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Remote Control System for Home Appliances using Spherical Image

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Abstract

Spherical images contain full 360 ° visual information of recorded locations. By sharing such an image, it is possible to reproduce immersive sense of a remote location. This paper proposes a remote home appliances control interface that uses spherical images on a mobile console. It allows users to control remote devices intuitively.

Categories and Subject Descriptors (according to ACM CCS): H.5.2 [Information interfaces and presentation]: User Interfaces—Graphical user interfaces

1. Introduction

The remote control system for home appliances has been developed by several researchers. Conventionally, in order to control home appliances, users manipulate original GUI widgets on mobile consoles, or uses overhead view image of the room on tabletop displays [SHS*09]. However, these systems have some limitations for controlling home appliances. Therefore, we propose a novel control system of home appliances by using spherical image to overcome the limitation of the angle of view (Figure 1). In addition, this image can present realistic sensation. Since our system allows users to control home appliances even if he/she is not in the room, the system helps users to control them in many situations.

Figure 1: *Left: A spherical image; Right: A user controls home appliances using spherical image on a mobile console.*

2. Related works

Thomas et al. proposed the CRISTAL system that provided an experience of controlling home appliances by enabling users to interact directly with those devices on an overhead view image of the room [SHS*09]. CRISTAL used an overhead view image, but this system had the limitation of the angle of view. Due to this limitation, several home appliances are off-screen. Moreover, this image is taken from around ceiling, so it is difficult to show some home appliances which are placed near the ceiling. As regards this limitation, panoramic image is effective [SS12]. Xing-Dong et al.'s system showed peripheral image using an omni-directional mirror attached to the mobile device's front facing camera [YHBI13]. However, users need special staffs to use this system.

3. Spherical image based remote control

Since a spherical image is shown as a flat surface (Figure 1 Left), we should attach it to the inside of the sphere, and then the system shows spherical image on a mobile console. Moreover, our system uses the polar coordinates parameters (θ, ϕ, r) for registering and controlling home appliances (Figure 2 Left). This is because we are able to specify the position of spherical image easily. When the user touches a home appliance on the mobile console, the system sends parameters of the position of the home appliance (θ, ϕ, r) to the database. However, home appliances in the spherical image are shown as having some areas, so it is not sufficient to represent only the point of polar coordinates. To deal with this issue, our system uses template matching technique on the spherical image to determine the area of home appliances. After matching, we assume that the horizontal pixel of cor-

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responding part is w and vertical one is h (Figure 2 Right). Then we set *width* as the horizontal number of pixels of spherical image and also *height* as the vertical number of pixels, and finally the area of home appliances (Θ, Φ) are given by

$$\Theta = 360^\circ \times w/width \quad (1)$$

$$\Phi = 180^\circ \times h/height \quad (2)$$

where Θ and Φ are represented as polar coordinate.

These parameters (θ, ϕ, r, Θ, Φ) are stored in the database and used for recognizing what users select and whether users select correctly or not.

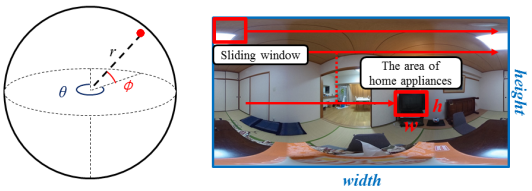

Figure 2: *Left: The model of polar coordinates system; Right: Our system uses template matching technique for determining the area of home appliances.*

4. Implementation

We implemented remote control system which was consisted of two sequences: registering sequence and controlling sequence. In registering sequence, we arranged several GUI buttons. For example, *category buttons* on left side, and *finish button* on upper right. At first, users search a home appliance which they wants to register, and then they touch the corresponding *category button* (Figure 3 Left). After selecting categories, users touch a home appliance which they wants to control. Finally, users touch the *finish button* if they wants to transfer controlling scene. In controlling sequence, users can control home appliances which are registered in previous sequence with touching. (Figure 3 Right)

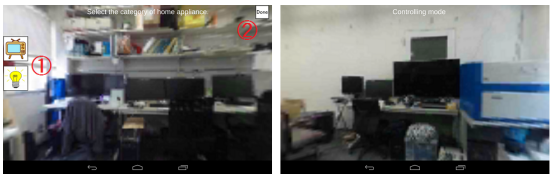

Figure 3: *Left: Users select categories of home appliances at first and then touch a home appliance to register; Right: In controlling sequence, the user can control home appliances with touching on mobile console.*

In order to distinguish which home appliance is selected by users, the system uses information in the database. We assume that the position where users touch in image coordinate is (x, y). The system identifies this position as a registered home appliance if it satisfies the following inequality.

$$\theta - \Theta/2 \leq x \leq \theta + \Theta/2 \quad (3)$$

$$\phi - \Phi/2 \leq y \leq \phi + \Phi/2 \quad (4)$$

After a user touches a home appliance as noted above (x, y), the system changes a spherical image on a mobile console to inform users about its status. In the meantime, the system sends the signal to a server. After the server received the signal from a mobile console, then the server sends information of home appliances to Arduino. Based on this information, Arduino decides which home appliances will be controlled and what kind of signals will be sent.

5. User Scenario

This system is useful for several situations. For example, when a user who doesn't know the detail of the room has to turn on/off home appliances, this system will help him/her because our system presents Virtual Reality environments as if the user were in the exact room a mobile console shows. Moreover, our system helps users when there are several same kind of home appliances in the room. The lights of a concert hall are good example. Even if a user doesn't know which switch to select, he/she can control them by using our system.

6. Conclusion

This paper proposed the system which allows users to control home appliances by using spherical images. The system dealt with positions of spherical images as polar coordinates and registered the positions and areas of home appliances on the database. When users touched a home appliance to control it, the system checked if the position where they touched was in the area of the home appliance or not. If they touched correctly, the system sent the signal to Arduino through the server. Then Arduino sent IR signals to the corresponding home appliance.

For future work, we plan to enhance the user feedback of controlling home appliances to users by using 360 ° video camera and HMD.

References

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