Proposal for Knowledge Community Application Using Bluetooth Low Energy

Nanami Kuwahara and Takayuki Fujimoto

***Abstract*—In this research, we use Bluetooth Low Energy technology to connect virtual and real spaces by enabling people to share knowledge over a short distance. Nowadays, people have various methods to collect information, such as search engines and Social Networking Services (SNSs). In addition, knowledge-sharing sites such as Yahoo! Chiebukuro and Quora are also used. Knowledge sharing services often take the form of 'bulletin boards' on the Internet. Bulletin board type services are highly convenient, but have problems of low reliability and limited connection with reality. One reason is considered to be the fact that these services are unique to the Internet. Therefore, this paper examines new knowledge sharing method that links virtual space and real space. We design a knowledge community system that enhances the reliability of information by clearly providing the connection with reality for users.**

***Index Terms*—Knowledge sharing community, space sharing, Bluetooth low energy, CQ**A.

I. Background

People use the Internet to search for information about things which they do not know or have questions about in daily life. There are diverse methods, some use search engines, while others use Social Networking Service (SNS) to get information. Besides, the others frequently use Q&A-type knowledge sharing services such as "Yahoo! Answers", "Quora", and "Apple Support Communities". [1], [2] Such knowledge communities contribute to people's solving problems and encountering new knowledge by sharing knowledge and experiences, and they have a certain need as a way to acquire information and knowledge on the Internet. 'Wikipedia' is classified as an open media knowledge community [3].

On the business industry, 'knowledge management' has recently attracted people's attention, and a variety of services and systems have been proposed and introduced for effective knowledge sharing and operations in corporate management [4].

Until now, most of the major knowledge sharing services are in the style of Bulletin Board System (BBS) on the Internet. Both the questioner and the respondent are users, and the basis of the service is to help each other by utilizing knowledge and expertise. In the mid 2000s, these mechanisms became established as a style of knowledge sharing on the Internet, and now they are established as a style called Web 2.0.

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BBS knowledge communities are highly convenient because users can easily share knowledge without restriction of location and time. On the other hand, 'unreliability', 'suspiciousness as a source of information', and 'limited connection with reality' that are inherent in Internet BBSs are rather common problems. These problems are caused by the factor that knowledge community services are Internet-specific services.

In this paper, as a new method of knowledge sharing, we design a prototype of a knowledge community system that enhances the connection with reality and the reliability of information by linking virtual and real spaces.

II. Purpose

In this research, we use Bluetooth Low Energy (BLE) to design an application to form a knowledge community in a virtual space linked to a real space. Regarding this application, knowledge sharing among users is possible only within the limited range of real space. The space range in which BLE can communicate is extremely limited, ranging from a few tens of meters to a maximum of 100 meters. Therefore, sets of question and answers can be repeated only among users who are within that range. In this way, knowledge sharing can take place. Users can share knowledge only within the real space range, while using the Internet.

Disseminating information on the Internet has the advantage of being free from the constraints imposed by time and location. On the other hand, the Internet has the disadvantage that there is no definitive information about 'who' 'when', 'what kind of quality' regarding information. For example, we cannot deny the possibility that the result for our search as to a certain restaurant in 'Tokyo' may be actually posted by a 'Brazilian', who is on the other side of the world. However, even so, those kinds of knowledge and information would be shared.

The system proposed in this research is linked to the real space, so that the knowledge sharing partner is guaranteed to be actually somewhere within a 100 meters radius. That certainty is reassurance to information recipient, because at least the information provider is not totally an irrelevant person. On the other hand, for the information provider, the system can create a 'sense of tension' that half-hearted information and knowledge cannot and should not be shared (and is meaningless) as long as it is provided to someone, who is present nearby. As a knowledge community, the system can provide new senses and experiences for the users.

III. Precedent Examples

In this chapter, we present the precedent services related to

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the proposed application, from the two aspects. One is the case that represents the knowledge community service. The other is a typical case of a BLE application.

