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Crawler Vehicle Rescue Robot Based on Arduino NANO

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Abstract: This paper introduces the Arduino NANO-based crawler vehicle rescue robot, including the traveling device. The traveling device includes an electrical screw jack, a power mechanism, a power supply, a camera, a curved snow shovel, a lighting device, and a control circuit. The control circuit is connected to the power supply, camera, lighting device, power unit, and electrical screw jack. The beneficial effect is that the control circuit can accurately control the height of the jack to ensure an effective rescue, power the rescue device and electronics, and effectively improve the efficiency of rescue.

Keywords: Image recognition; Traffic safety; Travel security

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1. Project overview

1.1. Study significance

The vehicle rescue robot can carry out tasks under harsh conditions, such as at disaster sites, battlefields, etc. Through independent operation, it can quickly carry out effective rescue operations, and improve the rescue efficiency and speed.

Traditional vehicle rescue often requires personnel to go to the scene to carry out tasks, facing a variety of dangers and risks, such as traffic accidents, bad weather, poisonous gas, and so on. The crawler vehicle rescue robot can replace personnel to perform tasks, reducing the risk of injury and life safety. It can deal with a variety of complex environments and terrain, such as mountains, deserts, etc. It has strong adaptability and flexibility traits and can perform rescue missions in different scenarios [1]. The crawler vehicle rescue robot is usually equipped with high-precision sensors, robotic arms, cameras, and other types of equipment. These help to obtain real-time field information to conduct analysis and judgment. It has strong execution ability, can effectively perform rescue tasks, and improves the ability and effect of rescue missions. In natural disasters or man-made accidents, there are often vehicles falling into dangerous situations, such as landslides, floods, earthquakes, and so on. The research and application of crawler vehicle rescue robots can help to meet these challenges, rescue trapped people in time, and reduce the losses caused by disasters.

1.2. Project background

With the development of robotics technology and the improvement of intelligent algorithms, researchers have begun to apply robots to rescue fields. The vehicle rescue robot project is based on this technological progress, aiming to use the autonomy, flexibility, and efficiency of the robot to improve rescue missions. In the process of vehicle rescue, rescue workers often face various risks, such as traffic accidents, bad weather, poisonous gas, and so on [2]. Therefore, the development of a crawler vehicle rescue robot can reduce the risk of people directly involved and ensure the safety of rescue workers. Different car trap situations may occur in urban roads, suburban villages, mountain woodland, and other diversified scenes with complex terrains and harsh environments. The purpose of the project is to develop adaptable, multi-functional robot systems that can perform rescue missions in various scenarios.

1.3. Analysis of current domestic and foreign research

Zhao from Qingdao Peak Jin Shengda Mould Co. LTD. patented an innovative jack [1]. He optimized the mechanical structure of the design of a traditional jack. Using the top plate hinge design technology to overcome the limitations of a traditional jack prevents the fixed angle of the top disc from causing changes to the car's chassis angle when lifted. It also reduces damage to the chassis by increasing the contact area of the top plate.

1.4. Study objectives

Given the vehicle rescue challenges, this study focuses on efficient rescue implementation. Arduino develops a robot system that can accurately identify vehicle rescue, perform rescue operations, adapt to different environments, have communication and cooperation ability, and ensure safety and reliability. This ensures improvement in the efficiency and success rate of vehicle rescue.

2. System composition

2.1. Video image transmission identification subsystem

The video image transmission identification subsystem is an important part of the crawler vehicle rescue robot. It is responsible for the identification and analysis of the real-time image data obtained by the video image sensor to help the robot understand the surrounding environment, identify the trap situation, and perform rescue tasks [3]. The on-site image data in real-time can be accessed or captured through the camera or other video image sensors. These sensors can monitor the surrounding environment of the vehicle, providing a comprehensive full range of view. Based on the identified target and environment characteristics, the environment understanding and map construction of the vehicle site are built, including the vehicle location, surrounding road conditions, obstacle distribution, and other information. The recognition results are displayed on the human-computer interaction interface in images, text, or other forms for the operators to monitor and operate the actions of the robot in real-time. Real-time image data can be transmitted to terminals such as mobile phones through the network or other communication means. The robot can also perform fault diagnosis of the video image transmission equipment, promptly identify and report any equipment issues, and attempt self-repair or switch to standby equipment to ensure stable system operation.

2.2. Drive control subsystem

The drive control subsystem is one of the key components of the crawler vehicle rescue robot, which is responsible for controlling its movement and enabling various tasks at the rescue site [4]. The electric drive

system includes the motor control of wheels, tracks, joints, and other components. By adjusting the speed and direction of the motor, the robot adapts to the movement with steering and attitude adjustment. Based on the sensor data and the target position, motion planning and path tracking are conducted to ensure that the robot can safely reach the target position according to the predetermined path while avoiding collision and danger. According to the environmental conditions and task requirements, the speed and acceleration of the robot are adjusted to achieve flexible dynamic control and adapt to different terrain and working scenarios. The sensor data is used to monitor the environment around the robot in real-time, detecting obstacles and potential collision risks. It then takes corresponding measures to avoid obstacles or stop moving to ensure the safety of the robot and the surrounding environment. The energy system is managed and optimized, including battery status monitoring, charging control, etc., to ensure long-term operation of the robot and smooth completion of rescue tasks. It can monitor and diagnose the faults of the drive control system in time and take repair measures to ensure the stability and reliability of the system.

