Multilingual Digital Signage Using iBeacon Communication

Tetsuro Ogi
Graduate School of SDM
Keio University
Yokohama, Japan
ogi@sdm.keio.ac.jp

Kenichiro Ito
Graduate School of SDM
Keio University
Yokohama, Japan
aa@z7.keio.jp

Shigeyuki Konita
Graduate School of SDM
Keio University
Yokohama, Japan
shige.konita@a5.keio.jp

***Abstract*—In the globalized society, it is required to realize information provision to foreigners so that they do not feel inconvenience. In this study, multilingual digital signage in which the displayed language is changed to the user's native language automatically when the user comes near to the digital signage was developed. This system specifies the native language of the user by acquiring the information of language that is set in the user's smart phone by using the iBeacon communication. In this study, the prototype system of the multilingual digital signage was constructed and it is used for the evaluation experiment in the university campus. From the result, we confirmed that this system can be used effectively for both Japanese and the foreigners.**

Keywords-multilingual information; digital signage; iBeacon; smart phone

I. INTRODUCTION

In recent years, the world is becoming globalized, and a lot of people visit foreign countries with each other. On the other hand, people living in the information society spend their daily lives while getting a lot of information. However, it is difficult for the people who are visiting foreign countries to acquire information in the same way as being in their home country, because of the difference of languages. Particularly in Japan, it is required to realize the information provision to the foreigners so that they do not feel inconvenience because Tokyo Olympic Games will be held in 2020.

In Tokyo Olympic Games in 1964, the pictogram that indicates restroom or emergency exit using an icon was created, and it has been spread into all the countries together with the following Olympic Games [1][2]. However, there is great difference about the amount of information provided in daily life between nowadays and those days. Therefore, the method of providing large amount of information in place of the pictogram is required. In order to meet such a requirement, the method of using a digital signage is considered [3][4].

In this study, as the method of providing information to all foreigners equally, multilingual digital signage was developed. In the following chapters, the concept and system configuration of the multilingual digital signage, the simulation about the recognition ratio, and the evaluation experiment using the developed prototype system are discussed.

II. CONCEPT OF MULTILINGUAL DIGITAL SIGNAGE

As a method of providing information to the people, there are two ways of using a smart phone that is owned by the user and using a digital signage that is placed in public space. When the smart phone is used, the user needs to search information by himself to access necessary information. On the other hand, when the digital signage is used, the user can find and acquire information by walking in front of the digital signage without performing any special action. In this study, the method of information provision using the digital signage was adopted so that the user who visits foreign countries can get information without making special efforts.

As for the digital signage that provides multilingual information, several techniques such as the method of displaying information written in several languages in cyclic order, the method of displaying multilingual information simultaneously, and the method of switching displayed language using touch buttons, have been used [5]. However, in the cyclic order method, the user must wait until the information written in his native language is shown, and in the simultaneous display method, the displayed information is hard to see because a lot of information is displayed simultaneously. In addition, in the touch button method, the user is requested to perform searching behavior by touching button in order to acquire information.

This study aims at realizing the multilingual digital signage that specifies the native language of the user and changes the language of the displayed information automatically, even if the user passes through the digital signage without doing any action. For example, when the user who speaks English comes near to the digital signage, the displayed language is changed to English, and when the user who speaks Chinese comes near to it, the displayed language is changed to Chinese automatically, as shown in Figure 1. In order to realize this function, the technology of specifying the native language of the user who comes near to the digital signage is necessary.

In order to specify the native language of the user, the method of detecting the nationality from the captured video image, or the method of specifying the language from the conversation of the user can be considered [6][7]. However, it is difficult to specify the native language of the user from the image of the facial expression, and it is not the automatic process to request the user's conversation. In this study, the method of acquiring the language information being set in the

2157-0426/16 $31.00 © 2016 IEEE
DOI 10.1109/NBiS.2016.57

user's smart phone was used to solve this problem. In the case of iPhone, since the languages in 40 countries can be set, the native language of the user or the language that is used to acquire information can be known by acquiring the language information being set in the user's smart phone. In this study, the technology of short distance communication using iBeacon was used to acquire the information of the language being set in the user's smart phone.

