DEVELOPMENT OF A SMALL INTERFACE ROBOT USING RT-MIDDLEWARE AS A COMMON ROBOT PLATFORM

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ABSTRACT

At present Japan is a low-birthrate, aging society. Many elderly people live alone far from their families, and robots and robotic technology are expected to support them. In particular, a service robot is strongly anticipated, and an interface robot to communicate between humans and home appliances has been developed by several companies. Because there are many similar problems in an aging society, a common robot platform is necessary in order to overcome such problems. Therefore, we have developed a small interface robot that helps the elderly in everyday interactions and communication. We use Robotics Technology Middleware (RTM), an international standard for robotics middleware approved by the Object Management Group. The interface of the development environment and the software components is defined. The architecture of RTM is suitable for various needs in society, and therefore, we have developed basic functions for an interface robot, including detection and tracking of a person using a laser range finder and a camera; taking a picture; and enabling remote control operations via the internet. These functions have been implemented in our robot system, and in this paper, we explain the detailed function of the interface robot and our experimental results.

1. INTRODUCTION

Japan is a scientifically advanced country with a low birthrate and an aging population. Many elderly people live alone far from their families, and robots and robotics technology are expected to support them. In addition, according to 2012 data from the Ministry of Economy, Trade and Industry (METI, 2014), the market for Japan's robotics industry will grow to 10 times of its current size by 2035. In particular, a service robot is strongly anticipated, and an interface robot to communicate between humans and home appliances has already been developed (i.e., Yamamoto and Doi, 2002). Because there are many problems in an aging society, a common robot platform is necessary to overcome them. Many robots have cameras and are used in inspection, patrol, entertainment, and other capacities. Among all robotic functions, taking pictures is fundamental. Therefore, it is necessary to build robots that can capture images. In the future, the number of robots in service roles with cameras will increase and thus, simpler designs are needed to allow users to view and use pictures easily. We have developed an interface robot that uses pictures for multiple purposes.

A Robotic Technology camera module (photography service) capable of taking pictures automatically has already been developed (Namatame *et al.*, 2014). This module has been in use for two years and has taken approximately 400 pictures, establishing that taking and outputting pictures is a necessary function of a robot. This camera module has been implemented using Robotics Technology Middleware (RTM). RTM is an international standard for the design and development of robotics middleware that has been approved by the Object Management Group. Because this photography service is a general purpose system, in this paper, we describe the development of RT components (RTCs) and the construction of an RT system capable of meeting various needs. Users can take photographs by voice command or by using a keyboard or a gamepad, and then print photos and/or distribute them via the communication network. We used the Robot Service Network Protocol (RSNP) to enable connectivity between the robot and the internet. RSNP was developed by Robot Services Initiative (RSi) as a common internet communication protocol for service robots. In addition to choosing the way to acquire the photos they want, users can print optional characters and the date on photos. We implemented this system on a human-tracking-camera robot that was developed in 2012 (Namatame *et al*., 2012). We confirmed the functionality of this photography service system on this robot, and describe it in detail in the rest of this paper.

2. PHOTOGRARHY SERVICE

2.1 Human-Tracking-Camera Robot

Figure 1 shows a human-tracking-camera robot, with a USB camera, two motors, and a laser range finder. The tracking-camera robot can recognize an object as a human being by scanning data from the laser range finder, and can pan and tilt to track the human.

Fig. 1 Human-tracking-camera robot

2.2 Construction of RTC System

We reused a part of the original photographic system and newly constructed the entire system, as shown in Fig. 2. The new RTC that we developed is outlined in purple, and is named as "Shutter_Control." Input RT components are outlined in red, picture-output components in blue, and human-tracking-camera components in yellow. We also developed a mode change function. We configured the human-tracking-camera robot such that this system runs in tracking mode normally. If a user inputs the command to commence photography, it changes to photography mode.

