallelism. And this algorithm can be used in combination with other algorithms to greatly improve its algorithm performance [8]. Although this algorithm has many advantages, it still has many randomness in practical work. If the parameters are not suitable, the algorithm will easily become deadlocked. Thus, the application of the ACO algorithm in the path planning of intelligent robots needs further research.

In summary, there are many studies on applying ACO algorithm to intelligent robots, but there are not many studies on applying ACO to the path planning of intelligent robots. Therefore, this paper uses the ACO algorithm to improve the path planning ability of intelligent robots and simulates it to analyze the personality rights of intelligent robots. It provides new ideas for related research in the field of intelligent robots in the later period, with important significance.

2. Literature Review

With the rapid development of artificial intelligence technology, the application fields of intelligent mobile robots are becoming more and more extensive. Many scientific scholars have researched its path planning and used different algorithms to plan its path. Kuric et al. (2017) designed two independent software tools to simulate the behavior of a wheeled mobile robot in its workplace through the application of the potential field method and its transformation in the topology graph. One was used to simulate the strategic level of global navigation, and the other handled its transformation to a topology graph. Finally, a multi-layer map system suitable for robot navigation and route planning for different tasks was obtained [9]. Bayat et al. (2018) studied the path planning of mobile robots with scattered obstacles in a known visual environment and proposed a path planning method based on optimization using the theory of charged particle potential field. The trade-off between traversing the shortest path and avoiding conflicts simultaneously was used to obtain the optimal path from the cost function optimization. Finally, the method was found to be feasible in practice and can be applied to static and dynamic environments to make a feasible, fast, vibration-free, collision-free path planning [10]. To realize that mobile robots are not disturbed by obstacles during the movement process, Hosseininejad et al. (2019) proposed a new method based on a cuckoo optimization algorithm for the path planning problem of mobile robots in a dynamic environment. And its feature vectors were optimized. Finally, it was found that the algorithm has good performance in finding short, safe, smooth and collision-free paths under different environmental conditions [11]. Wu et al. (2020) proposed a real-time dynamic path planning method for mobile robots capable of avoiding static and dynamic obstacles based on a hybrid algorithm of the beetle antennae search (BAS) algorithm and the artificial potential field (APF). Finally, it was found that by setting a safe range for the model, the robot's movement path was closer to the available path in the real environment, which proves the effectiveness and superiority of the algorithm [12].

With the improvement of the performance of intelligent robots, many scientific scholars have studied their legal personality issues in the context of anti-discrimination. To determine whether artificial intelligence systems can be regarded as legal subjects, Čerka et al. (2017) examined the concept and characteristics of the Supreme People's Court and defined its operating principle. In the end, it was found that the research results can be used to further define the scope of the rights and obligations of the Supreme People's Court [13]. Koos et al. (2018) analyzed whether artificial intelligence has a legal status similar to that of people and enterprises, and proposed the choice of liability for damage caused by artificial intelligence system activities. It is significant to study the related fields of artificial intelligence's legal rights [14]. Waldheuser et al. (2018) concentratedly reflected and bound various discussions in the broad field of robotics ethics, and expounded the moral issues involved in the application of intelligent robots. Finally, it was found that the ethical issues and concerns in robotics were not limited to issues of moral responsibility and legal responsibility [15]. Chou et al. (2019) analyzed the application status and government policies of nursing robots in Taiwan and proposed an inter-governmental integration and cooperation mechanism. The possible social, economic, legal and ethical aspects of the application of nursing robots were discussed. In the end, it was found that the ethics-related issues and policymaking of robots were independent [16].

In summary, in recent years, scholars in this field have done many studies on intelligent robot route planning and its ethics. But there are no many studies on applying the ACO algorithm to the functions of intelligent robots and their personality rights. Therefore, this paper applies the ACO algorithm to intelligent robots and analyzes their personality rights, which is significant to the application and improvement of later robots in related fields.

3. Method

3.1 Intelligent Robot Path Planning

Intelligent robots, also called intelligent mobile robots, are an integrated system with multiple functions, mainly including the perception and induction of the environment, the execution and control of behaviors, decision-making and planning. Intelligent mobile robots mainly use various technologies such as sensor technology, computer technology, artificial intelligence, information processing technology, and automation control, which are applied in many fields of society [17]. The entire system mainly includes a detection unit, a drive unit, a control unit, an execution unit, and some auxiliary mechanical devices.