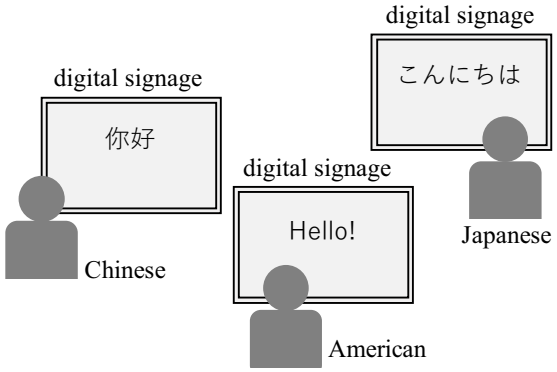

Figure 1. Concept of multilingual digital signage

III. iBeacon Communication

iBeacon is a technology of short distance communication using BLE (Bluetooth Low Energy), and it can be widely used because it has been introduced into the operating system of Apple's iPhone and iPad since iOS7. When the smart phone using iOS receives the radio wave of the iBeacon, a corresponding application program runs for 10 seconds in background. At this time, since the iBeacon sends the ID information such as UUID (Universally Unique Identifier), major, and minor data to the smart phone, the corresponding application program can run in the smart phone according to the ID of the iBeacon.

By using this mechanism, most of the applications using the iBeacon provides various services to the user's smart phone. For example, bargain information or coupon can be sent to the user's smart phone using push notification when the user comes to the neighborhood of the stores [8][9]. On the other hand, in this system, the iBeacon is used to receive the specific information from the user's smart phone when the user comes to the neighborhood of the digital signage.

Namely, when the smart phone receives the iBeacon signal from the digital signage, the application program in the smart phone sends the information of the language used in it during 10 seconds in which the application program is running in the background. By using this method, it becomes possible that the digital signage acquires the information of the native language of the user who is in front of it. In addition, when the smart phone becomes unable to receive the iBeacon signal, it is recognized that the user goes out of the neighborhood of the digital signage, and the application program is stopped automatically.

In this system, MyBeacon MB001 Ac of Aplix was used as iBeacon device. Since the distance of detecting the iBeacon signal is changed according to the radio wave strength of the iBeacon, the strength of the iBeacon signal was weakened to -20 dBm so that the user can be detected only when he comes near to the digital signage. In addition, since the accuracy of detecting the iBeacon signal varies by the individual difference of the smartphones, the actual detection distance of the iBeacon signal was measured using three iPhone devices. In the measurement, the iPhone was moved slowly approaching to the iBeacon device, and the distance at which the iPhone detected the radio wave of the iBeacon was measured 5 times for each iPhone.

Figure 2 shows the average and standard deviation of the detection distance of the iBeacon for each iPhone and whole data. From this graph, we can see that there is some individual difference in the detection distance of each iPhone. The average and standard deviation of whole data were 6.5m and 0.75m respectively.

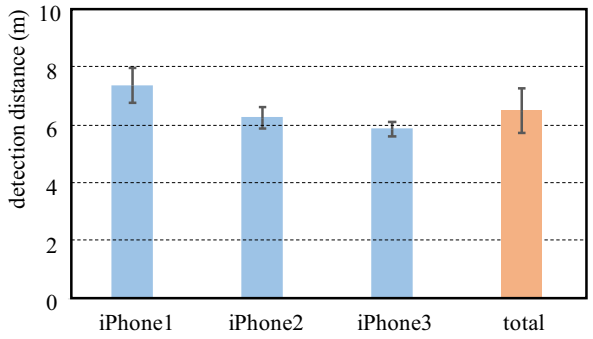

Figure 2. Detection distance of iBeacon by three iPhones

IV. Multi-Lingual Digital Signage System

In this study, multilingual digital signage system was constructed by using the above mentioned method of specifying the user's native language. Figure 3 shows the system configuration of the developed multilingual digital signage system.

