A Visually Attractive Interaction Device Suitable for Living Spaces

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ABSTRACT
We present "C^3 (C-Cube: Cubic Cushion Controller)", a multipurpose visually attractive interaction device to control home appliances. The design of C^3 is motivated by looking at the current interaction problems associated with IR remote controllers, i.e. easily lost, easily misplaced and embedded with many small buttons etc. We approach to solve these issues by augmenting a visually attractive cushion with remote controller facilities and offering user to interact with the appliances through patting and titling the cushion surface. This paper addresses C^3's design and implementation features in a summarized way. We also present a informal small user study that shows promising potentiality of our approach.

ACM Classification H5.2 [Information interfaces and presentation]: User Interfaces. - Interaction styles.

General Terms Design, Human factors

KEYWORDS: Remote control, multipurpose controller, home appliance, everyday objects, accelerometer.

INTRODUCTION
IR-based remote controllers are widely used to control the home appliances like TV, air conditioner, media player etc. These remote controllers have no designated locations and placed ad-hocly without any specific pattern. These usage pattern arises several problems. For example, they are hardly found and easily lost. Furthermore, the size and shape of the remote controllers of different appliances are similar which also confuses us. Multipurpose controller has been proposed as possible solution to this problem. However, these controllers have severe interaction drawbacks. Because of too many small buttons and functionalities, these controllers are confusing and very hard to use.

There are many researches about interaction techniques for the remote control of information appliances. Most of them present input methods alternating many small buttons[1, 2, 3, 4]. These systems use vision-based technique or sensors (e.g. accelerometers) or both. However, vision-based technique is unsuitable for living spaces primarily for two reasons. One is, these systems require complicated technical settings of the room (e.g. installing cameras or markers), which is economically not feasible. Besides, due to occlusion and clutter, most of the time we cannot get an expected recognition accuracy. The second one is the psychological aspect related to privacy obtrusion, many users feel awkward to live in camera-monitored spaces. On the other hand, accelerometer sensor based controller is getting very popular as it is unobtrusive and requires minimum infrastructure support. Recent proliferation of Nintendo Wii[2] suggests the end user acceptance of such sensor based controllers.

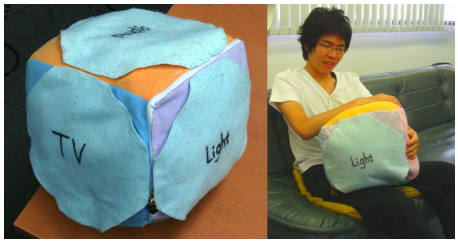

Figure 1: Visual appearance of C^3. C^3 can be used both as a cushion and as a controller. The physical body is visually appealing and suitable for living spaces like everyday objects.

In this paper, we present a multipurpose controller prototype "C^3 (C-Cube: Cubic Cushion Controller)" for home appliances adopting the notion of accelerometer based controllers. We augment a cubic cushion with a 3-axis accelerometer to have an appealing visual appearance without reducing the functionality as a cushion. Thus, this augmentation enables C^3 to be used both as a cushion and as a controller. Several appliances can be controlled by patting and tilting the surface of the cushion. C^3's visual appearance and haptic interaction make it very convenient to find and very simple to use.

APPROACH
C^3 has been built following two design principles: appealing visual appearance and simple interaction. C^3's physical body is a everyday cushion, and has a large body. Thus it is very easy to locate it and hard to misplaced. C^3 is buttonless and includes a 3-axis accelerometer that detects motion and tilt angle to recognize patting and tilting actions. Users can pat each surface of the body, and tilt it to control the appliances. These simple interaction makes C^3 very easy to use.

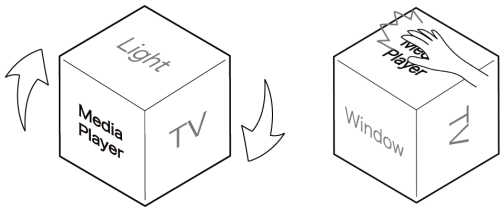

Figure 2: The actions in Select-phase: facing up and patting the surface indicating desired appliance.

