Path Planning of Robot Based on Improved Ant Colony Algorithm in Computer Technology

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Abstract. Mobile robot is a complex control system which integrates environment perception, path planning, dynamic decision making and behavior execution. After decades of development, ant colony algorithm has achieved good results in solving global optimization problems and is widely used in various fields. Although it has the ability to find the optimal solution, it has some defects: slow convergence speed and easy to fall into the local optimal solution. An improved ant colony algorithm is proposed to search through the improved it, select the path independently according to the number of pheromones, and improve by adjusting the heuristic factor function. The reason for this analysis is improved and optimized[1].

Keywords: Computer, Ant Colony Algorithm, Path Planning

1. Basic principle of ant colony algorithm

Ant system was first proposed by Italian scholar Dorigo, Maniezzo et al in 1990s. They're studying ants foraging, found that the colony as a whole shows some intelligent behavior, for example, ant colonies can be in different environments, Find the shortest path to the food source. After further study, Because ants release a substance called "pheromone (pheromone)" in their path, ants in ant colonies are aware of pheromones, They walk along the path of higher pheromone concentrations, And every passing ant leaves a "pheromone ", This creates a mechanism similar to positive feedback, After a while, The entire colony will follow the shortest path to the food source. The traditional ant colony algorithm is inspired by the ant foraging process, an ant colony algorithm was first proposed in 1991. In the artificial ant colony algorithm, m the total number of ants, The transfer of ants from one node to another is determined by pheromones on the path, At t moment, The probability of state transfer of ant k from node i to node j is as follows: after all ants complete one foraging, Need to update the pheromone, Over time, pheromones evaporate, At the same time, the amount of pheromones that ants pass through increases. Robot path planning is a hot topic in mobile robot research. It can be described as finding a running path from a given starting point to a specified end point in an obstacle environment. In the whole process, all obstacles must be bypassed safely and without collision, and the path should be minimized (or the time and cost should be minimized).
Nowadays, the methods used in robot motion planning include Dijkstra algorithm, A* algorithm and genetic algorithm. Dijkstra algorithm can ensure the search to the global optimal path, but it has a certain blindness. When the number of nodes increases, the algorithm explores many nodes and has low efficiency. In the process of finding the global optimal solution, genetic algorithm is a random search process. When the nodes increase, the search time is longer, and it is easy to appear precocious phenomenon. A* algorithm is a heuristic search algorithm, search has a certain directionality, simple implementation.

2. Difficulties in path planning technology of ant colony algorithm mobile robot
With the increase of market demand, more and more mobile robots are put into use. In order to improve the working efficiency of mobile robots and adapt to various working situations, path planning algorithms are required to have higher practicability and reliability. At present, there are the following difficulties:

2.1. Areas more
There are many application fields of mobile robot, and the working scene is not always fixed. The solution of path planning in simple environment can achieve good results, but it is difficult to find the global optimal solution in complex and changeable environment[2].

2.2. Autonomous research
At present, the main direction of path planning technology is to study how to accomplish the task independently in dynamic environment, and how to use sensors to obtain the information of the surrounding environment efficiently and accurately and transmit it to the mobile robot for path planning is a difficult problem to be solved.

2.3. Research on hybrid algorithms
With the increase of environmental and the requirement of many indexes, some are difficult to achieve ideal results. Some intelligent optimization algorithms have emerged, each algorithm has its own advantages under different performance indexes. However, no algorithm can deal with various applications.

2.4. Multi-sensor information fusion
In the complex and changeable environment, all kinds of moving obstacles around, want to plan a safe route quickly, the mobile robot is very important to obtain the surrounding environment information, the more complete the environment information, the higher the efficiency of the mobile robot.

2.5. Optimization of environmental modelling techniques
At present, many scholars have studied a large number of path planning problems and put forward many feasible and effective path planning algorithms. However, most of the algorithms are limited to their own optimization, but ignore the optimization and improvement of environmental modeling technology. A good map model can not only improve the accuracy of path algorithm, but also directly affect the search performance of algorithm.

3. How to improve ant colony algorithm
Based on the traditional ant colony algorithm, an improved ant colony algorithm is proposed to solve the problem of poor real-time and stability of path planning in the inventory process of inventory robot. The improved includes three points optimization: the first is to put forward an adaptive volatilization coefficient setting method, that is, to set a smaller volatilization coefficient in the early stage of the algorithm to reduce the attraction between ants, and to set a larger volatilization coefficient in the later stage of the algorithm. The second is to adjust the initial concentration on each
path and increase the pheromone concentration near the starting point and the end line. This can greatly improve the speed of early search[3]. The third is that when the global pheromone is updated, the pheromone concentration is strengthened on the shorter path and the pheromone concentration is reduced on the longer path according to the length of the path produced by a single iteration. The results show that when the traditional algorithm is optimized, the improved algorithm not only converges faster and more efficiently, but also finds better and more stable paths. The improved algorithm does have a faster convergence speed in the Traveller-like problem and can avoid falling into the local optimal solution and obtain the global optimal route[4].

