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Research on Dynamic Target Recognition System of Mobile Robot

Yanni Zhou[1, a], Li Jiang[1], Yuming Qi[1], Hui Li[1]

[1]Institute of robotics and intelligent equipment, Tianjin University of Technology and Education, Tianjin 300222, China

[a]791850893@qq.com

Abstract

Aiming at the problems of inaccurate target location and poor timeliness of mobile robots in the World Skills Competition, the dynamic target recognition system of mobile robots is studied. Firstly, the orientation information of the target object is acquired by high-speed camera, and the core controller judges how the robot moves next through relevant algorithms. Then, the control signals are sent to the actuator of the robot actuator to drive the actuator so that it can track the target object. The mobile robot senses the external environment and its own posture by using multi-information fusion sensor technology. Analyses, judge and make decisions on the environment to accomplish the expected tasks.

Keywords

World Skills Competition; Mobile Robot; Monocular Vision; Fast Recognition and Location.

1. INTRODUCTION

Mobile robots have very wide application prospects in many fields. For example, in industrial production, it can replace human beings to complete the tasks of cargo handling and equipment detection in harsh environments; in military, it can replace human beings to complete reconnaissance and mine clearance tasks in dangerous areas; and in scientific research, it can replace human beings to complete the exploration of outer planets or mineral deposits. An important feature of mobile robots is that they can acquire environmental information independently. For traditional tracking robots, laser, radar, ultrasound and vision are commonly used to obtain environmental information. Laser, radar and ultrasound are used to acquire environmental information by actively transmitting pulses and receiving reflected pulses. When there are other laser, radar and ultrasonic sources in the environment, they are prone to interference. There is no such problem in using vision, and the information obtained by vision is very rich, which can better express environmental information.

In the past, object recognition applications mainly focused on static recognition, and the target was either relatively geostationary or relatively stationary relative to the camera. When the target moves, there are many problems, such as slow recognition speed, low recognition success rate and serious decline of recognition accuracy. Therefore, the application field of dynamic object recognition technology is relatively limited, and the research of mobile robot target dynamic recognition system is of great significance.

2. RESEARCH STATUS OF MOBILE ROBOTS

The National Science Committee of the United States has predicted that tank is the core weapon of the 20th century and unmanned combat system is the core weapon of the 21st century. After 2000, the remote-controlled ground unmanned combat system will continue to

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equip troops and go to the battlefield. To this end, since the 1980s, the United States Defense Advanced Research Projects Agency (DARPA) has set up a special project and formulated a strategic plan for the ground space-man combat platform. Since then, a comprehensive study of outdoor mobile robots has begun all over the world, such as the Autonomous Ground Vehicle (ALV) Program of DARPA's Strategic Computer Program (1983-1990), the 10-year Robot and Intelligent Systems Program (RIPS) (1986-1995) formulated by the Ministry of Energy, and the subsequent Space Robot Program; the Robot Program for Operating in Extreme Environment organized by Japan's Ministry of Communications and Industry; and Europe. Robot project in Eureka, etc. [2].

In 2001, the French National Centre for Scientific Research proposed an interdisciplinary large-scale national plan called Robots and Artificial Bodies. The plan covers not only information science in robotics, but also robotics. The Robot and Artificial Body project integrates the perceptron actuator with the cognitive function in the intelligent system, and can accomplish all tasks independently in a changeable and open environment. The plan also realizes the functions of intelligent robots interacting with human beings and improving their behavior through learning. In this project, researchers have also carried out research on planetary robots, visual positioning of mobile robots, mobile operators and multi-mobile robots cooperation.

In 1998, Japan's Ministry of Economy and Industry first proposed the humanoid robot research plan. In the same year, Honda Corporation of Japan exhibited a humanoid mobile robot. The main purpose of this research and development is to provide an open architecture platform for humanoid robots to explore various applications of humanoid robots in life.

In 1999, South Korea's Ministry of Science and Technology put forward a plan called "21st Century Advanced Research and Development Plan", which includes micro-robots, robots in harsh environments, service robots and mine-clearing robots. Intelligent service robots in nine priority areas released by the Ministry of Information and Communications of Korea rank first, which shows the importance Korea attaches to robotics research.

