Research on Mobile Robot Path Optimization Based on RFID and WSN

Xiong Qiong

School of Information Engineering, Wuhan Technology and Business University, Wuhan 430200, China

E-mail: joan027joan@qq.com

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Abstract: In order to enable mobile robots to avoid obstacles autonomously and achieve the shortest mobile path, combining the advantages of RFID and WSN technology, it proposes a method of obstacle avoidance and path planning based on perception, judgment, re-perception, planning and behavior. It realizes the path optimization algorithm of mobile robots based on RFID and WSN, which can provide real-time location and path planning for mobile robots, which provides some technical reference for obstacle avoidance and path optimization.

1. Introduction

With the gradual improvement of automation level and the development of mechanical automation, mobile robots have become a trend of future development. Mobile robot is a self-planning, self-organizing and intelligent platform which can work independently in complex environment. Intelligent recognition, autonomous positioning and path planning are the key to realize the intelligence of mobile robot, and also the basis to improve the intelligence of mobile robot. Based on RFID and WSN technology, I have studied a path optimization algorithm for mobile robots, which can realize real-time location, obstacle avoidance and path optimization of mobile robots.

2. RFID and WSN Technology

2.1 RFID Technology.

Radio Frequency Identification (RFID) technology is a new automatic identification technology. It uses radio frequency signal to realize contactless information transmission through wireless coupling technology, so as to realize the wireless identification of the target. Within a certain range, the transponder of the RFID system enters the magnetic field of the reader, receives the wireless signal emitted by the reader, and has certain energy according to the inductive current of the received signal. When the energy reaches a certain level, the transponder will send the information stored in the transponder to the reader. After the reader obtains the information, it will start to the background processor for data processing. Handle. The working principle of RFID is shown in Figure 1.

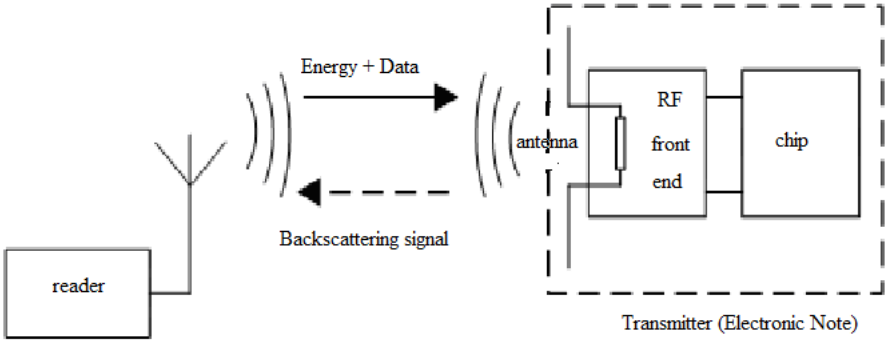

Fig. 1 The principle of RFID

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2.2 WSN Radio Frequency Identification Technology.

WSN is a communication network composed of low-cost micro-sensors, which includes sensors, processors, wireless communication and energy supply modules. Among them, the sensor module is mainly responsible for collecting target signals in specific areas; the processor module is mainly responsible for collecting and processing signals sent by the sensor module; the wireless module is mainly responsible for the transmission and reception of network information, communication protocols and various signals; the energy supply module is mainly responsible for the power supply of each module, generally using Wechat lithium batteries or solar cells. The working principle of WSN module is shown in Figure 2.

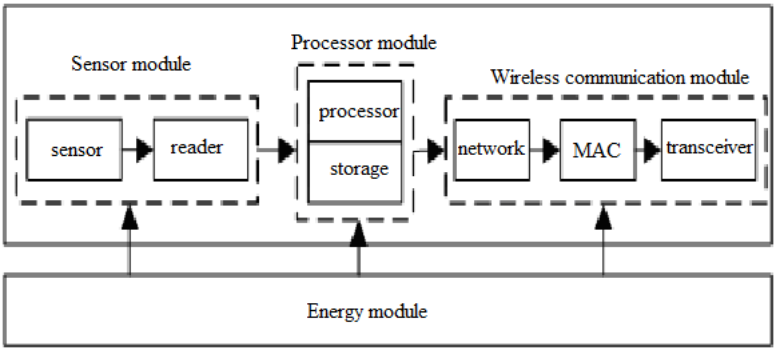

Fig.2 The working Principle of WSN Module

In a single sensor WSN network, the system is only a simple node. The signal collected by the sensor is analyzed and saved by the processor after analog-to-digital conversion. In addition, the information to be sent out will be sent out through the wireless communication module. The WSN module is a collection of multiple single sensor modules, and the transmission and analysis of each module's information are completed by wireless communication module.

