Connecting and Configuring Home Appliances Pointed with a Smartphone

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ABSTRACT

This study aims to develop a system that can intuitively access various connected appliances in a room. There are various home appliances in a room, each of which has configurable parameters. These are controllable with each remote controller or an IoT application. However, these controllers can be used only for a single appliance. To address this problem, we developed a system that obtains configurable information about an appliance using a smartphone. This system uses a smartphone gyro sensor to determine the position and direction of a user in the room, and allows users to instantly acquire and intuitively manipulate information about an appliance by pointing.

CCS CONCEPTS

• **Human-centered computing** → **Pointing devices**.

KEYWORDS

smartphone; gyro sensor; pointing; sensing; interactive;

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1 INTRODUCTION

This study aimed to develop a system that can access information in a room. There are various home appliances in a room, each of which has configurable parameters. For instance, an air conditioner contains information regarding the temperature and air direction. In addition, an audio system contains information about the volume and song playing. A remote controller corresponding to each home appliance can obtain and set this information. However, remote controllers generally correspond to each home appliance and can only be used for one appliance. Users need to switch to the corresponding remote controller for each home appliance; the more home appliances there are, the more remote controllers are required. An increase in the number of remote controllers may lead to their loss in a room.

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Internet of Things (IoT) devices can be used to address this problem. These devices integrate information about objects in the room and can be controlled via a portal device such as a smartphone app or voice assistant. Although these devices can control appliances in the room without being aware of them, they do not address the problem that the more appliances that exist in the room, the more complex the operation of selecting the appliance the user intended.

To address this problem, we developed a system that obtains configurable information about an appliance by pointing, which is the most-used action when specifying an object with a smartphone. This system allows users to acquire information and manipulate it instantly and intuitively on an appliance.

2 ESTIMATING POSITION AND ORIENTATION IN A ROOM USING SMARTPHONE GYRO

A method for detecting the pointing direction is necessary to identify the position of the user. Davidson[1] listed the methods for indoor positioning on a smartphone, including

(1) radiofrequency signals such as Bluetooth;
(2) self-contained sensors such as 3-axis accelerometers and gyroscopes;
(3) building floor plans; and
(4) magnetic fingerprints showing magnetic susceptibility patterns.

Method (1) requires specific equipment, and method (4) is undesirable because the magnetic susceptibility pattern changes depending on the placement of appliances and other factors. Therefore, using methods (2) and (3), this paper proposes an extended Bring Your Own Pointer (BYOP)[2] method to allow the pointing of the entire room. BYOP uses a smartphone as a pointer on the screen. The extended BYOP uses the gyro sensor of a smartphone to identify the position and point direction of the user in the room. First, the user points to three predetermined reference points to obtain the gyro sensor values. The current implementation uses the lower left corner, center, and upper right corner of the wall as points.

The extended BYOP determines the candidate position of the user using two reference point values. This is explained using reference points P1 and P2 (Figure 1). Create a circle of the circumferential angle used by the difference between the gyro sensor values of P1 and P2 (see α in Figure 1) and the perpendicular bisector of P1 and P2. The candidate user position is above the circumference of the circle. This process is performed for all reference point combinations, and the intersection of the three circles represents the position of the user. Subsequently, the direction of the user is estimated by the intersection of the wall and a straight line connecting the user position and one reference point rotated by an angle difference between the current sensor value and the reference point value.

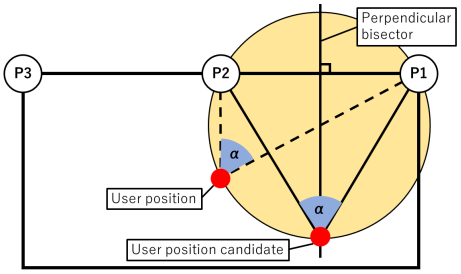

Figure 1: Method of finding user position

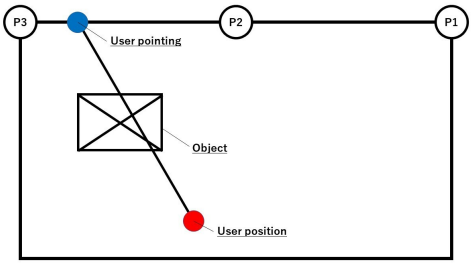

Figure 2: Top view of the room.

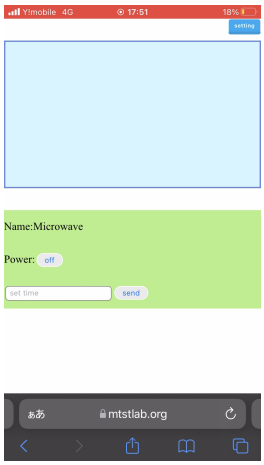

Figure 3: Sample of an interface.

3 IDENTIFYING AND OPERATING APPLIANCES IN THE ROOM

The extended BYOP provides a function whereby, when the user points to an object (e.g., a home appliance) in the room, its settings screen is displayed on the smartphone. The system requires the information of the object regarding height, width, depth, and coordinate positioning where it is in the room to recognize each object. This information must be registered before using the method.

This method generates the diagonal line an object used to determine whether users are pointing to the object. When the line extending from the user position to the user direction crosses at least one of the two diagonals of the object, the system recognizes the object (see Figure 2). This process will be realized for the top and side views of the room, with a final decision made based on what the direction line crosses in both cases.

After recognizing the object, the user wants to know about and control it. Figure 3 shows the display of a smartphone and sample of interface. When the user points at the object, they can get an interface to know and control it by swiping down the blue square area on the display of the smartphone. The green area in Figure 3 is a sample of the interface. Once the user gets the interface, it is unnecessary to keep pointing at the object.

4 CONCLUSION

This paper proposes a method for accessing in-room appliances using a smartphone. The proposed BYOP method estimates the position and pointing direction of a smartphone using its gyro sensor values. The control panel of the appliance appears on the screen of the smartphone by directing the smartphone to the appliance and thereafter swiping.

When two appliances are on the same line from the perspective of the user, the current method cannot distinguish whether the appliance is in the front or back. We will improve this method to address this shortcoming.

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