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REBO: A LIFE-LIKE UNIVERSAL REMOTE CONTROL

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ABSTRACT— This paper describes a novel remote control operational with stroking its surface. There are lots of remote controls in our houses for TVs, air conditioners, and so on. However, when we use a remote control, we need to look at both our fingers and the target appliance that we would like to control. It may be not significantly problematic for young people, but elderly people have a difficulty in manipulating remote controls with many buttons. We consider it will be comfortable for various people to use a remote control without looking at their fingers and pushing buttons. Also we consider a remote control should have life-like appearance to become a more familiar artifact to users. In this study, we propose a life-like remote control, Rebo, operational only with stroking its surface and apply to a TV system. The developed remote control has three advantages; familiarity, function awareness, and stroke manipulation in contrast with conventional remote controls with many buttons. These advantages enable users to feel much familiarity by using it, to easily notice its implemented functions, and to use it without looking at the fingers and buttons.

Key Words: universal remote control, stroke-based, life-like

1. INTRODUCTION

There are various remote controls in our houses. We have remote controls for TV, air conditioner, room light, and so on. Remote controls for appliances are commonplace devices and have been widely spread. However there are significant problems on remote controls. For example, any remote controls confuse us because we need to use various remote controls with different user interfaces. A universal remote [1] that aggregates functions of various remote controls is one of technical solutions for this problem. Users can control various appliances by manipulating a universal remote control, not using specific remote controls for each appliance. On the other hand, users for traditional button-based remote control need to search a target button and to move the fingers to push it. It may be not a serious problem for young people, but elderly people have a difficulty in such manipulation for remote controls. We consider it will be comfortable and easily operational even for elder people to use a remote control without looking at the fingers. Such a remote control is also comfortable to young people who are familiar to home electric appliances because of easy operation. Also we consider a remote control for appliances should have a life-like appearance to become a more familiar artifact to users. By such an appearance, users who are not so familiar to appliances get to use the remote control without hesitation.

In this paper, we propose a life-like remote control, Rebo, manipulatable only with stroking its surface [2] and apply to an advanced TV system. Users only 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; familiarity, function awareness, and stroke manipulation. The life-like appearance and facial expressions make it familiar with users. As for function awareness, we adopt action sloping [3, 4] that enables users to notice its functions. Therefore, users do not have to seek a button that they want and use it easily.

As a realized example of the proposed remote control, we develop an advanced TV system in which action sloping is implemented. We actually implemented some functions like channel select, power on/off on the advanced TV system, and confirmed the execution.

2. RELATED WORK

Rebo is a device which users can control various appliances only 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. In contrast with conventional touch-based remote controls, since Rebo utilizes users' strokes with the fingers, they do not need to visually recognize and understand any icon, signal, and acknowledgment from a remote control. A user can concentrate on the feedback from appliances, not a remote controls. Advantage of our approach partially resembles that of eyes-free approach for many people including visually-disabled persons and elder people.

Zhao et al. developed a potable audio player having eyes-free menu selection which utilizes touch input and reactive audio feedback [5]. Buil et al. also applied a touch-based manipulation to control headphones [6]. Brewster et al. designed eyes-free multi-modal interaction for Wearable devices [7]. Particularly for using mobile and wearable computers, input or output problems occur due to limited screen space and interaction techniques. In these studies, 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 [8]. They tried to apply a multi-touch table to control a physical robot agent and described analysis on users' interaction styles in complicated functions of the multi-touch interface.

All of these previous studies have 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 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.

Osawa et al. proposed a unique approach to anthropomorphize various appliances by attaching arms and eyes on them [9]. They actually developed artificial arms, eyes and attached them on a refrigerator, a printer and so on. Also they conducted experiments with participants and investigated user's behavior and interpretation on the anthropomorphized appliances. Their approach is similar to Rebo's one in terms of making appliances more familiar to users by anthropomorphizing them, but the concrete method is significantly different. In contrast that they attach additional equipments like arms, eyes to conventional appliances, we try to design a novel life-like remote control of an appliance.

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 [3, 4]. 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.

3. REBO AS A LIFE-LIKE REMOTE CONTROL TESTBED

Fig. 1 shows the developed life-like remote control, Rebo. Rebo is an universal remote controls of

Fig. 1 Rebo's appearance.

