The 18th IEEE International Symposium on
Robot and Human Interactive Communication
Toyama, Japan, Sept. 27-Oct. 2, 2009

Rebo: A Remote Control with Strokes

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Abstract— **This paper describes a new remote control operable with stroking its surface. There are lots of remote controls in our houses such as TV remote controls, air conditioner remote controls, and so on. However, when we use a remote control, we need to look at both the fingers and an appliance that we want to control. It is not highly problematic for young people, but elderly people have a difficulty in operating remote controls. It will be comfortable for people to use a remote control without looking at the fingers. In this study, we propose a remote control, Rebo, operable with stroking its surface and apply to a TV interaction system. The developed remote control has three advantages; (1) Familiarity, (2) Function awareness, and (3) Stroke operation. Those enable users to have familiarity with it, to easily notice its functions, and to use it without looking at the fingers. The feature of Rebo in comparison with conventional button-based remote controls is the tolerance for mistakes because it enables unfamiliar users to home electric appliances to use it casually without fear of mistakes and unexpected behavior.**

I. Introduction

There are various remote controls in our home. We have TV remote controls, air conditioner remote controls, room light remote controls, and so on. Home electric remote controls are commonplace devices. However, there are some problems in relation to remote controls. For example, many remote controls confuse us when we use home electric appliances. Universal remote[1] that aggregates functions of various remote controls is one of technical solutions for this problem. On the other hand, users need to search a button that they want and to correctly move the fingers to push it. It is not highly problematic for young people, but elderly people have a difficulty in operating remote controls. It will be comfortable to use a remote control without looking at their hands. Such a remote control is also comfortable to young people familiar to home electric appliances.

In this paper, we propose a remote control, Rebo, like a pet animal. Users stroke its surface with the fingers to control various home electric appliances far from them. Rebo has three advantages which conventional remote controls have never had; (1) Familiarity, (2) Function awareness, and (3) Stroke operation. Its life-like appearance and facial expressions make it familiar with users. As for Function awareness, we adopt Action sloping[2], [3] that enables them to notice its functions. Peripheral visual feedback provides a stroke operation of it. Therefore, users do not have to seek a button that they want and use it easily.

As an example of the proposed remote control, we develop an interaction system with TV. We confirmed that we can easily use it with stroking its surface.

The rest of this paper is presented as follows. Related work is described in the next section, and the concept and the basic architecture are explained in Section III. A TV remote agent as an implementation of a remote control agent, and discussion about its advantage of the TV remote agent and the interaction system are described in Section IV and V, respectively. Finally, we conclude our work in Section VI.

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II. Related Work

Rebo is a device which a user can controls various appliances by stroking with the fingers, and also a kind of *touch-based* remote control. In human-computer interaction and user interface, such touch-based remote controls have been developed so far. Since Rebo utilizes a user's stroke with the fingers, he or she does not need to visually recognize and understand any icon, signal, and acknowledgment from a remote control. The user can concentrate on the feedback from appliances, but remote controls. The advantage of our approach partially resembles that of "eyes-free" approach for many people including visually-impaired persons and elder people.

Shengdong et al. developed a potable audio player having eyes-free menu selection which utilizes touch input and reactive audio feedback[4]. Vincent et al. also applied a touch-based operation to control headphones[5]. Stephen et al. designed eyes-free multimodal interaction for Wearable devices[6]. Particularly for using mobile and wearable computers, input or output problems occur due to limited screen space and interaction techniques. They overcame the problems by developing a 3D audio radial pie menu and a sonically enhanced 2D gesture recognition system on a belt-mounted PDA.

