Push Type Digital Signage System that Displays Personalized Information

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***Abstract*—Though most digital signage systems attracted users' attention when they were installed, they have not been used effectively as time passed. In this study, push type digital signage system that identifies the user who walks in front of it and displays personalized information to the user was developed. In this system, the method of detecting the MAC address of the user's Wi-Fi device was used to identify the user, and the matching values between the user's interest and the contents' attributes were calculated to select and display the contents that attract the user's interest. By using this technique, the push type digital signage system that certainly makes user who walks in front of it look at the displayed contents was realized.**

Keywords-push type digital signage; recommendation; personalized information; visual cocktail party effect;

I. INTRODUCTION

In recent years, digital signage has become very popular, and it has been placed in various places such as station, museum, shopping mall, and so on [1][2]. Digital signage is a networked advertising tool for digital information, and it has advantages that the movie contents can be displayed and the displaying content can easily be changed. However, though the digital signage attracts people's attention when it was installed, it would not be seen by the people when time passes and it is no longer novel.

In order to solve such a problem, this study aims at developing a new digital signage at which a lot of people look without losing interest every time when they pass it [3]. In this system, it is required that the digital signage displays the information that the person who walks in front of it needs, by utilizing the interaction function effectively. In this study, push type digital signage that detects the person walking in front of it and displays personalized information matching with his or her interest was developed. In this paper, the concept of the proposed system, the elemental technologies, and the evaluation experiment using the prototype system are described.

II. PUSH TYPE DIGITAL SIGNAGE

The purpose of this study is the development of a new digital signage that can display personalized information to the people who walks in front of it. Although some of the recent digital signage displays interactive information by using the touch panel, hand gesture, or facial recognition technologies, these systems are targeted at the user who is going to use the digital signage from the beginning [4][5]. This study aims at constructing a digital signage system that displays information actively to the people that include a person who is not going to use the digital signage.

As a method of transmitting information from the system to the user actively, push-based information delivery is often used in the recent smartphone [6]. In this method, the application software that was installed beforehand is running in the background and it displays information on the screen of the smartphone when it is required. In the proposed system, the method of push-based information display is performed in the digital signage that is placed in the public space. Namely, even if the user who passes in front of the digital signage does nothing, the system selects and displays the information that the user wants.

It is known that the people pay selective attention for the object in which they are interested. For example, when someone called our name in the environment where a lot of people are talking in the party hall, we could selectively hear our own name [7]. This phenomenon is known as cocktail party effect and this effect also exists in the visual attention [8]. For example, we can easily find our own face immediately in the group photograph. In addition, it is often experienced that when we go shopping with a purpose, we become sensitive to the object and easily notice the related advertisement.

The push type digital signage that is proposed in this study is considered as a system that transmits the personalized information to the user based on the visual cocktail party effect. Moreover, this system is expected as an efficient advertising method that does not continue to display the contents not seen by anybody but transmits the required contents to the requiring person certainly. Figure 1 shows the concept of the proposed push type digital signage system.

In order to construct such a system, the function of identifying the user who passes in front of the digital signage as well as the function of displaying the contents in which the user is interested are required. In this study, the technology of identifying the Wi-Fi device that the user owns and the recommendation method that is often used in the internet shopping were used to realize these functions.

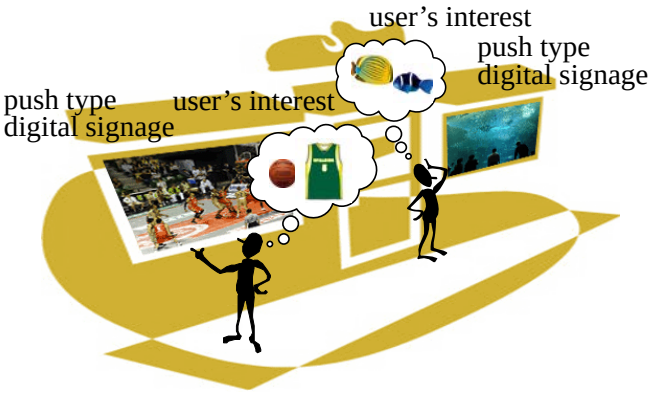

Figure 1. Concept of push type digital signage

III. IDENTIFICATION OF USER

A. *Detection of Wi-Fi Device*

In the proposed system, it is required that the system identifies the person who walks in front of the digital signage to display the information in which he or she is interested. In particular, since the digital signage is seen by not only the user who is standing in front of it but also the user who is walking near it, it is necessary to identify the user who exists at a distance from the digital signage. Therefore, in this study, the Wi-Fi device was used as a method of identifying the user, though there are several methods such as IC tag or facial recognition.