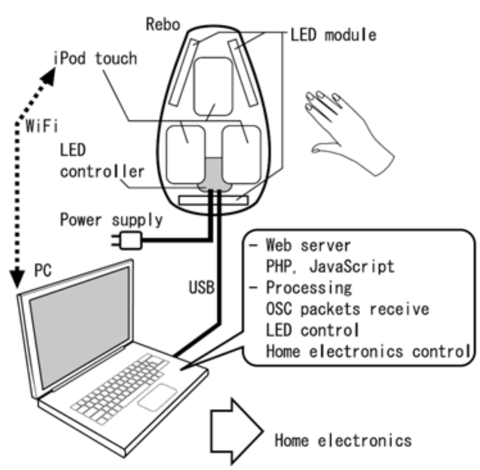

Fig. 2 Architecture of Rebo.

home electric appliances. It has a user-friendly appearance; a smooth white surface for stroking and a back side fits to users' thighs. We have carefully designed the shape of Rebo with cooperation of an industrial designer, one of the authors, and determined a life-like appearance shown in Fig.1. We consider this simple and life-like appearance significantly makes users to feel much more familiarity than conventional button-based remote controls. This appearance also makes users interested in it and guides them to use it without hesitation. The size of Rebo is 249 mm long, 146 mm wide and 96 mm high.

3.1 System Architecture

Fig. 2 shows architecture of Rebo system. In the current stage, a main processing device (PC) is not embedded in Rebo. In the next stage in near future, all of devices including batteries and the main processing device 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 for sensing users' stroking and the remaining one is used for displaying facial expressions. The iPod touches used as touch sensors are covered with a white, soft and smooth cloth. Touch positions are sent to a host PC through WiFi from iPod's web browser Safari. We adopted Open Sound Control (OSC) as a communication protocol. When a user touches the browser on an iPod touch, a JavaScript program is executed and then a PHP function sends OSC packets to a connected PC. Three full-color LED modules embedded in Rebo provide a user with light-based feedback when s/he manipulates Rebo.

In the following subsections, we explain three advantages of Rebo: familiarity, function awareness, and stroke manipulation.

3.2 Familiarity

Rebo has a life-like appearance in 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 pet to users. The body of Rebo is covered with soft and bouncy cloth and it is comfortable for users to touch Rebo. 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. Rebo currently has four different facial expressions like "Sleep", "Normal", "Select TV channels" and "Change sound volume". Therefore, interaction with Rebo can be the purpose of the user as well as manipulation of home electric appliances. We believe that this concept plays an important role for establishing familiarity between users and Rebo.

3.3 Function Awareness

Function awareness is user's awareness that which manipulation causes which function of a machine [3, 4]. For example, when a user purchases a new appliance which s/he has few experiences to use, s/he reads the owner's manual before using it to understand its functions. However searching for the desired functions and studying how to manipulate the appliance is often complicated and difficult. Therefore, a way for a user to comprehend machine's functions without reading the manuals would be useful.

In this work, we adopt *action sloping* [3, 4] that enables a user to notice its functions to realize function awareness. Action sloping enables machines to provide feedback that gradually changes in

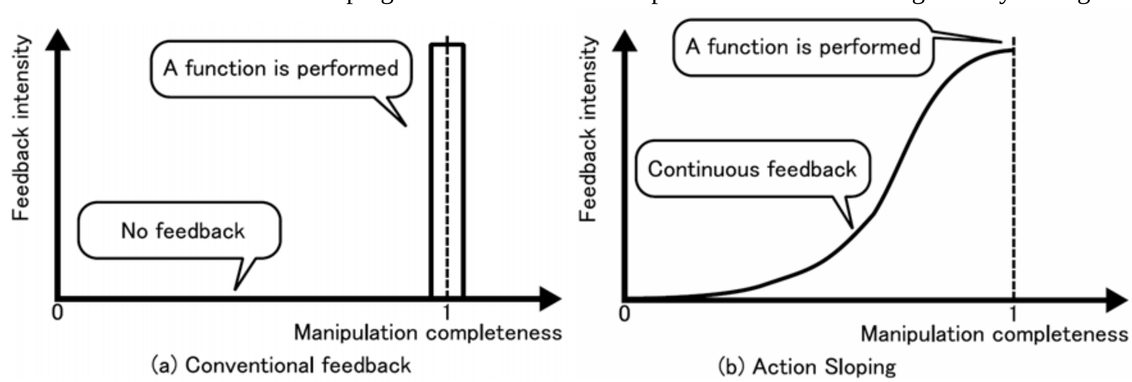

Fig. 3 Intensity of feedback behavior.