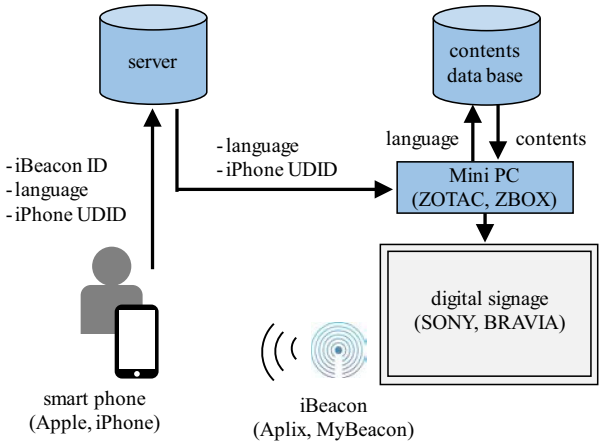

Figure 3. System configuration of multilingual digital signage

The digital signage consists of mini PC (ZOTAC, ZBOX CI520 nano) and 49-inch 4K TV (SONY, BRAVIA KJ-49X8000C). The iBeacon (Aplix, Mybeacn MB001 Ac) is mounted on USB of the mini PC, and it is used by supplying power from the USB. As a smart phone, the user used the iPhone in which the application program that reacts with the iBeacon signal was installed.

In this system, when the user comes into the radio wave area of the iBeacon and the user's iPhone detects the ID of the digital signage, the corresponding application program runs in background and it sends the information such as the ID (major, minor) of the iBeacon, UDID (Unique Device Identifier) of the iPhone, and the language used in the iPhone to the server. Figure 4 shows the screen image of the application program running in the iPhone. On the screen, the information of UUID, major, minor, accuracy, RSSI, and distance that the iPhone received from the iBeacon as well as the information of UDID and language that the iPhone sends to the server are represented. Practically, the user does not have to see this screen, because the application program runs in the background.

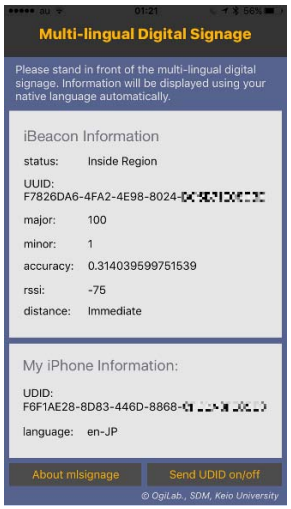

Figure 4. Screen image of iPhone application

On the other hand, the digital signage is always watching the information that is recorded in the server, and when the information of new user corresponding to the ID (major, minor) of the digital signage is written, the language of the displayed information is changed according to the user's language. In the system of the digital signage, the contents written in each language is stored in the data base, and when the displayed language is changed, the contents list is also changed so that the contents written in the user's language are displayed in order according to the contents list. By using this mechanism, it has become possible that the displayed language of the digital signage is changed automatically when the user comes near to the digital signage without performing any special action.

In this system, when the user comes into the radio wave area of the iBeacon, the application program sends the UDID of the iPhone as well as the language information to the server. Therefore, the server can monitor the movement of the users existing around the digital signage. When the language information sent to the server is changed, the current content is displayed for a certain time using the previous user's language so that as many users as possible can see the displayed information even when a lot of users come near to the digital signage one after another.

V. Simulation for Multiple Users

In this system, the digital signage changes the displayed language by detecting the native language of the user who comes near to the digital signage. In this case, when a lot of users come one after another, some users often pass through the digital signage before the displayed language is changed because the system cannot react to all the users simultaneously. In this study, recognition ratio of the users that means how many percentages of the users can see the digital signage written in their native languages was calculated by changing the parameters of the detection distance of the user, the number of arriving users, and the display time of the contents using Monte Carlo simulation.

