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Research on the Development of Mobile Manipulator Robot System Based on Embodied Intelligence

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Abstract: The core concept of mobile manipulation robots lies in the acquisition of knowledge and capabilities through direct interaction between the robot and its environment. This interaction not only improves the robot's perceptual ability, but also enhances its operational accuracy and efficiency. Mobile manipulator robot systems based on embodied intelligence have significant advantages in terms of task execution and adaptive capability in complex environments.

Keywords: Embodiment-based; Intelligent mobile manipulation robots; System development

Introduction

With the rapid development of science and technology, robotics has become an indispensable and important part of modern industry, medicine, military and other fields. Mobile operating robots have attracted much attention for their high flexibility and adaptability, and their ability to perform diverse tasks in complex environments. The introduction of the concept of embodied intelligence has injected new vitality into the development of mobile manipulators.

1. Definition and Principles of Embodied Intelligent Mobile Manipulator Robot System

Embodied Intelligent Mobile Manipulator Robot System is a robot system that integrates intelligent control, perception, motion and decision-making, etc. Its design is inspired by the intelligence and behavioral characteristics of living organisms, and it aims to simulate the behavior of human beings or animals, and to have the ability of autonomous mobility, collaborative operation, etc., in order to complete a variety of complex tasks.The principle of this system is based on sensors to acquire environmental information, data interaction with intelligent control system, and algorithmic analysis and decision-making to realize autonomous robot movement and operation while maintaining stability. The robotic system of embodied intelligent mobile operation includes various sensors, such as cameras, LIDAR, ultrasonic sensors, etc., which are used to obtain information about the surrounding environment, real-time monitoring and recognizing obstacles, target positions, etc.It is responsible for processing the data acquired by the sensors, performing data fusion and processing, designing suitable control algorithms, and realizing the robot's functions such as localization, navigation, and obstacle avoidance. According to the environmental information provided by the perception module and the feedback from the intelligent control module, formulate the robot's behavioral strategies, such as selecting suitable path planning, adjusting the movement speed and direction, etc. According to the instructions issued by the behavioral decision-making module, the driver and actuator of the robot are controlled to implement the corresponding actions to realize the robot's movement and operation tasks in the environment.

2. Key technologies for body-mounted intelligent mobile manipulator robotic systems

2.1 Perception Technology for Embodied Intelligent Mobile Manipulator Robot System

Visual recognition technology is one of the key capabilities for robots to perceive the environment and recognize objects. By using cameras and image processing algorithms, robots can acquire visual information from the environment and perform tasks such as target detection, object recognition, and attitude estimation.These technologies help robots to recognize obstacles, locate the position of a target, and make decisions to act accordingly. Sound recognition technology allows robots to sense and understand sound signals in the environment. By using microphones and sound processing algorithms, robots can recognize and understand voice commands and perform simple voice interactions with people.Sound recognition technology also helps the robot to sense the sounds generated in the environment such as alarms, sound signals, etc. to provide a more comprehensive perception of the environment. Environment perception techniques include the use of sensors to acquire and analyze various parameters in the environment to help the robot understand the condition of its surroundings.For example, LiDAR

can provide distance and shape information of obstacles, infrared sensors can be used for distance measurement, and ultrasonic sensors can be used for obstacle detection. These sensing technologies can help robots realize functions such as obstacle avoidance, navigation and localization to ensure the safety and accuracy of robot movement in complex environments.