Figure 1. Basic principles of ant algorithm.

3.1. Convergence Rate
Firstly, the initial pheromone value is increased by selecting the global favorable region according to the location information of it, and the initial pheromone value is distributed unevenly to improve. That the convergence rate of the improved ant colony algorithm is obviously accelerated, and the global optimal solution can be found, and the energy consumption loss of the mobile robot can be effectively reduced.

3.2. Two-dimensional plane path planning
Based on the research of two-dimensional plane path planning, the intelligent path planning algorithm divides the three-dimensional space into one plane, then rasterizes each plane, replaces the original path with the pheromone stored in the path node, reduces the pheromone storage space, and advances in layers.

Search method to develop three-dimensional spatial path planning research. In view of the complexity of 3D environment and the variety of geomorphology, the obstacle avoidance strategy is added, the path heuristic information is improved, a new heuristic function is constructed, and the initial value of path node pheromone is distributed unevenly according to the position information of starting point and target point and the direction of advance. The experimental comparison shows that the improved algorithm can find an optimal path safely, quickly and effectively in 3D environment, which not only effectively reduces the convergence times of the algorithm[5], but also has a high global search ability.

3.3. Genetic algorithms
It is found that the pheromone can be secreted in the process of searching the path of ant colony, which can be perceived by other ants in a small range and then make decisions, and finally the whole ant colony spontaneously gathers to the shortest path. Ant colony algorithm is based on multi-agent intelligent algorithm, which can effectively solve the global optimization problem, but it is difficult to achieve ideal results in complex environment. Genetic algorithm is a kind of evolutionary algorithm. The solution space of the required solution problem is regarded as an individual, and the individual with high adaptability can survive and participate in reproduction, that is, select the high quality
solution to eliminate the inferior solution. After many iterations, from the initial lower organisms to the higher organisms, the individuals with high fitness remain. Genetic algorithm is easy to combine with other algorithms for nonlinear complex problems. The disadvantage is that it is difficult to select various parameters of the algorithm, complex programming and calculation, and easy to fall into "precocious".

Figure 2. Algorithm code.

3.4. Adaptive adjustment heuristic function
The study found that each ant leaves a pheromone chemical on its path, which other ants in a certain range can feel and tend to move in the direction of high pheromone concentrations. The higher the pheromone concentration on a certain path, the greater the probability of ants choosing this path. Ant colonies communicate through pheromones and finally choose the shortest path to search for food. To solve the disadvantages of slow search speed and easy to fall into local optimum, the distance \(d(1\leq h\leq 8)\) from the target point is calculated according to the current ant energy. The heuristic weight of the surrounding grid is adjusted adaptively according to the size of the \(d(h)\) value. The smaller the value of \(d(h)\), the larger the heuristic weight of the \(h\) grid. This paper takes this ratio as 1:2:2:3:4:4 and 5, which not only improves the search speed, but also maintains the diversity of choices.

Figure 3. Ant colony pseudo algorithm.

3.5. Information updating mechanism based on wolf swarm allocation principle
In order to avoid local optimality and increase convergence speed, the study found that wolves distribute most of their prey to strong wolves, although they starve some weak wolves. This ensures that the strong wolf catches its prey next time and does not starve the whole pack, so it improves the survival of the pack. Based on the principle of wolf swarm allocation, this paper finds the ants with local optimal path in each cycle, increases the amount of pheromones released, and removes the pheromones released by ants on the local worst path.
4. Conclusion
Path planning algorithms are divided into three categories: traditional path planning algorithm, heuristic algorithm and intelligent bionic path planning algorithm. Heuristic algorithm has strong path search ability and can be used in discrete path topology. The common heuristic search algorithms are A* algorithm, Dijkstra algorithm and Floyd algorithm. As an intelligent model, ant colony algorithm has strong adaptability and cooperation\cite{6}. The adaptability is mainly manifested in the continuous optimization of the structure through the accumulation of pheromones to achieve the optimal goal. The robot path planning problem is a typical combinatorial optimization problem. The use value of ant colony algorithm is improved and applied.

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References
[1] Yang Weibo, Zhao Yanwei. An improved simulated annealing algorithm for solving TSP problems [J]. Computer engineering and applications, 2010.
[2] Chen Heping, Li Xiaoqin, Gu Jinguang, et al. Research on path planning algorithm based on vector map data [J]. Computer engineering and application, 2010.
[3] Tan Min, Wang Shuo. Research progress of robotics technology [J]. Journal of automation, 2013.
[4] Fang Haoran. Research on vision-based Quadrotor Aircraft navigation and Landing System [D]. Shenyang University of Science and Technology, 2017.
[5] Wang Hui, Wang Guangyu, Pan Dewen. Path planning for mobile robots based on improved particle swarm optimization [J]. Sensors and Microsystems, 2017.
[6] Hou Tianqiang. A novel particle swarm optimization based on prey–predator relationship [J]. Applied Soft Computing, 2018.