A. Yahoo! Chiebukuro (Japanese version), Yahoo! Answers (International version)

This service is a knowledge search and sharing service provided by Yahoo Japan Corporation in 2004.[5] In general, users post their Q&A while keeping their account IDs public. However, by using "coins" issued within the service, users can post without disclosing their account ID. It is a knowledge community service widely used in Japan. While this service has a large number of users, there are a certain volume of questions and answers that lack morals. Although this web service works as Q&A service, it also has a disadvantage that is particular to an online service. For example, there are cases where a questioner has taken the time to answer a question, which subsequently ends up being deleted on the online service. It is easy for both the question-askers and the respondents online to become irresponsible. In addition, some users may be exposed to the world or attacked on the Internet because of the default settings of making a part of users' IDs public. Moreover, since there are many users regarding the service, there are many posted questions. Therefore, there is a possibility that users cannot get answers unless they contrive ways to elaborate questions. Due to the increase in false information in answers and low-quality Q&A, the international version of Yahoo! Answers was shut down in May 2021. It is believed that the quality of the service and the morals of the users had reached a point that cannot grow worse, and it led to the shutdown of the service.

B. Quora

This service is a global question and answer site used all over the world.[6] The Japanese version was released in 2017. The service uses AI to display Q&A in the fields that match the user's interests. It is a system that only displays the answers that have passed a number of restrictions in the service. The purpose of the site is to accumulate answers (knowledge) by creating a database of questions and answers from users around the world. Since the site aims to be a high quality Q&A site, it requires users to register their real names. Therefore, it can be said that this method lacks anonymity and privacy. From different point of view, disclosing users' real names and occupations when they answer questions, increases the credibility of the answers.

C. AirTalk

This application allows users to chat with each other over a short distance.[7] It uses BLE for P2P communication, which is packet-free and allows users to communicate with people nearby. It is a completely anonymous communication application that does not require user registration. There is also no need to store information on the Internet. Therefore, it can be used as a temporary communication application. In addition, it is possible to post photos and texts on a map using the location information function of a smartphone to share locations [8].

D. Significance of the Proposed Application

From the previously mentioned precedent examples, it can be said that this application has novelty because it promotes 'knowledge sharing' among users in a certain range of physical space. Existing knowledge community services have high market shares and a large number of users.[9] On the other hand, there are also disadvantages such as quality control of questions and answers and issues of user's personal information, besides advantages.[10] The anonymity on the Internet is thought to have caused a lack of users' responsibility when providing information. Therefore, there is a certain need to refurbish the traditional methods of knowledge community sites (web bulletin boards). By setting the knowledge sharing not only online but also in the real space, it is possible to realize the locational relevance among users [11], [12].

Existing BLE chat applications provide several communication methods using BLE and location-based functions .[13] However, all of these functions are for joy as one-off event in the space with unknown users. The purpose of the proposed application is different because it has a mechanism to 'share knowledge in a certain limited space'.

The application adds physical spatiality to the text-base knowledge community. In this respect, this study is particularly novel.

IV. Proposal of the Application

In this chapter, we propose the application design based on the novelties focused in chapter 3. The purpose of the application is to increase the users' responsibility in writing and the value of space by adding a factor of the 'space' to the users' communication. The application has the following three features.

-It is possible to send and receive questions and answers between terminals.

-Communication is possible within the range of a circle, which has a radius of about 100 meters around the terminal.

-No user name or other information that can identify the individual is required.

The details of the mechanism and execution flow of the BLE knowledge community application are described below.

V. Application Mechanism

For the proposed application, we use Bluetooth Low Energy, one of the short-range communication standards. Based on this, we design a BLE knowledge community application for knowledge sharing in a restricted space. The detection range of BLE will be within a circle, which has a radius of several 100 meters around the terminal. The reason for this design is that the Internet has the demerit of "irresponsibility due to anonymity, besides the merit of "being able to obtain information anytime and anywhere." Through this application, we enable users to interact with nearby users, and make people aware of the possibility of their interactions in real space.

In addition, this application does not use any features that may identify individuals, such as user names. For example, users can post without entering their names or e-mail addresses, in the similar way as anonymous bulletin board sites. Therefore, there is no need for user registration or name setting when people starts to use the application. It is an application in which users can remain anonymous completely

and it allows them only to exchange text messages of questions and answers.

A. Action Flow of the Application

Figure 1 shows the action flow diagram when the proposed application is executed. The flow is presented using three lanes: application, question-asker, and respondent. When you start the application, you will be required to select either "Ask a question" or "No question". If you select "ask a question," you can fill in the question. Then the application will display the question. At the same time, the respondent who selected "No Question" can see the question from the asker in the application.