Micire et. al proposed a multi-touch remote control for human-robot interaction[7]. They tried to apply a multi-touch table to control a physical robot agent and described analysis

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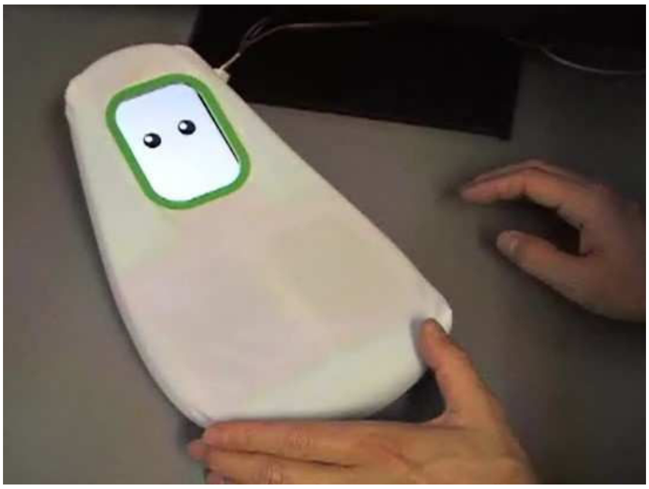

Fig. 1. Remote Control Agent: Rebo

on users' interaction styles in complicated functions of the multi-touch interface.

These previous studies attempted just to enrich usability of the user interface by touch-based devices like touch panels. In the view of developing touch-based interface devices, Rebo is very similar to the previous studies. However, we consider Rebo's touch-based approach is not only for usability of interface, but also for Partial execution for Function awareness as discussed later. Thus Rebo provides novel advantage of touch-based interface in a human-adaptive system.

There are more concrete control methods related to Rebo. For example, stroking alphabets and numbers, by Graffiti-like unistrokes, on a touch-pad device has been developed[8]. This kind of function can be implemented on Rebo to change a TV channel directly.

There are also studies on multi-modal remote control of appliances using speech, gesture, and so on[9]. Balchandran et al. have presented a novel prototype system that implements a multi-modal interface to control the television[10]. The system combines the standard TV remote control with a dialog management based natural language speech interface to allow users to efficiently interact with the TV. Unfortunately, in contrast with Rebo, these systems are unstable due to complicated speech recognition although natural language-based interface is provided.

Another view point of Rebo is a universal remote control by which a user can control various home electric appliances. One of the most advanced universal remote controls is Personal Universal Controllers (PUC). PUC is an approach for improving the interfaces to complex appliances by introducing an intermediary graphical or speech interface[11], [12]. A PUC executes two-way communication with everyday appliances; first downloading a specification of the appliance's functions, and then automatically creating an interface. At the final stage of our work, this kind of function such as an intelligent universal remote control will be implemented to Rebo.

Partial execution, one of Rebo's advantages, is an extension of our previous work on Action sloping for making a user to notice a robot's function[2], [3]. In our previous work, Partial execution was restricted in robot's physical functions like robot's motions. In contrast with it, in this work, Partial execution is generalized to partially execute various unphysical functions including feedback expression such as an animation on a two-dimensional surface.

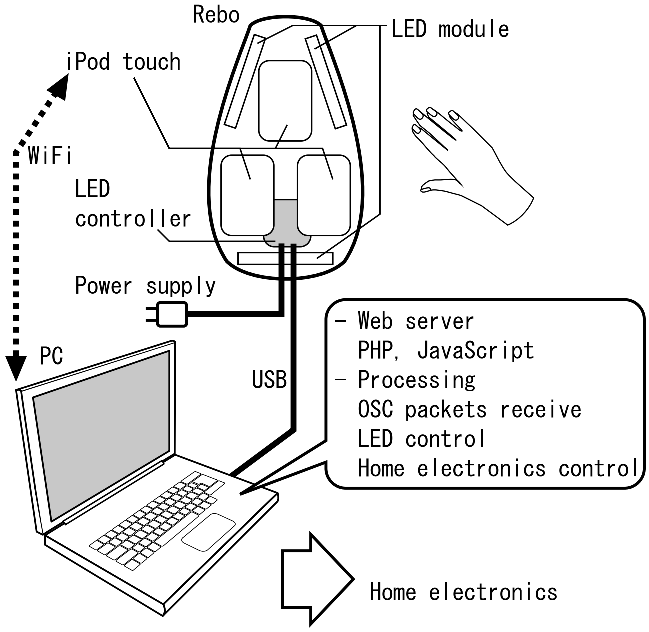

Fig. 2. System Architecture

III. Agent as a Remote Control

Figure 1 shows the developed remote control agent, Rebo. Rebo is an agent of remote controls of home electric appliances. It has a user-friendly appearance; a smooth surface for stroking and a back side fit for users' thighs. Rebo is different from conventional remote controls in being used. It is 249 mm long, 146 mm wide, and 96 mm high.

