International Journal of Informatics Society

08/11 Vol. 3 No. 2 ISSN 1883-4566

Informatics Society

Aims and Scope

The purpose of this journal is to provide an open forum to publish high quality research papers in the areas of informatics and related fields to promote the exchange of research ideas, experiences and results.

Informatics is the systematic study of Information and the application of research methods to study Information systems and services. It deals primarily with human aspects of information, such as its quality and value as a resource. Informatics also referred to as Information science, studies the structure, algorithms, behavior, and interactions of natural and artificial systems that store, process, access and communicate information. It also develops its own conceptual and theoretical foundations and utilizes foundations developed in other fields. The advent of computers, its ubiquity and ease to use has led to the study of informatics that has computational, cognitive and social aspects, including study of the social impact of information technologies.

The characteristic of informatics' context is amalgamation of technologies. For creating an informatics product, it is necessary to integrate many technologies, such as mathematics, linguistics, engineering and other emerging new fields.

Guest Editor's Message

Tsukasa Kudo
Guest Editor of the Eighth Issue of International Journal of Informatics Society

We are delighted to have the eighth and special of the International Journal of Informatics Society (IJIS) published. This issue includes selected papers from the Forth International Workshop on Informatics (IWIN2010), which was held in Edinburgh, Scotland, UK, Sept. 13-16, 2010. The workshop was held at Royal British Hotel. This workshop was the fourth event for the Informatics Society, and was intended to bring together researchers and practitioners to share and exchange their experiences, discuss challenges and present original ideas in all aspects of informatics and computer networks. In the workshop, 26 papers were presented at four technical sessions. The workshop was complete in success. It highlighted the latest research results in the area of networking, business systems, education systems, design methodology, groupware and social systems.

Each IWIN2010 paper was reviewed in terms of technical content and scientific rigor, novelty, originality and quality of presentation by at least two reviewers. From those reviews, 17 papers were selected for publication candidates of IJIS Journal. This eighth includes five papers of them. The selected papers have been reviewed from their original IWIN papers and accepted as publication of IJIS. The papers were improved based on reviewers' comments.

We hope that the issue would be of interest to many researchers as well as engineers and practitioners in this area.

We publish the journal in print as well as in an electronic form over the Internet. This way, the paper will be available on a global basis.

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An Experiment for an Interactive Internet Live Broadcasting System with a High-Quality Snapshot Function

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Abstract–The video quality on the Internet does not come up to TV quality yet. Although audience often ask for high-quality videos, it is difficult to improve the quality because of its huge video traffic. In this paper, we propose an Internet broadcast system with a high-quality snapshot function to improve user experience. While the proposed system delivers low-quality video to audience, it provides a high-quality snapshot function which enables the audience to take a snapshot of a desired and favorite scene anytime. To assess effectiveness of the snapshot function, we designed and implemented a prototype system. This paper reports results of an experiment in a commencement ceremony of our university using the prototype system.

Keywords: Internet Broadcasting, Interactive TV

1 INTRODUCTION

With the spread of broadband Internet connections, Internet users can watch video contents all over the web in recent years. Video players are integrated into most web browsers and the Internet users can watch videos easily on their web browsers without any installation of proprietary client software. These video platforms such as Adobe Flash and Microsoft Silverlight rapidly popularize video viewing on the web. Tens of millions of videos are shared in video sharing services like YouTube [1] and enormous numbers of on-demand videos are watched by Internet users in various countries. Furthermore, live video broadcasting by Internet users also gets popular nowadays. A lot of Internet users broadcast their original live video contents using PCs and web cameras. It is expected that these video sharing and broadcasting services would become widely used much further and network traffic of the videos would grow more in the next couple of years.

The huge video traffic, however, causes a problem of communications expenses. Although most video sharing and broadcasting services run on income from advertisements on their websites, it is difficult to make profits because of its expenses more than its advertising income [2]. Moreover, current online video services distribute videos with a few hundred kilobits per second (kbps). The video quality on the Internet does not come up to TV quality yet. While the video services should provide more high-quality videos, it is not easy to improve the video quality for the above reason.
There are two solutions to increase user experience; one is to improve video quality upgrading video resolution and bit rate, and the other way is to enhance added value of the video contents introducing interactive features and so on. Under present circumstances, the later is a realistic solution. Interactive television (iTV) [3-6] is a research area which provides interactive features to video contents in order to improve user experience. Ustream [7] and Justin.tv [8] which are typical services for live video broadcasting apply the iTV technologies to their system. In these services, live video viewers can communicate with broadcasters and other viewers using chat and social communication tools (e.g. Twitter) watching live video contents. These interactive functionalities are attracting the attention of many Internet users despite low resolution and bit rate of the live videos.
Meanwhile, we have been trying and conducting several experiments with Internet broadcasting in graduation ceremony of our university [9, 10]. In these experiments, we had to deliver live video over the Internet with a few hundred kbps because we only have 100 Mbps connections between our university and the Internet. Therefore, it was difficult to satisfy parents who could not attend the ceremony and would like to watch their children's proud moment because of its low-quality video. We needed to add something extra to our live broadcasting system introducing special functionalities to improve user experience without increasing network traffic.

In this paper, we propose an interactive internet live broadcasting system called *Photographable TV* which provides a high-quality snapshot function so that audience can take high-quality pictures of favorite scenes for their memories at any time watching live video. In case of graduation ceremony, parents of graduates can take ceremonial pictures remotely as if they were attending the ceremony. The pictures can be saved to local disks for their personal memory albums. Since the data size of still pictures is far small than that of video, the proposed system can improve user experience without increasing network traffic. To study the effectiveness of the high-quality snapshot function, we design and implement a prototype system. We also conduct an experiment in our graduation ceremony to evaluate how to use our system by audience and find issues.

The paper is organized as follows. In the next section, we describe related work discussing originality of our proposed system. Section 3 introduces the model of the Photographable TV system. Section 4 presents the design of the prototype system of the Photographable TV, its system architecture and user interface. Section 5 evaluates the prototype system and reports the experiment results. Section 6 gives some conclusions and our future work.

2 RELATED WORK

To increase video quality for improvement of the user experiment, there are many researches. Typical one of them is IP multicast [11, 12] In the IP multicast, a sender transmits a single data stream to the receivers. Since the routers on the

path to the receivers replicate the data stream so that multiple receivers can receive it if required, it can deliver high-quality videos without increasing network traffic on the sender. However, it is not easy to use over the Internet because all routers on the path to receivers must support IP multicast. On the other hand, unicast is widely used in the Internet although it delivers multiple same copies to each receiver. This is because the unicast does not need special functionalities of the routers and can be used in any different network environments. In this regard, our proposed system uses unicast for the video delivery over the Internet.

Nowadays the P2P technologies are popularly used in the Internet to distribute network traffic over the Internet [13-16]. In these researches, hosts built an overlay network on the Internet by the P2P technologies and forward the received data stream to the other hosts like overlay multicast so that it can avoid concentration of the network traffic on a sender. However, the P2P technologies often require proprietary client software. The installation of the software prevents Internet users from casually watching videos with these P2P technologies. Moreover, the P2P software is often prohibited to use in a particular environment such as office network and university network because it goes through firewalls ignoring its network architecture. For these reason, it is difficult to widely use P2P software and enhance video quality over the Internet without increasing network traffic on a sender.

For similar ideas to our high-quality snapshot function, there are several studies in educational system. Ichimura proposes Chalk Talks [17] which is a remote lecture system with high-quality pictures. The Chalk Talks uses a HDV camera to provide a lecture with high-resolution. Since the high-resolution video consumes network resources, it compresses the video for the Internet broadcasting. The Chalk Talks also provides high-quality pictures at fixed intervals to clients so that the students can watch the white board clearly. While the Chalk Talks provides high-quality pictures at fixed intervals, the Photographable TV provides high-quality pictures when audience requests. In addition, the Photographable TV aims to make a personal memory album so that audience can remember the live broadcasting for improvement of the user experience although the Chalk Talks aims to improve readability of the white board.

One of video sharing services, PANDORA.TV [18] provides a snapshot function to the viewers. In the service, there is an image capturing button on the video player and still pictures of favorite scenes can be captured in JPEG format watching videos. However, it does not provide high-quality pictures because resolution and quality of the pictures are same as that of videos. Our system offers high-quality pictures to the audience more than video quality.

3 PHOTOGRAPHABLE TV

Photographable TV is an interactive broadcasting system for Internet live video streaming for the purpose of improvement of user experience without increasing network traffic by a high-quality snapshot function to enjoy high-quality pictures of favorite scenes for a personal memory album. The high-quality pictures do not increase network traffic so much if audience sends requests in moderate intervals. Even if the video quality is not so high, the high-quality picture would improve user experience and activate social communication on the web.

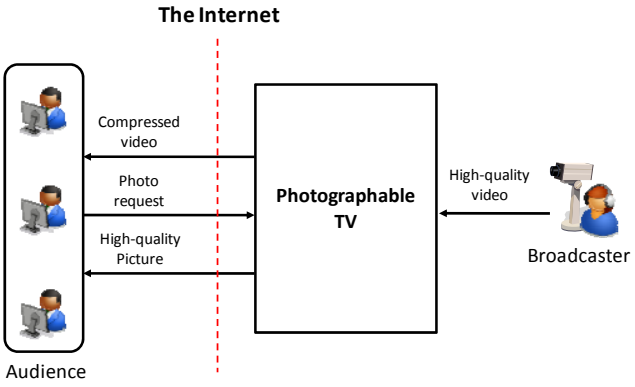

Figure 1: System model

Figure 1 shows the system model of the Photographable TV. This model consists of a broadcaster, its audience and the proposed system. Firstly, the broadcaster sends a high-quality video source to the system. The system receives and encodes the high-quality video storing the original source. The audience receives the compressed video from the system in real time and also can send a picture request to the system anytime watching the video. When the system receives the picture request, a high-quality picture is made from the stored original video source and sent to the audience. The audience can see and save the high-quality picture.

There are several issues to realize the Photographable TV. The Photographable TV requires encode functions for video and pictures. Since quality of pictures is equivalent of the original video quality, the original video should be uncompressed and high-resolution so that high-quality pictures can be made from it. However, it is difficult to send the original video over the Internet because the data size of the uncompressed and high-resolution video is too large. This is an issue. The encode functions must be near the broadcaster side not to across the Internet. Besides video encoding, the broadcaster's PC has to extract a frame from the video and encode the frame to make a still picture. It is expected to consume CPU resource of the PC and we should take care of its load. Another issue is frequency of the high-quality picture requests from audience. The proposed system is available in accordance with an idea that picture traffic is much less than video traffic. If the audience frequently requests high-quality pictures, the picture traffic would be considerable amount. We have to study how many times the audience requests the high-quality pictures and control the picture traffic not to exceed network capacity.

4 PROTOTYPE SYSTEM

We developed a prototype of the Photographable TV to conduct experiments for its evaluation. In this section, we describe the design and implementation of the prototype system.

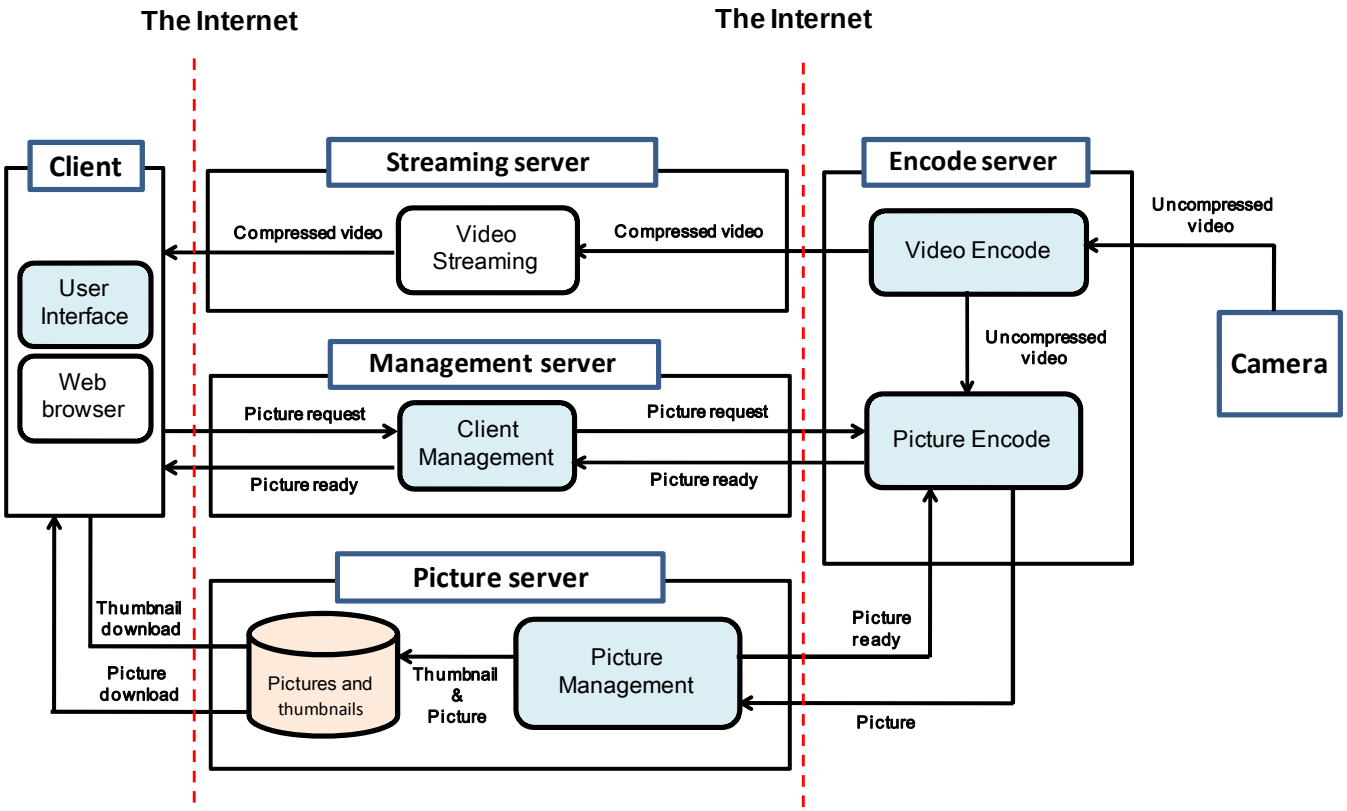

Figure 2: System Architecture

Table 1: Server specifications

Picture server	
OS	Windows Server 2003
CPU	Intel Xeon 2.00 GHz
Memory	1024 MB
Web server	Apache 2.2.14
PHP	PHP 5.3.1

Video streaming server and management server	
OS	Windows Server 2003
CPU	Intel Xeon 2.00 GHz
Memory	1024 MB
Streaming server	Adobe Flash Media Server
JAVA	JDK 5.0

Encode server	
OS	Windows Vista
CPU	Intel Core2 Duo P8700 12.53GHz
Memory	4096 MB
Flash	Flex SDK 3.0
Video camera	Panasonic NV-GS320-S

4.1 System Design

Figure 2 shows the system architecture of the prototype system. The system consists of four servers; an encode server, a streaming server, a management server and a picture server. The encode server has two functions. One is a video encode function and the other is a picture encode function. The video encode function receives an uncompressed video source from a camera and compresses the video for broadcasting. The uncompressed video source is also passed to the picture encode function. The picture encode function stores the uncompressed video so that high-quality picture could be made from the source.

