Cash Collection Model of Electric Power Business Office Based on Computer Algorithm

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Abstract. With the continuous development of intelligent algorithms, mobile robot (hereinafter referred to as MR) technology is gradually mature, which has been widely used in a variety of industries, such as industry, agriculture, medical treatment, service and so on. With the improvement of intelligent level, people have higher and higher requirements for MRs, which requires MRs to constantly adapt to different environments, especially dynamic environments. In the dynamic environment, obstacle avoidance technology has become the focus of intelligent robot research, which needs to continuously develop a variety of algorithms. By combining a variety of algorithms, we can realize obstacle avoidance and PP (hereinafter referred to as PP) of MR, which can realize obstacle avoidance more efficiently, in real time and intelligently. Multi algorithm fusion of MR has become the main trend of obstacle avoidance in the future, which will realize PP and optimization. Firstly, this paper analyzes the differences between traditional algorithms and intelligent algorithms. Then, the kinematics model and PP algorithm of MR are analyzed. Finally, the simulation is carried out.

Keywords: Mobile Robot, Dynamic Obstacle Avoidance Algorithm, Path Planning

1. Introduction
MR has become an important research direction of intelligent products in the future. It is a system with many characteristics, such as environment perception, PP and motion control [1]. Through MRs, we can solve a variety of high-risk matters, which will effectively solve a variety of matters. Through sensors, the MR can detect obstacles and collect state information, which can plan the path more scientifically [2-5]. By avoiding obstacles, we can finally reach the destination, which has become a method for MRs to judge, optimize the path and avoid obstacles. Therefore, in the dynamic environment, we must strengthen the research of PP, which will more scientifically optimize the path selection [6]. Through intelligent algorithm, we can effectively avoid obstacles, which can effectively realize PP decision-making and control [7].
2. Performance comparison

For the PP of MR, we have traditional obstacle avoidance algorithm and intelligent obstacle avoidance algorithm, which have many different characteristics in performance [8-10]. The traditional obstacle avoidance algorithm has great limitations, which is not suitable for complex and unknown dynamic environment. Intelligent obstacle avoidance algorithm can optimize the path in dynamic environment, but it needs a lot of computation. This paper analyzes the performance comparison of some traditional obstacle avoidance algorithms and intelligent obstacle avoidance algorithms, as shown in Table 1.

Table 1. Performance comparison

| Traditional obstacle avoidance algorithm | Intelligent obstacle avoidance algorithm |
|----------------------------------------|----------------------------------------|
| Grids                                  | NN algorithm                           |
| A * algorithm                         | It has good generalization ability and strong fault tolerance, which is suitable of unknown external environment information. |
| Visual graph method                   | Visibility binary tree                 |
| Free space method                     | All conditions of the external environment are considered, including the number and size of obstacles and the perceived radius of the robot. |
| Topological method                    | Rolling horizon control                |
| Artificial potential field            | Regardless of any obstacles, the resulting frame can ensure a uniform final boundary and meet the constraints. |
| Free space method                     | Neural controller                      |
| Topological method                    | The neural controller is used to avoid the collision between the robot and static or dynamic obstacles. |
| Artificial potential field            | Hybrid algorithm                       |
|                                        | Combining more than two algorithms and their respective advantages, the robot can quickly avoid obstacles and select the optimal path. |

3. Related mathematical model

3.1. Establishment of kinematic model of MR

The kinematics model of MR mainly consists of two coordinate systems: robot coordinate system and world coordinate system [11]. The robot coordinate system is represented by \((X_R, Y_R)\) and the world coordinate system is represented by \((X, Y)\). The kinematic coordinate system of the MR is shown in Figure 1.
In this paper, the kinematic model of MR is established, as shown in Formula 1. \( \dot{\hat{A}} \) is the current motion state matrix of the MR. The robot has three influencing factors in the world coordinate system, namely X, Y and \( \theta \). The running state of the MR is controlled by the speed of the left and right wheels of the robot, which are \( v_1 \) and \( v_2 \) respectively [12].