Among them, the research on the path planning methods of mobile robots occupies an extremely important position in the field of path navigation. Existing path planning methods can be roughly divided into global path planning algorithms and local path planning algorithms. Common global path algorithms include fast random search tree algorithms, genetic algorithms, and viewable methods. Common local path planning algorithms include artificial potential field method (APF), fuzzy logic algorithm (FLO), neural network algorithm (NNA) and simulated annealing algorithm (SAA). Generally, global path planning is to find a relatively optimal path for a mobile robot according to a path search algorithm in a real work environment. The local path planning is to use the relevant sensors carried by the robot to obtain the specific parameter information of obstacles in the path planning environment when the robot is in an unknown working environment, to further sense the surrounding environment. Then, it corrects the self-walking path according to the parameters of real-time feedback, and finally, it reaches the target point [18]. In this research, the ACO algorithm is mainly used to analyze and study the path planning and performance of intelligent robots.

3.2 Aco Algorithm

The ACO algorithm is inspired by the process of ant colony searching for food in nature and belongs to the category of positive feedback. Scholars observed, analyzed, studied and summarized the foraging behavior of ant colonies, and finally developed the algorithm. Some rules can be found in the algorithm, including the ant's perception range, the environment for finding food, the method of foraging, the principle of movement, the situation of encountering obstacles and the method of contact. In this series of methods, the presence of pheromone plays a decisive role. ACO algorithm is an artificial ant colony system. In this system, the biggest difference from the real ant colony is that the artificial ant colony has a memory function. And in the path selection process, different decision rules are used for path selection, which is pseudo-random. It is different from the ACO algorithm which chooses paths based on probability, that is, randomness [19, 20]. The following equation is used to represent the movement principle of the k-th ant.

$$j = \begin{cases} \arg\max\left[\tau_{iu}(t)\right]^{\alpha}\left[\eta_{iu}(t)\right]^{\beta}, q \le q_0 \in (0,1) \\ p_{ij}^{k}(t), q > q_0 \end{cases} \quad (1)$$

Where: $q_0 \in (0,1)$ represents a constant. $q \in (0,1)$ represents a random number. $\tau_{iu}(t)$ represents the pheromone concentration value of some points i and j in the path. $\eta_{iu}(t)$ represents the distance between some points i and j in the path. In the ant system, its update rules are also significantly different from the real ant colony. When all the ants complete the node selection once, the local pheromone will be updated, and only the optimal path will be updated after each cycle. The updating principle is as follows.

$$\tau_{ij}(t+1) = (1\text{-}\rho)\tau_{ij}(t) + \Delta\tau_{ij}^{k}(t) \quad (2)$$

The global pheromone is further updated based on equation (5).

$$\tau_{ij}(t+n) = (1\text{-}\alpha)\tau_{ij}(t) + \Delta\tau_{ij}^{k}(t) \quad (3)$$

$$\Delta\tau_{ij}^{k}(t) = \begin{cases} \dfrac{Q}{L_{BEST}}, (i,j) \in \text{Global optimal path} \\ 0, (i,j) \notin \text{Global optimal path} \end{cases} \quad (4)$$

Where: α represents the global pheromone volatility factor. Aiming at the basic ACO, it is mainly to improve it. It includes local pheromone update rules, the introduction of improved global pheromone update, and the increase of the limit of pheromone concentration. Among them, the global pheromone update and improvement mainly include pheromone increments, parameter design from constant to staged, and selection strategies changed according to the iterative stage [21].

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The steps of the ACO algorithm can be divided into (1) Initializing and modeling some parameters (such as the number of cycles, the grid number, and the number of ants); (2) Using the position at this moment as the initial position to calculate all ants and selecting the next node; (3) Analyzing whether it has entered a trap, if yes, then rolling back and returning to (2), otherwise, observing if the ants meet or have reached the end point; (4) Waiting for the optimal selection of this node to end, updating the pheromone of each path and starting the next cycle again; (5) Analyzing whether the conditions set in advance (usually the iteration times) are met, if yes, continuing to the next step, otherwise, returning to (4); (6) Obtaining multiple optimal paths after each cycle and the current global optimal path; (7) Analyzing whether the obtained path meets the end requirement of the algorithm (usually path length), and if it is satisfied, the required optimal path is obtained, otherwise, returning to (4) to continue to use the algorithm to find the local path. The ACO algorithm flow is shown in Figure 1.