2.3 Integration of RFID and WSN.

The function of WSN technology is to build a wireless sensor network system and to receive the data information received by sending. RFID is not only used for simple coding statistics, but also has the ability to analyze and process data information, which is similar to sensor system nodes. This paper integrates RFID and WSN effectively, maximizes their value, makes full use of the advantages of RFID data processing and WSN wireless network data acquisition, and achieves accurate positioning and path tracking of the target system. The fusion of RFID and WSN is mainly the fusion of two nodes. Using RFID technology to read data and WSN to transmit data wirelessly, the implementation block diagram is shown in Figure 3.

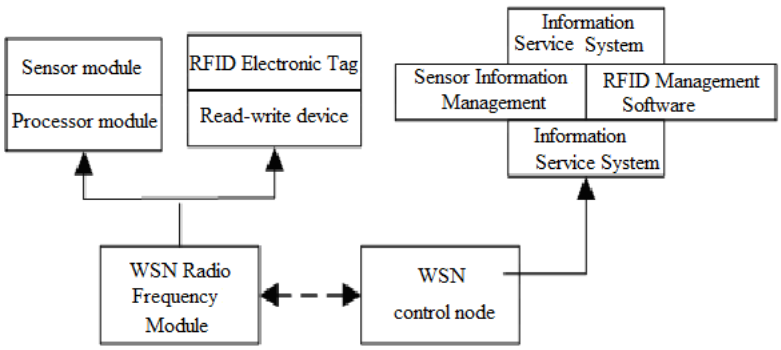

Fig.3 The combination block diagram of RFID and WSN

3. Implementation of WSN Location Algorithms

WSN positioning technology is the premise and foundation of path optimization for mobile robots. For navigation and path optimization of mobile robots, first of all, positioning functional

nodes are needed. Each node can not only locate itself according to the distribution information of surrounding RFID nodes, but also provide location information for mobile robots to realize positioning and path planning. WSN positioning technology includes a large number of nodes. This node is equipped with mobile nodes of GPS or other positioning devices. It periodically sends out its own location information during the movement. In addition, it can also be equipped with fixed beacon nodes.

The goal of WSN positioning technology is to calculate the location information of the positioning object. In sensor node positioning, there are mainly three ways: trilateral measurement, triangulation and maximum likelihood estimation. The WSN localization algorithm studied in this paper adopts the principle of maximum likelihood estimation. The algorithm uses the distance between N known coordinate nodes and mobile robot to determine the coordinates of nodes, as shown in Figure 4.

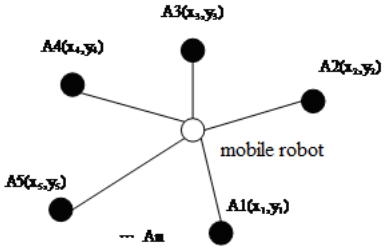

Fig.4 The maximum likelihood estimation location principle

As shown in Fig. 4, the distances of N known coordinate nodes and mobile robots are respectively d_1,d_2,d_3,d_4,…,d_n,. The formulas for calculating the distances are as follows:

$$\begin{cases} (x_1-x)^2+(y_1-y)^2=d_1^2 \\ (x_2-x)^2+(y_2-y)^2=d_2^2 \\ \vdots \\ (x_n-x)^2+(y_n-y)^2=d_n^2 \end{cases} \tag{1}$$

After simple transformation, it is as follows:

$$\begin{cases} x_1^2-x_n^2-2(x_1-x)x+y_1^2-y_n^2-2(y_1-y_n)y=d_1^2-d_n^2 \\ x_2^2-x_n^2-2(x_2-x)x+y_2^2-y_n^2-2(y_2-y_n)y=d_2^2-d_n^2 \\ \vdots \\ x_{n-1}^2-x_n^2-2(x_{n-1}-x)x+y_{n-1}^2-y_n^2-2(y_{n-1}-y_n)y=d_{n-1}^2-d_n^2 \end{cases} \tag{2}$$

