Object Manipulation by Absolute Pointing with a Smartphone Gyro Sensor

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ABSTRACT

The purpose of this study is to operate various computers around us using our own smartphones. Methods for operating computers around the home by voice, such as the Internet of Things (IoT) appliances, are now widespread. However, there are problems with operation by voice; it is limited in terms of instruction patterns that can be expressed, and it cannot be used simultaneously by many users. To solve the problem, we propose a method to determine the location pointed to by a user with a smartphone gyro sensor. This method achieves controller integration, multiple functions, and simultaneous use by multiple people.

CCS CONCEPTS

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

KEYWORDS

smartphone; gyro sensor; pointing; sensing; interactive;

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1 INTRODUCTION

The number of computers around us is increasing; we know it as ubiquitous computing. For example, TVs, air conditioners, lighting, etc. In recent years, devices that allow these computers to be operated by voice have become widespread, e.g. Google Home[1], Amazon Echo[2]. However, the method of operation by voice is restricted to only performing operations that are easily expressed by voice, it is difficult for many people to simultaneously carry out operations and it is vulnerable to noise.

Another object manipulation method is the pointing operation. Wilson et al. [2] proposed a method for measuring the position of a location at which a user is pointing by observing with cameras the infrared light emitted from the device possessed by the user. Seifert et al. [1] proposed a method to determine the position pointed at with a laser beam, to manipulate the object located at that position with a smartphone. However, these methods have problems, such as the need to observe with a camera the terminal position of the light emitted from a device and the use of specialist equipment that are costly when many people wish to use them. To solve the problem, the goal of this study was to realize a pointing operation method that only requires smartphones.

The pointing operation can be used in a greater variety of environments than voice commands. In addition, an implementation that uses only a smartphone achieves low cost and allows simultaneous use by many people. Furthermore, by dynamically changing controller parts such as the buttons displayed on the smartphone, different operations can be realized for each operation target device. In this study, we limited the objects that can be manipulated to objects on a virtual 2D plane (see Figure 1).

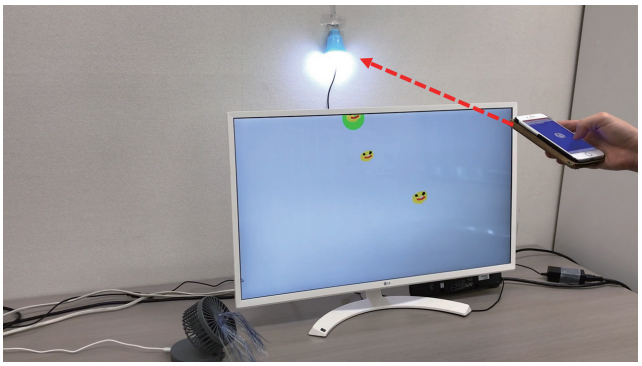

Figure 1: The proposed method for operating computers by pointing with a smartphone's gyro sensor. When the user points the smartphone to the light and taps the screen, it turns the light on.

2 TECHNICAL DETAILS

In the proposed method, a virtual two-dimensional orthogonal coordinate system and two reference points on the coordinate system are defined. Then, based on the value of the gyro sensor when the user directs the smartphone to a reference point, the position pointed to is calculated by linearly converting the value of the gyro sensor. As a matter of caution, here, the proposed method is left-handed, according to the development environment (Processing[3]) in which the coordinate system is implemented. That is, when the

[1] https://store.google.com/jp/product/google_home
[2] https://www.amazon.com/b/?ie=UTF8&node=9818047011

[3] https://processing.org/

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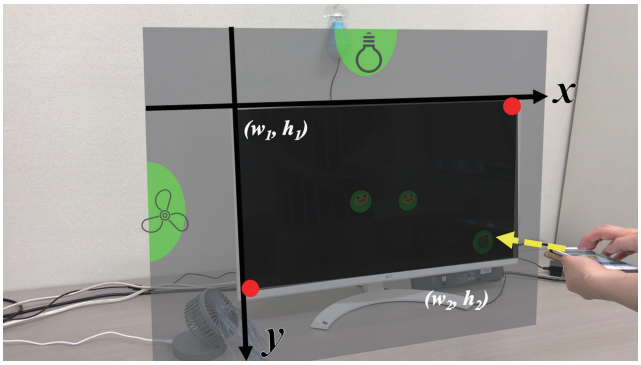


