Digital Signage System Using a Directional Speaker and Displaying a Target Image

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***Abstract*— Many recent digital signage systems use sensors to switch content based on surrounding conditions dynamically. However, many people are unaware of the displayed content. Therefore, we considered a design to improve this. In this study, we developed and evaluated a digital signage system with a directional speaker and the ability to present an image of the target. We designed and evaluated a digital signage system that uses a directional speaker to call out and present an image of the subject. Our proposed system showed that the subjects had increased the impression of the advertisements.**

Keywords—digital signage, directional speaker, Kinect

I. Introduction

Recently, many advertisements on digital signage, which show information using electronic display devices, such as displays, have attracted significant attention. Functions that enhance the impression of digital signage have been discussed and investigated. Additionally, electronic advertisements tailored to the characteristics of the target audience using sensors, such as cameras, have been developed.

Previous research includes studies that change the display content based on a person's position and movement [1][2] and studies that estimate a person's face direction and line of gaze to switch the display of content [3][4]. However, if the target does not notice such devices, their effectiveness will be diminished.

In this study, we considered and evaluated a design that would make it easier for the target to notice advertisements in digital signage tailored to such targets. To achieve this, we added a function that would make it easier for the target to notice the advertisement by talking to it from the electronic advertisement. This function was implemented using a directional speaker that follows the target person. We also added a function to display an image of the target person as part of the advertisement display to make the target person aware that he/she is the target of the advertisement. Based on these proposals, we implemented a digital signage system and evaluated it.

II. Proposal Systems

We assumed a public facility, such as a shopping mall or a train station, as the setting environment for this system. The target users to whom the system presents the advertisements are as follows:

・People near the front of the digital signage;

・People who have been staying near the signage for a while.

Figure 1 shows the system configuration. We fixed two stepping motors for angle control at the bottom of the directional speaker. Each motor can control the angle of elevation (Pitch) and the angle of azimuth (Yaw). Therefore, the directional speaker can be controlled by two axes in our system. Our system estimates the position and moving speed of the subject based on the position of the subject's head coordinates obtained from Kinect, which is Microsoft's image recognition system. It then uses a microcontroller to control the motor and radiates the audio toward the subject.

The Kinect also provides a color camera image, so the target area is cut out from the image and displayed as part of the digital signage.

Figure 2 shows the designed device. The directional speaker used the product [5] sold as an experimental kit.

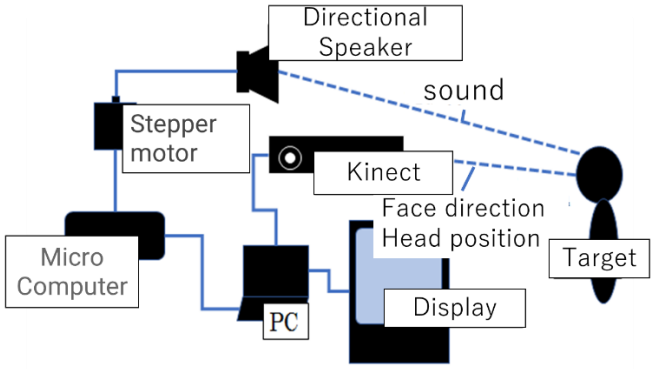

Fig. 1. System configuration

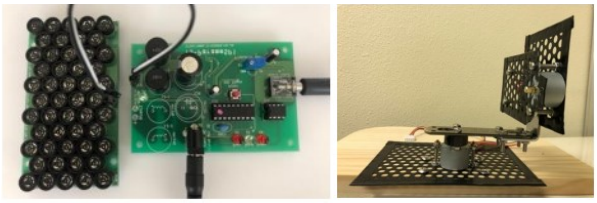

Fig. 2. Directional speaker and turntable

III. Evaluation Experiment

A. Experimental environment

We conducted a questionnaire-based subjective evaluation experiment using the implemented device to evaluate our system. Figure 3 shows the experimental environment.

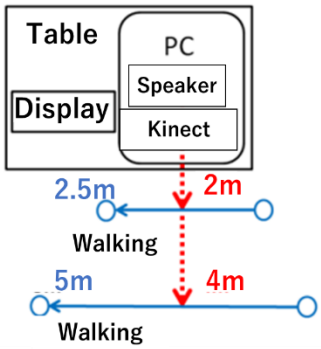

Fig. 3. Experimental environment

First, we evaluated the performance of the developed system in tracking the voice. Consequently, we found that the system was effective when the subject walked slowly (about 0.35 m/s); meanwhile, it was not so effective when the subject walked quickly (about 0.80 m/s) due to the delay in following the directional speaker. Since people who walk quickly are considered as in a hurry, they are not appropriate as the target for the proposed method for having people watch the signage. Instead, we calculated the walking speed of the target in advance and excluded those who walked faster than a certain speed from the advertisement.

Figure 4 shows the appearance of the system. Kinect is placed at the top of the display that displays advertisements. The height of the directional speaker should be adjusted to Kinect and placed next to it.

Fig. 4. Appearance of the system

B. Subjective Evaluation Experiment

We asked 15 participants to respond to a questionnaire about the advertisement presentation method of our system. We chose the in-train broadcast of the Yamanote Line, one of the railroad networks in Tokyo, as the voice content for this experiment. The participants were asked to walk along a straight line at a horizontal distance of 2 and 4 m from the PC.

TABLE I. QUESTIONNAIRE EVALUATION RESULTS

Questions	Evaluation
I would use this system often.	3.7
I felt it was difficult to convey information.	2.1
The audio was easy to understand.	3.7
I feel uncomfortable with the system.	2.9
It is clear where the information is coming from.	4.1
I felt that there were many inconsistencies in the system.	1.9
Information left a strong impression.	4.1
I wanted to introduce this system actively.	3.9

The results are presented in Table 1. The results showed that the developed system tends to leave a strong impression on the target audience; however, it has the disadvantage of increasing discomfort. The main causes of discomfort are the reflection of the directional speaker's voice heard in the environment and noise caused by the speaker's performance. Moreover, this can be reduced by improving the installation environment and equipment.

Additionally, from the interviews with the subjects, there were opinions that it was embarrassing to see the subject's image reflected in the image. Therefore, it is necessary to consider other methods to make the subject aware of this.

IV. CONCLUSION

In this study, we developed a digital signage system with a function to track the subject with a directional speaker and display an image of the subject to make digital signage more conscious. A questionnaire survey of 15 participants about the developed system showed that the system could make a strong impression on the target with advertisements; still, the noise from the speakers can cause discomfort.

In future studies, we will consider adding a target selection function. We can reduce their discomfort by choosing the right people to send the information. Additionally, by adding a function to say hello to our system, the target audience can receive information as if they were interacting with a digital signage, which is an inorganic tool for transmitting the information. This further enhances the presence and impression of the sign.

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