Development of Remote Controllable Patrol Robot with Fire Extinguishing Function

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Abstract

This study's target is developing domestic patrol robot for ordinary homes. The robot's main functions are to patrol and to observe. Robot moves around the home at regular interval, or regular time, and find out abnormality. In many homes, wheel will not be suitable for moving around the home because wheel comparatively needs turning radius, and Japanese home may not be large enough to move wheel robot. Therefore, we adopted Omni Wheel for the robot. Omni Wheel can turn around by small turning angle, so it will be able to use in various homes, even narrow corridor at home. And if the robot found out a fire, or user did, the user can let it extinguish the fire due to that it possesses a fire extinguisher. In brief, the robot patrols around home, with Omni wheel which can move smoothly anywhere and if it find out any abnormality or fire, it alarms user. This is the main purpose of the robot.

Keywords: Fire Extinguish, Remote Operable Robot, Extinguish First-Aid-Fire.

1. Introduction

In these days, single-person households are quickly increasing.⁽¹⁾ Among the single-person households, elderly man's single-person households have a lot of problems. Most elderly people who live by himself live apart from his family so that they don't communicate enough with his family.

It takes a lot of labor for his family to grasp his life circumstances. In spite of that, elderly man's lack of communication raises the risk to contract cognitive

impairment. In addition to this, in the case emergency occurred, it may delay to deal with the emergency. For instance, if a fire occurred in the house where an elderly man lives by himself, it may difficult itself to extinguish the fire by himself. In particular, it is too difficult for an elderly man with weak legs to extinguish the fire. In such case, even though he became aware of fire is occurring, the fire becomes big and situation gets serious.

In 2012, the total number of the fires is 5,089, and the number of residential fire is 1,916. In addition, the number of persons killed in residential fires is 1,016, and 677 of the number is elderly person.⁽²⁾ In other words, 70 percent of people killed in residential fires are elderly persons.

Therefore, we targeted to construct a system to watch an elderly person for his family. The robot uses Omni Wheel as actuator. Owing to this, the robot can move smoothly in the house, and the operability increases.^{(3) (4)} The robot is equipped with a fire extinguisher, and in the case of a fire occurred user who received an alarm from the elderly man can extinguish the fire from remote place by controlling the robot through the internet.

2. Structure

2.1 Structure of System

This system is supposed to be controlled from remote place through the internet. Concept image of this system is given in Fig. 1. The main function of the robot is watching an elderly person. The user operates the robot through internet, and communicates with an elderly person. For this purpose, this system has interfaces like microphone and

Fig. 1. Concept Image of the System.

Fig. 2. Structure of the Robot.

camera. User can watch the image from camera in real time through the robot. Thereby user can communicate with an elderly person smoothly.

The Watching System is consisted of communication interface, controller, and communication section. Accessing a control site on the internet, the user can get the image from camera and sound from microphone, and operate the robot on the site. Hence, the user can watch elderly person and communicate with him without specific device.

2.2 Structure of Robot

The fire extinguisher robot is consisted of three parts, actuator, controller, and extinguisher. The actuator is Omni Wheel, and the controller is Raspberry Pi and Arduino, and the extinguisher is a fire extinguisher. The structure of the robot is given in Fig.. 2. In addition to this, appearance of the robot is given in Fig.. 3.

Actuator uses 4WD 100mm Omni Wheel. Omni Wheel is wheels which can move in every direction without

Fig. 3. Appearance of the Robot.

Fig. 4. Omni Wheel.

turning of wheels. Conventional wheel needs certain turn to change the direction, and it is able to move direction which is determined by limit such as the structure of wheel. In contrast, Omni Wheel can move in every direction without turning so that the mobility and operability is increased so much. The appearance of Omni Wheel is given in Fig. 4. The load upper limit of the Omni Wheel is 5.0kg, and weight of the home powdery fire extinguisher is 2.6~4.0kg. Therefore, this robot can contain a general fire extinguisher.

This robot uses Arduino as a controller of actuator. In

Fig. 5. Movements of Omni Wheel.

addition, Raspberry Pi is used as a processor of control order and a communicator through internet. Raspberry Pi processes the control order by the user and transfer the result of processing to Arduino, and Arduino operates the Omni Wheel.

2.3 Watching System

The Watching System of this robot consists of a camera and a microphone as a main interface. The user accesses a site to control the robot, and operate the robot with a control interface on the site. The now available motions of the robot are move straight, move rightward, move leftward, move backward, and rotate. Movements of Omni Wheel are given in Fig. 5. Since those movements could be done at a same time, the robot can move easily, even in a house which has complex form. In the case of emergency, in addition to this watching system, this robot can extinguish a fire with a fire extinguisher. Thereby, this robot works in usual, and if a fire has occurred, it can act as

Fig. 6. Image of Screen of the Control Site.

a fire extinguisher robot.

2.4 Extensibility of Function

This robot uses Raspberry Pi and Arduino in controller. Hence, it has very high versatility. Arduino is a microcomputer that can be programmed using C or C++, and is abundant in I/O function and extensibility. Therefore, the robot is able to contain various functions like Carbon monoxide density detection function.

Raspberry Pi is a computer which was equipped with ARM processor, and we make programs run using this computer in this system. The greatest feature of this computer is GPIO. GPIO is a unit that can communicate with the outside by exchanging signal. Owing to this feature, we can exchange signal in a program such as Python, or Ruby, and so on. We put communication system through internet into practice using Raspberry Pi in this

system. Various programs can be run on Raspberry Pi, so the robot can be equipped with various functions. This robot has a great capacity of the extensibility of function.

3. Experiment

3.1 Methods

We examined the robot whether it can be operated remotely in practice. We used “heimcontrol.js” as an operating interface on a browser. Verification content is to find out the problems of remote operation, and to detect how comfortable the operation is.

3.2 Result

The actual screen of the control site is given in Fig. 6. As a result of this experiment, the operation of the robot was smooth, but speed of motion was not so good. It is due to that the movement speed of Omni Wheel is not fast, and that it needs to switch between moving and turning when it moves. In addition to this problem, even though the camera video image is good enough, its quality depends on the speed of network line of both user and robot. Therefore, when the speed of cellphone line like 3G line is not enough, the communication with video image has some difficulty. To solve this problem, the control interface should be not control buttons but some shape with smooth change of direction like analog stick. In regards to the speed of the line, it can't be solved by improving internet line, meanwhile, certain improvement is expected by a function that switch the quality of camera video image in response to the speed of the line.

4. Conclusions

How to utilize Watching System in security is a big problem of this system. In this system, relatively large robot moves around in a house so that movement of the robot may have a risk to injure human. We will continue to review such risks, and continue to improve the robot to reduce such risks beforehand. In addition to this, in the property of the system, if it was used for a wrong purpose, the user's privacy may be violated. Therefore, how to set an access limitation on using is a problem, so we will further our examination in regards to that.

Besides, a proper jet of the fire extinguisher agent to the origin of a fire is a problem for this robot as a fire

extinguisher robot. For this purpose, it is needed to make injection tip's angle of elevation of the fire extinguisher adjustable. Hence, we will develop an attachment that makes some angle of elevation adjustable using motor. Setting a fire hose in the attachment, hose become operable. This attachment is now in development.

The completion target of this robot as a fire extinguisher robot is completely remote, approach the fire as quickly as possible.

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