The compressed video is sent to a video streaming function on the streaming server. The streaming server sends the video to each client by unicast when requested. The audience can send a picture request to a client management function on a management server watching the video through a user interface on the browser of the client when they would like to take pictures of specified scenes. The client management function keeps client IDs and forwards the picture requests with their client IDs to the encode server. When the picture encode function receives a picture request from the management server, it encodes high-quality picture from the uncompressed video. The encoded picture is sent to a picture management function on a picture server. A thumbnail is made from the picture and they are stored in a database on the server. After that, a picture ready message is sent to the picture encode function and it is forwarded to the client management function with the client ID and location information of the thumbnail and the picture. The client management function forwards location of the pictures based on the client ID. The client only downloads the thumbnail from the picture server to save network resource in case the audience does not like the shot. After the audience confirmed the thumbnail, the client downloads the picture from the picture server and displays it on the user interface. The audience can save the high-quality picture to the local disk on the client to enjoy the pictures after the broadcasting.

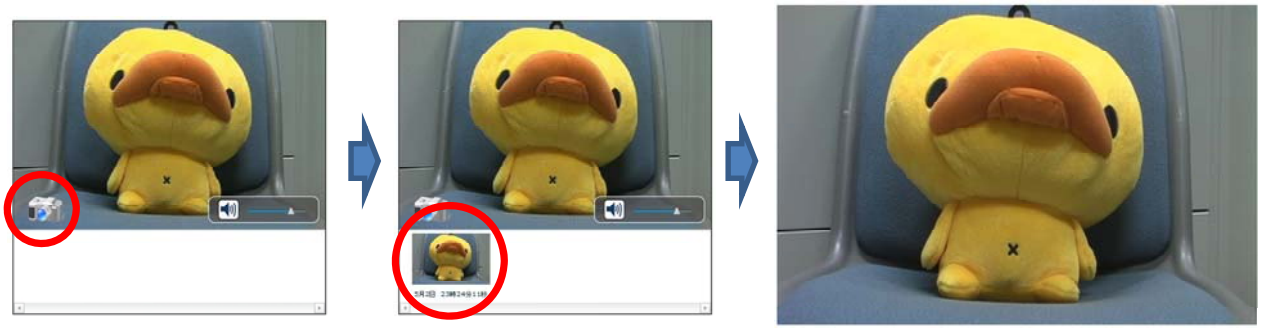

Figure 3: User interface for clients

4.2 Implementation

We implemented the prototype system based on the system design. The video/picture encode function on the encode server and the user interface on the client are implemented based on Adobe Flash written in ActionScript 3.0 for ease of video delivery and viewing over the Internet. The client management function is implemented by JAVA because it works on various environments. The picture management function is implemented by PHP script on a web server so that it is easy to upload pictures on the web server and make thumbnails of the pictures. We used Adobe Flash Media Server for the video streaming on the streaming server. The specifications of these servers are shown in Table 1. We used same PC for the video streaming server and the management server.

Video Encode

The video encode function receives raw video data from the camera with resolution 720x480. The raw video is resized and compressed by Flash framework to broadcast it in real time. Then, the compressed video data is sent to the streaming server in few hundred kbps. A still picture is captured in BMP format and passed to the picture encode function.

Picture Encode

Since the BMP file is not compressed, the file size becomes about 1 MB for a 720x480 still picture. It is too large to upload the file to the picture management server over the Internet. Therefore, we compressed the BMP data in JPEG format. After the compression, the files size will be from 30 KB to 50 KB and the network traffic between the encode server and the picture management server can be reduced.

When the BMP data is compressed in JPEG format, it increases CPU load of the encoder server. If the clients frequently send picture requests to the encoder server, the picture generation would be aborted. To make matters worse, the frequent requests would cause huge network traffic between the encode server and the picture server even if the data size of the JPEG files is small. Therefore, we introduced periodic picture buffering scheme into the picture encode function. The picture encode function stores BMP data on the memory at fix intervals. In this implementation, we set the interval to 500 msec taking into account the server load. When a picture request is arrived, the encode function searches latest picture on the memory. To reduce the delay from the moment when the shutter is clicked at the client to the moment when a snapshot actually is taken at the encode server, video buffering time on the client is sent and the picture encode function minus the video buffering time from the arrival time of the picture request to search the latest picture. We assume the transmission delay between the client and the picture encode function is small and the delay time is ignored. The BMP data is encoded in case it was not previously encoded. If the BMP data has been already encoded, it does not process the picture encode and returns only the picture URL to the client. The buffering scheme can reduce the server load and network traffic between the encode server and the picture server.

Picture Management

The compressed JPEG picture is sent to the picture server. The picture management function receives the picture. At the same time, a thumbnail of the picture with resolution 120x90 is made from the picture. The data size of the thumbnail is a few Kbytes. The high-quality picture and its thumbnail are saved in a public directory on the local web server. The client receives URL addresses of the picture and thumbnail. Although there is no user authentication to see the pictures in the prototype system, access control technologies should be introduced so that the pictures can be accessed by audience who owns them.

Client Management

We implemented four functions for the client management; 1) client ID management, 2) connection management, 3) picture request forwarding and 4) logging. The function of client ID management generates and keeps client IDs for each client which accesses to the management server. The client ID is a unique 22 characters and sent to the client when connected to the management server for first time. The client keeps the unique ID as a cookie on the web

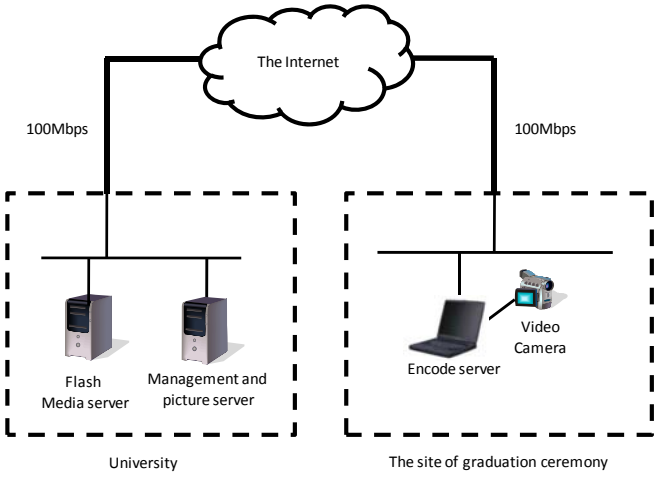

Figure 4: Network configuration

browser and can use the same ID thereafter. The ID is used for the picture request forwarding and system logging to identify the clients. The connection management function associates the client ID with its connection. The function of picture request forwarding notifies the encode server of a picture request with a client ID and replies the result to the client based on the ID. The logs maintain connected and disconnected time and the picture requests with their IDs.

User Interface for Clients

Figure 3 shows the user interface for clients. The compressed video is shown on the upper portion of the interface. The camera icon is a snapshot button to send a picture request to the management server. When the camera icon is clicked, it is not available before its response arrival. After completion of a picture request, a small snapshot picture is added to the thumbnail list by downloading from the notified URL address. A high-quality picture is displayed with resolution 720x480 on the other browser window when the thumbnail is clicked. The high-quality picture can be saved to the local disk of the client by an image saving function of the web browser.

5 EXPERIMENT

We conducted an experiment in our graduation ceremony with the prototype system in order to evaluate how to use our system by audience and find issues.

5.1 Methodology

Figure 4 shows the network configuration in the experiment. A flash media server and a management/picture server were placed in the University. These servers connected to the Internet at 100 Mbps. The graduation ceremony was held in the other place and we prepared 100 Mbps connections for the venue. An encode server and a digital video camera were employed. The bit-rate of the video streaming was 200 kbps. Any Internet users could watch the video streaming in real-time on our website for the broadcasting. We recorded number of the viewers, CPU load of the encode server and a log of photo requests on the picture/encode server.

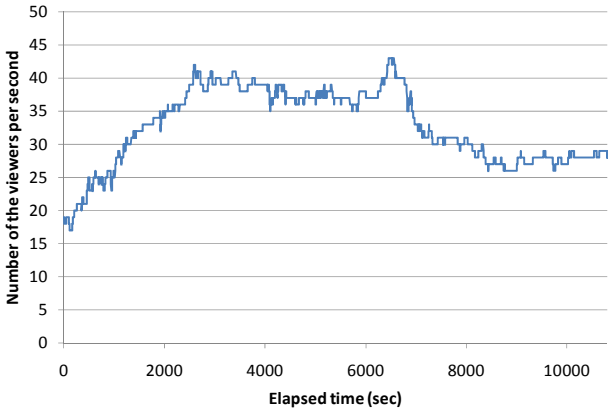

Figure 5: Number of the viewers per second

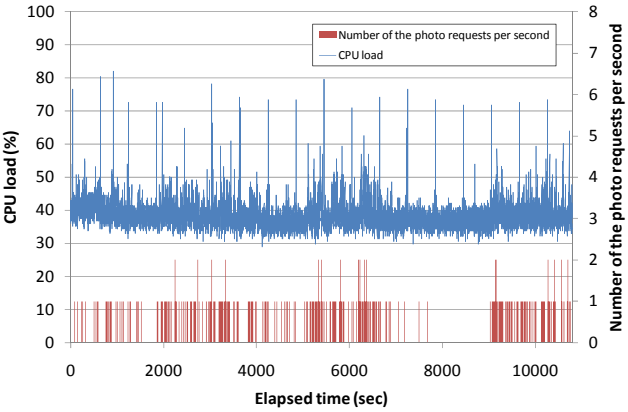

Figure 6: CPU load of the encode server and number of the photo requests per second

5.2 Results

We analyzed the results to know how many people used and its scalability. Note that we excluded broadcasters and researchers related to the experiment from these results.

At first, we counted the number of the viewers through the broadcastings to study how many/long people used our system. Figure 5 shows the number of the viewers per second from 13:00 to 16:00. The total number of unique viewers is 148. The maximum and average numbers of the viewers are 43 and 33 respectively. As a whole, the prototype system kept the number of viewers throughout the broadcast. We presume the photographable TV could improve user experience of the audience and attract them not to stop viewing.

We also analyzed CPU load of the encode server and number of the photo requests per second to study its scalability. Figure 6 shows the results from 13:00 to 16:00. From the graph, the CPU load was around 40%. Although the load momentarily marked around 80%, the encode PC remained power throughout the experiment. While the number of the photo requests per second constantly occurred, the prototype system could provide the snapshot function. Since the total

number of the photo requests was 423, the viewers used the snapshot function frequently.

From the experiment, we found the prototype system could be used by several tens of viewers at least and load of the encode server was suppressed by the periodic picture buffering scheme. The prototype system could provide the snapshot function for small-scale live broadcasting.

6 CONCLUSION

In this paper, we proposed an Internet broadcast system with a high-quality snapshot function toward improvement of user experience. The proposed system delivers low-quality video to audiences. Meanwhile, it provides a high-quality snapshot function which enables the audiences to take a picture of a desired and favorite scene anytime. We designed and implemented a prototype system and evaluated the system in our graduation ceremony. From the result, prototype system worked stably throughout the experiment even if more than 40 users watched the broadcasting simultaneously and the snapshot function was used 423 times. We confirmed the prototype system could provide the snapshot function for small-scale live broadcasting.

As future work, we will study server load when audience increases and its scalability. We will also conduct experiments at various events to evaluate the Photographable TV further in practical situations.

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(Received July 28, 2010)
(Revised August 15, 2011)

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One-click Peer-encouragement Mechanisms for Web-based Health Promotion System to Prevent Metabolic Syndrome

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Abstract - Metabolic Syndrome has grown as one of the most serious diseases in the world. Several activities to reduce or prevent this serious disease has been conducted in many countries. In Japan, the government established the law to prevent metabolic syndrome under which many metabolic people have to try to reduce their weight under instruction of healthcare nurses. To support the activities, many computer systems have been developed to help their activities and also to keep their motivation for it. However, many people still fails to reduce their weight since the effort for it is so hard that they feel difficult to continue the effort. In this paper, we propose a peer-encouragement mechanism for SNS based health promotion systems in which users encourage one another by themselves to improve their motivation for everyday's effort. Through one-month evaluation experiment, we confirmed that the proposed peer-encouragement mechanism works effectively in practical scenes.

Keywords: Medical Systems, Peer Encouragement, SNS, Health Promotion, and Metabolic Syndrome.

1 INTRODUCTION

Currently, metabolic syndrome has been generally regarded as one of the most serious diseases over the world. Although there are several definitions per country, metabolic syndrome is generally defined as the state that people put on significant weight [1]. Unfortunately, the prevalence of metabolic syndrome is considerably high all over the world [2]. The problem is that the people of metabolic syndrome have higher risk to be cardiovascular diseases or diabetes in the future, resulting in higher medical cost. Once people come to be cardiovascular disease or diabetes, their medical cost gets far higher. The importance to prevent metabolic syndrome is widely recognized.

Therefore, various activities to reduce or prevent metabolic syndrome has been tried all over the world. Especially in Japan, the government established the law to prevent metabolic syndrome under which many metabolic people are trying to reduce their weight under instruction of healthcare nurses. Recently in the instruction scene, several information systems are applied to improve the effect over reduction of users' weight. Typically in such systems, users report everyday's effort on reducing their weight through the Internet, and healthcare nurses periodically make proper advices according to their daily report in order to motivate further continuous effort of them.