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. Fig. 3(a) shows the conventional method for exhibiting feedback behavior. When a function of a machine is executed, feedback is provided for the user. However, the machine provides no feedback at all if the user does not perform a function.

In contrast, with action sloping shown in Fig. 3(b), a machine exhibits feedback behavior even when a function is not performed. It provides feedback in response to user's incomplete manipulation. Therefore, action sloping enables users to understand relationship between user's action and the machine's functions. 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/her manipulation when the TV actually turns off. In contrast, action sloping gradually provides feedback before the TV actually turns off. Before the user touches the button, the TV decreases the image dimensions to express "the TV is likely to turn off". This action sloping requires a sensor that can measure the distance between the user's 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' manipulation by showing a part of an executing function. For example, when a user strokes Rebo for a short time to turn off the TV, 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 turns off the TV power eventually.

Feedback expressions of the machine strongly depend on its functions and are designed for each application. We need to develop the methodology to design adequate realization of action sloping in various domains related to a remote control.

3.4 Stroke Manipulation

Rebo has no button and a user strokes its surface to control appliance. In this kind of manipulation, s/he does not need to move the fingers precisely and not seek the button that s/he wants to push. It is more comfortable for the user to gaze at a machine that s/he 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. Thus we consider Rebo's manipulation by stroking has advantage over conventional button-based remote controls.

4. A TV REMOTE CONTROL AND EXPERIMENTS

We developed Rebo, as a TV remote control based on the proposed remote control to implement all of the three advantages in the previous section. In addition, we also designed feedback behavior of the TV and constructed an advanced TV system. The advanced TV system is a simulated TV in which a movie player plays recorded TV programs on a PC monitor in multiple channels like a real TV. Also, traditional remote controls can communicate the advanced TV system, and we can implement and test various action sloping methods on the advanced TV system. Unfortunately implementation of action sloping and partial

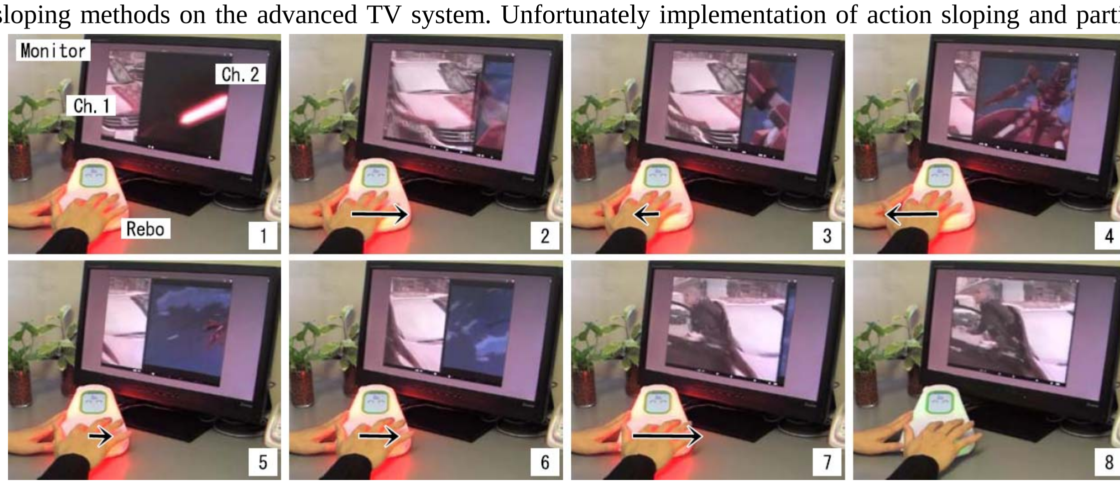

Fig. 4 Partial execution: changing a TV channel by stroking Rebo.

Fig. 5 Sound volume control.