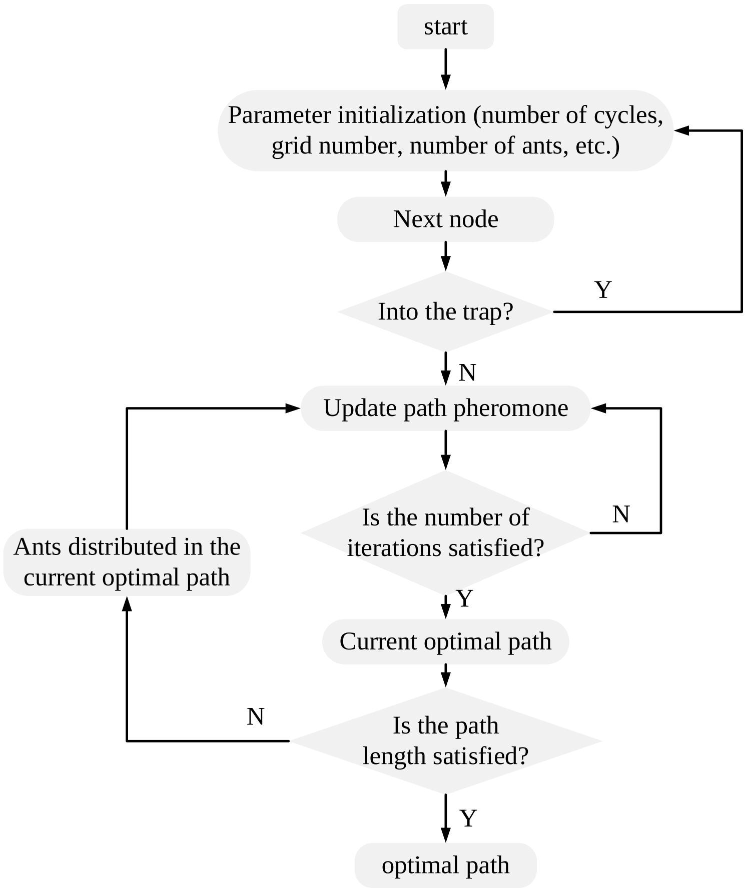

Fig.1 Flowchart of the Aco Algorithm

3.3 Personality Rights of Intelligent Robots

With the rapid development of artificial intelligence, the intelligent mobile robot is used as a kind of autonomously operating machine device. It can execute commands by receiving human commands, perform work by running pre-designed fixed programs, or take action by using artificial intelligence technology. As robots become more and more intelligent, it is also reasonable to give intelligent robots personality rights. In particular, the autonomous robot does not require human intervention. It can act and process problems independently as humans. Moreover, it can learn, think, and reason. Therefore, it belongs to strong artificial intelligence robot. In this study, the personality rights given to intelligent robots discussed also mainly target intelligent robots with strong artificial intelligence.

Scholars of different countries have different understandings of personality rights. Personality rights can usually be divided into four types. First, the definition of personality right cannot be separated from personality, and it needs to be explained by personality. Second, the personality right is defined from its spiritual value. Then, the personality right is defined from the perspective of the object of personality right. Finally, the above three viewpoints, namely the value, characteristics and object of personality right, are combined to systematically

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explain personality right [22]. Therefore, the personality right can be defined as the individual right that the law must give the right subjects to safeguard their existence and dignity. The characteristics of personality right are shown in Figure 2.