Figure 2: The virtual plane in the proposed method. Red circles represent reference points. Green semicircles represent positions of the fan or light.

coordinate plane is viewed from the front, the x-axis is to the right and the y-axis is to the bottom. We use the following expressions for calculation:

$$x = w_2 + (w_1 - w_2) \times ((\alpha - \alpha_1)/(\alpha_2 - \alpha_1))$$
$$y = h_1 + (h_2 - h_1) \times ((\beta - \beta_1)/(\beta_2 - \beta_1))$$

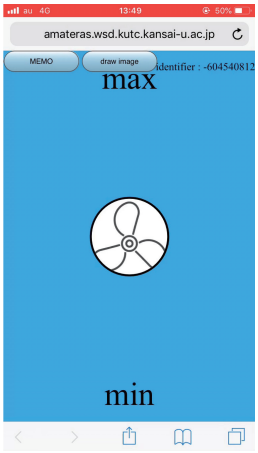
In this formula, x, y are the x- and y-coordinates of the coordinate system that contains the position pointed to by the user. w_1, h_1 and w_2, and h_2 are the x, y coordinates of the respective reference points. α_1, α_2 and β_1, and β_2 indicate the α, β values of the gyro sensor when pointing to the respective reference points.

The proposed method consists of a relay server, a main system, and an application that operates on a smartphone. The operating procedure of our proposed system is as follows.

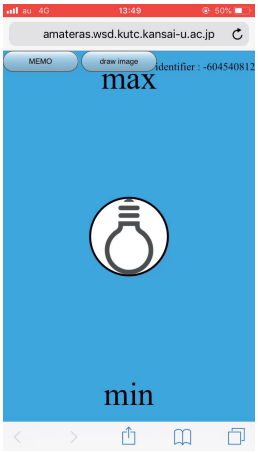
(1) Connect the server and the main system application.
(2) Read a QR code using the smartphone. Then, the smartphone-side application and the server are connected.
(3) Point the smartphone to each respective reference point and register by tapping the screen each time.
(4) Point the smartphone as desired by the user.

Since step (1) of the procedure only needs to be performed once by the system installer, subsequent users who perform the pointing can start from step (2). The role of the application that operates on the smartphone is to transmit the value of the gyro sensor, the tap status of the screen, and the information necessary for the operation of the device to the main system via the relay server. The application can also dynamically arrange control buttons on the screen of the smartphone.

Because this application is not complex, it can be used on any smartphone if implemented as a web application. The role of the main system in the proposed method is to calculate the coordinates pointed to by the user. In addition, it is to send feedback for the operation of the device or to the user according to the coordinates. By comparing the coordinates obtained in this way with the coordinates of the object previously entered into the system, the object pointed to by the user is identified and manipulated (see Figure 2).



(a) When facing the fan



(b) When facing the light

Figure 3: Interfaces of the application that operates on a smartphone. The operable object is displayed.

3 DEMONSTRATION

In our demonstration, we realized three object operations: display, light, and fan. First, on the display, the user can operate the cursor by pointing. In addition, it is also possible to place a picture drawn by hand at the indicated position on the display. If you have a picture drawn by someone on the display, you can place the cursor on the picture and tap the smartphone several times to capture the picture and keep track of your pointer. When the fan or light can be operated by pointing the smartphone to each, an image notifying the user of this is displayed on the screen of the smartphone (see Figure 3). When you tap the smartphone while operating the fan, the fan turns on and the wind blows in the system shown on the display. Point the smartphone at the light and tap to turn on the light. The display also becomes brighter simultaneously.

4 CONCLUSION

We propose a method that involves pointing using a smartphone. Our system can calculate the coordinates that the user is pointing to, so the user can manipulate the actual object. In future work, we plan to conduct experiments to show how much error there is in the action carried out by the user, and to develop a method that can detect locations not only on a plane but also in 3D space.

REFERENCES

[1] Seifert Julian, Bayer Andreas, and Rukzio Enrico. 2013. PointerPhone: Using mobile phones for direct pointing interactions with remote displays. *Human-Computer Interaction – INTERACT 2013* 8119 LNCS, PART 3 (2013), 18–35. https://doi.org/10.1007/978-3-642-40477-1_2

[2] Andrew Wilson and Steven Shafer. 2003. XWand: UI for Intelligent Spaces. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '03)*. ACM, New York, NY, USA, 545–552. https://doi.org/10.1145/642611.642706