This activity is actually effective to keep users' motivation for the everyday's effort to improve their weight. However, this style of instruction still requires much labor of health care nurses if they want to keep users' motivation at high level. One of the challenges in this area is to motivate users to continue their effort to reduce weight without increasing the labor of health care nurses.

In this paper, we propose the peer-encouragement mechanisms among users in which users encourage one another to improve motivation for everyday's effort by themselves without healthcare nurses. By this peer-encouraging mechanism, more users will keep their motivation to continue their activity without increasing healthcare nurses' labor. In our method, encouragement is done with simple "one-click" operation so that people can encourage others without stress and labor. In this paper we present the concept of peer-encouragement and the system design to be applied into practice.

The rest of this paper is organized as follows: In Sec. 2 we present the background of metabolic syndrome and the current activities to prevent/cure people against it, including the related information systems to help the activities. In Sec. 3 we present the concept and the mechanism of peer-encouragements and also its intended effects. In Sec. 4 we show the design of the system that we developed and explain how they work. In Sec. 5, the evaluation results for this system are presented, and we conclude the work in Sec. 6.

2 BACKGROUND

2.1 Prevalence of Metabolic Syndrome

As mentioned above, metabolic syndrome has been generally regarded as one of the most serious diseases over the world. It brings not only the problem of public health, but also the problem of economical cost. It is known that many countries try to prevent/reduce metabolic syndrome, but as the background of the activity there are the problem of high prevalence of metabolic syndrome people in many countries [2].

In United States, the metabolic syndrome prevalence is over 20% and about 47 million U.S. residents have the metabolic syndrome [2]. In Britain, National Diet & Nutrition Survey [3] reported that the number of patients is 9.4 million and about 10.2 million people are in the spare group. In Japan, The National Nutrition Survey reports (2008) [4] that the number of patients are estimated at 25.3% and spare group people at 21.9% in male, and 10.6% and 8.3% in female, respectively. Note that the considerable part of the patients is in

working age. Further, the prevalence of diabetes, into which metabolic syndrome may grow when it gets significant, are also reported high in both U.S. and Japan [5][6].

2.2 Activities to Reduce Metabolic Syndrome

To reduce or prevent metabolic syndrome, various activities are going on in several countries. Specifically in Japan, the government has established laws in which companies are responsible to make efforts to reduce weighted staff, and are executed from April 2008. Consequently, many companies started to pay for the effort to reduce the level of metabolic syndrome of their employees, not to be penalized for it. As a result, now it is commonly seen that healthcare nurses continuously make instruction to improve health of the employees of companies.

Now we focus on how the healthcare nurses make instruction to people. In fact, the main method that the health care nurses apply in order to improve health of the metabolic syndrome candidates is the decision of small daily goals that they try to pursuit every day at their home. Note that the daily goals are determined individually under instruction of a healthcare nurse not too difficult to pursuit. In many cases, the daily goals are selected and many of them are intended to do daily moderate exercise or improve nutrition balance of daily meals. But in practice, many people in fact are not able to continue to pursuit the goals every day since it is difficult to keep their willing to continue for such personal home activities. The problem is that many people tend to stop such activities before long, which significantly degrades the performance of the instruction of healthcare nurses.

2.3 Assisting Health Promotion using Information Systems

As one of the ways to make people continue their health promoting activities, there are various web services which intend to have such people informed about or interested in their health promoting activities [7][8][9]. For instance, Matsumoto et al. [7] proposed an information system to assist to improve dietary habit, by recording user's meal history and providing users nutritionally well-balanced menus based on medical information. This system would help users improve their daily nutritional balance without healthcare nurses. As another instance, an web system K-zoku [8] tries to help users build their health promoting plans and visualize the daily achievements to motivate users to continue diet activities. In K-zoku users can determine their daily goals under the guide of provided medical information, and record daily achievements. Users always check their achievement level of their activities to motivate to continue their plans. Those systems are useful to help users promote their health, but healthcare nurses do not related with the system. Since users have to try to lose weight alone without professional knowledge, the effect of this kind of systems is limited.

On the other side, several information systems exist which try to help healthcare nurses instructing users health promoting [10] [11] [12]. This kind of systems typically try to help communications via the Internet between healthcare nurses and users in home who are trying to achieve daily goals i.e., users input their daily achievement in pursuing goals into the system. then their healthcare nurses check them and provide advices periodically. There are several success cases of this kind of systems in Japan and consequently it is now regarded that the advices from healthcare nurses are actually effective to motivate users to continue their health promoting activities. For example, Yoshihiro et al. [10] proposed a system to support healthcare activity of (relatively light) diabetes people. In this system users input daily cure records into the system via mobile phones and nurses send back advices periodically. As another example, Harasuma Diet by Hitachi co.ltd. [11] is a commercial web system which supports healthcare nurses instructing users health promoting. In this system "100 kcal card," which shows a small goal to reduce energy of 100 kilo calories, is prepared to help instruction, and once the daily goals to try are determined, users records the daily achievements of the goals. By using 100 kcal cards, the labor of healthcare nurses to determine users' daily goals is considerably reduced and also periodical advice improves the health promotion effect of the users.

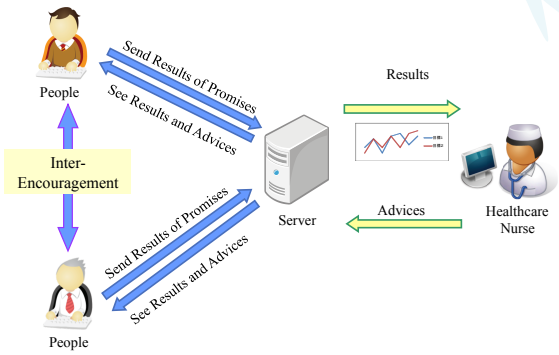

Figure 1: Overview of Our System Scenario

However, in fact, the effect to keep users' motivation to continue their health promoting activity is still limited so that considerable part of the people quit their activities. One solution for this problem would be that healthcare nurses pay more effort to communicate with users, but it is not practical. To improve the health promoting effects without increasing healthcare nurses, some systems introduces a mechanisms to promote communication among users using the mechanisms of SNS (Social Network Services) [13]-[18], i.e., they allow users to send messages to other users. This mechanism actually increase user's communication, however, the number of users who send messages are quite limited since sending message is so time consuming.

Thus in this paper, to help healthcare nurses to assist users' health promotion activities, we propose a mechanism which enable users to encourage one another among them (which we call peer-encouraging mechanisms) with simple one-click action. By this peer-encouraging mechanism, users will keep their motivation by themselves without increasing labor of healthcare nurses.

3 PROPOSED MECHANISMS

3.1 The Concept

We firstly describe the base system structure that we intend to extend, and to introduce the peer-encouragement mechanisms. Figure 1 shows the basic functions of such systems. In the Internet there is a web server in which our server programs are installed. Since we suppose to extend typical healthcare supporting systems, it is expected that healthcare nurses consult users to determine their daily goals to achieve, and the daily goals are set into the system. Then, users input their daily achievements into the web server everyday, and check the achievement history by themselves at home. Note that in the typical systems, the healthcare nurses are able to check the achievement history of users at the hospital, and also able to send some advices if needed. Some practical systems provide SNS based functions to motivate users continuing their activity, where users can communicate with one another via text messages. However, such text-based mechanisms are used only a part of people who are accustomed with computers. The mechanisms to motivate more people to continue their health promoting activity are desired.

In this paper, instead of such text-based communication functions, we propose the mechanism called "peer-encouragement" by which user can encourage other users with a single "one-click" operation. In our system, a user checks other users' daily achievement histories, and if he/she feels like encouraging one, then he/she makes an encouragement by one-click action to raise motivation of other users. Note that we prepare two sorts of encouragement, i.e., "encouragement" and "admiration" that we can select case by case (both of those are called "encouragement" in the following.) Note that we do not think that only this simple mechanism would make effect in the health promoting activities. Several environmental mechanisms which work together with this one-click action is essential.

Our idea is to create cycle of encouragements among users. If a user is encouraged by others, the user's motivation would be raised a little, and then he not only goes to continue his health promoting activities, but also he would feel like encouraging other users. This phenomenon makes a chain of encouragements, and it grows to be a cycle after all. In this way, we expect a sustainable cycles among users which always raise their motivation to continue their activities. Figure 2 illustrates the phenomenon: once an user first "encourage" someone, then he not only encourages the user as a reply, but also encourages others in turn. Chain of this phenomenon would create cycles. In this way the first single encouragement would be augmented to be circulated among users.

To create cycles stably, several environmental mechanisms are essential. First, the encouragement operation should be sufficiently simple and clear so that users can make encouragements without labor and stress. Next, sufficient number of encouragements is necessary to keep stable cycles of encouragements. Finally, the encouragements should result in some kind of connectivity between users so that users can compare themselves with other users. Over those points we will discuss in the next subsections.

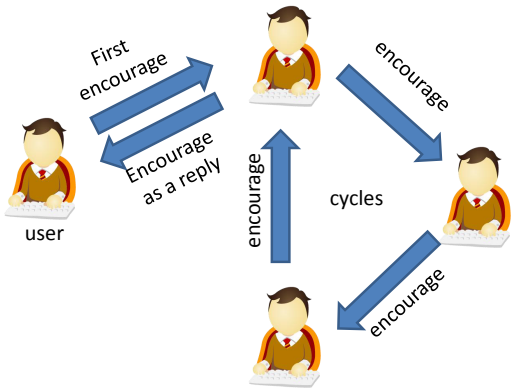

Figure 2: Cycles of Encouragements among Users

3.2 Classifying Daily Goals

Now we consider about the scene that an user makes encouragement to other users. To create encouragement chain as many as possible, the interface should be simple and clear not to have users feel labor or stress. Therefore, we propose "one-click encouragement," which is done by simply pressing "encourage" button in the screen. However, not only simple enough the interface is, but also the interface should be clear such that we can imagine the healthcare activity of the user enough to feel like encouraging him. Usually, the healthcare activities of the users are imagined from their achievement history (thus healthcare nurses are able to send proper advices in the typical systems). But note that there are the problem of privacy when users see the other user's daily achievement history, i.e., many people would not feel well when their achievement history is put open in public. Especially, the specific description of daily goals may not accepted by some people.

On this problem, our solution is to classify daily goals into several categories. Then, when we see another user's history, we are able to understand the sort of his each daily goal (without seeing the specific description of daily goals). This would include acceptable information for us to imagine his activities and come to feel like encouraging him. As the categories for the purpose above, we select the following 8 categories:

Food Amount (FA): Daily goals in this category try to reduce daily calories ingested to reduce weight, e.g., stop eating between meals, eat 2/3 of usual amount of rice, etc.

Nutrition (NT): This category tries to improve nutritious balance of daily foods, e.g., eat fruits 3 times a week, drink coffee without sugar, eat vegetable salad once daily, etc.

Light Exercise (LE): This category tries to perform light exercise, e.g., use stairs instead of elevator, perform stretching after taking a bath, etc.

Hard Exercise (HE): This category tries to perform hard exercise, e.g., walk 10,000 steps a day, jog outside everyday, perform physical training 5 times a week, etc.

Daily Measurements (DM): This category tries to measure

their body periodically, e.g., measure weights twice (morning and evening) a day, etc.

Prohibit Drinking (PD): This category tries to quit drinking alcohol, e.g., quit drinking twice a week, drink 1/2 of the usual amount of beer, etc.

Prohibit Smoking (PS): This category tries to quit smoking, e.g., quit smoking 3 days a week, reduce the number of cigarettes to 1/2 of usual, etc.

Others (OT): This category includes daily goals which are not included in the above 7 categories, e.g., get up early, chew foods sufficiently many times, etc.

3.3 Augmenting the Number of Encouragements

If the probability to occur chain encouragements is low, the number of encouragement reduces as time passes and cycles would disappear soon. For this problem, we propose two solutions. One is to enforce users to encourage other users when they input daily records. This method provides a constant number of encouragements everyday not to reduce cycles. An anxiety is that users feel the enforced encourage operation laborious or stress, resulting in stopping to use our system. This point should be confirmed in the evaluation.

Another solution is to create automated encouragements to augment the number of encouragements. This also provide encouragements everyday not to reduce cycles. The anxiety of this method is that users would be discouraged when they know that computers, but not real people, are generating encouragements, resulting in lose interests to use this system. In this work we selected the former solution and developed a prototype system based on it.

3.4 Connection among Users

To create sustainable cycles of encouragements, we regard it also important to create connection among users. The connection among users here means formation of some recognition against other users, i.e., feeling of friends or rivals who lead us to act with or compare us with those people. Through those connections we intend to make users interested in other individual users, by which we expect to augment users' motivation for their activities and the number of encouragements. Specifically, if the list of users who recently encouraged you is given, one would go to see the daily activity of the users, and then he would make encouragements for them with high probability as a reply for them. As another example, if a ranking of the number of encouragements is given, one would check users around the rank of you. Further, if one found users whose daily activities are similar to him/her, then he/she may wish to continuously watch them as his/her rival user.

We regard such kind of connections among users as quite essential when discussing the formation of sustainable cycles. Consequently, in our system design, we implement the following as shown afterwards:

- the list of users who recently encouraged you,
- the list of users you recently encouraged,
- the list of users you want to watch (watch list),
- and ranking of 1-week achievement score and the number of encouragements given.

Also as information by which one may be interested in others, we allow users to input their profile information and put it open to public.

Table 1: Software Used for the Server

Software	Version
CentOS	4.3
Apache	2.0.52
PostgreSQL	7.4.13
PHP	4.3.9
Postfix	2.2.2.10

4 SYSTEM IMPLEMENTATION

4.1 overview

We carefully designed the system with the peer-encouragement mechanism and the environmental mechanisms in order to make the circulation of encouragements work well. Overview of the system has been explained in Sec. 3.1 and Fig. 1. We implemented the server using the software shown in Table 1. Note that, since in this paper we evaluate the effect of peer-encouragement mechanisms, we illustrate the interfaces for general users only (i.e., the interface for healthcare nurses are not included in this paper.)

The interfaces for general users consist of 7 views: top view, daily goals settings, achievement history view, peer-encouragement view, ranking view, profile edit view, and settings. We omit the transition diagram since users can move among those views using the menu bar seen in the upper part of each view.