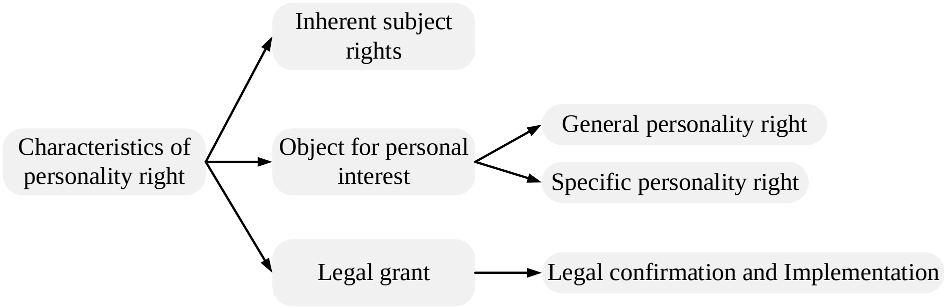

Fig.2 The Characteristics of Personality Right

Personality right, as an inherent subject right, is conferred by law. In ancient Roman times, not everyone enjoyed a sound personality right (freedom, civil rights, and family rights). In modern times, the personality right has become commercialized and civilized. Also, the personal interests of a legal person have gradually been incorporated into the protection of the law. With the advancement of time and the widespread application of intelligent robots, the matching of personality rights has become an inevitable inquiry [23]. For the matching of the personality rights of intelligent robots, the personality rights in legal theory should be further analyzed. It can be found that the rights enjoyed by intelligent robots should be examined by civil rights subjects other than natural persons. In the field of general personality rights, intelligent robots should be given with the content of personality equality, personality independence, personality freedom and dignity. Because once the intelligent robot is included in the new member of the civil rights subject, it will enjoy the general personality right completely. In terms of specific personality rights, there is a considerable gap in the personality rights enjoyed by intelligent robots. That is, the individual is independent and civil rights are different. Thus, specific personality rights are different. This paper proposes to include specific personality rights in the scope of enjoyment of intelligent robots, such as the right to life, name, body and freedom. Therefore, the inclusion of the right to body in the scope of intelligent robots in this paper is based on independent rights. Since the individual is independent, the statement that the components of the intelligent robot body are considered to be part of the subject body is also true. In this research, it mainly targets intelligent robots with strong artificial intelligence. While the personification or intelligence of intelligent robots is constantly improving, their external forms are increasingly like humans. Then, the necessity of giving some personality rights to intelligent robots with strong artificial intelligence needs to be analyzed. Therefore, it is necessary to analyze their personality rights.

3.4 Path Planning of Intelligent Robot Based on Aco Algorithm

In the path planning of intelligent robots with strong artificial intelligence based on ACO algorithm, this study first uses the grid method to construct a map. After performing global path planning on a grid map of known obstacles, the intelligent robot uses sensors to detect the path and obstacle information in the map. If there are no obstacles, it will continue to drive along the originally planned path. If there are obstacles, corresponding avoidance measures will be taken according to the collision situation. At this time, the ACO algorithm is used to plan the local path. After obtaining the optimal local path, the robot continues to move until the endpoint is reached. Among them, the path planning flowchart of the intelligent robot based on the ACO algorithm is shown in Figure 3.

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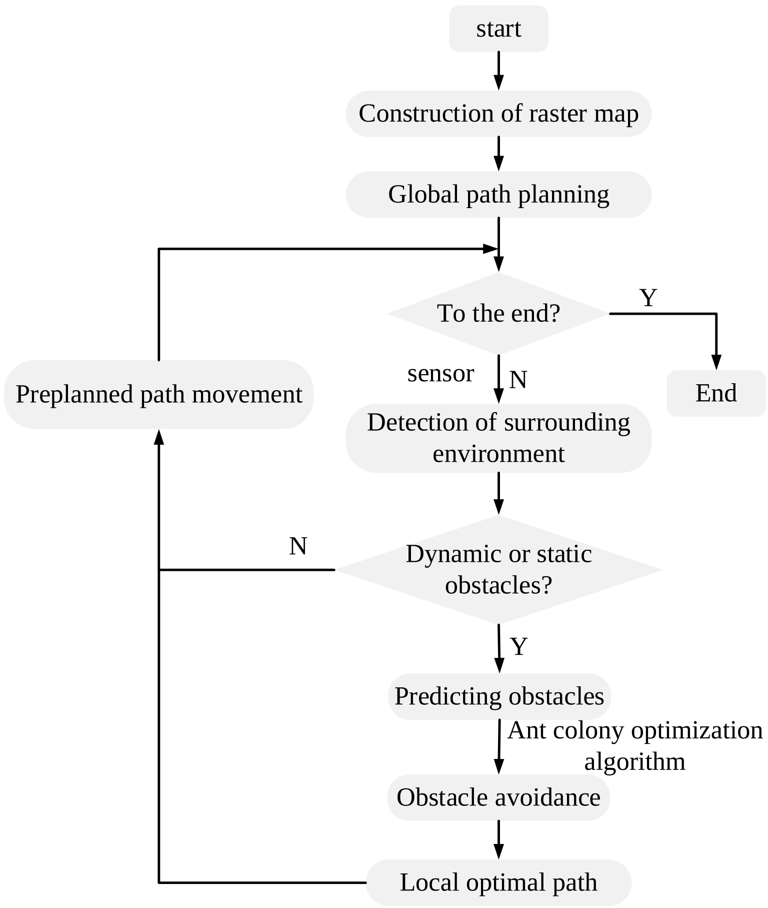

Fig.3 Path Planning Flowchart of the Intelligent Robot Based on Aco

The Matlab software is used to simulate the intelligent robot based on ACO using the grid map to obtain a path planning and analyze its path. In the simulation process, the required hardware and software environment configurations are shown in Table 1. Then, the planning effect of different iteration times on the global path is analyzed.