When the respondent actually checks the displayed question, the respondent can answer the question. In another case, if the respondent does not actually check the displayed question, the question-asker will be waiting for the answer from the respondent. Through the answer displayed in the application, the question-asker can check the answer from the respondent. If there is no answer to display in the application, the question-asker can decide whether to "exit the application" or not. When "exit the application" is selected, the application will finish. When the “exit the application” is not selected, the screen will return to the "Ask Question" or "No Question" options.

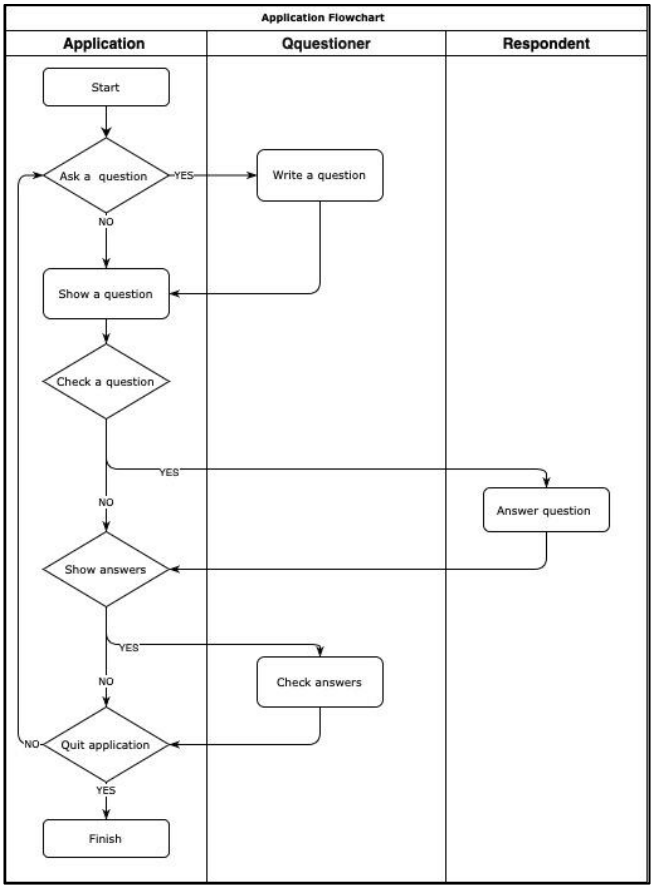

Fig. 1. Action flow diagram of application.

B. System Flow of the Application

In this section, we describe the flow of space processing and knowledge sharing, focusing on the timeline of questions. In Figure 2, each horizontal line indicates the timeline of each user’s questions. The left side of the timeline is the past, the right side is the future, and the further to the right, the newer the question. When a user posts a question in the application, the dotted timeline changes to a solid line. Then, other users can answer the question on the solid line.

The gray circle and part of white circle (both are enclosed by dot line) represents the physical space range where the synchronized application use is possible. The owners of the timeline on the circle are the users, who are within the range of physical space that BLE can detect their devices. In Fig.2, a community for users A to D, and the other community for users D and E, are generated.

Focusing on the gray circle, (BLE main range) we can see the questions asked by the three users. User A was the first to ask a question in the circle and user B was the last to ask a question. On the other hand, user D, who is in the same-circled range, asked his or her question after walking through the BLE main range. Therefore, user D's question is not displayed to the users, who are in the main range. Also, various other interactions are exchanged in the main range space. For example, user C asked a question and then received answers from users A, B, and D. On the other hand, ˙user C sent an answer to user B's question after receiving the answer to his or her question.