4.2 Top View

Fig. 3 shows the top view of the system, to which users first come after the authentication. Three fields ① ② and ③ are shown, which is to be explained below. The left button of field ① brings users to the pop-up window in which users input their daily achievements for daily goals. In our system, users can input the achievement of each daily goal, body weight, and a short comment of the day. After the input of those daily records, users are brought to the peer-encouragement view to enforce them to make encouragement for other users. The right button in field ① brings users to the peer-encouragement view directly. The detail of the peer-encouragement view is seen in Sec.4.5.

The field ② of Fig. 3 shows the 1-week daily achievement history of an user. In this figure, three goals are shown by categories LE(Light Exercise), NT(Nutrition) and FA(Food Amount). Each goal's 1-week achievement history is seen in a row. Each row consists of two sub-rows. The upper sub-row

Figure 3: Top View

shows the daily achievement of the daily goal in four levels, i.e., double O, O, triangle and X. If the goal is weekly goal (i.e., the goal to achieve the fixed number in a week, e.g., twice a week), different character meaning "excuse" may be used, which means the goal is not achieved but is allowed. The lower sub-row shows the number of encouragements received from other users in each day. This count is done for each kind of encouragements "encouragement" and "admiration" represented by different color of stars. In the second rightmost column, the statics values including the number of days continuing to input achievement are shown. In the rightmost column, the rankings of achievement score in the past 1-week in each goal category are shown. The second lowest row shows the daily comments of the user. In the lowest row body weights are seen if they are input by the user.

The field ③ of Fig. 3 shows the three *user lists*; *the watch list* is the list of users you want to watch continuously, *the encourage user list* is the list of users you encouraged recently, and *the encouraged user list* is the list of users who encouraged you recently. To add users into one's watch list, the user can go to the peer-encouragement view (see Sec. 4.5) or the ranking view (see Sec. 4.6) and click the link to add people into his/her watch list. Other two lists are updated automatically according to the history of encouragements about each user. In each user list, users are displayed with the list of categories of his/her daily goals and his/her newest comment. By clicking each user, we can go to the top view of the user. The design of the top view of other users consists of only the field ② and the function that you make encouragements for the user is added, i.e., the two encouragement buttons are added.

4.3 Daily Goals Setting View

Fig. 4 shows the daily goals setting view, in which at most 10 daily goals are set. There are seven fields to explain. Field

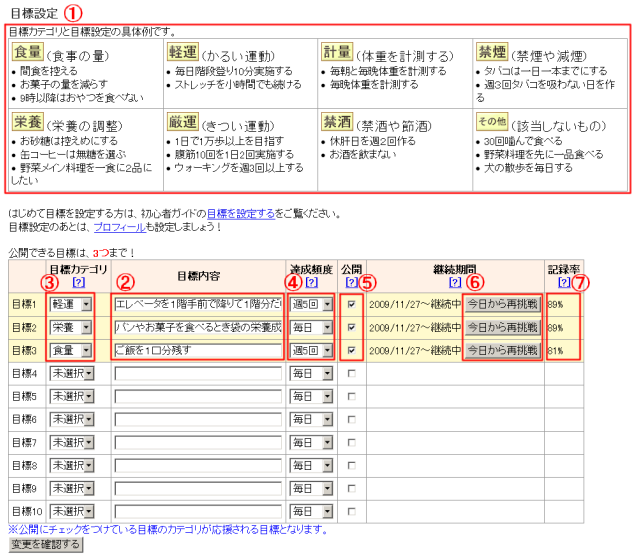

Figure 4: Daily Goals Setting View

① shows the examples of goals for reference. To guide users the correspondence between text-form daily goals and the categories, this field is necessary. The other six fields are the part of the web form to set daily goals. In the second leftmost column (field ②) we fill the text representation of daily goals. Then, in the leftmost column (field ③) we select the corresponding category among 8 candidates shown in Sec. 3.2. In the column ④, we select the type of the goal, i.e., daily goal or weekly goal (if we select weekly goal, we can select the number of expected achievements in a week.) In the column ⑤ users select whether the goal is open in public or not; users can select at most 3 goals to be open, to which other users make encouragements. In the column ⑥ we see the period of time that we are trying to achieve that daily goal, and users can reset the starting day and restart for this goal by pressing the button (i.e., the achievement history is cleared). In the column ⑦ we see the ratio of days that the user inputs the achievements so far.

4.4 Achievement History View

In the achievement history view, users can see the daily achievement history of themselves. The items that users can see is all the input data they input so far, the record of encouragements received from other users so far, and some related statistic values. We omit the explanation of this view since there is no specific feature in this view.

4.5 Peer-encouragement View

In the peer-encouragement view we can encourage other users with one-click "encouragement" or "admiration" operation. To augment the number of encouragements, we make users encourage other users at least once a day, as mentioned in Sec.3.3. So, after inputting the daily achievement, users are forced to come to this view and to make encouragements. Also, users can visit this view at their will after that.

Fig. 5 shows the view to encourage other users, where 5 users are selected and shown in 5 rows. Field ① of Fig. 5

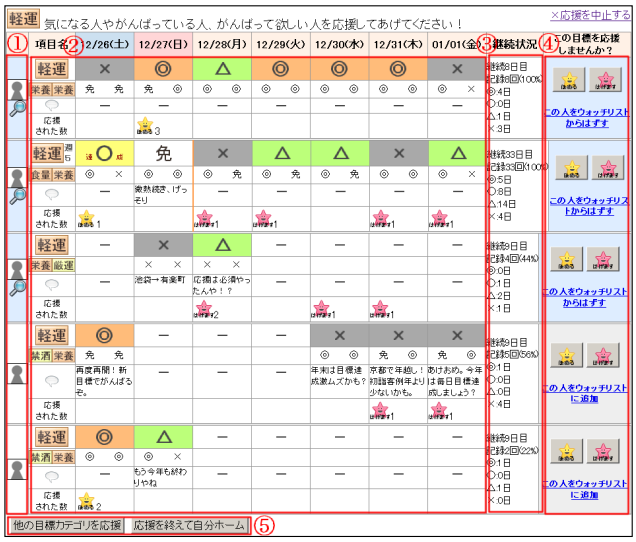

Figure 5: Peer-encouragement View

Figure 6: Ranking View

shows the 5 users whose nickname is hidden. Those users are selected basically at random, but we embed a mechanism that the users of less received encouragement is more likely to be selected. Field ② shows the achievement history of users as a reference data to decide whether you encourage them or not. In this field, the information seen is mostly the same as the field ② of top view (Fig. 3), i.e., the 1-week achievement history of three daily goals, the daily comments, and the 1-week history of received encouragements for each user. In the field ③ we see some statistic variables which is the same as the field ② of Fig. 3, i.e., the length of time in days since the users start trying their achievement, the number of input in days, and the number of each level of achievements (i.e., double O, O, triangle, and X). You can encourage those 5 users according to the information described above; the encouragement is done by two buttons shown in field ④ in Fig. 5. Each of two buttons corresponds to two sorts of encouragements, i.e., "encouragement" and "admiration." Also, by clicking the hyper link below the two buttons, we can add the user into our watch lists. Note that you are not necessary to encourage all those 5 people. However, at least one encouragement is required to finish this view. When you finish encouraging, you can continue to encourage other users or return to your top view, using the buttons seen in field ⑤.

4.6 Ranking View

In the ranking view we can see the weekly ranking of achievement scores and the number of encouragements obtained (for each of "encourage" and "admiration"). The ranking is created for each category of daily goals; each ranking consists of users who have at least one daily goal which belong to that category. Fig. 6 shows the ranking view. In field ① we can select the ranking to look: the upper tabs correspond to 8 categories and "all categories" added at the leftmost tab. Specifically, from its left side, the categories All, FA, NT, LE, HE, DM, PD, PS, OT described in Sec. 3.2 are shown. If we click one, the ranking shown in fields ③ ④ ⑤ changes to the corresponding ranking table. The three buttons in field ① allows us to select the sort of ranking, i.e., from the left side, achievement score, the number of "admiration" obtained, and that of "encouragement" are placed. The field ② shows your rank in the ranking table selected in the operation of field ①. In fields ③ ④ ⑤ the ranking table is shown. The leftmost column shows the user nicknames and their rank, The second leftmost column shows the users' three goal categories and the 1-week achievement history. The next three columns show the achievement score, the number of "admiration," and that of "encouragement," respectively. The achievement score is simply calculated as the weighted sum of daily achievement levels of a user. Specifically in this system, double O is 4 points, O is 3 points, triangle is 2 points, and X is 1 point. The newest daily comments of each user are also seen in those fields. Note that fields ③ ④ and ⑤ are dyed with different colors: in the ranking you can easily recognize yourself by orange color ④, do the users in your watch list by blue color ③, and other users are not colored (white) like field ⑤. When we click the users seen, then we move to their top view where we can make encouragements for them, and can add him/her into our watch lists.

4.7 Profile Edit View

In this system users can input their personal profiles into the system and open them in public. The data items which are possible to input are: living area, sex, birthday, blood type, hobby, profession, and introduction texts. The profile is intended to be the information to connect users, i.e., an user is possibly interested in other users from the information. This information can be seen in their top view, and also we can search users using those items from the search form of the system.

4.8 Setting View

In the setting, users can modify the settings of remainder mails, which is sent everyday at the determined time not to forget inputting daily achievements. Users can select whether

they use this function, and can set the e-mail address and the time to receive the e-mail. In this e-mail, information of receiving encouragements are seen so that they can get to know someone has encouraged them.

5 EVALUATION

5.1 Methods

We evaluated the one-click peer-encouragement mechanism using the system implementation introduced in the previous section. We operate the system about one month with 29 people and obtain event logs and answers of questionnaire. As for the questionnaire, the selected questions and the answers are shown in Table 2. Here, we adopt 5-level rating for all the questions, where 5 is the most positive and 1 is the most negative evaluation. In this experiment, we mainly try to evaluate how effectively the peer-encouragements are circulating in advance of practical use in the scene of healthcare instructions.

Several conditions, however, should be properly prepared to obtain reliable results from the experiments. Especially, whether the daily goals are adequately determined or not affects significantly on the evaluation results, so we conduct that each participant consults a healthcare nurse to determine their adequate daily goals. Although many of participants are not even candidates of metabolic syndrome, they all have room to improve their lifestyle, so that they all set daily goals with their will to improve their lifestyle and promote their health.

5.2 Results

First we present the results on circulation of encouragements observed. Fig. 7 shows the number of encouragements observed, presented as accumulated numbers in time course. Here, the “enforced” encouragements mean the encouragements which are made when users first come to the peer-encouragement view without their will as described in Sec.4.5., while the “active” encouragements mean those which are made when users come to the peer-encouragement view or other users’ top view at their will.

From this graph, the number of the active encouragements are far larger than enforced encouragements (about 86% of all the encouragements were the active one). Note that we see the rapid change of the curve around 2010/1/5, which would be the effect of new-year days. Fig. 8 shows the specification of the active encouragements classified by sources from which users made encouragements from. Here, “user lists” means the three user lists (the watch list, list of the users who encouraged you, and the list of users you encouraged) described in Sec.4.2, i.e., they are the encouragements that users click other users in those user lists and encourage them in their top view. The “encouragement view” means the encouragements from peer-encouragement view described in Sec.4.5. The “ranking view” means the encouragements from ranking view described in Sec.4.6, i.e., users click other users in the ranking view and made encouragements at their top view. The “user’s top” means the encouragements made at users’

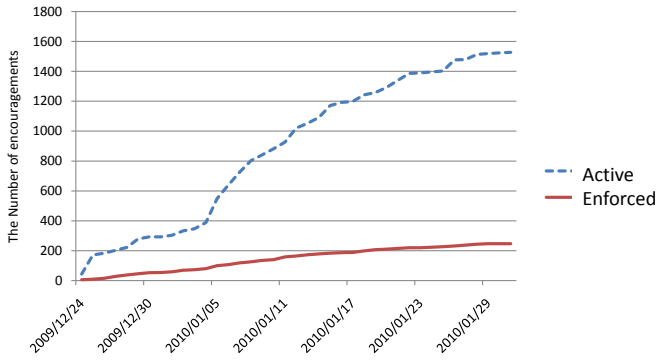

Figure 7: Number of Active/Enforced Encouragements

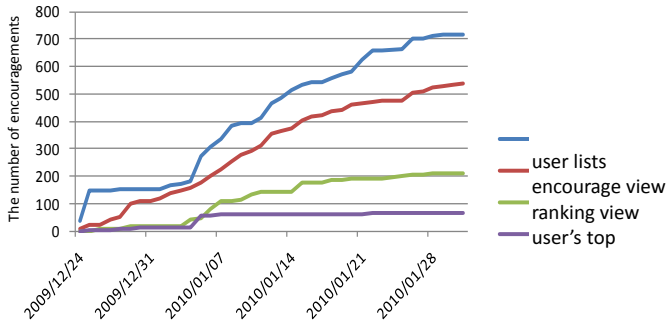

Figure 8: Source of Active Encouragements

top view to which users come using keyword search form of the system.

The graph shows that the encouragements from the user lists and encouragement view count large number. Consequently, users are not only interested in encouragement view where users are randomly seen, but also encourage others using some kind of “connections” among users described in Sec.3.4. Fig. 9 shows further specification of “user lists” of Fig. 8. From the graph, the watch list does not work as a source of encouragements after 10 days past, while encouragements from other two user lists continuously increase in the whole period. This result implies that users tend to make encouragements based on the past encouragements of themselves or other users, e.g., they tend to make encouragements as a reply for other users, or tend to re-check the users they have encouraged before.

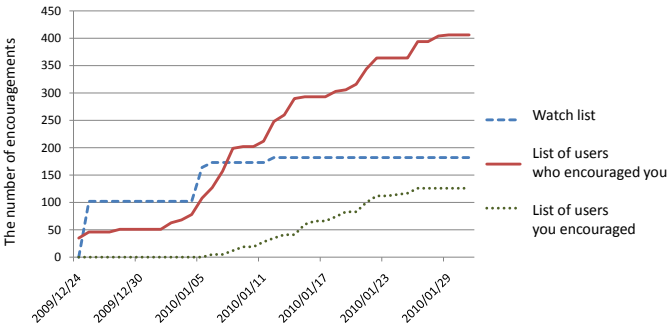

Figure 9: Source of Active Encouragements made from User Lists

Table 2: Questions and the Results (Selected from the questionnaire)

No.	Questions	Evaluation (# of answers)					
		average	5	4	3	2	1
A-1	How much did you motivated to continue your activities from the received encouragements?	3.5	1	14	3	0	3
B-5	Did you feel laborious to make encouragements?	3.5	5	6	3	5	1
F-1	Did you keep your motivation to continue your activities throughout the experiment?	4.0	3	16	1	0	1
F-2	Do you think that this system will work in the practical healthcare scenes?	3.8	3	13	3	2	0

Note that, from the result of the question B-5 seen in Table 2, users feel everyday's enforced encouragements somewhat laborious and time consuming. However, on the other side, they still continue to make encouragements at their will not only to the users from whom they received encouragements, but also to the other users from peer-encouragement view. This implies that the labor for enforced encouragements would be at allowable level and the motivation to continue which comes from receiving encouragements would be larger in total.