A. System Architecture

Fig. 2 shows the architecture of our system. In the current stage, a main processing device (PC) is not embedded in Rebo. In the future, all of devices including batteries and PC will be embedded in the body of Rebo.

Rebo has a display for facial expressions, full-color LED modules, and three touch devices (iPod touches) are embedded in the body. Two iPods are used as touch sensors and the remaining one is used for displaying information. The iPods used as touch sensors are covered with a soft and smooth cloth. Touch positions are sent to a host PC through WiFi from iPod's browser, Safari. We adopted Open Sound Control (OSC)[13] as a communication protocol. When a user touches the browser on an iPod, a JavaScript program is called and then a PHP function sends OSC packets to a connected PC.

One of the embedded iPods is used for the facial expression display. An OSC server on the PC deals with OSC packets and rewrites a local XML file. A JavaScript program on the iPod for facial expression periodically accesses the XML file using Ajax. According to the XML file description, the program on the iPod changes gif animations. The concrete facial expressions are described in Section IV.

Three full-color LED modules embedded in Rebo provide a user with some light-based feedback when he or she operates Rebo. The user can grasp the result of their operation from their peripheral vision. The LED modules are controlled by the PC through USB connection. We use a programming language, Processing to deal with OSC packets, the LED modules, and XML file writing/reading. It can communicate with home electric appliances through infrared signals.

In the following paragraphs, we explain three advantages of Rebo: Familiarity, Function awareness, and Stroke operation.

B. Familiarity

Rebo has a life-like appearance (Fig. 1) and facial expressions to acquire familiarity with a user. We adopt the concept of "intermediate entity between artifacts and animate beings". Rebo is not only a tool but also a partner. The body of Rebo is covered with soft and bouncy cloth and it is pleasant to the touch. When the user strokes Rebo, it changes its facial expressions to inform him or her of various emotional states of Rebo. We consider this makes the user more comfortable with Rebo. Therefore, interaction with Rebo can be the purpose of the user as well as operation of home electric appliances. We believe that this concept plays an important role for establishing familiarity between users and Rebo.

C. Function Awareness

Function awareness is awareness that which operation causes which function of a machine. For example, when a user purchases a new home electric appliance, he or she reads the owner's manual before using it to understand its functions. However, searching for the desired functions and studying how to operate the remote control often can be complicated and difficult. Therefore, having a way for the user to comprehend a machine's functions without reading the manuals would be useful.

In this study, we adopt Action sloping[2], [3] that enables a user to notice its functions to achieve Function awareness. Action sloping makes machines provide feedback that gradually changes in intensity as the user carries out given actions. As for intensity of feedback behavior, it is assumed that the volume, frequency and quality of representation are changed. Some patterns of feedback behavior that can be used are changing lights displayed, sounds emitted, or timing of movements.

Figure 3(a) shows the conventional method for exhibiting feedback behavior. When a user operates a machine or remote control with performing triggering action, it executes

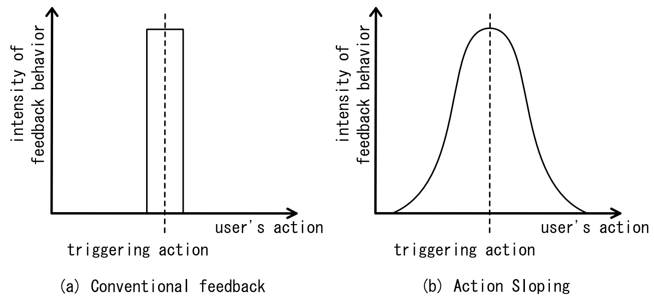

Fig. 3. Intensity of Feedback Behavior

a function. The user observes the machine's behavior as feedback behavior. However, the machine provides no feedback if the user operates it without triggering action. In contrast, with Action sloping, shown in Fig. 3(b), the machine exhibits feedback behavior even when the user takes actions other than the triggering action. Changing the intensity of feedback behavior in response to the user's action, the robot will encourage the user to perform the triggering action.