2.2 Decision-making and planning technology of embodied intelligent mobile manipulator robot system

Path planning technology is one of the key technologies in the embodied intelligent mobile manipulation robot system. It calculates the optimal path for the robot in the complex environment by considering the robot's position, the target position and the environmental conditions. Common path planning algorithms include A* algorithm, Dijkstra's algorithm and so on.Through path planning, robots can quickly and accurately find the optimal path in various complex environments and realize autonomous movement. In the embodied intelligent mobile operating robot system, task scheduling technology is used to sort, arrange or execute multiple tasks in parallel so that the robot can complete the tasks efficiently. Through task scheduling, the robot can reasonably organize and arrange the execution order of tasks based on constraints such as task priority, timeframe, and resources, in order to improve the efficiency and quality of task execution. Intelligent decision-making technology uses machine learning and artificial intelligence algorithms to analyze and model sensory data so that the robot can make reasonable decisions based on the current environmental state and task requirements.For example, the robot can decide whether to avoid obstacles according to changes in the current environment or adjust its action strategy according to the results of task execution. Intelligent decision-making technology can equip robots with adaptability, flexibility and initiative, and improve the intelligence level of the system.

2.3 Execution and control technology for body-bodied intelligent mobile manipulation robot system

Motion execution technology is used to control the robot to execute specific motion postures and actions to realize the operation tasks. By accurately controlling the robot's joints and actuators, the robot can be made to accomplish various actions, such as grasping, placing, and scanning. Motion execution technology needs to combine the results of sensing and decision making to adjust and optimize the robot's motion control in real time to ensure the accuracy and stability of the motions.Attitude adjustment techniques are used to maintain the balance and stability of the robot. During mobile operation, the robot may be subjected to external disturbances, resulting in attitude deviation or instability. Attitude adjustment technology monitors the robot's attitude changes by using sensors such as gyroscopes and inertial navigation, and adjusts the robot's attitude through control feedback algorithms to keep it balanced and stable. Tracking control technology is used to realize the position and trajectory control of the robot during motion. By using sensors to measure the position and velocity information of the robot, the tracking control technology can make the robot move according to a predetermined trajectory during the motion process and maintain good control performance and motion accuracy.

3. Application Areas of Embodied Intelligent Mobile Manipulator Robot System

3.1 Application of Body-Mounted Intelligent Mobile Robot System in Industry

On the production line, the robotic system with body-intelligent mobile operation can undertake all kinds of assembly tasks.Through visual recognition technology, the robot can accurately detect and identify parts, and then utilize autonomous control and manipulation technology to carry out assembly work at a specified location. The embodied intelligent mobile operation robot system is able to realize efficient and precise assembly operation, which greatly improves the production efficiency and quality. In the industrial production process, a large amount of material handling work is required.Intelligent mobile robot system with body can acquire material position information through perception technology, plan the optimal handling path through path planning and decision-making technology, and then utilize execution and control technology to accurately handle materials. This robot system can autonomously and efficiently complete all kinds of handling tasks, reducing labor intensity and improving work efficiency. The robotic system can also work with human workers to accomplish industrial tasks. For example, in collaborative assembly tasks, robots can assist human workers in assembly operations through visual recognition technology, improving assembly speed and accuracy.

3.2 Application of embodied intelligent mobile operation robot system in the service field:

The embodied intelligent mobile operating robot system can assume the role of a waiter in the restaurant field to provide efficient and accurate restaurant services. The embodied intelligent mobile operating robot system can improve the service efficiency of the restaurant, reduce labor costs, and provide a good customer experience at the same time. In the tourism industry, the robotic system can act as a tour guide and provide tour guide services to tourists.The robot can acquire information about its surroundings through perception technology and communicate with visitors through speech recognition and synthesis technology. The robot can introduce the historical and cultural background of the attraction, provide guided tour information, and help tourists answer questions. The embodied intelligent mobile operating robot system can provide convenient, accurate and interesting tour guide services in the tourism industry, increasing the value of the tourists' experience.

4. Conclusion

The development of mobile manipulation robot system based on embodied intelligence is promising. By continuously receiving environmental information, analyzing, deciding and executing actions, the embodied intelligence mobile manipulation robot system can realize the robot to efficiently and flexibly complete various tasks in complex and changing environments. We look forward to more innovative and groundbreaking research results in the future, injecting new momentum into the development of this field.

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