As seen above, in this experiment new encouragements are constantly generated by enforced encouragements mechanisms, and the encouragements actually chain via peer-encouragement view or via the mechanisms to keep "connections" such as user lists. As a result, encouragements are continuously supplied by users in the whole period of the experiment. Consequently, it is concluded that our mechanisms actually circulate encouragements among users.

Next we will see the effects of encouragements on users' motivation to continue their activity. From the result of question A-1 (see Table 2), high ratio of users answer that receiving encouragements from other users raise their motivation to continue their activities. Note that, as for 3 users who give the rating 1 for question A-1, we found that they also give low rating (1 or 2) for B-5, i.e., it infers that they are not motivated since they feel too much labor or stress in the operation of making encouragements. On the other side, from the event log, the number of daily records and that of received encouragements have very high correlation coefficient 0.85. Also the number of created encouragements and that of received ones have also high correlation coefficient 0.65. Consequently, users are typically motivated by receiving encouragements (except for few exceptions seen in the result of A-1), and in fact the number of users' daily records has deep relation with encouragements. Those results clearly show that the encouragements have motivated users to continue their activities.

Finally we see the total impression of users for our system. Question F-1 (in Table 2) shows that most of the users could keep their motivation throughout the period of the experiment. Also, F-2 shows that many users answer that they have good impressions and possible to have active impression in putting our system into practice. Although they are not professional in this area, but this result shows that at least many people feel well from the user's point of view.

6 CONCLUSIONS

In this paper we proposed a peer-encouragement mechanisms to improve users motivation to continue their healthcare activity while the amount of healthcare nurses' labor does not increase. We present our concept of peer-encouragement mechanisms in the healthcare scenes, and show the system design of a healthcare supporting systems to work in practice. Through one-month experiment, we confirmed that the proposed peer-encouragement mechanisms work effectively to create circulation of encouragements among users, and consequently the users are continually motivated to continue their healthcare activity without increasing healthcare nurse's work.

For the future, evaluation in the practical scene is necessary to try the mechanism to be put in practice. We would like to improve our system in consideration of the results obtained from this experiment, and try to conduct experiments in practical scenes.

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(Received July 6, 2010)
(Revised August 31, 2011)

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[Practical Paper] Problem and solution of delay in UHF RFID

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Abstract—RFID (Radio Frequency Identification) is important hardware for the ubiquitous society. There are some RFID technologies and the UHF (Ultra High Frequency, 860-960MHz) RFID is one of the key technologies because the access distance is longer than other technologies.

The UHF RFID tag does not have a battery generally. Power for tag is supplied from a reader as a radio wave. So a high power output is required for a reader. In Japan, high power reader (1W, 36dBm output) for UHF RFID can be used since April 2005. However, high power reader causes the interference problems. One of them is that a reader is interfered by the output of another reader while it is receiving the response from a tag. The distance between readers is estimated about 1.6km under the Japanese regulation.

Since January 2006, low power reader (10mW, 13dBm output) can be used. At the same time, carrier sense mechanism called LBT (Listen Before Talk) is introduced to prevent interference between RFID readers. If all the channels are used, a reader must wait until one of other readers releases a channel in the LBT mechanism.

We show the problem of the UHF RFID system caused by the LBT that readers are influenced by other readers and do not keep realtime capability when readers work simultaneously. We also show the solution for this problem. The name of the solution is the "cycle-divide method" which can keep the realtime capability by changing the session ID and suspending the transmission of the non-realtime reader's cycle.

Keywords: Radio Frequency Identification, anti-collision, realtime system, non-realtime system, time sharing

1 INTRODUCTION

RFID (Radio Frequency Identification) is important hardware for the ubiquitous society in which everything is connected easily via "Everyone anytime and anywhere anything" network. There are some RFID technologies and the UHF (Ultra High Frequency, 860-960MHz) RFID is one of the key technologies because the access distance is about 3m without battery and it is longer compared with other technologies such as 2.4GHz RFID. So it is expected to be applied to logistic management system and so on.

The UHF RFID tag does not have a battery generally. Power for tag is supplied by a reader as a radio wave. So a high power output is required for a reader. In Japan, high power reader (1W, 36dBm output) for UHF RFID can be used since April 2005. However, high power reader causes the interference problems described in Section 2. One of them is that a reader is interfered by the output of another reader while it is receiving the response from a tag. The distance between readers is estimated about 1.6km under the Japanese regulation.

Low power reader (10mW, 13dBm output) can be used since January 2006. At the same time, carrier sense mechanism called LBT (Listen Before Talk) is introduced to prevent interference between RFID readers. In the Japanese LBT, 9 and 14 channels are defined for high power and low power respectively and if all the channels are used, a reader must wait until one of other readers releases a channel.

It is easy to imagine that some readers must wait and cause read failures by the LBT when more than 9 readers work at the same time [1-3]. It means that the realtime RFID readers such as gate monitor cannot detect the RFID tag when other non-realtime readers such as stock control work simultaneously. In this paper, we discuss about the interference between realtime readers and non-realtime readers [4-6], and propose the solution.

2 PROBLEM IN UHF RFID

2.1 Interferences in UHF RFID

One of the key features of UHF RFID is the communication distance. The tag without the battery (passive tag) can be accessed from 3m distance. It means that the response (reflected wave) from a tag is extremely small and the transmission wave of very far reader may cause the interference as described above.

There are four interference paths. Figure 1 shows the interference paths and the interfered distance [3].

- Route<1>: reader-reader interference
  A reader is interfered by the command of another reader while it is receiving the response from a tag. Interference distance is estimated about 1.6km

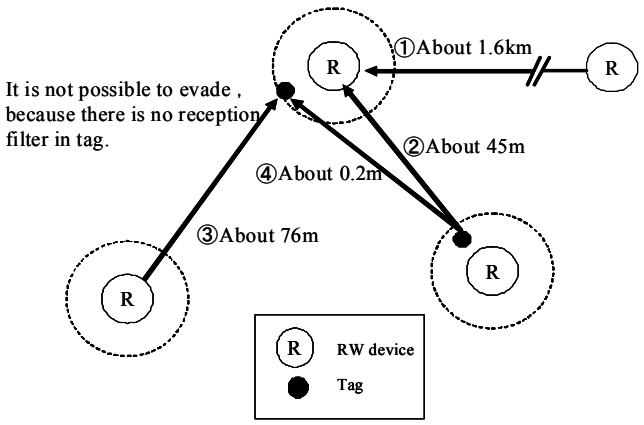

Figure 1: Interference distance between systems

- Route<2>: tag-reader interference
  A reader is interfered by the response of a tag that is owned by another reader while it is receiving the response from the owned tag. Interference distance is estimated about 45m.
- Route<3>: reader-tag interference
  A tag is interfered by the command of another reader while it is receiving the command from the owner. Interference distance is estimated about 76m.
- Route<4>: tag-tag interference
  A tag is interfered by the response of another tag while it is receiving the command from the owner. Interference distance is estimated about 0.2m.

It is necessary to prevent these interferences. Especially reader-reader interference is the key because the distance is about 1.6km which can easily cover a factory or a building.

The key concept to prevent reader-reader interference is to separate radio wave. There are two same ways to separate, the first one is to change the frequency and the second one is to change the time slot. The technologies to prevent interference are called anti-collision, and the followings are summaries of the anti-collision technologies [7-10].

1. **Frequency hopping method**

This method is classified into the method of changing the frequency. In the United States, the bandwidth for RFID is 26MHz (902-928MHz) and it is possible to assign about 100 channels. The reader changes the frequency dynamically to reduce probability of the collision (the readers use a same channel).

2. **LBT (Listen Before Talk)**

This method is classified into the method of changing the time slot. The reader must confirm that the channel is not used by sensing carrier (Listen) before using channel (Talk). If the channel is used, the reader waits until the channel is released. This solution is suitable for the countries which wide bandwidth is not assigned to. For instance, the bandwidth for RFID is 3MHz (865-868MHz) under the European regulation. Japan also adopts this method.

3. **Subcarrier method**

This method is classified into the method of changing the frequency. A slight electric wave from the RFID tag has a big influence on interference. In the Class1-Generation2 standard that EPC Global proposes, the subcarrier method is included.

This method modulates the subcarrier, changes the frequency of up-link signal and down-link signal, and has evaded the interference between readers.

4. **Down-link and up-link channel division method**

This method is classified into the method of changing the frequency. This method changes sending and receiving frequency. A reader transmits a command as a down-link signal and changes the frequency for the up-link signal. A response from a tag is carried on the up-link frequency. So the frequency of the down-link and up-link is changed and prevent the interference. For instance, the interference is reduced by allocating one channel for down-link, and three channels for up-link.

2.2 LBT and the problem

In Japan, the discussion to introduce UHF RFID has been started in the Ministry of Public Management, Home Affairs since 2004. Radio Law was revised in April 2005 and January 2006 as mentioned above. Table1 shows the overview of the regulation for the UHF RFID in Japan.

The LBT mechanism is introduced since January 2006, so reader-reader interference problem was solved. In the LBT for the high power RFID, we can use 9 channels and sense carrier 5 to 10 milliseconds before transmission, then start transmission maximum 4 seconds, sleep 50 milliseconds before next transmission.

It is possible to prevent interference between readers by sensing carrier and waiting for a channel release, however, the reader must wait when all channels are used. As a result, delay may happen, and the possibility to fail to read in realtime comes out. It is important for the realtime RFID system to evaluate this delay and to find a solution

It thinks about correspondence by the above-mentioned each method by actual use. It is a situation in which two or

Table1: Standard of 950 - 956MHz Band passive type RFID

	High power type	Low power type
Output	air electric power: 1W or less air gain: 6dBi or less	air electric power: 10mW or less air gain: 3dBi or less
Frequency	952 - 954MHz	952 - 955MHz
License	Premises wireless station	Specified low power radio station (The license is unnecessary.)
Channel	9 Channels (200KHz)	14 Channels (200KHz)
Carrier sense	5 - 10ms, -74dBm	10 - 15ms, -76dBm
Transmission time	Continuousness 4 seconds, 50ms stop	Continuousness 1 second, 100ms stop
Access distance	About 3m	About 50cm

more medium-scale buildings where a lot of RFID readers were set up in each floor have built. To simplify the model, assume that each floor is a big one room and it is not partitioned by the wall.

Two or more readers transmit in each of these floors and the transmission command of the per-device is transmitted to the RFID tag that reflects the floor and the wall and exists on the entire floor when there is a device. Then, the R/W device in the same floor controls timesharing by the carrier sense. In this case, the frequency channel need not be changed, and it is possible to unite them with the same channel. It is necessary to give a different frequency because the interference between R/W devices is generated even if the shielding effectiveness is applied to the ceiling and the wall when there is a hierarchical relationship of the floor. Moreover, when such two or more buildings are side-by-side, the interference problem between buildings remains and it doesn't become an effective solution only by the frequency dividing and timesharing.

Recently, the skyscraper might increase, it be adjacent between buildings, and the factor of interference increases. It becomes impossible to secure realtime of the delay in the interference workaround until present depending by application for which realtime like the gating arrangement is necessary.

3 MODELING OF SIMULATION

3.1 Operation overview of Gen2

The UHF RFID technology called Class-1 Generation-2 (alias Gen2) [11] settled on by EPC global is now a main stream, though there is various kinds of UHF RFID. Figure 2 shows the operation overview of the protocol of the Gen2 and the above-mentioned Radio regulation.

Reading tag is often executed two or more times. It is called a cycle here. LBT of 50 milliseconds is needed between cycles. Next, the processing that is called a round following initialization is repeated at each cycle. Initialization can be divided roughly into initialization according to the processing system of the reader and the initialization of tag (session initialization). A round is composed of the round initialization and slots. In addition, a slot can be divided into the inquiry and the reading to tag. When the corresponding tag does not exist, the reading time becomes unnecessary.

The number of slots is decided during the round initialization. Tags decide the slot number to respond randomly according to the number of slots. If there are multiple tags in the same slot, the reader does not detect response, so tag reading process is just skipped and they are read in the next round.

The formula that the reader puts out the electric wave is shown by the next expression.

$$T(\text{cycle}) = T(\text{system dependent part}) + T(\text{session initialization}) + N_R \times \{T(\text{round initialization}) + T(\text{inquiry}) \times N_S + T(\text{tag reading}) \times N_T\} \cdots\cdots (1)$$

N_R: Number of rounds in a cycle
N_S: Number of slots in a round

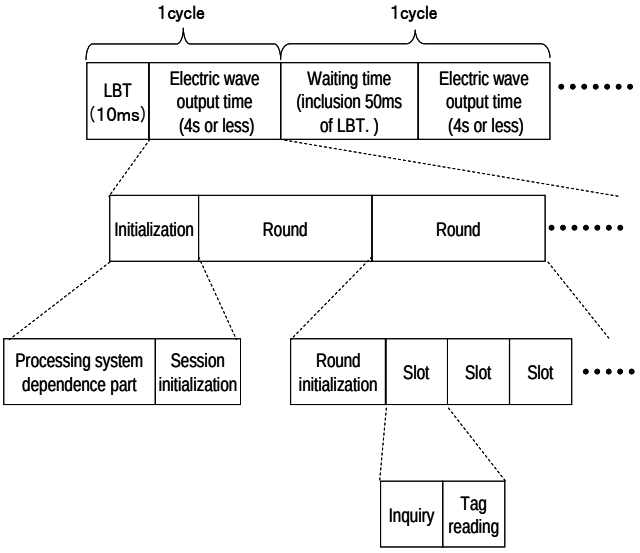

Figure 2: Operation overview of Gen2

N_T: Number of tag to read

The transmission rate by one channel (200 kHz) becomes about 40kbps, and Table 2 shows typical values for each T.