3. RTC APPLICABLE TO MULTIPURPOSE USE

We developed a new RTC named "Shutter_Control." Users can customize the way they can input and output their pictures using this RTC.

3.1 Input function of "Shutter_Control" RTC

Table 1 shows the various modes of the photography system and the available commands. We have only been able to use voice input so far. Ultimately, in this RTC, users will be able to input not only voice but also use a keyboard or a gamepad to issue commands. Figure 3 shows examples of the RTC connections. Camera images are input as "CameraImage," numbers are input as "TimerCount," and then, the robot's mode corresponds to the number. If users want to issue commands by voice, they use a microphone.

Table. 1 Commands and modes

Command	Modes	Voice	Gamepad
0	Tracking		START
1	Photography	Take a picture	A
2	Cancellation	Never mind	B
3	Printing	Print a picture	X
4	Indication	Show me a picture	Y
5	Transmission	Send a picture	LB
6	Greeting	Hello	RB
7	Greeting	Thank you	BACK

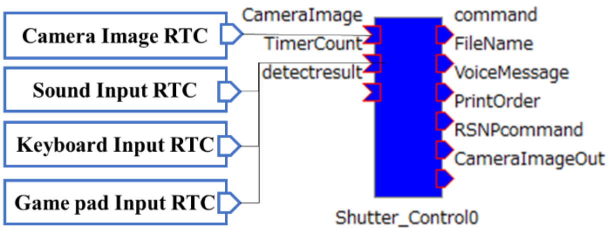

Fig. 3 Input to Shutter_Control

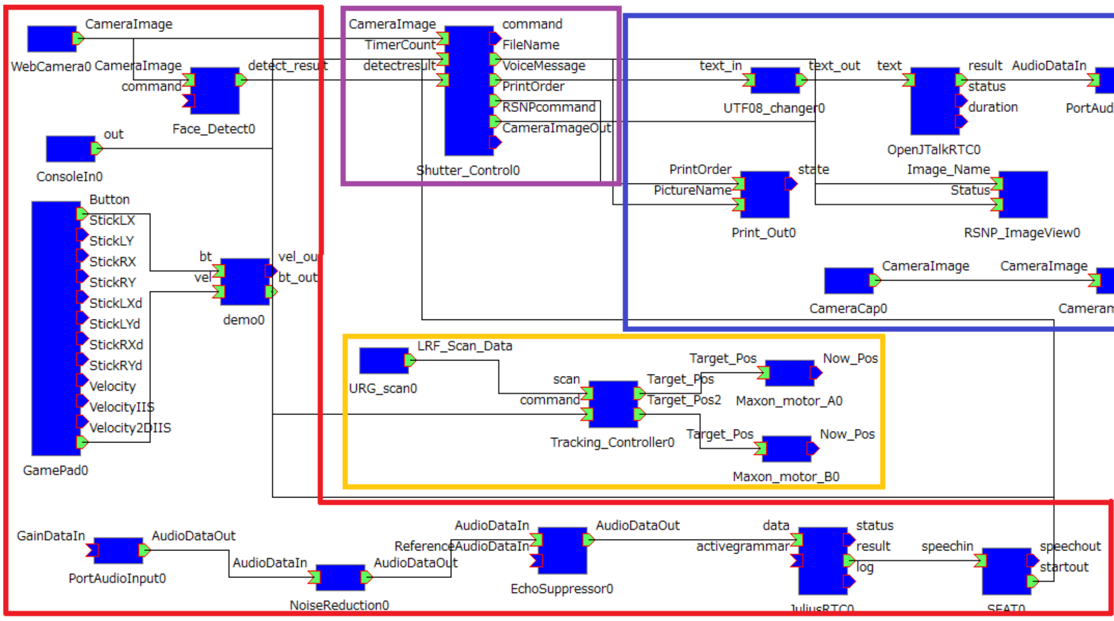

Fig. 2 System diagram of developed robot system

3.2 Picture Output by RSNP

Figure 4 shows output options for the RTCs. Users can choose to print, display or save a picture to an RSNP server on the internet. It is possible to confirm pictures saved on the internet taken at various places. In addition, in the "Shutter_Control" configuration parameters, users can specify a comment and a date to print on their pictures.

