

Rescue Robot to Climb Using the Winch

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Abstract

We have developed a rescue robot which can climb the side wall of the building. This robot has two winches and a long master-slave controlled arm. To carry out the climbing behavior, at first, the hook attached to the tip of the wire is hooked to the building by manipulating the arm, then the winch is hoisted to lift the robot body. Repeating the above operation by using two hooks and two winches, the robot will finally climb to a high place.

Keywords: rescue robot, climb, master slave control, winch

1. Introduction

Various disasters occur frequently in many parts of the world. Recently, when some serious disasters happened in the world, rescue teams from around the world would gather in a short period of time and search for survivors. However, since there is a fear of aftershocks and secondary disasters, it is not easy for rescue teams to make a approach. For example, in a case of collapsed buildings, it is necessary to rescue quickly the survivors as possible. In these situations, help and cooperation form a rescue robot [1] is expected. In this study, for the purpose of searching person and transporting, we propose a rescue robot using winches which can climb the wall of the building to which rescue teams cannot get close if the building is at the risk of collapse.

2. Rescue robot system

2.1 Specification

The specification and the appearance of the robot are shown in Table.1 and Fig. 1, respectively

2.2 Structure

The robot has the main crawler and the variable inclination crawler that can be changed up and down. Two hooks are mounted at the front portion, which has been connected by winch and wire, respectively. The winch subtracts hoisting wires with a strong force by using a worm reduction gear, and releases. Furthermore the robot has a long lightweight five joints arm with a hook grip mechanism at the tip, which is controlled by the command of the five joints of the master arm of the operation panel. The arm transforms the hook at place that is the best hooking position. All control of the crawlers and the master arm are the hand-operated remote-control.

2.3 Master-Slave Arm Control System

The gripping and hooking of the hook are controlled by a master-slave system. Its structure and control block diagram are shown in Figs.2-4, respectively. Each joint angle of the master arm is detected by the potentiometer, each joint of the slave arm of the robot has been positioned at same angle by the angle RC servo motors .Rotation angle detection

voltage of the master arm is taken into the A/D converter inside the microcomputer, and is outputted as a PWM signal of a servo motor of the corresponding joints. Grip unit performs the grip and release behavior in ON/OFF of the solenoid.

2.4 Procedure of climbing behavior

The climbing behavior is shown in Fig. 5. First, crawler makes approach to the building and starts climbing operations from there. A hook is carried and hooked at a high point. Then by winding the winch, the robot itself climbs to high altitude. Then, by hooking the other hook at higher point using the arm, removing the former hook and winding the latter winch, the robot climbs to a higher place. By repeating this, finally the robot climbs to high place .

Table. 1 Specification

Total length	420 [mm]
Total width	300 [mm]
Total height(including arm)	200 [mm]
Max arm length	1400 [mm]
Climbing ability	70 [deg]
Climbing height by one action	800 [mm]
Machine weight	10 [kgf]
Loading weight	3 [kgf]
Winding speed of the winch	0.07 [m/s]
Vehicle speed	0.2 [m/s]
Method of operation	Wired controller
Method of arm control	Master-slave control



Fig.1 Overall of Rescue Robot

3. Experimental result

3.1 Climbing Movement

The climbing operation shown in Fig. 5 was confirmed. Operation of grappling hook action takes

an average of 40 seconds $\pm$ 20 seconds and it takes 60 seconds to hoist wire of 600 mm. Hook operation requires skill of human operation. It was confirmed that the robot can climb to 600 mm in about one and a half minutes to finish its operation.