For example, we can consider a case of using a TV remote as follows. When a power button is pushed (triggering action is performed), the TV turn off (feedback behavior). A user receives feedback of his or her operation when the TV turns off. In contrast, Action sloping constantly provides feedback before the TV turns off. Before the user touches the button, the TV decreases the image dimensions to express "the TV is likely to turn off". This is a just example and needs a sensor that can measure the distance between the fingers and the button.

In this study, a user interacts with Rebo by stroking it. This kind of interaction manner bears a continuous action and easily achieves Action sloping. We utilize this feature and propose "Partial execution" as a way for the user to notice functions of the machines. Partial execution is a feedback expression method that provides a meaning of users' operation by showing a part of an executing function. For example, when the user strokes Rebo for a short time, Rebo decrease the image dimensions of the TV for a short time. If the user strokes Rebo for a long time, it decreases the image dimensions and turned off the TV power.

Feedback expressions of the machine strongly depend on its functions and are designed for each application.

D. Stroke Operation

Rebo has no button and a user strokes its surface to control devices. In this kind of operation, he or she does not need to move the fingers correctly and not seek the button that he or she wants. It is more comfortable for the user to gaze at a machine that he or she wants to control than to gaze at the remote control, because the feedback from the machine is more important than that from the remote control. However, the operation by stroking is different from the operation by pushing a button in a physical feeling. We then use LED lighting as an acknowledgment of the operation.

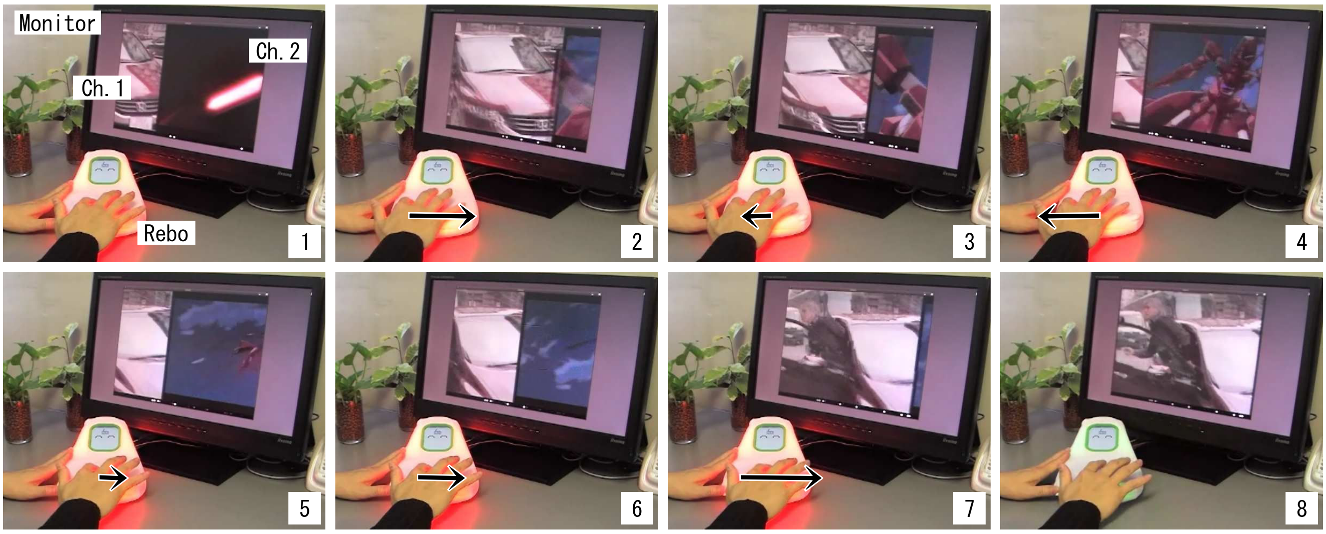

Fig. 4. Channel Switching

Fig. 5. Volume of Sound Changing

The advantage of the LED lighting has less interference against auditory and visual information. If a remote machine such as a TV provides auditory information, it is inadequate that a remote control provides auditory feedback. In contrast, expressions by simple LED lighting can be grasped by users from their peripheral vision. It is comfortable for them to use Rebo without looking at it. We call this method "Peripheral feedback". Peripheral feedback has less interference against their central visual field. Peripheral feedback is similar to peripheral display[14], [15], and its concept is based on our view that "the central player is the remote machine and the backseat player is the remote control".