The expression (2) can be transformed into a linear equation, in which,

$$A=\begin{bmatrix} 2(x_1-x_n) & 2(y_1-y_n) \\ \vdots & \vdots \\ 2(y_{n-1}-y_n) & 2(x_{n-1}-x_n) \end{bmatrix} \tag{3}$$

$$b=\begin{bmatrix} x_1^2-x_n^2+y_1^2-y_n^2-d_1^2+d_n^2 \\ x_{n-1}^2-x_n^2+y_{n-1}^2-y_n^2-d_{n-1}^2+d_n^2 \end{bmatrix} \tag{4}$$

$$X=\begin{bmatrix} x \\ y \end{bmatrix} \tag{5}$$

Therefore, the coordinates needed to solve T-point can be obtained as follows:

$$\hat{X}=(A^TA)^{-1}A^Tb \tag{6}$$

4. Path optimization strategy for mobile robots

Mobile robots need to prevent collisions with obstacles in the process of moving. Especially in complex working environments, obstacles are not only strange in shape and disorderly placed, but also may often have moving obstacles such as human and other moving objects. Therefore, obstacle avoidance and path planning for mobile robots are very important. This paper presents a method of obstacle avoidance and path planning based on perception, judgment, re-perception, planning and behavior. The perception information is provided by RFID and WSN systems, the planning is realized by mobile robot intelligent control system, and the behavior is realized by picking robot driving actuator. The structure of path optimization strategy for mobile robots is shown in Fig. 5.

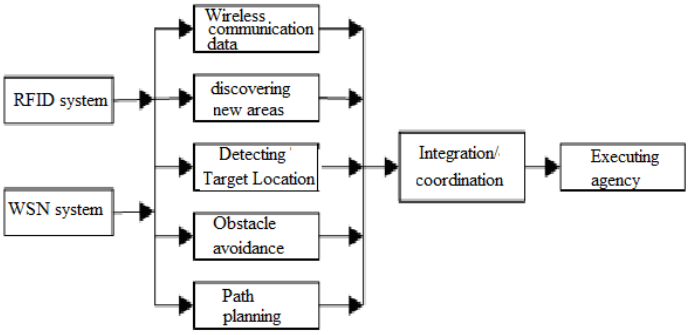

Fig.5 Path optimization strategy structure for mobile robots

As shown in Fig. 5, when a mobile robot operates in an unknown environment, it detects the environmental information through the sensors it loads, and plans the mobile robot's motion path according to different local information. The RFID system obtains the local environmental information of the surrounding area and makes reasonable judgments. The WSN system obtains the location information of the picking robot and obstacles by using the location of the nodes. So the path optimization of mobile robot can be realized.

In practical applications, first of all, we need to build WSN and RFID tag platforms in the mobile robot operating area, while mobile robots carry GAIZ and RFID reader to realize their own positioning, obstacle avoidance and path planning. The path planning of the mobile robot is shown in Figure 6.

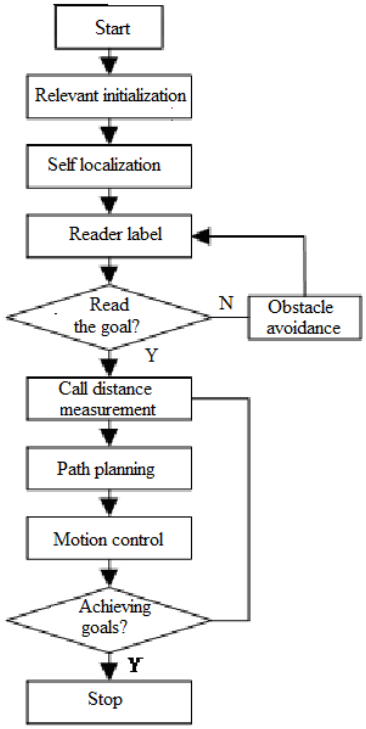

Fig.6 Path planning for mobile robots

5. Conclusion

Aiming at the problem of mobile robot location and path planning, it designed and studied a path optimization algorithm for mobile robot based on the fusion of RFID and WSN. Combining the advantages of RFID and WSN technology, it proposes a method of obstacle avoidance and path planning from perception to judgment to re-perception to planning to behavior. It uses RFID system to obtain local environmental information and WSN system to obtain location information of picking robots and obstacles, so as to realize location and path planning algorithm.

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