

Research on SLAM Path Planning of ROS Robot based on Lidar

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Abstract. In order to improve the autonomous navigation performance of robot, an automatic mapping and path planning method based on ROS robot is proposed, which uses two-dimensional laser radar to collect the surrounding environment. Gmapping algorithm is used for automatic optimization and mapping, Class A algorithm is used for global path planning, and DWA method is used to realize the local obstacle avoidance function of the robot. Experiments show that this method can realize the automatic generation and automatic navigation of the robot.

Keywords: Lidar; ROS Robot; SLAM; Path Planning.

1. Introduction

At present, mobile robot technology has been developed rapidly, and has been widely used in agriculture, service industry, logistics and other industries. SLAM is an important technology for robots, which involves robot positioning and mapping. Path planning is to design an effective route according to specific optimization principles (accuracy, safety, optimality), which is a feasible route for mobile robots to successfully avoid dynamic obstacles when completing from the starting point to the target. In order to solve the SLAM problem of mobile robots, Wang Yuanhua and others proposed a line segment feature based on local and global features

2. Overall Design

2.1 Design of Autonomous Navigation System

2.1.1. AMCL Positioning System

AMCL positioning system is a Monte Carlo algorithm based on particle trust. Its basic idea is to use particle filter method to track the robot's attitude based on particles, and determine the robot's attitude distribution by particle weighting. The method includes two categories of pose: one is to predict the pose, the other is to update the pose. First, locate any pose, then use the information of the sensor to assign the importance of each particle, predict the pose in time t , and estimate their motion trajectory. Then, according to the scanning results of the sensor, the importance of the sampled particles is corrected. The higher the importance is, the closer the pose is to the actual pose. On this basis, resample the particles to achieve accurate positioning, and repeat this step when the particles are below the critical point. When navigation starts, AMCL will initialize its particle filter according to the set parameter conditions, and then use the 2D Pose Estimate button to initialize the pose of Rviz [2].

2.1.2. SLAM System based on 2D Laser Radar

According to different sensor types, SLAM can be realized in two ways: one is to analyze the external images by using the camera, that is, visual SLAM and laser radar SLAM. The lidar used in this paper is to send the laser around the target, and then through its reflection to detect the surrounding environment, and then get the corresponding map and location. In addition, when the camera is used outdoors, it is seriously affected by the environment and light, while the laser radar is little affected by light, so it can work in the dark.

This paper introduces a kind of G Gmapping algorithm using RBPF filter to complete the design of SLAM. Because RBPF method needs a lot of calculation in practical work, and the particles are

sampled for many times during drawing, which will lead to the deterioration of particles and the decline of species diversity. The Gmapping algorithm improves the recommended particle sampling distribution, so it can reduce the number of particles required for pose calculation; At the same time, we suggest selective resampling, setting appropriate sampling particle number, and sampling when conditions are met [3].

2.1.3. Path Planning

2.1.3.1 Global Path Planning

The traditional A * algorithm is a heuristic path search method combining BFS and Dijkstra algorithm. The general form of its valuation function is $f(n) = g(n) + h(n)$. $F(n)$ is the generation value of node n from the starting node to the destination node; $G(n)$ is the actual generation value from an initial node to an arbitrary node; $H(n)$ is a heuristic function, which refers to the generation value consumed when a robot moves from n nodes to a target node. The time complexity of the A * algorithm is greatly related to the position of the starting point and the number of nodes. The number of expansion points increases in the starting point in a wide area and the target point in a narrow area. When the starting point and the target point exchange positions, the number of expansion nodes decreases significantly. Finally, in two different cases, a simulation comparison was carried out to verify the non-accidental results. Several experiments show that the search efficiency of A * algorithm has a great relationship with the starting point and the end point position. The starting point position has a great impact on the search efficiency. If the starting point is open, the number of search nodes will be twice that of the narrow area, and the search time will also increase. Therefore, A * method has obvious shortcomings.

Aiming at the search strategy of the existing A algorithm, it is improved to improve the effectiveness of path planning. A * algorithm is a bidirectional search method based on head and tail. Its search range starts from the starting point, while the improved method is to expand both the starting point and the target point. When the extension nodes are the same, the search will be terminated. The heuristic function of the improved A+algorithm is X_{sn} is the abscissa of the current node; X_{En} is the abscissa of the current node in the other search direction; Y_{sn} is the ordinate of the current node; Y_{En} is the ordinate of the current node in the other search direction The simulation test is carried out under various test conditions, and the initial and end positions are adjusted respectively. The improved A * algorithm has better stability. No matter in narrow or open areas, it can achieve nearly the same search speed and number of expansion nodes [4].

2.1.3.2 Local Path Planning

DWA algorithm can complete real-time path planning and real-time obstacle avoidance. Its basic idea is: to obtain the linear speed and angle of the mobile robot in each cycle, first discretize the robot, then use the current state of the robot to predict the possible situation, and evaluate each path according to certain measurement indicators (such as obstacle approach, global path, speed) to eliminate inappropriate paths (with obstacles), Finally, select the path with the highest score and send the corresponding speed information to the mobile platform.

2.2 Real Environment Experiment of Mobile Robot

2.2.1. Hardware Platform

The hardware platform of the system takes the master computer as the core, and is connected with a laser radar sensor, which is used to measure everything and targets around the robot; The system is also equipped with attitude sensors to obtain the motion state and acceleration of the entire robot, and is driven by a brushless motor.

2.2.2. Software Platform

In the ROS robot system, the laser radar and IMU attitude sensors are added to realize the real-time monitoring of the environment and attitude information; Brushless DC motor and steering gear

are used to control the motion of the robot, obtain the overall situation of the environment, process the collected data, and then use the Gmapping algorithm to establish a complete environment map to obtain a global static map; At the computer ROS end, the request access of ssh is realized, and the remote control of the whole system is realized.

2.2.3. Path Planning Experiment

Based on the laboratory corridor, this paper simulates the indoor basic environment by adding cartons, cones and other obstacles. Using the function of G mapping in ROS, the two-dimensional environment map is drawn. View the planned route in the Rviz visual interface through the navigation function package. With the movement of the robot, part of the cost map will be updated constantly, and the local route will also change, successfully avoiding obstacles.

3. Conclusion

In this paper, a two-dimensional laser radar-based SLAM system is studied. On this basis, this paper presents an A-type algorithm based on head tail bidirectional search, and simulates it. The simulation results show that the algorithm proposed in this paper has better search performance compared with the conventional A * algorithm. The research results show that the use of A * head tail search automatic optimization method can realize the detection and avoidance of unknown dynamic obstacles, reach the target position, and improve the robot's autonomous navigation ability and work efficiency.

References

- [1] Huang Yakun. Research on indoor SLAM and path planning of robots based on lidar [D]. Lanzhou Jiaotong University, 2020.
- [2] Wu Xin. Research on Laser Radar Map Construction and Path Planning of Mobile Robot under ROS [D]. Shaanxi: Xi'an University of Technology, 2021.
- [3] Wang Zhu. Research on obstacle detection and SLAM path planning based on lidar [D]. Beijing: Beijing Jiaotong University, 2021.
- [4] Su Zhifeng. Path Planning and Tracking Control of Mobile Robot Based on Lidar [D]. Jiangxi: Nanchang Aviation University, 2020.