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Research on the development status of wheel-footed rescue robots

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Abstract

Now natural disasters and man-made, accidents are frequent, and in the vast majority of disasters, the environment of the rescue site is often very complex and there are a variety of safety risks. Therefore, the existing research on rescue robots is reviewed, and the advantages and disadvantages of various rescue robots are found to have a positive effect on the future development of rescue robots. In this paper, by studying the existing literature review, rescue robots are roughly divided into two categories: "search and rescue robots" and "rescue and evacuation robots", and by comparing various types of composite mobile robots, it is concluded that wheel-footed robots are the most widely used in rescue robots. Finally, based on the existing wheel-foot rescue robot configuration, the development direction and purpose of the wheel-foot rescue robot are summarized and discussed.

Keywords

Wheel food, rescue robot, multi-sports mode.

1. Introduction

In most major disasters, the rescue scene is intricate, at the same time, there may be various difficulties hindering the rescue work. First timing after a disaster occurs, the on-site environment is often very dangerous and have various safety hazards. Entering hastily without adequate preparation will result in untimely and unprofessional rescue activities, resulting in inability to save precious lives, and even putting rescuers into trouble.

Because of the complicated on-site environment, the requirements for mobile rescue robots need to be very strict, and enable them to complete established rescue missions in extreme environments.

2. Research status of rescue robots

The current mobile rescue robots are mainly divided into two types: crawler type and multi-legged type. The crawler type has good moving speed and gripping ability, but it will be unable to stabilize and safely cross obstacles when crossing higher or wider obstacles. The multi-legged robot has good obstacle crossing ability on more complicated roads, but the general multi-legged robot has the disadvantages of slow moving speed, complicated control, and high difficulty.

Rescue robots can be divided into "search and rescue robots" and "rescue evacuation robots" according to their operational functions.

2.1. search and rescuer robot

The main operation function of the search and rescue robot is to detect and locate the internal situation of the damaged building and the trapped wounded before the rescuers enter the disaster site after the disaster occurs; obtain the environmental data of the disaster site to

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provide reference for the rescuers to follow-up rescue plans in accordance with. A fast and reconfigurable rescue robot designed by Hunt and others of Case Western Reserve University in the United States for urban search and rescue missions is a typical search and rescue robot. The wheel leg part is a deformable mechanism made of carbon fiber material, so this robot uses the crawler maneuver mode or the wheel leg maneuver mode to maneuver according to the site conditions in different terrain environments. There is also a snake-shaped search and rescue robot designed by Tien Suo Uzi, which is driven by a nylon rope and can move about five centimeters per second. The PackBot search and rescue robot designed by the American company iRobot uses a flipper track design, which can adapt to obstacles ahead by adjusting the flipper track.

Search and rescue robots have been widely used in modern rescues because of their strong ability to traverse the complex terrain of disaster sites and strong information sensing capabilities.

2.2. Rescue evacuation robot

The main operating function of the rescue evacuation robot is to transfer and transport the wounded, hazards and rescue materials at the disaster site.

The most typical one is the rescue and evacuation robot ROBOCUE developed by Kikuchi Manufacturing Co., Ltd., which uses crawler maneuvering. And there is also a retractable stretcher hidden inside the robot. After confirming the wounded, the stretcher can be extended from the body, and the wounded can be placed on the stretcher and retracted through the front end of the robotic arm. The wounded can also inhale oxygen through the oxygen cylinder inside the rescue robot. In addition, the "Crawler" rescue robot of the Yokohama Police Department in Japan also uses an internal cabin to take the wounded out of the rescue scene. There is a vital sign detection device in the internal cabin, which can detect the wounded condition while transporting the wounded. Because rescue evacuation robots need to make contact with people, the research on ergonomics in rescue evacuation robots is also very important. Due to the technical reasons of domestic "rescue evacuation robots", most of the current "rescue evacuation robots" are still in the experimental stage.

With the deepening of research on rescue robots and the increasing requirements for rescue robots, wheel-footed type has been widely adopted by rescue robots because of its good obstacle crossing ability and mobility.

3. Research status of wheel-footed robots

Wheel-footed robots are compound mobile robots, which can have a simple control scheme while realizing fast maneuverability and good environmental adaptability. Among them, it is mainly divided into classic wheel-footed robots, wheel-footed robots with deformed structures, and wheel-footed robots with mixed wheel-footed robots.

3.1. Wheel-footed robot with wheel-and-foot tandem

The wheel-footed robot with wheels and feet in series is a structure in which the wheels are directly designed at the end of the robot's traveling feet. The robot can directly maneuver through the end wheels or drive the foot wheels to perform foot-type maneuvering. The earliest classic wheel-footed robot can be traced back to Lunokhod-1, a lunar rover sent to the moon by the former Soviet Union in the last century. The more classic is the Rolling-Wolf robot of Yanshan University. As shown in figure 1. Its legs adopt a three-degree-of-freedom serial-parallel hybrid structure, which has high flexibility and impact resistance. It has carried out multi-objective optimization on the leg structure to improve the movement of the robot. Performance and mechanical properties.