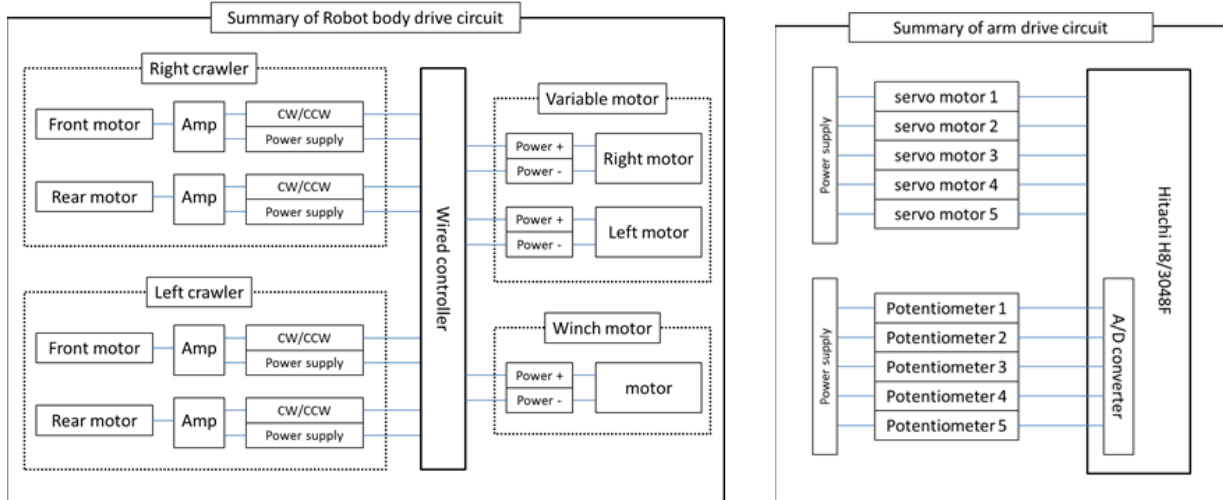


Fig.2 Summary of System

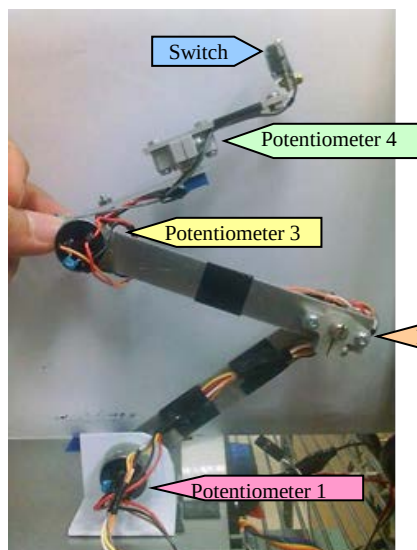


Fig.3 Master Arm

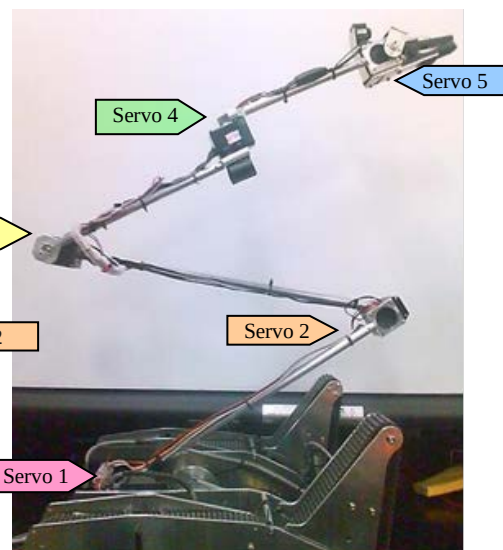


Fig.4 Slave Arm

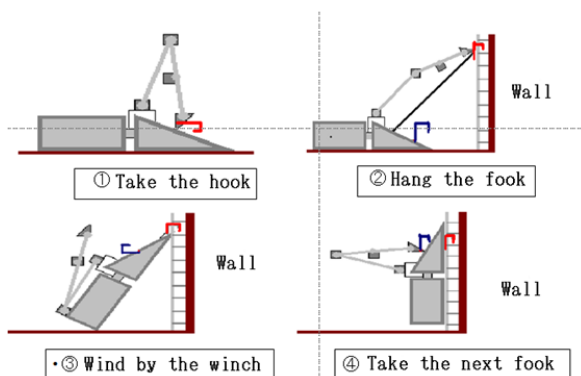


Fig.5 Procedure of the climbing behavior

4. Conclusion

A method that uses a winch as one of the methods of climbing the building was proposed. A small robot was developed and its operation was confirmed.

5. References

- [1] NAKAMOTO.H., FUKUSHIMA. F. Edwardo and HIROSE.S (2002) .Research On Hyper-Tether No. 12 Development of launching and anchoring gripper, Robotics and Mechatronics Conference 2A1-J10 pp.1-2