IV. TV Remote Agent

We developed a TV remote agent based on the proposed remote control agent to implement all of the three advantages in the previous section. In addition, we also designed feedback behavior of the TV and constructed an interaction system.

A. Stroke Operation

Functions we implemented in the system are channel switch, volume of sound change, and power on/off. The TV screen was implemented on a PC. In this section, operation methods of Rebo and feedback behavior of the TV are described.

1) Channel Switch: Figure 4 shows a series of screenshots in which the positions of two video pictures are changed as a user strokes the surface of Rebo right and left. When the user widely strokes the surface of Rebo with her fingers, a video picture goes the outside of the TV frame and another video picture comes into the frame. When the user strokes Rebo for a short time, a part of another video picture comes into the frame and then goes out of the frame automatically. In this implementation, we used recorded TV movies and did not use TV tuners. It is technically possible to capture TV movies and show them in the monitor.

2) Volume of Sound Change: When a user strokes Rebo up and down, the volume indicator (a vertical bar) is shown on the video picture (Fig. 5). The length of the indicator is changed as the movement distance of the fingers is changed.

3) Turn On and Off: A series of screenshots in the top of Fig. 6 shows a video picture being reduced in an image dimensions. When a user touches Rebo for more than one second, the image dimensions of the video picture are reduced and finally disappeared. If the user stops touching Rebo before the picture is disappeared, the video picture is enlarged and goes to an ordinary size. On the other hand, a series of screenshots in the bottom of Fig. 6 shows a video picture being enlarged. When the TV has been turned off, the picture is gradually enlarged while the user touches Rebo.

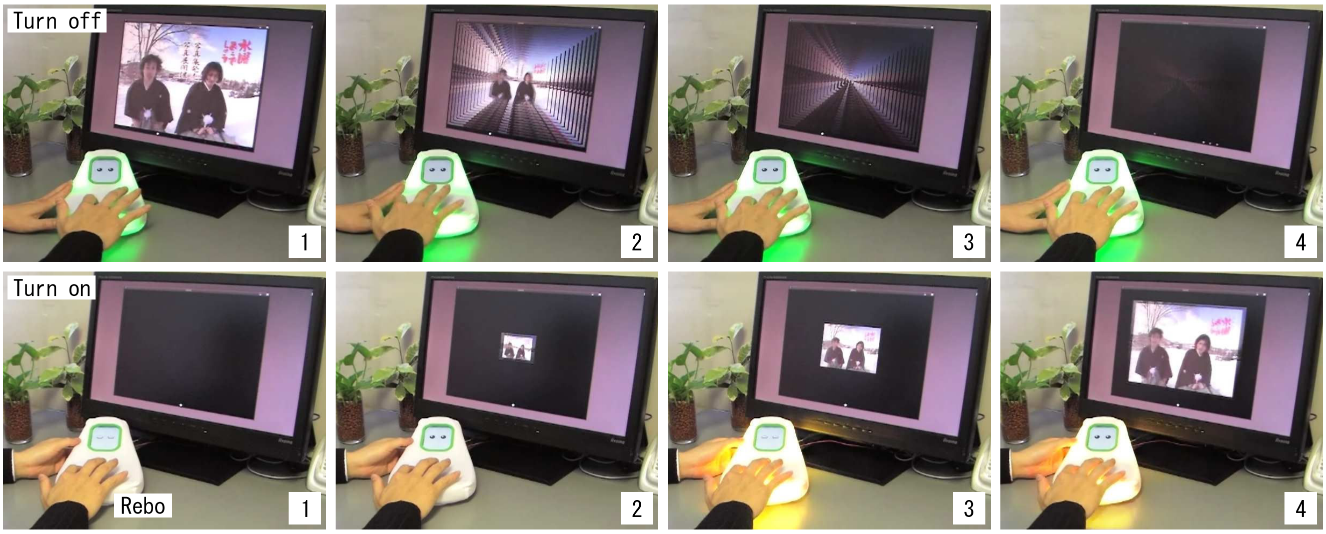

Fig. 6. Turn On and Off

Fig. 7. Facial Expressions

When the user stops touching before the picture becomes to a maximum size, it is automatically going down and then disappeared.

