돔 형태를 이동할 수 있는 외벽 이동로봇의 실험 연구

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Experimental study of a mobile robot that can move the dome shape façade

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1. Introduction

1.1 Related works and introduction

As the number of high-rise buildings of various façade increases, the cost of building maintenance is increasing. People are directly carrying out façade management tasks, but safety accidents are also increasing. There have been previous efforts to replace it with robots. These studies studied robots for automation of robot cleaning targeting flat surfaces.[1~3] However, there were limitations in managing various exterior walls other than flat surfaces.

In this paper, we designed a robot platform that can work on various types of façade by combining a four-legged robot and an anchor robot for various façade works. This robot was actually operated to test its driving and obstacle-avoidance functions.

2. Robot configuration

2.1 Robots of entire platform system

The entire robot system consists of two anchor robots, an ascender robot, a wheel leg robot, and a turret. The anchor robot moves on the horizontal rope at the top and adjusts the workspace. The ascender robot is connected to the fixed part of the anchor with a rope, and moves to a large position by rolling the rope around the ascender. A wheel leg robot is connected to the bottom so that it can respond to various slopes and obstacles. A turret whose position can be adjusted to stabilize the robot's center of gravity and posture connects the ascender and wheel legs. The shape and composition of the entire robot are shown in Fig. 1.

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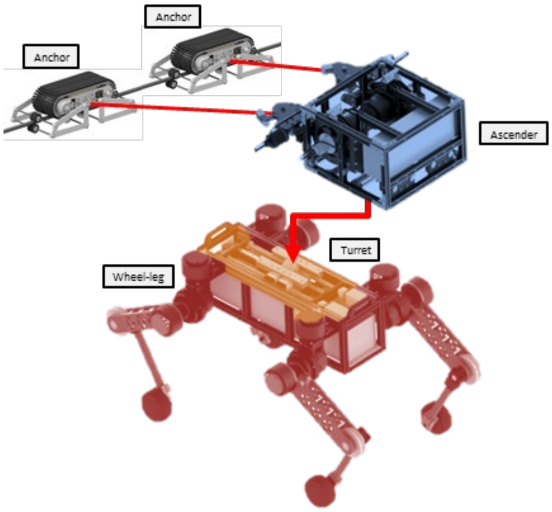

Fig. 1 Robot configuration of the irregular façade management robot platform

2.2 Robot system configuration

Anchor, ascender, and wheel leg robots are each composed of independent systems centered on the MCU (microcontroller unit). Each of these systems is connected to the main computer to control the entire system. The structure of the robot components is shown in Fig. 2, and the robot system structure is shown in Fig. 3.

The main communication for robot control is unified through CAN (Controller Area Network). Anchors, wheel legs, ascenders, and turrets all have CAN buses, and each robot can be individually controlled by connecting or disassembling them. Communication to the main computer was also configured via CAN.

The main system of the robot is composed of ROS2 (robot operating system 2) foxy, allowing independent control and monitoring of each robot's node. Basic functions necessary for overall control through nodes such as SLAM and trajectory planning are integrated. Based on this, the entire control node controls how the entire robot should be driven, and each robot is controlled by the individual control nodes of the subordinate robots according to this judgment.

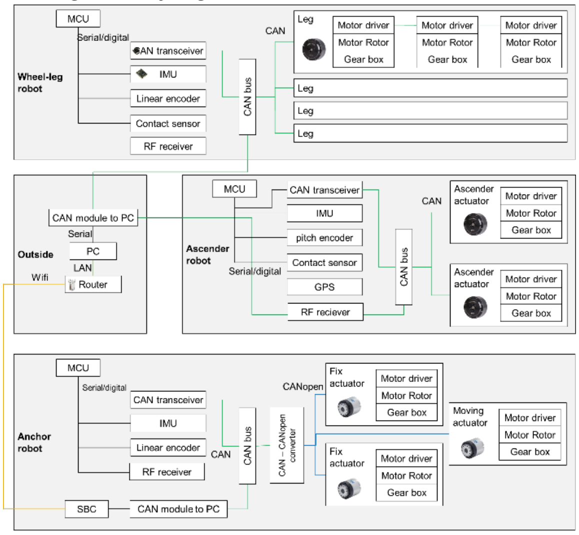

Fig. 2 Component diagram of the robot platform

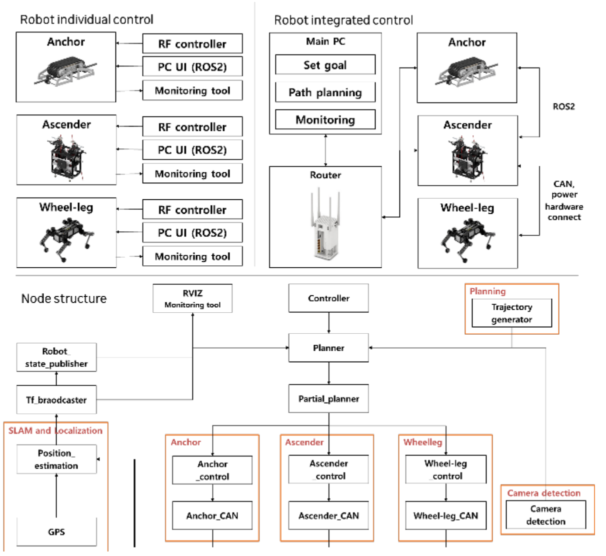

Fig. 3 System diagram of the robot

3. Robot operation test

3.1 Test configuration and operating test

In order to test whether the robot could actually operate, an experiment was planned to run over obstacles with a height of 255mm at 0, 45, and 90 degree inclines. The rope was fixed and an experiment was conducted to check whether the ascender moves and the wheel leg moves properly depending on the obstacle. The control required to overcome obstacles was carried out by configuring a control algorithm based on ZMP. [(4)] All obstacles were successfully overcome, but an instability problem occurred due to the center of gravity at 90 degrees.

Fig. 4 Overcoming obstacle test in (a) 0°, (b) 45°, (c) 90°

4. Conclusion

A robot system capable of cleaning and maintaining buildings on various types of façade was presented. This platform was actually operated to test obstacle avoidance from three angles, and it was successfully performed. Follow-up research is being planned to improve the structure of the robot to solve posture problems related to the center of gravity and to enable automatic systematic control of the robot in addition to manual control.

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