In the simulation, the detection distance of the user was given by normal distribution with average of 6.5m and standard deviation of 0.75m based on the measured data described in the previous chapter, and the walking speed of the user was assumed to be 1.0 m/s. The distribution of the arriving time of the users can be given by exponential distribution, and the number of arriving users was changed from 1 person to 10 persons per 1 minute in the simulation.

The display time of the information in the digital signage should be decided according to the display contents. Though the user can understand the displayed information in short time when the image content is displayed, the user needs more time to read the displayed information when the text content is displayed. The display time of the contents was changed from 3 seconds to 15 seconds. In the simulation, how many percentages of the users can see the displayed information written in their own native languages before they pass through the digital signage was calculated on the above-mentioned condition.

Figure 5 shows the result of the simulation. From this graph, we can see that the recognition ratio of the users improves when the number of arriving users is small and the display time of the contents is short. Table 1 shows the change of the recognition ratio of the users on the condition that the display time was 15 seconds and the number of arriving users was changed, and this table indicates that the number of arriving users should be less than 2 persons in order to keep the recognition ratio larger than 75%. Table 2 shows the change of the recognition ratio on the condition that the number of arriving users was 10 persons and the display time was changed, and this table indicates that the

display time should be less than 5 seconds in order to keep the recognition ratio larger than 75%.

The number of arriving users is affected by the installation location of the digital signage, and the display time of the information depends on the displayed contents. Therefore, the installation location of the digital signage and the contents of the displayed information can be designed effectively by considering the result of this simulation.

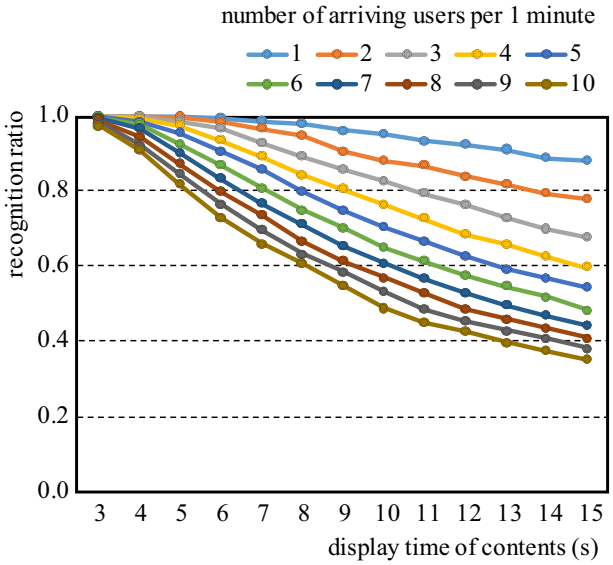

Figure 5. Recognition ratio for number of arriving users and display time of contents

Table.1 Recognition ratio when number of arriving users is changed

arriving users	1	2	3	4	5
recognition ratio	0.88	0.78	0.68	0.60	0.54
	6	7	8	9	10
	0.48	0.44	0.41	0.38	0.35

(display time is 15 seconds)

Table.2 Recognition ratio when display time of contents is changed

display time (s)	3	4	5	6	7
recognition ratio	0.97	0.91	0.82	0.73	0.66
	8	9	10	11	12
	0.61	0.55	0.49	0.45	0.43
	13	14	15		
	0.40	0.37	0.35		

(number of arriving users is 10 persons per 1 minute)

VI. Evaluation Experiment

As an evaluation experiment of this system, the multilingual digital signage constructed in this study was placed in the university campus, and the students of iPhone user including foreign students were asked to install the application program into their smart phones and to use the multilingual digital signage.

In the digital signage, the information from the student office was displayed. After the use in a certain period, 20 students that include 10 Japanese students and 10 foreign students were asked to answer a questionnaire and an interview. Though the native languages of the foreign students are not necessarily English, all the information for the foreign students was displayed in English on the multilingual digital signage, because the information to the foreign students is usually given in English. Figure 6 and Figure 7 shows that the displayed language is changed to English and Japanese respectively in the experiment.