B. Facial Expressions and LED lighting

Figure 7 shows implemented facial expressions of Rebo. It goes a sleep mode when its surface is not touched for 10 seconds. In the sleep mode, Rebo closes the eyes and slowly blinks the LED in a blue color. When a user touches Rebo in the sleep mode, it wakes up with rapidly blinking the eyes and the LED in yellow shown in the upper 3rd picture in Fig. 6. When the user strokes Rebo right and left in the channel switching operation, it lights the LED in red with a smile. When the user strokes it up and down in the volume of sound change operation, it lights the LED in purple with a smile as well. If Rebo is not being touched, it lights the LED in green and sometimes blinks the eyes.

C. Partial Execution for Function Awareness

By the operation of Rebo described above, users easily operate it without looking at their fingers and searching buttons. They can concentrate on the feedback from the TV monitor, but Rebo. Animations of the video picture such as sliding and zooming are implemented as Partial execution for Function awareness. They can understand the meaning of the animation based feedback from the TV before the function is completely executed. Therefore, they can immediately notice the function of the TV by stroking Rebo.

V. Discussions

In this paper, we developed a TV based interaction system as an example of Rebo. In this section, we mainly discuss a difference between Rebo and conventional button-based remote control in an operation method.

Let us consider to implement a button-based remote control with functions equivalent to Rebo in a TV interaction. The button-based remote control needs to have two buttons for switching channels, another two buttons for changing volume of sound, and a button for turning on and off. It may be possible to develop such a useful button-based remote control because of a small number of buttons. We can design the buttons with different in colors and shape, and that will enables users to easily distinguish them by visual and haptic feelings.

The feature of Rebo in comparison with such button-based remote control is the tolerance for mistakes. In our proposed system, a user concentrates on the feedback from a TV because he or she can operate Rebo with strokes without looking at it. The user can cancel the function before it is completely executed because he or she understands which function is executed by observing the feedback based on Partial execution from the TV. For example, when the user wants to change the volume and operates Rebo, he or she tries other ways in stroking by observing the video picture moving left and right. However, in the button-based remote control, when the user pushes a button, the channel was changed immediately. The user has to search a button that tunes the previous channel and push it, and then search a button for changing the volume.

The tolerance for mistakes in Rebo enables unfamiliar users to home electric appliances to use it casually without a fear of making mistakes and unexpected behavior. We have a plan to investigate the effect of this tolerance in an experiment with elderly people.

As for functionality of the TV system with Rebo, it can be improved. If it would provide a function that a user writes a channel number on its surface to switch channels, it will provide functions equivalent to popular TV remote controls.

Also Rebo's familiarity and Function awareness are obviously advantages because conventional remote controls have never had them. However, these advantages should be evaluated through quantitative and qualitative experiments with adequate participants. Thus we are planning to conduct such experiments.

We consider that the concept of Rebo is applicable to many other remote controls besides a TV. It is our future work to develop such remote controls and functions for a TV.

VI. Conclusion

In this paper, we propose an agent as a remote control for home electric appliances, Rebo and develop a TV interaction system. Rebo has three advantages; (1) Familiarity, (2) Function awareness, and (3) Stroke operation. Life-like appearance and facial expression makes it familiar with users. We implemented five facial expressions as a life-like behavior and video picture animations as feedback from the TV to enable users to easily notice its functions. LED lighting provided Peripheral feedback for users to concentrate on the feedback from appliances, but remote controls. The feature of Rebo in comparison with a button-based remote control is the tolerance for mistakes. This enables unfamiliar users to home electric appliances to use it casually without a fear of making mistakes and unexpected behavior.

In the next stage of our study, we have a plan to apply Rebo to various home electric appliances and enable users to seamlessly control them depending on the context.

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