Table 1 Hardware and Software Configuration Table

Software	Operating system	Linux 64bit
	Integrated development environment	Pycharm 2019.3
Hardware	Memory	Kingston ddr4 2400MHz 8G
	CPU	Intel core i7-7700@1.6GHz 8 核
	GPU	NVIDIA Jetson TX2

The boundary constraint equation is as follows.

$$\min f(x,y); x \in R^n, y \in R^n \tag{5}$$

$$\begin{cases} st.g_1^1(x,y) \geq 0, \cdots, g_1^p(x,y) \geq 0; \\ \cdots \\ g_i^1(x,y) \geq 0, \cdots, g_i^q(x,y) \geq 0; \\ \cdots \\ g_N^1(x,y) \geq 0, \cdots, g_N^r(x,y) \geq 0 \end{cases} \tag{6}$$

$$1 \leq i \leq N \tag{7}$$

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Where: $f(x,y)$ is the objective function and it is usually the length of the path. $g_m^n(x,y)$ is the n-th constraint on the intelligent robot based on the m-th obstacle. The penalty function is constructed through the function $f(x,y), g_m^n(x,y)(m=1,2,...,N)$.

4. Results and Discussion

4.1 Analysis of the Impact of the Iteration Times on the Path Length

In the grid map of this research, ACO is used to simulate and analyze the intelligent robot with strong artificial intelligence. In path planning, the optimal path changes when the iteration times are 25, 50, and 100 are shown in Figure 5. It can be found in Figure 5A that when the iteration is 25 times, the path length of the intelligent robot with strong artificial intelligence in the grid map fluctuates greatly. However, the overall path length decreases with the increase of the iteration times. It can be found in Figure 5B that when the iteration is 50 times, when3. the iteration is less than 40 times, the path length fluctuates significantly and gradually decreases. When the iteration is more than 40 times, the fluctuation of the path length of the intelligent robot with strong artificial intelligence can be ignored. Analyzing the path change of the intelligent robot with strong artificial intelligence when the iteration reaches 100 times in Figure 5C, it is still found that the path length is stabilized with the iteration reaching 40 times. Finally, the global optimal path length is about 30.3. Therefore, it can be inferred that the length of the global path of the grid map optimized by ACO is the stable path length after the iteration reaches 40 times.

4.2 Analysis of the Impact of Intelligent Robot Personality Rights

As robots become more intelligent today, the performance of intelligent robots is constantly improving. When facing different problems, intelligent robots with strong artificial intelligence are increasingly capable of handling them independently. Therefore, in the emergence of more complex intelligent robots, what kind of rights and obligations of intelligent robots with strong artificial intelligence and what kind of responsibility will they bear after causing damage are issues that must be taken seriously. Before giving personality rights to intelligent robots with strong artificial intelligence, it is necessary to establish ethical principles for their personality rights and use human ethics as the cornerstone. Ultimately, ethical norms are incorporated into the personality rights legislation of intelligent robots for practice, so that intelligent robots with strong artificial intelligence can make life more convenient and efficient.

5. Conclusions

With the rapid development of science and technology, the research on intelligent robots has become the focus of scientific researchers in various countries. As robots become more intelligent, their personal rights and ethical considerations cannot be ignored. In this study, ACO is used to improve the path planning ability of the intelligent robot and simulate it. Finally, it is found that after the iteration is more than 40 times, the path length of the intelligent robot with strong artificial intelligence on the grid map will almost be unchanged, that is, the global optimal path is completely planned. Further analysis of personality rights reveals the inevitability of giving them personality rights when robots become more intelligent. Also, the application of intelligent robots with strong artificial intelligence makes people's lives more convenient and efficient.

In summary, this study constructs intelligent robots based on ACO under the background of anti-discrimination, which can plan the global optimal path, and the robots become more intelligent. Therefore, it is necessary to give them personality rights. The study provides an experimental basis for related research in the field of later intelligent robots. However, with the rapid development of science and technology, more and more new technologies will emerge. In real life, environmental information changes in real-time. Therefore, in the follow-up research, the algorithm needs to be further improved to make it have more flexible control capabilities, making the robot more intelligent.

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