This method is premised on the user who is owning a Wi-Fi device such as a smartphone. The Wi-Fi device always searches for an access point of the Internet around it when the switch is on. In this case, the identified number of the MAC address of the smartphone is transmitted to the router. Therefore, it becomes possible to identify the Wi-Fi device, namely, the owner of the smartphone, by giving the router function to the digital signage.

In this study, the router of NEC AtemWR8175N and Wi-Fi device of Apple iPhone are used. However, since the latest router has too strong radio field strength, it detects Wi-Fi devices from the wide range of space. Therefore, in this system, the router was put into the paper box, and it was wrapped by aluminum foil to reduce the radio field strength. Figure 2 shows the router wrapped in aluminum foil. And figure 3 shows the result of the measured distance in which the iPhone could be connected to the router when the number of aluminum foil was changed. In the measurement, the connectivity was measured ten times by moving the location of the iPhone every 1m for each number of the aluminum foil, and the average value and the standard deviation of the connection distance were plotted.

In the actual usage, since the iPhone performs polling to the access point at intervals of 10 seconds, the user may move and approach the digital signage during the time of the interval. Therefore, we decided to wrap the router in one aluminum foil so that the user does not pass through the digital signage during the interval of the polling, assuming that the user walks about 10m between the polling times [9].

Figure 2. Router wrapped in aluminum foil

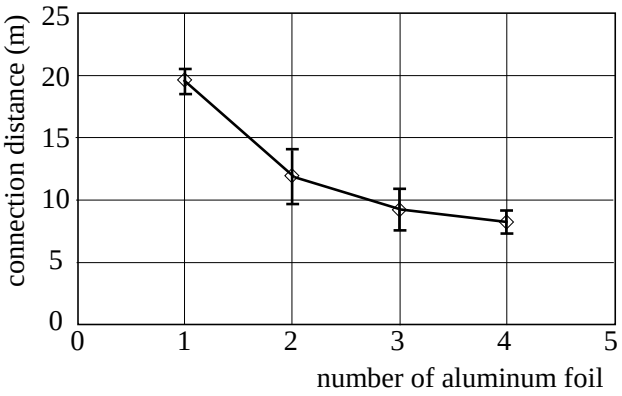

Figure 3. Number of aluminum foil and connection distance

B. *Measurement Experiment*

In this study, an experiment was conducted to verify whether the user can be identified at the appropriate position by using this method. In the experiment, the digital signage equipped with the router was placed in the corridor in the university building, and the subjects were asked to own the iPhone and to walk toward the digital signage from the position 50m away from the router. Although the iPhone accesses the router at 10 seconds intervals, the timing of the connection can be measured by monitoring the lists of the MAC addresses of the connecting devices with the router. The connection position of the iPhone was measured by recording the screen of the monitor together with the scene of the subject walking along the corridor by the video camera.

The number of subjects was 10, and the connection position for each subject was measured 8 times. Table 1 shows the result of this experiment. In figure 4, the average value of the connection distance for each subject is plotted, where x-axis and y-axis mean walking speed and connection distance, respectively. From this graph, we can see that the connection position was closer to the digital signage, when the subject walked faster. The average value of the walking speed was 1.44 m/s and the average value of the connection distance was 19.7 m from the router. From this result, we can understand that the user's ID was detected enough away from the digital signage. In this experiment, there were six errors in which the iPhone was not connected to the router by the

time the subject passed through it in 80 measurements. We can consider that this error was caused by the instability of the radio field strength of the Wi-Fi device.

Table 1. Result of experiment on connection distance

	average	standard deviation
connection distance (m)	19.7	10.49
walking speed (m/s)	1.44	0.198

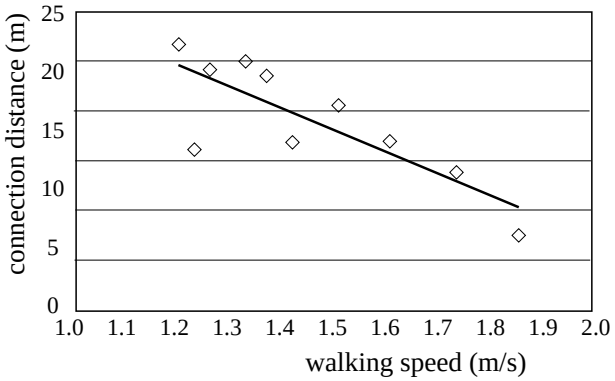

Figure 4. Walking speed and connection distance

IV. CONTENTS SELECTION

After the detection of the user's ID, it is necessary to display the contents which matched with the user's interest. In the field of the Internet, the recommendation that displays the desired contents based on the access history has become popular. In this study, the recommendation method based on the content-based filtering was applied to displaying the information in the real world [10][11].