The United States has invested a lot of money and research efforts in the research and application of mobile robots. For example, Robot, Inc. launched Roomba, an intelligent vacuum cleaner robot, which can automatically avoid obstacles, automatically plan paths according to indoor environment, and even automatically drive to the socket to recharge itself. The U.S. military developed Big dog, a military mechanical dog. Big dog shows amazing activity and adaptability. It is suitable for mountain, snow, ice and other harsh environments. It can automatically adjust its posture even when it encounters violent collisions. The mechanical dog can deliver 40 kilograms of ammunition, food and other items to soldiers at a speed of 6.5 kilometers per hour on the battlefield. Big dog has been used in Afghanistan's anti-terrorism battlefield.

In China, the military intelligent robot platform (ATB-1) is jointly developed by the organizations led by Tsinghua University, National Defense University of Science and Technology and other universities. It lays a foundation for the research of mobile robots in China. And then during the Ninth Five-Year Plan period, "Intelligent Robot Platform 2", the highest speed is 74Km/h. Its birth represents a new step for China's mobile robot technology.

3. RESEARCH STATUS OF DYNAMIC RECOGNITION

Computer vision began in the 1950s, and its main research is to detect static objects in images, so as to obtain the position of objects. Since the 1970s, scholars have gradually begun to solve some low-level visual problems, including target detection, edge segmentation, simple target tracking methods and so on. In the 1980s, David Marr, an Englishman, put forward a relatively perfect theoretical system of computer vision, which made computer vision develop rapidly as

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an independent subject. According to Marr's visual representation, information processing is divided into the bottom, middle and high levels. In the following decades, many scholars began to put forward the limited goal of computer vision orientation development, the special vision system of characteristic tasks, and advocated phased realization of sub-goals, in order to achieve the substantive development of computer vision [6]. Because of the limitations of computer technology, the research of computer vision in the past period mainly focused on static image processing. Even in the face of dynamic images and moving objects, a strong static processing method was adopted. Until the 1980s, the emergence of Optical Flow has changed the way of image processing, making the research of dynamic image sequence into a peak period [7].

In the past, object recognition applications mainly focused on static recognition, and the target was either relatively geostationary or relatively stationary relative to the camera. When the target moves, there are many problems, such as slow recognition speed, low recognition success rate and serious decline of recognition accuracy. Therefore, the application field of object recognition technology is relatively limited, and the practical significance of dynamic object recognition can not be fully and effectively reflected. It urgently needs to depend on a carrier to bring its performance into full play and show its superiority [8].

Existing dynamic object recognition can only recognize some very simple objects or only a limited number of marking points by pre-set very obvious feature points, such as the fluorescent points of small spheres. By using these identified points, the known shape of the object is analyzed and the current attitude of the object is restored. In industry, there are some applications based on visual inspection of parts. In these applications, the position relationship between parts and industrial cameras is usually relatively fixed. Robots will keep relatively static when collecting images. Constant lighting conditions and stable working environment will be adopted to create a more ideal environment, so that a better recognition effect can be obtained. These applications can only be regarded as static object recognition. When the two are no longer relatively static and the object to be recognized is more complex, the recognition success rate and recognition speed will be greatly reduced to an unacceptable level.

4. TARGET DYNAMIC RECOGNITION SYSTEM

4.1. Platform Construction

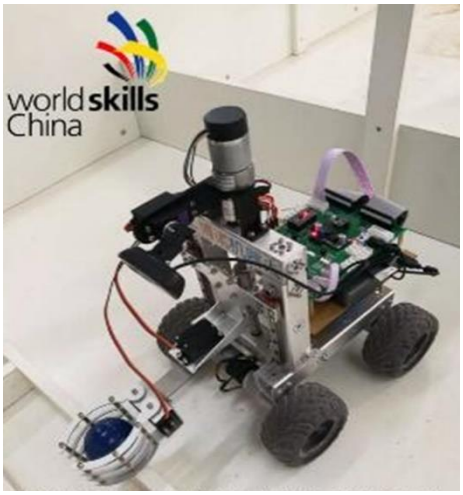

Fig 1. Mobile Robot

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Firstly, the mobile robot as shown in Figure 1 is built. The control system takes NI myRIO 1900 as the controller, the computer as the upper computer, programmed by LabVIEW software in the computer, collected the target information through the camera, and transmitted the information to the myRIO controller. After the processing of the control algorithm, the control strategy is formulated, and the modules of driving motor, lifting pinch and fetching are completed. The control operation realizes the omni-directional movement of the mobile robot and the grasping of the target. The working principle is as follows:

Mobile robots need to complete the movement, positioning and pose adjustment. The four wheels of the chassis of mobile robots are driven by four stepping motors with encoders, and the speed of each wheel is controlled by PID speed regulation. The distance between the mobile robot body and the surrounding edge wall is measured by ultrasonic sensors to realize the positioning and pose adjustment of mobile robots. The lifting mechanism of mobile robot controls the lifting motor through myRIO control drive module. At the same time, the encoder records the rotational speed of DC motor and feeds back to myRIO. MyRIO decides the starting and stopping of motor according to different tasks.

In robot vision, binocular cameras are combined with ultrasonic sensors and infrared sensors. Parallax of two cameras is calculated by binocular cameras, and three-dimensional information of corresponding objects in real environment is obtained by a series of inverse transformations.

4.2. Moving Target Detection Algorithms

At present, video moving object detection algorithms which can be implemented and widely used include inter-frame difference method, background difference method, optical flow method and some advanced fusion algorithms.

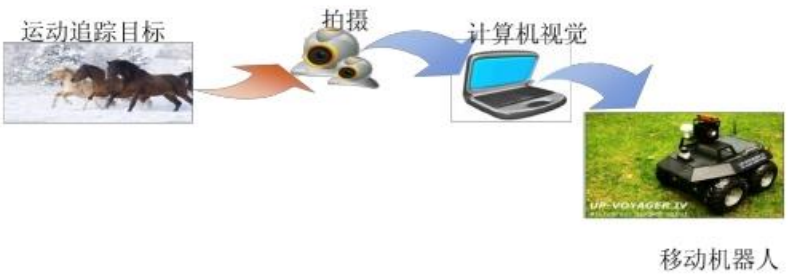

Fig 2. Mobile Target Tracking Flow Chart

Fig. 2 shows the flow chart of moving target tracking. First, the camera acquires the image information of the dynamic target and transmits it to the computer, records the image of two adjacent frames, calculates the Gauss ambiguity and difference, gets the control vector of the target, judges the position of the target object relative to the center of the interface, and controls the moving direction of the mobile robot through myRIO programming. There are three common methods of background modeling: inter-frame difference method, Mixture Gauss model, and complex background object detection method based on color co-occurrence statistics. Interframe difference method is the simplest, most direct and most commonly used background modeling. Considering the experimental conditions such as tracking time and location, the inter-frame difference method is the most suitable one.

4.3. Experimental Study

The human-computer interaction interface is set up. The camera acquires the image and recognizes it. Then the information is fed back to the computer. The computer calls the program

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to control the different motion of the robot. At the same time, the operator observes the motion through the human-computer interaction interface on the computer and adjusts it in real time, so as to realize the human-computer interaction.

According to the requirements of the mobile robot project site in the World Skills Competition, the inside diameter of the site is 2m*4m. The mobile robot starts from the designated starting position and automatically completes the delivery task of the target ball in the designated position. The actual site is shown in Figure 3.

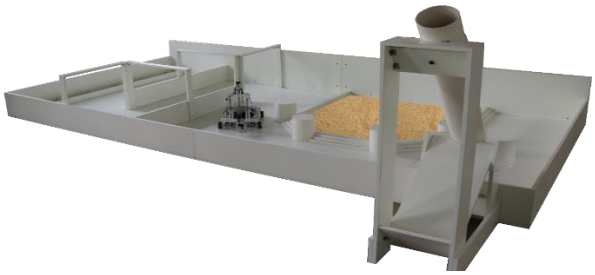

Fig 3. Laboratory site

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