T (processing system dependence part)	about 10ms
T (session initialization)	about 2ms
T (round initialization)	about 1.5ms
T (inquiry)	about 0.8ms
T (tag reading)	about 6ms

If there is one round in which there are 16 slots:

$$T(\text{cycle}) = 12\text{ms} + (1.5\text{ms} + 0.8\text{ms} \times 16) + N_T \times 6\text{ms} = 26.3\text{ms} + N_T \times 6\text{ms} \cdots\cdots (2)$$

Multi-cycles are necessary for practical use. In that case, the number of reading times is given by the following expressions.

$$N(\text{the number that can be read}) = T(\text{can be read}) / (T(\text{cycle}) + T(\text{LBT})) \cdots\cdots (3)$$

T (can be read): time that tags pass the accessible area, i.e. reader repeats cycles during this period.

T (LBT): 10 milliseconds for the first cycle, and 50 milliseconds for the second and the following cycles.

Table 2: Typical Values for each T

	Number of bits	Time* (msec.)	Gen2 Command
System dependent part	-	10.0	-
Session initialization	50	2.0	SELECT
Round initialization	27	1.5	QUERY
Inquiry	9	0.8	QREP
Response	34	0.9	
Tag reading	23	1.1	ACK
Response	144	4.0	

* Including interval time between commands

3.2 Model of gate monitor (realtime processing)

Accessible distance of a UHF RFID is 2-3m. The gate monitor must complete reading while a person or a thing moves such a distance. For instance, the passing speed of a person is about 5km per hour, and it is assumed about 10km per hour in the band conveyer, 5km/h and 10km/h mean 1.4m/sec and 2.8m/sec respectively. Therefore, T (can be read) is about 1 to 2 seconds.

On the other hand, the number of tags can be assumed several pieces on the gate. For instance, one person passes the gate with a few items.

So we assume following values in the following simulation.

T (can be read) = 1 second
T (cycle) = 50 milliseconds

50 milliseconds for T (cycle) means that there are 4 tags and the system reads them in one round which has 16 slots.

In the simulation, gate passing events are given by the Monte Carlo method, and the state of the readers are updated every ten milliseconds. For instance, a reader changes in the state of LBT when a gate passing event is generated. It changes in the state of ACTIVE if there is an open channel after ten milliseconds. The state of LBT is continued when there is no open channel. Time in the state of LBT is measured when a reader changes in the state of ACTIVE, ten milliseconds are subtracted, and then the delay by LBT is obtained. The state of ACTIVE is continued during T (cycle). After T (cycle), the state is changed to LBT2 if the time is within T (can be read). In the state of LBT2, a reader waits for 50 milliseconds. A reader repeats ACTIVE state and LBT2 state during T (can be read).

After an event (i.e. a human pass the gate), the next event is generated evenly within the fixed time as following.

T (mean time) ×2 – T (can be read)

For instance, 1800 events per hour means T (mean time) is 2 seconds, and if 1 second is assumed for T (can be read), then the next event is generated within 3 seconds. In this simulation, event distribution within 3 seconds is uniform and share 9 channels by all the gate readers. Because the carrier sense level is –74dBm in the Japanese regulation and it is equivalent to 1.6km away from high power reader (1W, 36dBm output).

3.3 Model of stock control (non-realtime processing)

The many tags are read simultaneously when the inventory is executed in the stock control in bulk. It causes two differences compared to the gate model. The first is that the reader works eventually because an operation is done by human. So we introduce T (interval) instead of T (can be read). T (interval) is the interval time for the next operation and the event of the next operation is given by 2 times of T (interval) by the Monte Carlo method.

The second is T (cycles). The slots per rounds are assumed 16, and the typical T (cycles) are followings.

T (cycle) = 161 ms (20 tags and 2 rounds)
T (cycle) = 235 ms (30 tags and 3 rounds)

If there are many tags, some tags may respond in the same slot. In this case, a reader can know there are some tags to read and expand the number of slots from 16 to 32 or more for the next round. So T (cycle) may be more than several hundreds milliseconds. In the simulation in chapter 4, T (cycles) are changed from 100 milliseconds to 500 milliseconds.

4 SIMULATION AND PROBLEM

4.1 Simulation results of gate monitor

As mentioned, LBT may cause delay for each read cycle if there are many readers. The delay is calculated in this simulation with following parameters.

Number of gates: 15 - 150
T (cycle): 50 milliseconds
T (mean time): 2 seconds
(Traffic = 1800 events / hour)
T (can be read): 1 second

Traffic that passes the gate is given by the Monte Carlo method by using these parameters, and the relation between the number of gates and the amount of traffic was simulated.

The delay time is expressed at the probability distributions because traffic is given based on the probability by the Monte Carlo method. Figure 3 shows the relation between the delay time and probability distributions. The figure shows that, in case of 40 gates, the delay time is less than 100 milliseconds with 98% events while remained 2% events may wait for more than 100 milliseconds.

In this simulation, T (cycle) is 50 milliseconds, typical T (LBT) is 50 milliseconds, and T (can be read) is 1 second, so it is easy to understand that expected cycles are 10 per event. So number of total cycles an hour is 18000. Probability of 98% means that 360 cycles are delayed more than 100 milliseconds.

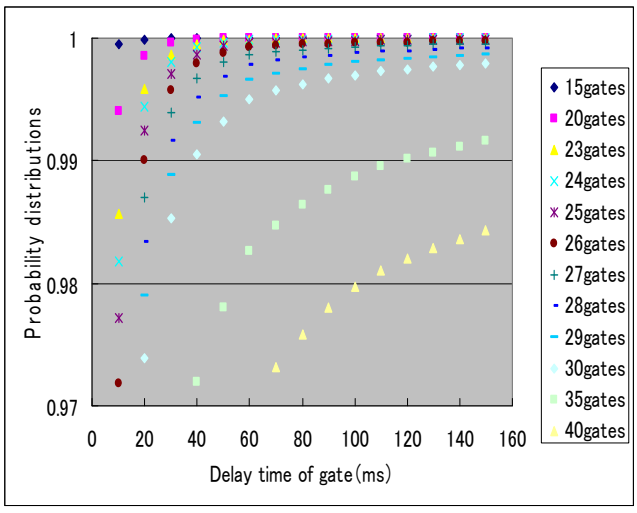

Figure 3: Relation between the delay and probability distributions

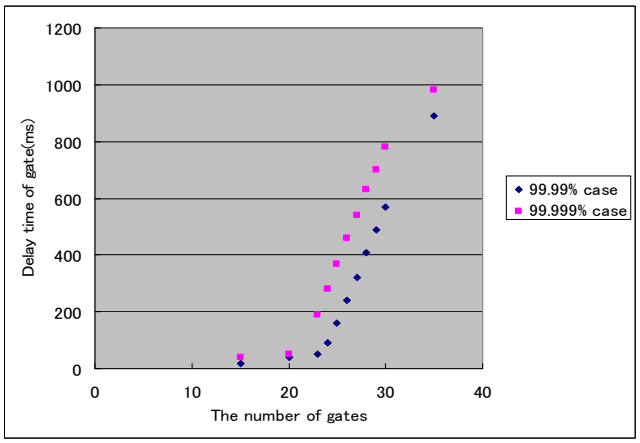

Figure 4: Relation between number of gates and delay time

In the system on practical use, probability of 99.99% or more is needed. Naturally, when the range of probability is expanded, delay time grows, too.

Figure 4 shows the relation between the number of gates and the delay at the probability of 99.99% and 99.999%. For instance, the delay times for probability 99.99% and 99.999% are 160 milliseconds and 370 milliseconds at the 25 gates respectively. It is shown that delay time rapidly stands up on the boundary of about 25 gates in Figure 4.

Figure 5 shows the relation between the number of gates and probability at the expected cycles of 60 to 80 percent. As described, the number of expected cycles is 10 per event. The number of expected cycles decreases by the delay, and it is shown as a probability distributions. The expected cycles of 60 percent means 6 cycles per event. The figure also shows that the boundary of the influence is about 25 gates.

4.2 Simulation results of gate monitor and stock control

Consider that there are two systems in a same building.. The first one is a gate monitor system discussed above and the second one is a system that reads tags in bulk like an inventory control system. T (cycle) for the second system is a several hundreds milliseconds typically.

The simulation conditions are:

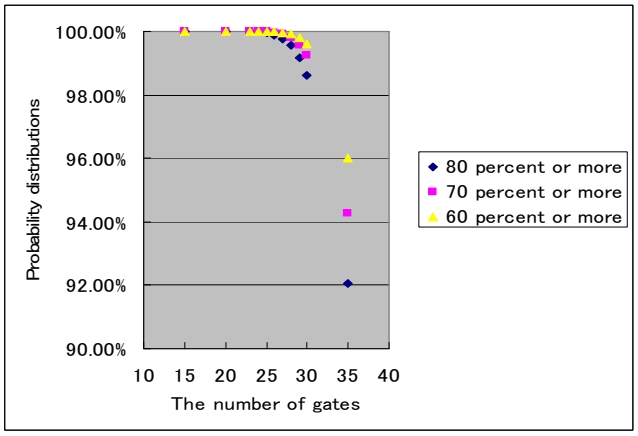

Figure 5: Relation of number of gates and the probability

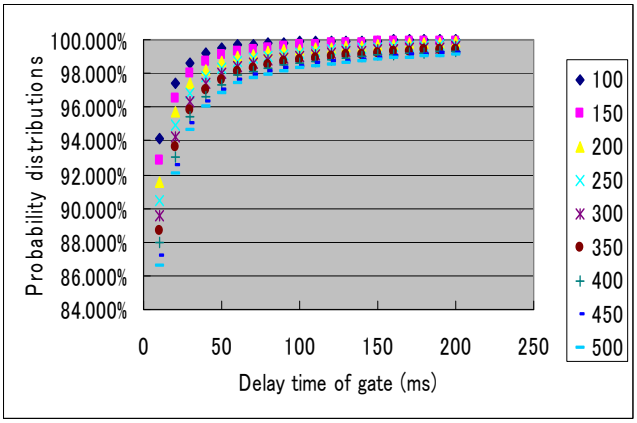

Figure 6: Delay time and probability distributions

Gate monitor system (same with 4.1):
- Number of gates: 25
- T (cycle): 50 milliseconds
- T (mean time): 2 seconds
- T (can be read): 1 second

Stock control system:
- Number of stock controls: 5
- T (cycle): 100 - 500 milliseconds
- T (interval): 500 milliseconds

Figure 6 is similar with the Figure 3 in case of 25 gates, with changing T (cycle) of stock control from 100 milliseconds to 500 seconds.

Figure 7 shows the relation between T (cycle) of stock control and the delay in the gate system at the probability of 99.99% and 99.999%.

4.3 Summary of problem

According to the simulation results, the delay time is increased when the stock control system coexists with the gate system. It means that the number of reading cycles at the gate may decrease, and the reading accuracy at the gate where realtime processing is necessary worsens as the reading time of the stock control becomes long.

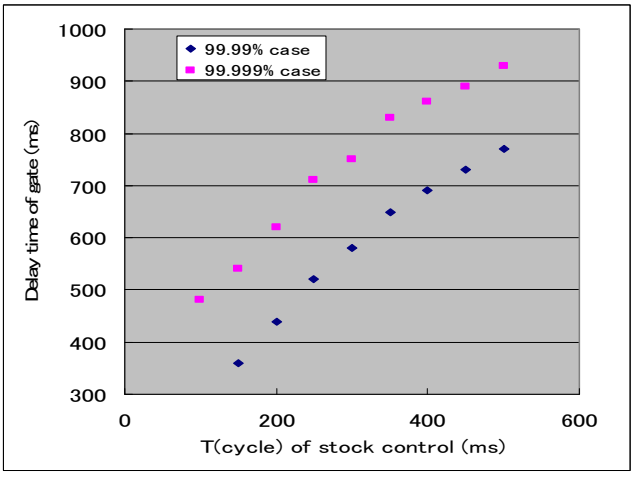

Figure 7: Reading time of gate delay time and stock control

4.4 Summary of problem

According to the simulation results, the delay time is increased when the stock control system coexists with the gate system. It means that the number of reading cycles at the gate may decrease, and the reading accuracy at the gate where realtime processing is necessary worsens as the reading time of the stock control becomes long.

5 SOLUTION AND VERIFICATION

As described in Section 3, a cycle consists of session initialization and one or more rounds. In the Gen2 standard, there are four sessions and some sessions can maintain the state during the fixed time even if the access by the reader stops. For instance, session S2 and S3 are able to maintain the state for two seconds or more.

Table 3: State maintenance (Gen2 standard) of the session

Session	Maintain the state
S0	less than 5seconds more than 500 milliseconds
S1	500 milliseconds
S2	2 seconds or more
S3	2 seconds or more

We propose the "cycle-divide method" to solve the reader-reader interference. The solution is that either of S2 or S3 session is used on the stock control side, and other sessions are used on the gate side. In addition, we stop the reader between rounds on the stock control, and restarts after LBT (Figure 8).

We assume that 8 tags can be read in each round and simulate with T (round) for stock control as 75 milliseconds. Again, we show the simulation parameters.

Gate monitor system (same with 4.1):
- Number of gates: 25
- T (cycle): 50 milliseconds
- T (mean time): 2 seconds
- T (can be read): 1 second

Stock control system:
- Number of stock controls: 5
- T (cycle) = T (round): 75 milliseconds
- T (interval): 500 milliseconds

Figure 9 shows the result. The "cycle-divide method" is our proposed method and Figure 9 shows the improvement by the proposed method. It shows that gate reader may wait for 600 milliseconds applying our method while it may wait for more than 900 milliseconds applying the earlier method when stock control readers use channels for about 500 milliseconds.

6 CONCLUSION

In this paper, we show the problem of the UHF RFID system caused by the LBT that readers are influenced by other readers and do not keep realtime capability when many readers work simultaneously.

