HomeOrgel: Interactive music box for aural representation of home activities

Maho Oki, Koji Tsukada
Ochanomizu University
2-1-1Otsuka, Bunkyo-ku, Tokyo, Japan
g0420510@edu.is.ocha.ac.jp, tsuka@acm.org

Kazutaka Kurihara
AIST
qurihara@nifty.com

Itiro Siio
Ochanomizu University
siio@acm.org

ABSTRACT
We propose a music-box-type interface, "HomeOrgel", that can express various activities in the home with sound. Users can also control the volume and contents using the usual methods for controlling a music box: opening the cover and winding a spring. Users can hear the sounds of current and past home activities, such as conversations and opening/closing doors, with the background music (BGM) mechanism of the music box. This paper describes the concepts and implementation of the HomeOrgel system.

Author Keywords
Auditory display, ubiquitous computing, smart home, HCI

INTRODUCTION

In the near future, it is expected that large numbers of computers and sensors will be installed in the home. Many research projects have been proposed to address this future environment [4][6]. Although these projects help in the recording of users' activities in the home, there has been relatively little discussion of display and playback methods. We propose an auditory interface modeled on a music box, "HomeOrgel", which can present home activities by means of natural sound.

HOMEORGEL

The HomeOrgel helps users to hear various activities in the home with natural sound. Users can control the HomeOrgel in a manner similar to a music box; by opening the cover, they can hear the sounds of home activities, such as conversations and opening/closing doors, with the background music (BGM) mechanism of the music box. As shown in Fig. 1, the HomeOrgel consists of a cover and a knob with a spring. Basic usage of the HomeOrgel can be described as follows:

(1)When the user opens the cover, the HomeOrgel plays music.
(2)The user can change the volume by movement of the cover: the volume increases (decreases) with the extent of opening (closing) of the cover.
(3)When the user closes the cover, the music stops.
(4)When the user winds the knob on the back of the HomeOrgel by about a half-turn, the HomeOrgel plays the sounds of past activities (*e.g.*, 1 h ago).
(5)The knob turns automatically with a spring and will stop in several seconds. Sounds of past activities are compressed to within a certain length (*e.g.*, 20 s).
(6)When the user winds the knob through more cycles, the HomeOrgel will play the sounds of activities further back in the past (*e.g.*, 1 day ago)

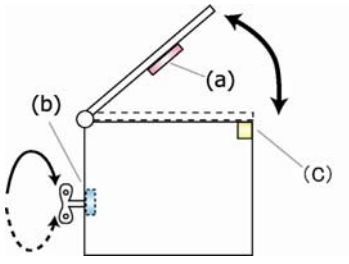

Figure 1 : Usages of the HomeOrgel: (a)an acceleration sensor to control volume. (b) a rotary sensor to play sounds of past activities, (c) a magnetic sensor to play/stop BGM.

Design of sounds

The HomeOrgel generates various sounds, based on home activities that are detected by numerous types of sensor installed in the home: in the entranceway, living room, kitchen, bathroom, *etc*. Table 1 shows mappings of (1) home activities, (2) installed sensors, and (3) generated sounds. We designed these mappings taking account of the balance between users' privacy and expressiveness. First, the system does not use "direct" sounds (*i.e.*, connection of a microphone and speaker directly). When simple activities, such as opening/closing doors, cooking, or bathing, are detected, the HomeOrgel plays pre-recorded sounds. The HomeOrgel detects various other activities, such as conversations or watching TV, using microphones. As these activities contain rich ambient information, they are recorded in short time intervals (*e.g.*, 5 s) and played back in reverse order. Thus, we can maintain voice quality and intervals of conversation without disturbing the users' privacy. As noted above, past home activities are summarized in reverse order for efficient browsing.

Situations	Activities	Equipped sensors	Generated sounds
Entrance	A person entering or leaving the home	Push switches, magnet sensors	Interphone calling, opening/closing the door
Living room	Conversations, watching TV	Microphones, TV audio outputs	Conversation and TV sounds played in reverse order
Kitchen	Washing, cutting , cooking	Water sensors, vibration sensors, temperature sensors,	Washing , cutting, cooking

Table 1. Examples of event-sensor-sound mappings

IMPLEMENTATION

We have developed a prototype of the HomeOrgel system, which consists mainly of sensors and a speaker attached within an existing music box (Fig. 2). The system detects the state of the cover—open or closed—using a magnetic sensor. It also detects the degree of rotation of the knob and the spring using a rotation sensor. Moreover, the HomeOrgel system detects the angle of the cover using an acceleration sensor. Currently, we assume an environment in which numerous sensors have already been installed, and have therefore developed an auditory display system that generates sounds from sequential sensor data.

DISCUSSION

Several methods are available for displaying home activities using visual displays. First, the user can obtain detailed information using a security camera-like interface: by capturing videos of a room with a camera and displaying them in another room. However, this approach not only disturb users' privacy it also prevents visual attention being directed to other tasks. Next, ambient visual displays using LEDs or lamps have several merits in that they neither disturb users' privacy nor prevent visual attention in daily activities. However, it is quite difficult to create simple mappings between lamps and home activities. For example, simple LED arrays hardly offer clear mappings.

RELATED WORK

Several research projects have proposed techniques to visualize home activities. Digital family portrait [3] embeds wellbeing-related information into the picture in a picture frame. The Video [4] proposes an always-on video media space, balancing privacy and awareness in compromising home situations. As HomeOrgel focuses on auditory media, it has several differences in relation to other systems. There are currently several research projects investigating aural representations of home activities. Music Monitor [6] illustrates how music can be used to balance attention between two active rooms in the home (*e.g.*, kitchen and living room). Seamless User Notification [2] describes a method for notifying users through auditory cues embedded in an ambient soundscape in the environment. MusicBottles [1] introduces a tangible interface that deploys bottles as containers and controls for digital information. When the cork is removed from a bottle, the corresponding instrument becomes audible. The HomeOrgel helps users access auditory contents based on home activities simply and flexibly using the metaphor of a music box. Sonic Interventions [5] reported interview data and sound recordings gathered from seven households. This study offers fresh insight into ways in which the domestic soundscape can be managed and understood.

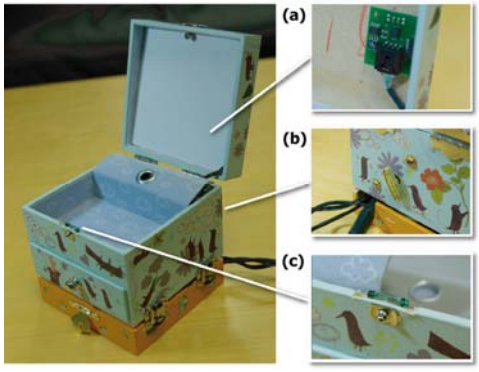

Figure 2. Prototype of the HomeOrgel: (a)rotation sensor; (b) knob with a rotation sensor; (c) magnetic sensor.

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