In this method, the user is asked to register the level of his or her interest in each category as the user's profile, and then, the contents that match with the user's interest are displayed. The category was classified into two steps of field and item. The user's interest was classified into several fields such as travel, gourmet, sport, movie, etc., and for example, the field of sport was classified into several items such as baseball, soccer, tennis, karate, etc. The user registered the level of his or her interest for each field and for each item using the number between 0.0 and 1.0. In this case, the MAC address of the smartphone and the user's attribute of the interest are related, by registering the user's interest from the Web site using the smartphone.

On the other hand, the attributes of the contents stored in the digital signage were also registered in the same classification of the categories using the number between 0.0 and 1.0. For example, the attribute values of the travel contents would be different between the travel aiming at a gourmet and the travel aiming at a sport.

Based on these data, the matching value is calculated as product operation between the user's interest and the attribute of the contents, and the largest number of the product in every category of the field and the item was used as the matching value. In this system, several contents with higher matching values were selected, and one of the selected contents was displayed on the digital signage randomly.

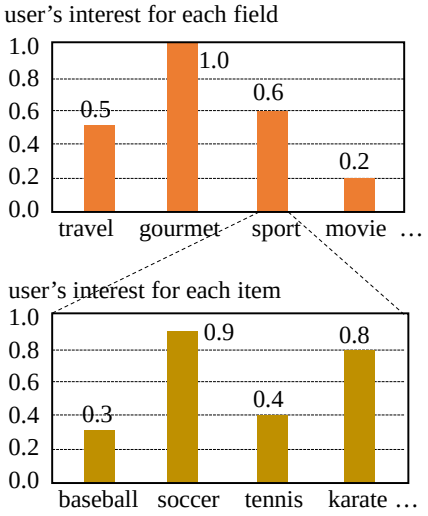

Figure 5. Example of profile data of user's interest

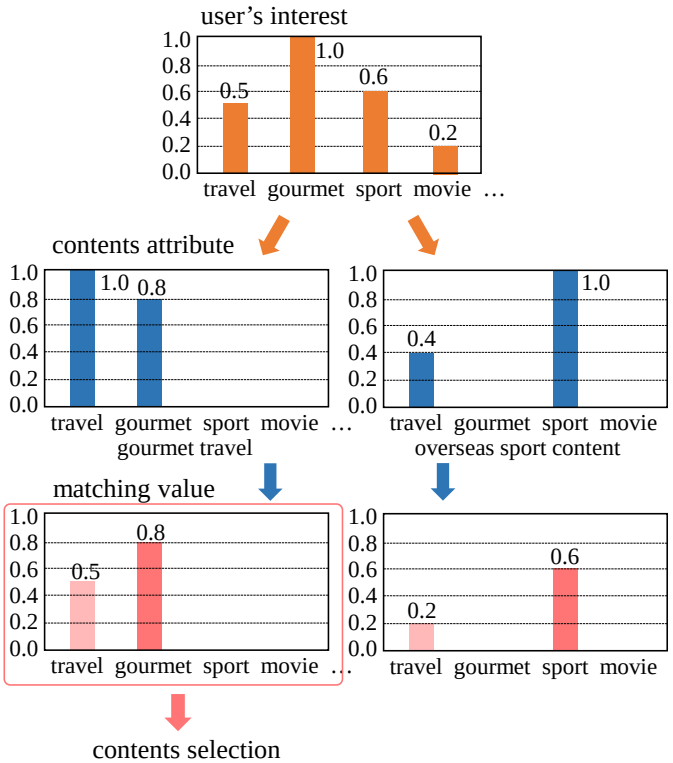

Figure 6. Calculation method of matching value

Figure 5 shows the example of the profile data of the user's interest, and figure 6 shows the method of selecting displayed contents based on the matching value between the user's interest and the contents attribute. By using this method, the contents with higher matching value and randomness can be displayed. Moreover, in this system, whenever the user's ID was detected, the user's profile data was retrieved and the matching value with the contents attribute was calculated, so that the change of the user's profile can be applied.

V. EVALUATION EXPERIMENT

By using the above mentioned methods of detecting the user's ID and calculating the matching value, the push type digital signage at which anyone looks was developed. Figure 7 shows the system configuration of the constructed push type digital signage system. In this system, Panasonic 42-inch television TH-P42VT2 installed on the stand of Sanwa Supply CR-PL12K was used as the display, and Dell Vostro470 PC was used to control the displayed contents. In addition, the router used for detecting the user's ID was connected to the PC through the network. As a contents player, VLC media player was used to replay the video and image contents stored in the contents server.