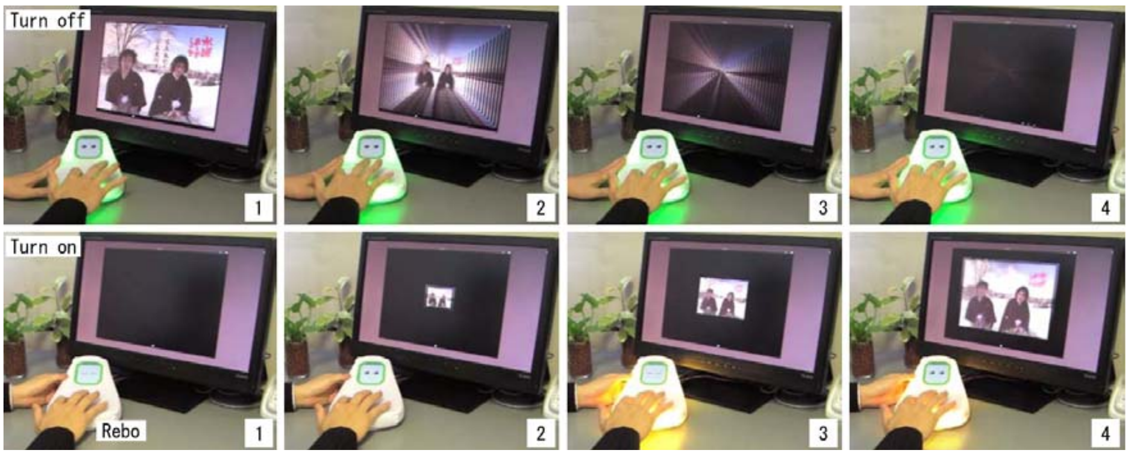

Fig. 6 Partial execution in power on/off.

execution on a real TV is hard, thus we need to use an advanced TV system.

Functions we implemented in the advanced TV system are channel select, sound volume change, and power on/off. In this section, manipulation methods of Rebo and feedback behavior of the TV are described.

4.1 Channel Select

Fig.4 shows a series of screenshots in which the positions of two videos are changed as a user strokes the surface of Rebo right and left. When a user widely strokes the surface of Rebo with the fingers, a video picture goes the outside of the TV frame and another video picture comes into the frame. When a 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. As described earlier, we used recorded TV programs and did not use TV tuners in this implementation. It is technically possible to capture TV programs and show them in the monitor.

4.2 Sound Volume Change

When a user strokes Rebo up and down, the volume indicator (a vertical white bar) is shown on the video (Fig. 5). The length of the indicator is changed as the movement distance of the fingers is changed. This is a typical example of indication-based partial execution to express the varying sound and the bar indication.

4.2 Power On / Off

A series of screenshots in the top of Fig. 6 shows a video being reduced in an image dimensions. When a user touches Rebo for more than one second, the size of the video is reduced and finally disappeared. If the user stops touching Rebo before the video is disappeared, the video 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 being enlarged. When the advanced TV system has been turned off, the picture is gradually enlarged while the user touches Rebo. When the user stops touching before the video becomes to a maximum size, it is automatically going down and then disappeared.

4.3 Experiments

We are currently preparing to conduct experiments to evaluate the advantage1s of Rebo. Impression on the appearance, usability, ease of finding functions, and eye movements will be compared between Rebo and a typical TV Infrared remote (IR remote). Eye movements measured by an eye-tracking system (Tobii T60) will be used to investigate the manipulation without looking at Rebo. Fig. 7 shows a snapshoot of an experimental environment. Through these experiments, we will evaluate Rebo's advantages: familiarity, function awareness, and stroke manipulation.

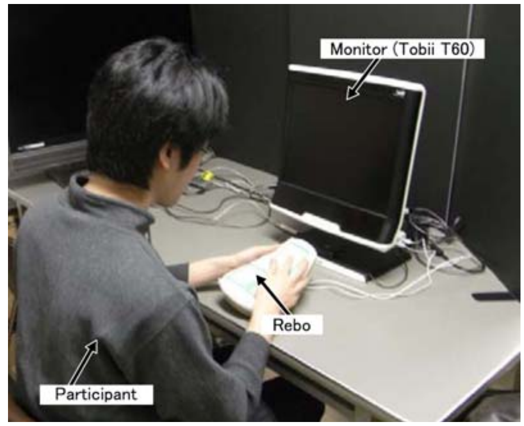

Fig. 7 Experimental environment.

5. CONCLUSION

In this paper, we proposed a robot-like remote control, Rebo, for controlling home electric appliances and implemented Rebo for an advanced TV system. Rebo has three advantages; familiarity, function awareness, and stroke manipulation. Life-like appearance and facial expression makes it familiar with users.

We implemented four facial expressions as a life-like behavior and video picture animations as feedback from an advanced TV system to enable users to easily notice its functions. Also we confirmed the complete execution of Rebo on the advanced TV system. We have a plan to conduct conducted experiments with participants to evaluate Rebo's advantages.

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