3. Specific implementation methods

3.1. Overview of the robot

The following will provide a clear description and technical scheme of the crawler vehicle rescue robot along with the attached drawings. The embodiment described is only part of the crawler vehicle rescue robot, not all of them [5].

Figure 1 and **Figure 2** show the technical scheme of the crawler vehicle rescue robot based on Arduino NANO from the side and top view. The components include the chassis (1), electrical screw jack (2), stepper motor (3), multiple tracks (4), camera (5), lighting device (6), power supply (7), control circuit (8), cradle (9), and curved snow shovel (10). The power supply is removable and can be used with a rechargeable lithium battery. Power is given to the control unit which connects to the other components through wires. The control circuit contains a trigger, transmission, and receiving circuit which receives instructions from devices like a mobile phone that can be connected through Bluetooth or a 2.4 GHz wireless LAN connection.

The electrical screw jack is positioned on the chassis. The robot's movement is facilitated from the multiple tracks, driven by the stepper motor connected to the control unit. The cradle, equipped with a camera and lighting device can perform coaxial rotation following instructions from the control unit. The curved snow shovel is positioned in front of the robot with bolts. The overall movement of the robotic vehicle is based on directions provided to the control circuit.

To use the robot during a mission where a vehicle is trapped, the personnel start by identifying the trapped vehicle and removing the integral unit. Subsequently, the personnel activate the control circuit by establishing Bluetooth or 2.4 GHz wireless LAN connection to a mobile phone. The camera feed can be viewed directly from the mobile phone. From here, the personnel can send instructions from the mobile phone to the control circuit. This includes sending control signals to drive the motor under the trapped vehicle. Once the control circuit receives the signal for instructions, it follows accordingly. The personnel can adjust the camera perspective as instructed. For clear vision, the lighting device can also be activated. With further instructions, the robot will then move and position the electrical screw jack correctly to lift the trapped vehicle. Hence, necessary repairs and rescue operations on the trapped vehicle can be carried out.

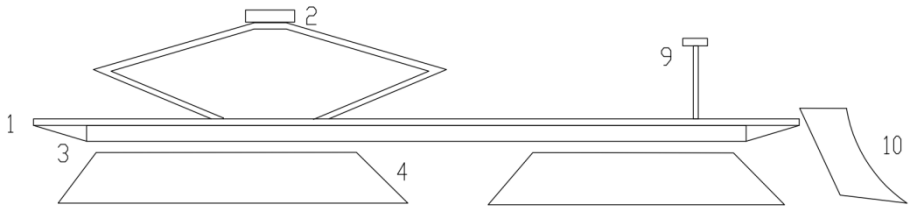

Figure 1. Overall side view of the robot

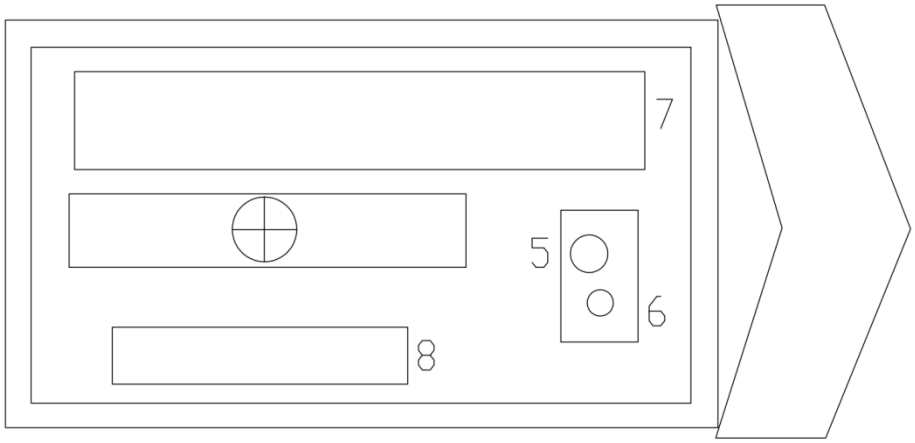

Figure 2. Overall top view of the robot

3.2. Innovation

By using a variety of sensors, the crawler vehicle rescue robot achieves comprehensive awareness, utilizing advanced technologies like deep learning for intelligent recognition. This includes identifying situations where vehicles are trapped and assessing environmental conditions, enhancing the precision and effectiveness of rescue operations. The crawler vehicle rescue robot is designed to adapt to various terrains and environments, from urban roads to mountainous forests. With diverse robotic equipment, it can effectively carry out rescue missions in complex scenarios.

4. Conclusion

The success of this project is the result of various scientific and technological progress. From mechanical design to artificial intelligence, from sensing technology to emergency management, the results of multi-party cooperation enable crawler vehicle rescue robots to play a role in a variety of scenarios. This result is just a small step in this aspect. With the continuous development of technology, the crawler vehicle rescue robot will become more intelligent, flexible, and reliable. We look forward to seeing these technologies play a greater role in the future of disaster relief, bringing more safety and hope to people.

Disclosure statement

The authors declare no conflict of interest.

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