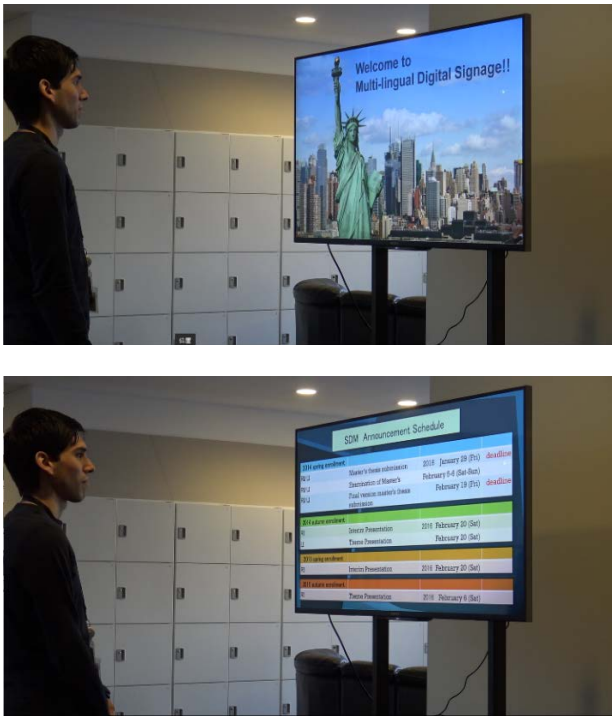

Figure 6. Multilingual digital signage displaying information in English

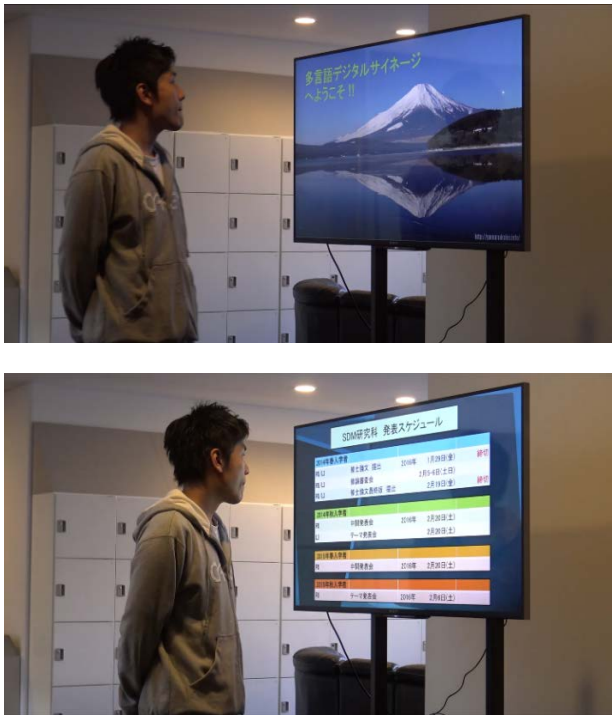

Figure 7. Multilingual digital signage displaying information in Japanese

Figure 8 and Figure 9 show the results of the questionnaire for the questions of "Do you think this system convenient?" and "Would you like to use this system?". The subjects were asked to answer the questions using the five grade system. From the results, the percentages of the answers of "strongly agree" and "agree" were 90% in both questions. For details, the percentages of the answers of the foreign students and Japanese students were 100% and 80% respectively. It is thought that this is caused by the difference of consciousness against the mechanism that the native language of the user is known by the system.

Figure 10 shows the result for the question of "Do you feel resistance for the possibility that the native language is known by the system?". This result indicates that the Japanese students feels more resistance than the foreign students. In addition, from the interview to the subjects, we understood that the Japanese students often feel resistance for the possibility that the nationality is known by other people when they go to the foreign countries, but most of the foreign students have actually experienced some trouble caused by the language in Japan. From these results, we confirmed the effectiveness of the multilingual digital signage that was developed in this study.