\[
\begin{pmatrix}
\dot{X}_i \\
\dot{Y}_i \\
\dot{\theta}
\end{pmatrix} = \begin{bmatrix}
\frac{1}{2} \cos(\pi - \theta) + \frac{L}{B+C} \sin \theta , \\
\frac{1}{2} \sin(\pi - \theta) - \frac{L}{B+C} \sin \theta , \\
\frac{1}{2} \sin(\pi - \theta) + \frac{L}{B+C} \cos \theta , \\
\frac{1}{B+C}
\end{bmatrix}
\begin{bmatrix}
\frac{1}{2} \cos(\pi - \theta) + \frac{L}{B+C} \sin \theta , \\
\frac{1}{2} \sin(\pi - \theta) - \frac{L}{B+C} \sin \theta , \\
\frac{1}{2} \sin(\pi - \theta) + \frac{L}{B+C} \cos \theta , \\
\frac{1}{B+C}
\end{bmatrix}
\begin{bmatrix}
v_1 \\
v_2
\end{bmatrix}
\]

(1)

3.2. Principle of penalty algorithm

This paper mainly studies the global PP algorithm, which measures the superiority of the path by establishing the penalty function. By selecting the penalty function, we can constrain the path length and collision free, which will transform the PP into an extreme value problem. The penalty function \( E \) is shown in formula 2.

\[
E = \mu_c E_c + \mu_l E_l
\]

\[
E_c = \sum_{i=1}^{N} \sum_{k=1}^{K} C_i^k
\]

\[
E_l = \sum_{i=1}^{N-1} \left[ (x_{i+1} - x_i)^2 + (y_{i+1} - y_i)^2 \right]
\]

Among them, \( E_c \) is the collision penalty function and \( \mu_c \) is the weight coefficient; \( E_l \) is the path length penalty function and \( \mu_l \) is the weight coefficient. \( K \) is the number of obstacles; \( N \) is the number of path points; \( C_i^k \) is the collision penalty function of the i-th path point to the kth obstacle.

The neural network algorithm of single point to single obstacle penalty function is shown in Formula 3.
By deriving the penalty function, we can obtain the dynamic motion equation about the path point \( P_i(x_i, y_i) \), as shown in Formula 4.

\[
\begin{align*}
\dot{x}_i &= -\eta \left[ 2\mu_i(2x_i - x_{i-1} - x_{i+1}) + \mu_c \sum_{k=1}^{K} f'(x_i) \sum_{m=1}^{M} f'(y_{im}) \omega_{xm} \right] \\
\dot{y}_i &= -\eta \left[ 2\mu_i(2y_i - y_{i-1} - y_{i+1}) + \mu_c \sum_{k=1}^{K} f'(y_i) \sum_{m=1}^{M} f'(y_{im}) \omega_{ym} \right]
\end{align*}
\]

(4)

4. Simulation experiment and analysis

4.1. Global optimal path simulation

In this paper, matlab r2016a is used for simulation, which can first plan a path in the static obstacle environment. The grid environment is 20x20. In this paper, the blue x point is set as the initial point and the red x point is set as the target point. The simulation diagram is shown in Figure 2. In this paper, a global optimal path is planned by neural network algorithm (formula 3).

Figure 2. PP based on neural network algorithm

4.2. Path simulation of avoiding static obstacles

In the process of driving, when the MR can detect the static obstacles in front through the sensor. By generating local sub target points through the algorithm, the robot can skillfully avoid obstacles, which can realize the automatic avoidance of static obstacles. The path diagram of MR avoiding static obstacles is shown in Figure 3.
4.3. **Dynamic obstacle avoidance path simulation**

In a given environment, this paper adds two dynamic obstacles, namely Ob1 and Ob2. The MR senses the obstacle Ob1 and predicts a side collision. Therefore, the MR avoids obstacles by staying for a moment. When the Ob1 does not cause collision, the MR can continue to walk along the originally planned path. Through the sensor, the MR detects the dynamic obstacle Ob2 and predicts the frontal encounter. The local target points are generated by neural network algorithm, and the robot continues to move along the planned path after avoiding obstacles. The completed PP diagram for avoiding dynamic obstacles Ob1 and Ob2 is shown in Figure 4.

5. **Conclusion**

With the development of artificial intelligence, intelligent obstacle avoidance algorithm has become an indispensable ability of MR, which is also the key problem in PP in the future. Through neural network algorithm and PP, MR can complete dynamic obstacle avoidance, which is also the mainstream direction of PP algorithm in the future.

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