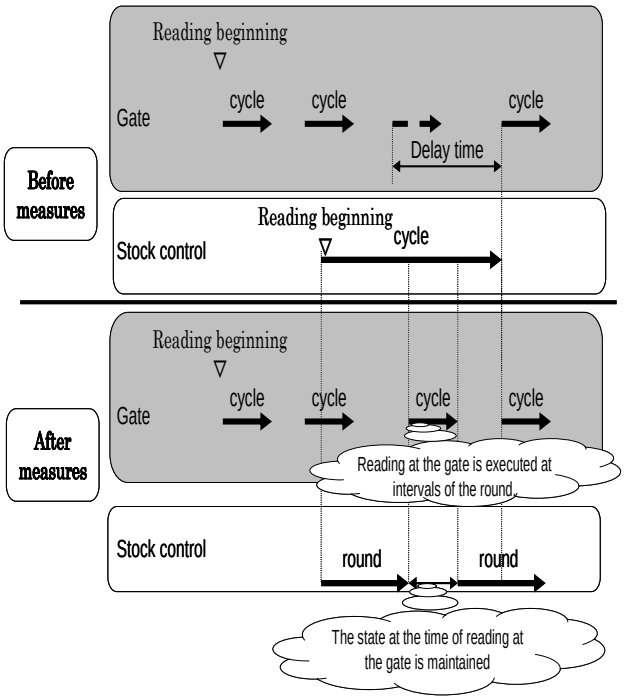

Figure 8: Sequence of the "cycle-divide method"

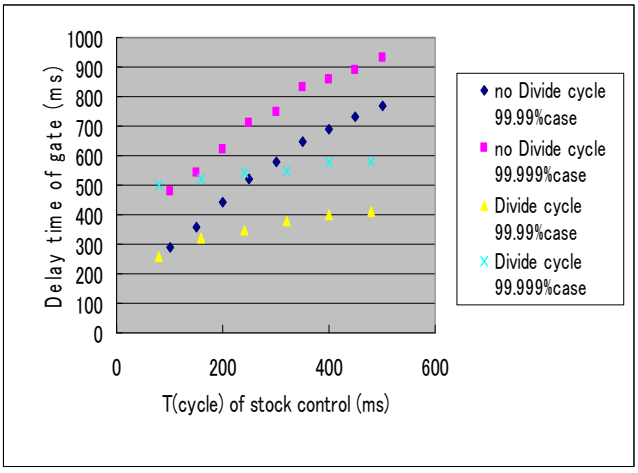

Figure 9: Delay relation between inventory system reading time and gate system

We also show the solution for this problem. Our solution named the "cycle-divide method" is very effective, and keeps the realtime capability by changing the session ID and suspending the transmission between rounds of the non-realtime readers.

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(Received July 28, 2010)
(Revised August 22, 2011)

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[Practical Paper] Development of a Communication System with Pictograph Translation for Parent and Child

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Abstract—Children in day care facilities can experience anxiety and a sense of isolation. Equally, working parents have on-going concerns about their children's state of mind. A system to enable mail communication between children and parents has been developed. By using QR code cards and a touch screen with pictographs, pre-school age students are able to create and transmit mail messages. The message is translated into text, which is transmitted to the parent. The parent's response is then converted to pictographs. Field trials and evaluations have indicated that the system is useable and has good potential. Nevertheless further improvements are possible.

Keywords: Communication, Parent and Child, Translation System, Pictograph, Mobile Phone

1 INTRODUCTION

The number of working mothers has been increasing over recent years [1]. This often results in pre-school age children being placed in day care facilities or nursery schools. Pressure of work may lead to parents asking the facility to keep their child for longer hours and/or parents arriving late to collect their children. This causes stress for both parent and child. The child can feel anxious or isolated and, through a combination of worry and guilt, the working parent finds it hard to concentrate on their job.

Therefore there is a need for mechanisms to facilitate communication between parents and young children. We selected an asynchronous communication mode to maximize convenience, especially for parents who may not be able to communicate in real time from their place of work but who can readily use a mail function.

Three to five year old children recognize pictures and animation more easily than characters. Therefore, we selected pictographs as the mechanism for exchange emails. Pictographs are already used in mail communications instead of sentences, but the pictographs used on mobile phones are not easy for children. Therefore we invented an original pictograph lexicon based on a survey.

Using our system, a child can create mail using pictographs and a parent can write mail using sentences. The system translates between the pictographs and sentences. We have further developed and improved the system based on opinions from a company that was developing products for preschools. We tested the system in preschools. Both parents and children involved in evaluation found it useful.

2 BACKGROUND

Many kinds of information equipment for children such as child-friendly mobile phones are now available on the market. However such equipment requires the user to be able to read. In addition, there are products available so that parent can see his or her child from a distance by using a camera. Mimarmorikun [2] is one such system. However, its use is limited because a parent cannot access the image via a mobile phone and it does not offer interactive communication. Alternatively, there are communication systems using pictographs [3,4], but these systems are not practical for use in communication between parent and child.

We sought to develop a system with the merit of enabling communication at any time, by using a mail function. Since the primary criterion was that any system must be useable by young children, we chose to use pictures and animation rather than conventional text. Prior to creating a working system, we collected questionnaire responses from 56 parents and 29 caregivers and teachers at three preschools. Our purpose was to determine the perceived value of the system and to collect information on the likely content of parent child communications.

The survey elicited the following responses. On the plus side respondents believed that parents could resolve feelings of unease about their children and children themselves might be less anxious.

On the downside, there was concern expressed about the increased burden the system may place on caregivers and pre-school teachers. The questionnaire responses found more positives than negatives in using the system so the basic approach was seen as valuable.

Nevertheless, the perceived weakness would have to be resolved. So, it was clear that the interface would have to be very child friendly to enable children to use it unassisted.

Three to five year olds are better at understanding pictures and animation than recognizing characters or reading/writing sentences. Therefore, the child interface uses animation. In addition, the pictures and animation are activated by touch panel rather than keyboard and mouse.

We used responses from questionnaires from 67 parents and their child to identify the most useful range of pictographs for communication between parent and child. This resulted in a set of 70 keywords, each with an associated pictograph [5,6].

3 SYSTEM CHARACTERISTICS

The communication system has a translation function between pictograph and text message. The system translates both the child's pictograph message to text message, and parent's text message into a pictograph message. A parent can use either a mobile terminal or a personal computer, while the child uses a special terminal located in their preschool or nursery school.

Figure 1 shows the catalogue of pictographs and the screen for creating pictograph sentences. Pictographs can be selected by touching this screen, and this builds a pictograph sentence on the upper left-hand side of the screen. In this case, the pictographs are "Sad", "Meet me", "Soon", so it means "I am sad. Please meet me soon."

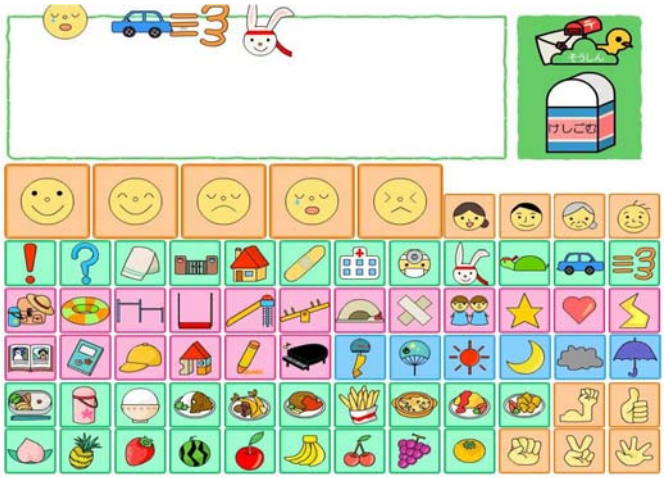


Figure 1: Screen for creating mail using pictographs.

Since the system can be used with either a personal computer or a mobile phone, a parent can access it regardless of time and place. The pictograph message is translated into text and sent to the parent's mobile phone or personal computer. Conversely, the parent's text response is translated into pictographs and transmitted to a special terminal in the preschool.

4 SUMMARY OF SYSTEM STRUCTURE

Figure 2 shows the system structure. Children can use a terminal in their preschool. They operate it by using the touch panel of a 19 inch liquid crystal display. They can log on to this terminal easily using the QR code reader. The children's terminal has 70 different pictographs arranged in the pattern shown in Figure 1. The server manages necessary information such as parent's address and child's name using an address list. The translation block translates between pictograph messages and text messages. The parent utilizes either a mobile phone or a personal computer. In addition, the parent can review the picture diary described in the next section using Internet [7].

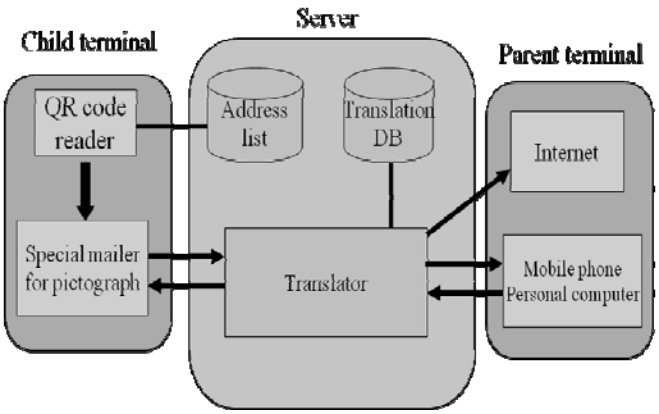


Figure 2: System structure.

5 SYSTEM FUNCTIONS

5.1 Log on function using QR code

Figure 3: Nameplate with QR code.

The preschooler logs on using a name card with a QR code shown. These are personalized for easy recognition (Figure 3). The log in screen uses animation (Figure 4) to make the process easier for small children. The QR code automatically identifies the child and the parent's mail address. Once logged on, the child can then proceed to create and send messages.

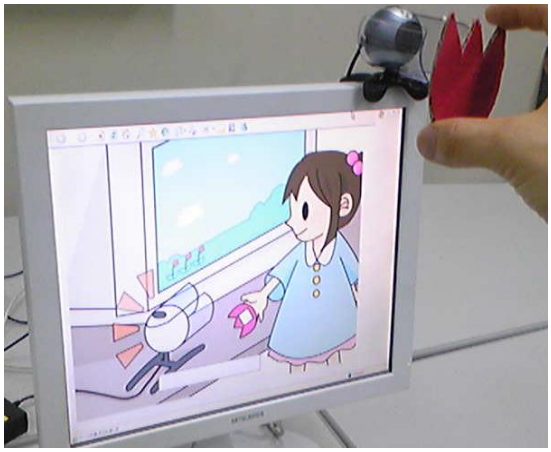


Figure 4: Log on screen.

5.2 Operation using the touch panel

The child's terminal in preschool can be operated by finger touch on the panel. No mouse or keyboard is required so a child requires little if any assistance from the staff.

5.3 Pictograph translation function

A pictograph translation function in the server (Figure 2) converts pictographs to sentences and vice versa. A survey of 56 parents and 29 caregivers and teachers enabled us to identify the key elements of conversation and led to the choice of 70 pictographs.

5.4 Picture diary function

Children's messages are stored on the server in both pictograph and sentence form. This diary is accessible via the Internet. Figure 5 shows a view of the picture diary. This function enables parents and their children to review the communications later and discuss them together. We believe that this is a positive resource for parent and child communication. It also enables parents to keep a record of the messages and see patterns in the type of messages their child has sent.

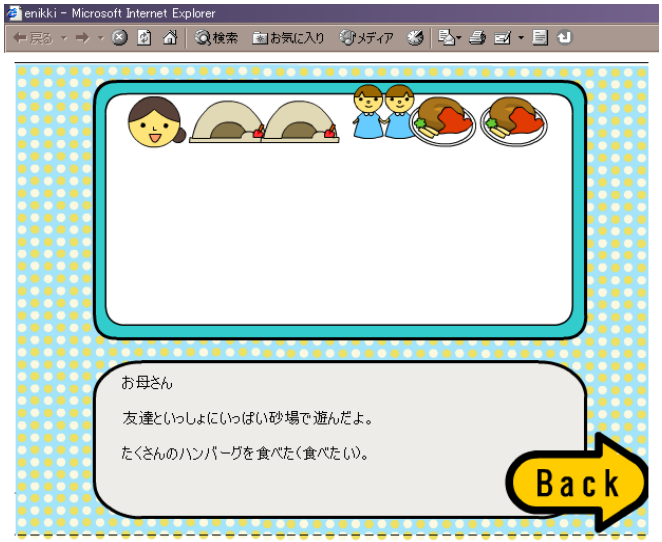
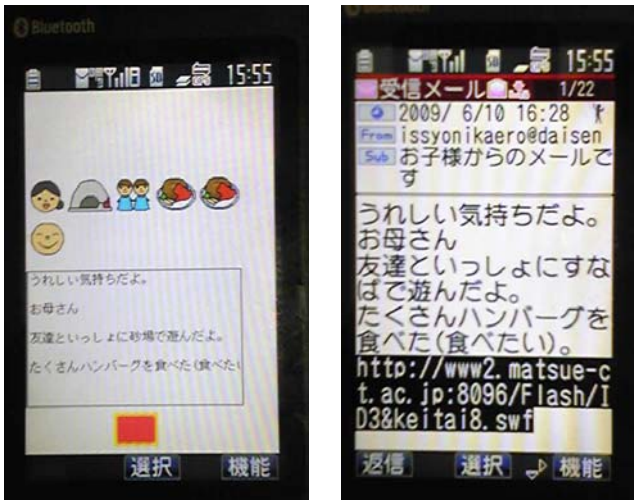


Figure 5: Picture diary.

5.5 Function for pictograph browsing using mobile phone

Parent can read transferred text message via mobile phone or personal computer. The pictographs selected by the child can also be viewed. Sample screens are shown in Figures 6 (A) and (B).



(A) Transferred mail (B) After connection to URL

Figure 6: Sample screens of browsing pictographs and translations on mobile phone.

6 IMPLEMENTATION

6.1 Language

We developed the special mailer program using FLASH. Thus, we could make dynamic content including animation , and could develop a system a child would find interesting. The program for text processing, translation and mail processing was developed using PERL.

6.2 Translation Algorithm

The pictographs are divided into five categories; "feelings", "person", "adjective or adverb", "verb and noun", and "other". The translation program translates the pictograms in each category sequentially.

Order of translation: feeling → person →

adjective or adverb → verb and noun → other

Translation result:
"Mother, I am sad. I played seesaw with my friend. I want to eat (ate) much curry rice."

Figure 7: Example of pictograph translation.