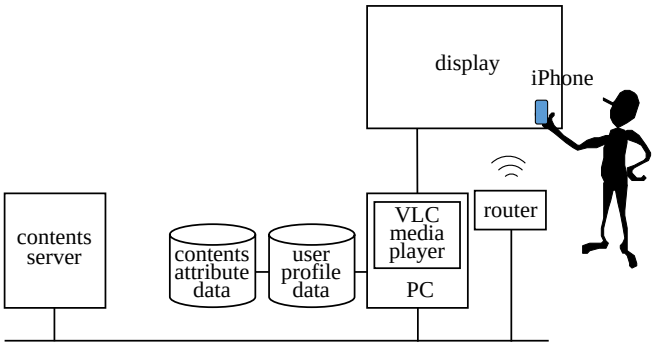

Figure 7.System configuration of push type digital signage

In this study, in order to verify the effectiveness of the proposed system, evaluation experiment which measures the user's behavior when the push type digital signage displays the content matching with the user's interest was conducted. In the experiment, the subjects were asked to walk along the corridor in the university building where the digital signage was placed. And the difference in the user's behavior was measured between when the contents matching with the subject's interest were displayed and when the contents not matching with the subject's interest were displayed.

The subjects were asked to register the level of their interest in each category beforehand. Each two contents with high matching value and low matching value were selected, and each content was displayed two times. In total, each subject walked along the corridor eight times. However, in the experiment, these contents were displayed before the subject came to the connecting point so that the trouble in which the content is not displayed due to the instability of the Wi-Fi connection does not occur. The purpose of this experiment was not told to the subjects, and the scenes of the experiment in which the subjects walked along the corridor toward the digital signage were recorded with the video camera. Figure 8 and figure 9 show the condition and scene of the experiment.

In the experiment, the time when the head of the subject was facing toward the digital signage was measure from the recorded video image. Figure 10 shows the result of this experiment for 10 subjects. From the result of the experiment, the average times when the subject's head was facing toward the digital signage when displaying the contents with high matching value and low matching value were 4.22 seconds and 2.46 seconds, respectively. And from the t-test, there was significant difference at 1% level between them. From these results, we can understand that when the contents in which the user is interested were displayed, the user looks at the digital signage for a longer time, and the effectiveness of the proposed system was verified.

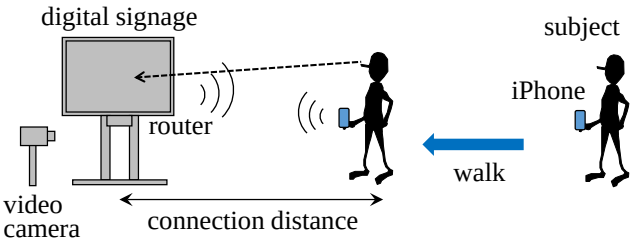

Figure 8. Condition of evaluation experiment

Figure 9. Scene of evaluation experiment

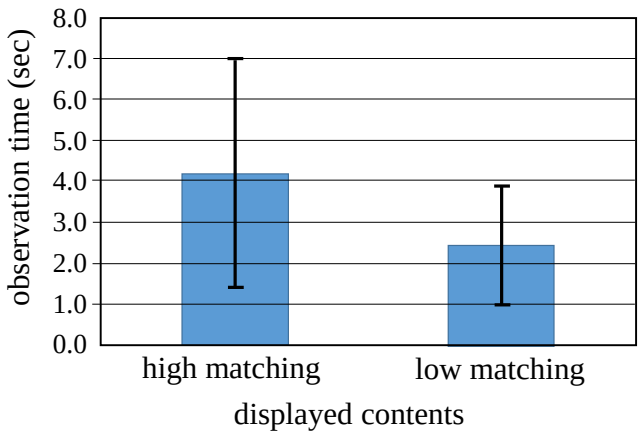

Figure 10. Displayed contents and observation time

VI. CONCLUSIONS

In this study, the push type digital signage that detects the user's ID and displays the contents in which the user is interested was developed. In this system, the method of detecting the MAC address of the user's Wi-Fi device and the method of selecting the displayed contents based on the content-based filtering were used. Moreover, from the evaluation experiment, the effectiveness of the proposed push type digital signage was confirmed based on the user's behavior of looking at the displayed contents.

In the future work, we are planning to examine the contents selection method when several users walk in front of the digital signage simultaneously and to conduct the social experiment by installing the proposed digital signage in the actual shopping mall.

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