Appearance Design

We have picked a large cubic cushion for the body of C^3 (Figure 1). The body resembles a large dice, and each surface can be associated with different appliances. An accelerometer is embedded into the cushion. The soft body of the cushion protects the accelerometer from being damaged. Each surface is visually marked for the associated appliances.

Interaction Design

The user interacts with C^3 by patting and tilting it. The interaction of C^3 consists of *Select-phase* and *Control-phase*. To select the desired appliance, the surface associated with the appliance should be face up and patted (Figure 2). To control the selected appliance, patting and titling actions are used in conjunction. These actions are mapped into appliance-specific protocols. For example, to control a media player, first, we have to select the player by facing up the surface that indicates media player. We can play the next track by patting the right surface, play the previous track by patting the left surface, fast-forward the music by tilting it to the right, and fast-rewind the music by tilting it to the left.

Since there is overlapping in select and control phases actions, we must have to recognize the order and appropriateness of the actions properly. For example, patting the top surface cannot be used as an input of control-phase. In addition C^3 provides a sleep mode to ignore unwanted inputs. In the sleep mode, only select-phase is available.

IMPLEMENTATION

The physical body of cubic cushion (about 35cm on a side) is augmented with a 3-axis accelerometer. We have used "Wii Remote"[2] because of its high accuracy. Furthermore, Wii Remote has a force-feedback which is used in C^3 to provide responses to users' interactions. The C^3 is connected to a host machine via bluetooth which analyzes the sensor data to map the user actions to appliance specific commands. In current prototype, we have implemented a TV, a Media Player and a Light as target appliances and are controlled from the host machine based on C^3's input.

INITIAL EXPERIMENT

We conducted a small informal user trial of C^3 in our laboratory. Nine volunteers, that not affiliated with this project participated in this trial. Initially, they were provided with a tutorial on how to use C^3, followed by a 10-minute learning stage. Then they were asked to control the provided appliances (a TV, a Media Player and a Light). There were about fifteen operations in the whole experiment associated with these appliances that can be controlled by C^3. Finally we interviewed each of the participants.

Result

Overall, participants' reactions were positive. From system perspective, more than 90% of inputs were correctly recognized and mediated to the appliances properly. No participants complained about the input recognition. All of them agreed that the visually attractive body of C^3 is convenient to locate it and hard to misplace it. Most of participants answered that they can put C^3 on sofa or bed just like regular cushions while not using it. So it can be used both as a cushion and as a controller. Seven participants answered that they would like to use C^3 if it is commercialized. Some participants thought the body of current C^3 is too large and should be smaller. However, they did not criticize the overall functionalities. One important finding from the interviews was the fact that: *when they use their appliances, most of the time they use only a few buttons.* This is very crucial for C^3's overall evaluation as it justifies our selection of a cubic cushion and only two actions, i.e. tilting and patting for controlling home appliances.

DISCUSSION AND FUTUREWORK

The result of the experiment shows that our approach is promising. A cushion body like C^3 is visually appealing and is suitable for living spaces like everyday objects. However, the best size, shape and material vary from user to user. C^3's functionalities are independent of its physical body, so the body can be resized or replaced easily. Kawasaki et al. proposed a similar approach of using an everyday object as a controller[1], however their approach relies on vision-based techniques thus highly vulnerable to privacy threats. The advantage of our approach is its simplicity and suitability for living spaces.

However, C^3 is not free from flaws, too. Current C^3 has few outputs and it's difficult to use C^3 as a controller for appliances with rich outputs like air conditioner. One way to solve this problem is to incorporate more actions and using different body. Also, currently the mapping of actions to appliance specific commands are hard coded. We are working to provide a framework to make this mapping more generic.

In this paper, we proposed a remote controller with appealing visual appearance yet simple to use and presented C^3 as an exemplary prototype using accelerometer. C^3 was well accepted by users as not only a controller but also a cushion that reveals such a controller has promising potential as multipurpose controller in living spaces. However our approach needs more evaluations. We are working on augmenting other everyday objects with more rich sensors (e.g. gyro-sensor) and hope to come up with some interesting results soon.

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