This system can be used to provide the customized information effectively by using the short distance communication between the individual device of the smart phone and the digital signage that is placed in the public space [10]. Therefore, this technology can be used not only to transmit the language information but also to transmit the user's attribute information, so that the digital signage using this method can be used to display several information such as the customized advertisement or the healthcare information [11][12].

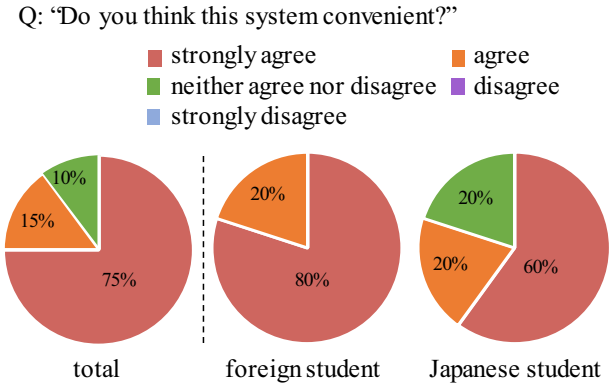

Figure 8. Result for the question about convenience of this system

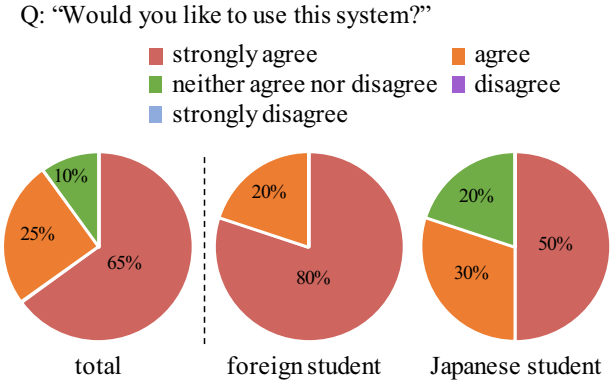

Figure 9. Result for the question about acceptance of this system

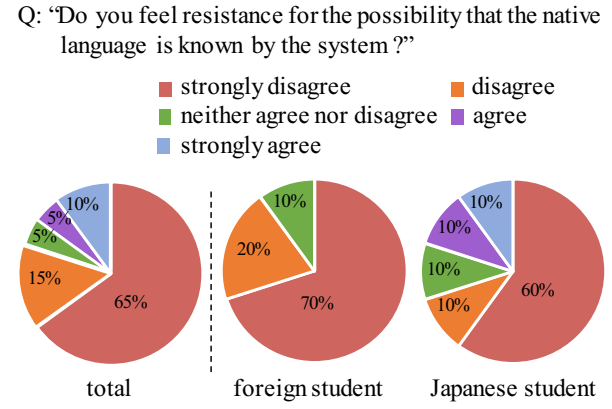

Figure 10. Result for the question about resistance for the system

VII. CONCLUSIONS

In this study, the multilingual digital signage was developed as the method of providing information equally to the foreigners in the globalized society. In this system, it is possible to change the displayed language automatically when the user comes near to the digital signage, by using the mechanism of background communication of the iBeacon. From the evaluation experiment by the foreign students and Japanese students using the prototype system, it was confirmed that most users felt the effectiveness and accepted the use of this system.

In the evaluation experiment conducted in the university campus, the students were asked to install the application program into their smart phones. However, when this system is used by the user who visits the foreign countries for sightseeing, the scheme in which the user installs the application program in his or her smart phone beforehand is needed. In the future, it is required that this technique will be standardized and it will be introduced in the operating system of the smart phone.

ACKNOWLEDGMENT

This study was conducted as part of "Research and Development on Utilization of Fundamental Technologies for Social Big Data" (178A04) of NICT (National Institute of Information and Communication Technology).

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