Research on Robot Environment Perception based on Artificial Intelligence

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Abstract: With the rapid development of robotics and artificial intelligence, intelligent robot systems for different application scenarios have gradually integrated into military, industrial, and family fields, which will have a great impact on future production and lifestyle. As the basic function necessary for intelligent robots, environmental intelligence perception directly determines the completion effect of robot work tasks. In this paper, the key technologies of environmental intelligent sensing system based on mobile robot are studied. The key technologies such as "establishment and update of environmental model", "robot path planning algorithm" and "environment map description and display with semantic information" are briefly introduced. Common methods, and some problems in the traditional methods have been improved.

1. Introduction

An intelligent mobile robot is a type of robotic system that performs its own work tasks by sensing the information of itself and the external environment through various types of sensors carried by itself or externally assisted, relying on such information to realize the motion decision of the robot. Intelligent mobile robots are gradually being applied to many fields such as military, production, rescue and home, which have a very significant impact on future production and lifestyle. On the military side, robots are known as one of the key weapons of future warfare and play a very important role in national defense security. The US military's claw-armed robots have been involved in mission execution, and unmanned aircraft, reconnaissance robots, bomb-removal robots, and explosion-proof robots have also been applied. In terms of scientific research and production, where some people are not convenient to work, it is practical to use robots instead of humans. For example, in nuclear equipment inventory management and safety maintenance, if using intelligent robots for environmental monitoring and safety maintenance, when there are excessive doses, equipment loss, position change, etc., the intelligent robot can not only make quick judgments and decisions, but also can quickly perform some work tasks before the staff arrives to minimize the harm of the accident, thus ensuring Safety of nuclear equipment and nuclear facilities. In the field of home applications, service robots such as security robots, cleaning robots, and elderly service robots are gradually entering people's lives and changing the way people live. In addition, intelligent robots can also play their role in many areas such as fire prevention and rescue.

2. Environmental intelligent sensing technology based on mobile robot

The information used to create and update the environmental model comes from various types of sensors. According to the use of the sensor in the system, the sensors commonly used in current types of robot systems can be divided into two categories. Among them, the sensors for completing the detection of the surrounding objects by the robot include: a laser scanner, an infrared sensor, an ultrasonic sensor, a microwave radar, a tactile sensor, a proximity sensor, a visual sensor, etc.; the sensor for completing the position determination of the robot itself includes: photoelectric coding (odometer), gyroscope, speed and accelerometer. Among the sensors used to complete the robot's detection of obstacles, sensors using active ranging methods such as ultrasonic sensors, infrared sensors, and laser scanners have been applied on a large scale, and are standard configurations of various types of robot systems, although their respective applications. There are certain differences in the scene (such as laser scanners with high precision but high price, large amount of acquisition

and real-time weakness, infrared sensors have certain requirements on object color, ultrasonic sensors have scattered angles and are sensitive to temperature, etc.), but they The way of working is similar, that is, the distance between the robot and the object is determined by measuring the difference between the transmitted signal and the received signal. In this system, the information acquisition method based on ultrasonic sensors is adopted.

3. Mobile robot autonomous obstacle avoidance based on multi-sensor information

The research on multi-sensor fusion method has been started since the mid-1980s. It has been 20 years since the scholars of various countries have achieved certain results in this respect, but multi-sensor data fusion is only applicable to one aspect, so it is difficult to determine multi-sensors. A general approach to convergence. For multi-sensor systems, information is diverse and complex, so the basic requirements for information fusion methods are robust and parallel processing capabilities. At present, the information fusion method can be roughly summarized into two categories: random class and artificial intelligence class. The stochastic class methods include weighted average method, Kalman filter method, Bayesian estimation, statistical decision, cluster analysis method, wavelet transform method, DS evidence reasoning, etc.; artificial intelligence class has fuzzy clustering theory, expert system, nerve Network, fuzzy neural network.