The RTC named as "Cameraman_RSNP0" shown in Fig. 4 sends a picture that is taken using the "distribute_camera_image" method of the "Multimedia_Profile" class in RSNP. The picture is in BMP format on "RSNP_ImageView." Therefore, the picture is captured by "Camera_Cap" and converted to JPEG format.

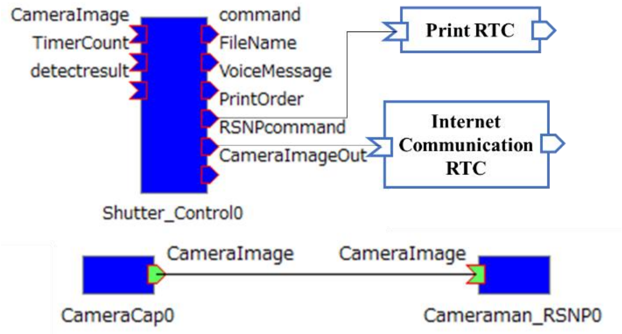

Fig. 4 Picture output RTC

3.3 Tracking and Photography Modes

The RTC named as "Tracking_Controller" that tracks a human is shown in Fig. 5. The human-tracking camera tracks the human by moving motors to pan and tilt after measuring the distance to the human and detecting his/her movement with the laser range finder. Normally, the system runs in tracking-camera mode by default; however, the tracking stops if command 1 is input to "Tracking_Controller." Tracking starts again when command 0 is input or after 10 min. By using the tracking camera, it has become possible to adjust the direction of the camera while locating the human and initiating photography.

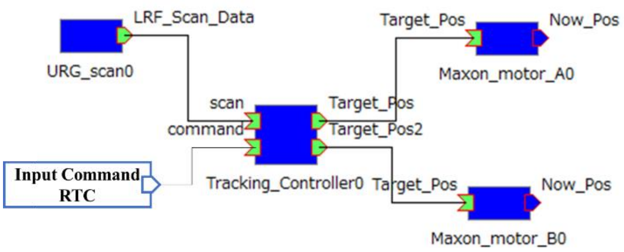

Fig. 5 RTC of human-tracking camera

4. VERIFICATION EXPERIMENTS

We verified the validity of the functions developed by basic experimentation. Figure 6 shows the experimental setup. The robotic system was confirmed to change modes between tracking a human and taking a picture. We were able to select the input by voice, a keyboard or a gamepad, and the output by printing, displaying, and saving to the RSNP server on the internet. However, the system is still very unstable to locate a human and take his/her picture. We intend to improve all aspects of the system's performance through further experimentation.

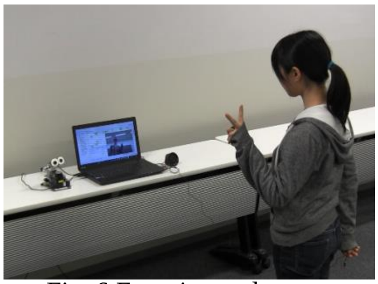

Fig. 6 Experimental setup

5. CONCLUSIONS

We developed a small interface robot using RT-middleware. The robot was designed as a common robot platform to cope with the various human needs. In particular, we considered the various ways of inputting commands and outputting a camera image, and developed the necessary RT components. Thus, a user of our robot can acquire pictures in three ways: by voice, a keyboard or a gamepad. Furthermore, there are three ways to output pictures, including transmission to the internet via RSNP. Users also have the option to print information on their pictures. Thus, we were successful in developing a small interface robot using RT-middleware, which has the functions of tracking humans and taking picture for multiple purposes. Next, we plan to test the robot in an environment such as a senior center for the elderly person in order to identify additional problems to be overcome.

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