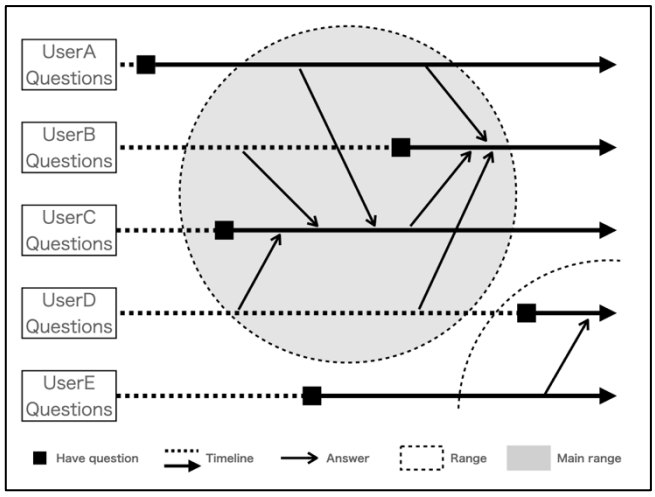

Fig. 2. System Flow of the Application

VI. Execution Example and Application Screen

To clarify the usage of the application, we present an example of the application execution. The application is executed as indicated in the flow shown in Fig. 1 and Fig. 2. Fig. 3 indicates space image around each user. ‘The circled range” indicated in Fig. 2 is represented as the black overlapping area of the circles in Fig. 3. The concentric circle for each user in Fig. 3 has a radius of about 100m, and when the circles overlap, a knowledge community is generated. The black area is the area where questions and answers can be exchanged.

Here, we present a concrete example of the application execution. The assumed use situation is ‘in front of a busy station’. Many people come and go, such as those waiting for someone, passers-by, smokers, and etc. As shown in Figure 3, the users are standing in front of the station. There are seven users and seven communities are generated at the same time (the black overlapping areas of the circles). In this case, when another user enters the BLE range for the application of a user's smartphone, question sharing is performed upon their

application.

Next, we present some examples of the application screens used by each user. The application screen examples for user1 to 3 (indicated in Fig. 3) are shown in Fig. 4 to 6. We will describe the flow of questions and answers for each screen. The space image in Fig. 3 is linked to the usage screens of the application below.

Fig. 4 shows user1's answer and question screens. User 1 is answering the questions from User 2 and User 3. Also, the question from User 1 is answered by two other users.

Fig. 5 shows user 2's answer and question screens. User 2 is answering the questions from User 1 and User 3. Also, the question from User 2 is answered by three other users.

Fig. 6 shows user 3's answer and question screens. User 3 is answering the questions from User 1 and User 2. Also, the question from user 3 is answered by three other users. This is how the application is executed.

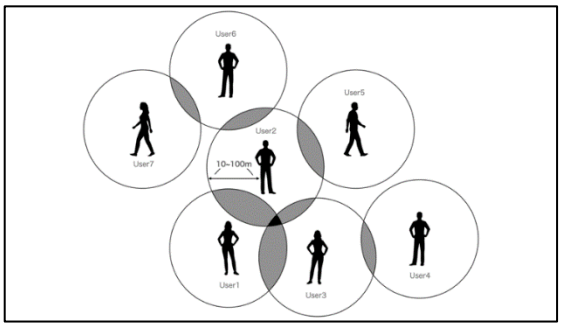

Fig. 3. System flow of the application.

Fig. 4. User1 answer & question screen.

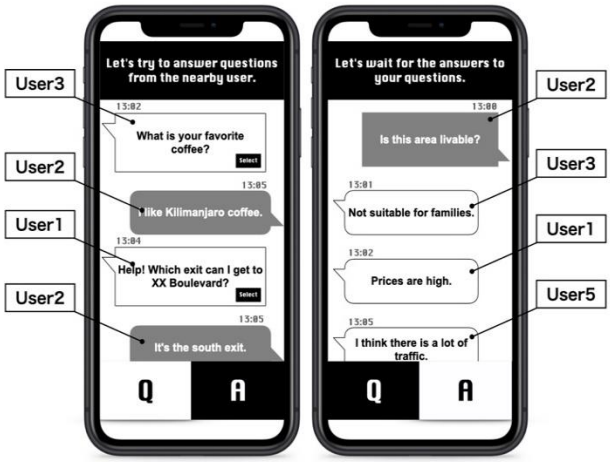

Fig. 5. User2 answer & question.

Fig. 6. User3 answer & question.

VII. Conclusion and Future Work

In this paper, we proposed the design for a knowledge community application utilizing BLE. Until now, knowledge sharing has been done through online anonymous bulletin boards. However, by adding a factor of physical space range, we created a new knowledge sharing method for a terminal use. This time, we designed an application of the proposal, and we will implement the application in the future. We will also conduct evaluation experiments with subjects to examine the practicality of the application. We will ask them to actually use the application and investigate the impact of text exchange in the physical space range.

This application can be a possible breakthrough to rethink the system regarding the aggression and responsibility, which is behind the Internet.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Nanami Kuwahara wrote the paper; all authors had approved the final version.

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