1) Bayesian Estimation Bayesian estimation is a common method for merging multi-sensor underlying layers in static environments. The information is described as a probability distribution for an uncertain environment with Gaussian noise. Durrant-Whyte represented the task environment as a multi-sensor system model of a set of uncertain geometric objects. In the entire system, each sensor is represented by a useful static description capability to extract these objects. Multiple sensors in the system act as a decision-making team, and multiple sensors must determine the consistency of a team's observations of the environment. Multi-Bayesian estimation combines each sensor as a Bayesian estimate, combining the associated probability distributions of individual objects into a joint posterior probability distribution function. By using the likelihood function of the joint partition function to minimize the final fusion value of the multi-sensor information, a priori model of the fusion information and environment provides a feature description of the entire environment. H. Pan et al. considered that the advantage of the Bayesian method is that it is concise and easy to handle related events; the disadvantage is that it cannot distinguish between objects that are not known to be uncertain and that are required to be processed. Especially in practical applications, it is difficult to know the prior probability. When the a priori probability of hypothesis is in contradiction with reality, the result of reasoning will be very poor, and it will be quite complicated when dealing with multiple hypotheses and multiple conditions. Kalman Filter (KF) Kalman Filter is used to fuse dynamic bottom-level redundant sensor data in real time. This method uses the statistical characteristics of the measurement model to recurse and determine the optimal fusion data estimation in statistical sense. If the system has a linear dynamics model and the system noise is white noise, Kalman filtering provides the only statistically optimal estimate for the fused data. The recursive nature of Kalman filtering allows system processing without requiring a large amount of data storage and computation. KF is divided into Decentralized Kalman Filter (DKF) and Extended Kalman Filter (EKF). DKF enables full decentralization of multi-sensor data fusion, with the advantage that failure of each sensor node does not cause the entire system to fail. The advantage of EKF is that it can effectively overcome the impact of data processing instability or the linearity of the system model on the fusion process. The disadvantage is that it is necessary to have a good understanding of the overall physical laws of multi-source data in order to accurately obtain $p(d|f)$, but it is necessary to predict the prior distribution $p(f)$. Nowadays, this method is more and more popular, especially in the multi-sensor multi-target tracking system. For example, Tomatis et al. use the Kalman filter hybrid method to realize the navigation of mobile robots. It shows that the success rate reaches 96% on the 1.15km route. From the tracking accuracy of mobile robots, the deviation from the target point is only 9mm. Probability and Statistics Method Suppose a set of random vectors $1x, 2x, ..., nx$ respectively represent the data information obtained by n different sensors. According to each data ix, a decision id can be made for the completed task.

The neural network algorithm is based on the research results of human information processing in modern neurobiology and cognitive science. It has good fault tolerance, hierarchy, plasticity, adaptability, associative memory and parallel processing ability. These characteristics of the neural network and powerful nonlinear processing capabilities meet the requirements of multi-sensor data fusion technology processing. In multi-sensor systems, the environmental information provided by each information source has a certain degree of uncertainty. The fusion process of these uncertain information is actually an uncertainty reasoning process. The neural network determines the classification criteria according to the sample similarity accepted by the current system. This determination method is mainly expressed in the weight distribution of the network. At the same time, the neural network specific learning algorithm can be used to acquire knowledge and obtain the uncertainty reasoning mechanism. Multi-sensor data fusion is realized by using the signal processing capability and automatic reasoning function of the neural network. The research effect of the information fusion technology combined with the neural network and other methods has been remarkable, and a trend has been formed. For example, D-S evidence theory combined with neural networks, fuzzy sets and neural networks, wavelets and neural networks, and genetic algorithms and neural networks. Fuzzy neural network method Fuzzy neural network is the product of fuzzy theory combined with neural network. It combines the advantages of neural network and fuzzy control, integrating learning, association, recognition, adaptive and fuzzy information processing. The combination of fuzzy logic and neural networksis one of the key technologies for implementing machine intelligence. The combination of fuzzy technology and neural network technology can effectively exert their respective advantages and make up for the shortcomings; the advantage of fuzzy technology lies in the logic reasoning ability, easy to carry out high-order information processing, and introduce fuzzy technology into neural network, which can greatly Widening the scope and capabilities of neural networks to process information, not only to process accurate information, but also to process fuzzy information or other inaccurate information, not only to achieve accurate association and mapping, but also to achieve inaccurate association and mapping. Especially fuzzy association and fuzzy mapping. The neural network has strong advantages in learning and automatic pattern recognition. The use of neural network technology for fuzzy information processing makes the automatic extraction of fuzzy rules and the automatic generation of fuzzy membership functions possible, so that the fuzzy system can become an adaptive fuzzy system.

4. Conclusion

At present, the working environment of mobile robots is not as good as ours. But as their application areas become more widespread, the work environment will be more complex. The study of its environmental perception is also called an important topic. Its working environment can be divided into known, fixed structural environment and complex and variable non-structural environment such as ruggedness and obstacles. Path tracking and autonomous obstacle avoidance of mobile robots are the two most basic aspects of mobile robot motion, and they are also the most fundamental and important issues in environmental perception research. Many researchers at home and abroad are working on the research of mobile robot environment perception. A variety of sensors are installed on the mobile robot, and the information fusion method is used to fuse the obtained information to obtain a consistent description of the environment. With the development of sensors and computer technology, research on the fusion of various sensor information will be deeper and more results will appear. It can be said that research on a variety of sensor information fusion environment perception has important significance and broad application prospects.

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