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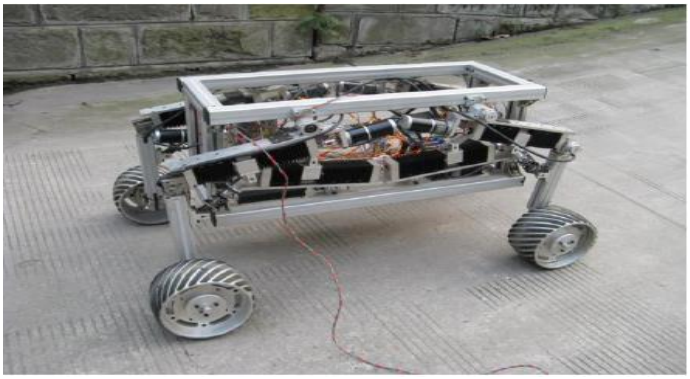

Fig.1 Rolling-wolf robot

The wheel-foot tandem type wheel-foot robot has the characteristics of simple structure, flexible maneuverability, strong environmental adaptability, strong obstacle crossing ability and large carrying capacity, but it also has the required control complexity and large number of motors. Disadvantages.

3.2. Wheel-footed robot with deformable structure

The wheel-footed robot with deformed structure adopts its wheels to form a structure similar to the legs and feet after a certain change, so that the robot has good obstacle crossing ability and mobility at the same time. Bailong et al. designed an active displacement wheel-leg mechanism, which uses a hinged multi-four-bar structure to complete the transformation between wheel-leg modes. In the leg mode, obstacles with a height of 2.8 times the wheel radius can be crossed, and it has the characteristics of high obstacle crossing success rate and strong obstacle passing ability.

The deformed wheel-footed robot has the advantages of compact structure, strong environmental adaptability and very simple control. However, because of the structure of the deforming wheel, the center of mass is unstable and the bearing capacity is poor.

3.3. Wheel-footed robot with separated wheels and feet

The wheel-footed robot with separated wheels and feet is a very obvious difference between the wheels and legs and feet of the robot. Generally, the mechanical structure with wheels and legs and feet are designed separately at the same time, and the wheeled maneuvering mode and the leg and foot maneuvering mode are switched through the posture switching of the wheel-footed robot.

The quadruped robot HyTRo-I developed by the University of Science and Technology of China uses a mechanical decoupling method to combine leg and foot movements with wheeled movements, as shown in Figure 2.

Fig.2 Quadruped robot HyTRo-1

The wheel-footed robot of the deformed structure is also simple in structure, has a strong carrying capacity, and is very simple to control. However, its ability to adapt to the environment is poor, and its ability to overcome obstacles is also very limited.

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4. Development status and prospects

The technological development of rescue robots is more and more biased towards the design of rescue robots in a wheel-footed configuration due to the special requirements of their operations. The current development directions of wheel-footed rescue robots mainly include intelligence, high performance, miniaturization, and multi-machine coordinated rescue.

4.1. Intelligent

The scene environment of rescue robots is often very complicated during operation. So the rescue robot needs to have a high degree of intelligence, so that the rescue robot can quickly make path planning, target search and target object recognition judgments. Especially as a "rescue evacuation robot" at the rescue site, it will quickly and accurately identify the target object or the wounded and adopt a flexible way to carry and transfer the wounded and the target object. Therefore, the improvement of the intelligence of wheel-footed rescue robots is an important direction for the forward development of wheel-footed rescue robots.

4.2. High performance

Wheel-footed rescue robots also need to be developed and developed in the direction of high performance. At present, the rigid-flexible hybrid structure design in the mechanism design is also one of the development trends to improve the performance of wheel-footed rescue robots. The structural design of the rigid-flexible hybrid structure can effectively improve the performance of the wheel-footed rescue robot, and improve its adaptability to the rescue environment and the ability to overcome road obstacles.

4.3. Miniaturization

Another direction of the design and development of wheel-footed rescue robots is the miniaturization of rescue robots. The miniaturized wheel-footed rescue robot can easily reach a narrow space, and must have strong adaptability and a small mass structure. One of the difficulties in miniaturization of wheel-footed rescue robots is that the walking feet of the robots are generally large in size and weight, and there may not be enough space to accommodate them in actual tasks.

4.4. Multi-aircraft cooperative rescue

Multiple wheel-footed rescue robots cooperate to complete a certain task together is a very important part of the future development direction of rescue robots. The rescue robot group can increase the diversity of rescue methods and methods through mutual cooperation. The wheel-footed rescue robot in the multi-machine coordinated operation of the wheel-footed rescue robot can not only work together with multiple wheel-footed rescue robots of the same model, but also multiple wheel-footed rescue robots of different models and types. Cooperate with each other to complete the task of rescue workers. The same type of wheel-footed robot adopts multi-machine cooperative operation to expand the rescue robot from point rescue to surface rescue; different types of multi-machine cooperative operation can simultaneously perform search and detection, blasting clearing, wounded transportation and other rescue links.

5. Conclusion

At present, with the vigorous development of the large field of robots, the research and design of various rescue robots have been carried out to a certain depth, and wheel-footed robots have good ability to pass through complex terrain, rapid maneuverability and stable control system. Etc. gradually become the mainstream choice of rescue robots. Wheel-footed rescue robots are still in the stage of rapid development, and there are still some new wheel-footed rescue robots that continue to emerge.

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The research and design hotspots of the wheel-footed rescue robot in the configuration include the robot's maneuverability, obstacle crossing ability, climbing ability, volume, reliability and robustness, etc., through the designed robot structure and its kinematics And dynamic analysis and simulation to design a high-performance wheel-footed rescue robot.

Improvements in the future research and application of rescue robots will effectively improve rescuers' ability to respond to emergencies and effectively ensure the safety of rescuers and the wounded.

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