The translation algorithm is shown in Figure 7. First, the words of "feeling" and subject must be translated because the child primarily wants to explain his or her feelings to the recipient. For example Figure 7 shows that the algorithm translates the pictographs of "sad" and "mother" to "I am sad, mother" and conveys his or her feelings first. Next, the algorithm converts what the child did or wants to do by

combining “adjective or adverb” and “verb and noun”. As shown, if there are pictographs of “with friends” and “see-saw”, the translator interprets this as “I played seesaw with my friends “. This is because, to a child, “seesaw” means the activity such as “I played seesaw”. On the other hand, plural pictographs are translated as “much”. In this example, curry is translated “I want to eat (ate) much curry.” Janken such as “Goo” or “Choki” are assigned to the “other” category and are translated last in the text message.

7 METHODOLOGY AND OUTCOMES

We evaluated this system twice in preschools in Matsue city. We re-evaluated the child- terminal, because at the time of the first trial we had developed only a PC screen. We could evaluate with mobile phone, on the second trial because we have now developed the parent’s terminal. On the first occasion, five year olds operated the system offline. The second time, parents and children used mobile phones and the special terminal online. Figure 8(A) is a picture from the first evaluation and Figure 8(B) shows the second trial. The evaluations were based on two items. First, “Could a child use the system unassisted? (Observations of 30 adults.) Second “Did translation result agree to the child’s intention?” (Responses from seven children.)

(A) Children using the special terminal

(B) Parents and children using the system

Figure 8: System in Use.

We explained the operation method to groups of three children at a time. Then, they each had a chance to try it out. All the children tried twice.

The children were then asked to send a message to their mothers. After sending the message, the children were interviewed regarding the content and intent of their messages.

The outcomes were positive. The child participants had no difficulty understanding how to log on using a nameplate with a QR code or how to send mail. They could also use the eraser function and understand its purpose.

Six of seven children said the translation result agreed with their original message. The exception was a child who selected too many pictographs and this obscured the text translation.

The reaction of the children during field trials and evaluations was very positive. They were very enthusiastic and wanted to try it by themselves. We believe that this was in part due to the appeal of the animation and pictographs, which the children understood easily. All the children could use the system immediately, confirming that the system has potential as a communication medium.

In the second experiment, eleven pairs of parent and child used and evaluated this system. We showed standard sentences to parents, and they then created and sent messages. Each child responded to the parent’s message and the parent then sent a response. After the field trial, parents answered a questionnaire. The questions were divided into evaluation of the mobile terminal functions and evaluation of the system as an effective means of communication.

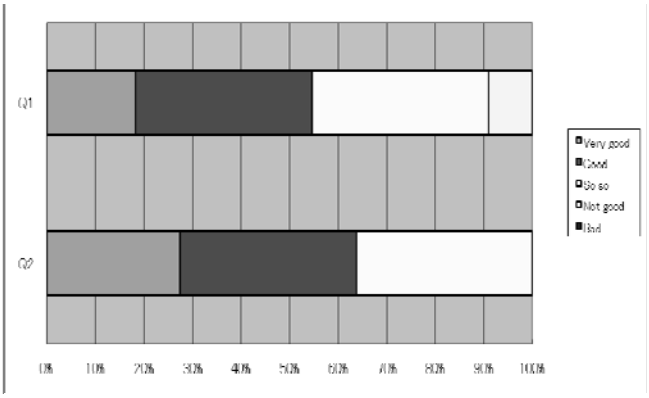


Figure 9: Evaluation of the function of mobile terminal.

The questions and results are as shown below.

(a) Function of pictograph view screen of mobile phone

Q1 How useable did you find it?

Q2 Could you see the screen and pictographs easily?

(b) The system as a hole

Q1 Were you satisfied with the translation function?

Q2 Did you feel this system would be effective for relieving your child’s sense of isolation?

Q3 Did you think this system would be useful as a tool to communicate with your child?

As shown in Figure 9 the evaluation of usability of the mobile terminal was good. Prior to the trial, an earlier questionnaire had indicated that about 50% of parents were concerned about the additional burden the system would place

on the nursery school staff. However, after the field trial, 80 % of parents agreed that this system was useful for communication (Q3 of Figure 10). Parents commented that this system was interesting and they were happy to receive mail from their children while at work. They commented that this system would be useful.

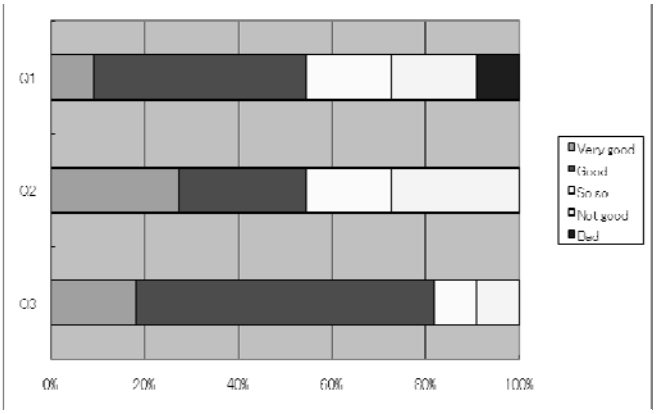


Figure 10: Evaluation of the system.

Although the questionnaire results, comments and our observations were generally positive, there are still some problems to be resolved.

We could observe as each child-parent pair communicated through mail exchange. Most children could not respond adequately to their parents, because the children had only pictograph translations of the sentences and so could not always understand their parent's intention. For instance, a sentence "I will be late to go to the preschool, because I am busy now." could not translate to pictographs adequately. Whereas parents could see both pictographs and sentences. To resolve this problem, we are considering ways to also show sentences to those children who can read, and for the system to read the sentence by speech synthesizer for those who cannot.

Figure 11: Example of improved screen for pictograph mail.

Another problem is that the pictographs cannot distinguish between past and future. For instance even if the child's intention was to convey "I ate", the translation result is "I ate or I will eat", so the message to the parent is ambiguous.

There was a problem with the pictograph table as children took a long time to select from the many pictographs to make a message. We have therefore modified the screen. Figure 11 with the new arrangement of the pictograph table can be compared with Figure 1. The expressions and foods are now ordered as shown. In addition, some pictographs that were not used by the children have been deleted. Main changes are as shown below.

(1) First line includes pictographs of family and emotions because these are most important to the child.
(2) Next lines include pictographs of foods and play activities.
(3) Other pictographs follow. Unused pictographs such as "Uchiwa", "Fuurin" and "Goo" were deleted from the table.

Future evaluations will include comparison of the original and new pictograph tables.

Japanese is written using two syllabaria, hiragana and katakana plus kanji. Conventionally, children learn hiragana first followed by katakana, then finally kanji are introduced. Many children learn to read words, if not sentences, in hiragana and katakana before they enter elementary school. Therefore, storybooks for younger learners are presented in a mixture of hiragana and katakana. Parents with slightly older children, five years old and above, commented that it would be convenient to enhance the pictograph message with hiragana and katakana. If the child can read a little, he or she could then communicate more smoothly. To accommodate the wider age group we are planning to offer a choice of pictographs and characters.

8 CONCLUSIONS

We developed the communication system to offer asynchronized communication between parent and child. The system relies on a QR code log-on card that identifies the child and the target recipient. Children create messages by selecting pictographs that are translated into text and transmitted to the parents' mobile phone or personal computer. The reverse process enables parents to send messages back.

We improved the system after receiving comments from a company that is developing some products for preschools and receiving questionnaire responses from pre-school institution staff and parents. After trials that demonstrated that system use was within the capability of preschoolers, we ran evaluations and sought further feedback from parents and pre-school staff. This has led to further improvements such as modifying the pictograph catalogue. Additional modifications will include including an option for older children such as six years old to select Japanese characters and refinements of the pictographs to include verb tenses. Enabling the child to select a recipient from father, mother or grandparent will also make it more useful. This system received the Grand Prix Award at the Chugoku Campus Venture Grand Prix in 2009.

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(Received July 6, 2010)
(Revised December 2, 2011)

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[Practical Paper] Pictograph Communication using Tabletop Interface

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Abstract - The interpretation of the pictograph is approximately common through the world. We have developed a meeting type pictograph chat system that we assume to use at the tourist information center. The system can easily add a photograph as a pictograph, and use a tabletop interface for easy operation. Two users can operate the system simultaneously. Results of experiments show that the understanding degree of chat contents tended to improve when we used the photograph as a pictograph.

Keywords: pictograph, chat, tabletop interface, tourist support

1 INTRODUCTION

The Japanese who traveled in the foreign countries or the foreigners who traveled in Japan increased, and opportunities to regard communication as a foreigner increased. However, it is not still easy to communicate with a partner, who speaks a different language. Therefore a system supporting communication between different languages is requested without learning a specific language. The interpretation of the pictograph is approximately common through the world. Some systems support for communication using pictographs [1],[2].

We have developed a meeting type pictograph chat system that we assume to use at the tourist information center. The system can easily add a photograph as a pictograph, and use a tabletop interface (Diamond Touch Table) [3] for easy operation. In this paper, we show the experimental results using the system.

Chapter 2 explains the related work about this system, and Chapter 3 shows the proposed system. Chapter 4 describes the experiments and results, and Chapter 5 is the conclusion.

2 RELATED WORK

Pictograph chat communicator II [2] is a system, using only pictographs to communicate each other. The system consisted of two PCs via LAN. Pictographs are in color but a part is monochrome symbols. There are 547 pictographs in the system. This system has 9 tabs (including the History Tab), and pictographs are divided into 8 tabs. The application experiments of this system were performed by a Japanese student and a foreign student or an overseas international conference participant. The communication was performed smoothly. There was an opinion that there were few kinds of pictographs and few objective pictographs.

Zlango [4] is a pictograph-based system built for web and mobile messaging. The system has about 200 pictographs, which are changed from time to time, depending on its usage. Unused pictographs are deleted and new ones are being added to the system. The pictographs are divided into groups such as “People”, “Actions”, “Places”, and “Feelings”. Zlango was developed in Israel and could be installed in cell phones in 12 countries. Zlango’s customers include Portugal Telecom/TMN, Globe (Philippines), Kiyv Star (Ukraine), Celcom (Malaysia) and other mobile operators.

3 THE PICTOGRAPH CHAT COMMUNICATOR III-T

3.1 Design policy

(1) The use of the tabletop interface

We use Diamond Touch Table, which is one of a tabletop interface. The system has a large view area and enables the intuitive simultaneous operation with plural people.

(2) A function to display a proper noun as a pictograph

We implement a function, which adds photos or images as pictograph. The pictographs which are made from these photographs and images let difference in interpretation of the communication reduce.

3.2 System configuration

The system was developed for Diamond Touch Table. In the upper part of the system, a mirror reflects a picture from a projector, and then the picture is displayed on a display of Diamond Touch Table. The screen display domain is 490mm x 650mm. Two users use it in a meeting. They can operate the system simultaneously. They can use it synchronously. The number of pictographs is 560 and the size of pictograph is 45x45 pixel (29mm x 31mm on the screen). The system can use photographs as pictographs. A photograph can be fetched from Web or a digital camera. We use Flash, PHP, and XAMPP for the system. Figure 1 shows a screen of the system. The system consists of about 2,000 lines programs.

3.3 Operation of system

At first the user chooses one's icon. In Figure 1, “cat” icon (left in bottom) is a user’s icon. A supporting pictograph (left in middle) is displayed when user chooses a tab (square and colorful button in bottom). If user finds the objective pictograph, then user touches the pictograph. The pictograph is selected and then input to the input field (left in bottom). In Figure 1, pictographs of “question” and “drop of water” are in the input field. The func-

Figure 1: A screen of Pictograph chat communicator III-T.

tion of delete and sorting are equipped at the input field. User repeats the operation mentioned above and makes a sentence. If the sentence is completed, then user touches the input button (pentagonal button in the middle of bottom). The sentence is represented vertically in the output field (right in top). Another user operates it in the same way in the other side simultaneously.

The additional function of the pictograph was implemented by PHP and Flash. When user wants to add the pictograph, user pushes the browser start button (a picture of the earth in the right of bottom) of Figure 1 and runs a browser. Next, user searches the image which user want to add as a pictograph on Web, and then user saves it in a designated folder manually. When user takes in a photograph from a digital camera and flash memory, user copies it in a designated folder and has only to save it.

4 EXPERIMENTS AND RESULTS

4.1 Experiments

The experiment went with two one set. One acts as a tourist, and the other acts as a member of explanation of the tourist information center at Osaka city.

We explained only the simple operation of the system to a subject. We do not explain the meaning of the pictographs. When user cannot express the content that user wanted to convey only with a pictograph prepared beforehand, we directed that user took an image from Web at any time. The experiment was finished when a member of explanation of the tourist information center replied it for all questions of the tourist.

The procedure of the experiment is shown below.

(1) The subject of the part of tourist asks questions decided beforehand such as a place or a route about sightseeing spot to a member of explanation position of the tourist information center. The questionary is shown Table 1. We do not tell a content of question to a member of explanation of the tourist information center at all. The subject assumed that there was knowledge around the sightseeing to some extent. Figure 2 shows a scene of experiment.

(2) The subject wrote down how he/she interpreted the meaning of one's remark and the remark of the partner after the chat end. The subject did questionnaire entry last.

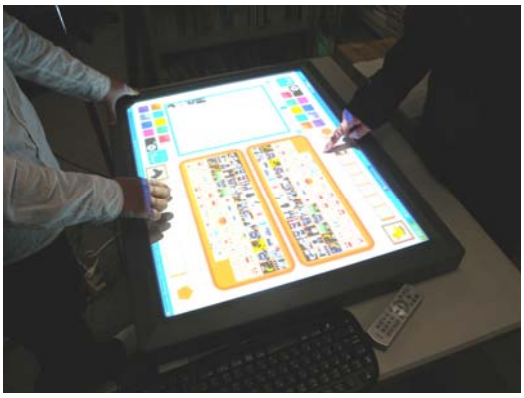

Figure 2: A scene of experiment.

Table 1: Questionnaire.

Questionnaire
(1) How do I go from Osaka to the Chinatown of Kobe?
(2) How does it take time?
(3) How much does the fare depend on?
(4) Which direction should I walk in if I arrive at the station?
(5) What is the recommended cooking in the Chinatown?

4.2 Results of Experiments

We have performed experiments using the system eight times. Three foreigners act as tourist (other five times were Japanese). Table 2 shows an experiment number and the profile (nationality, male/female, pictograph user/non-user) of the subject.

Figure 3 shows a result of a chat (experiment No.7). The bus icon corresponds to the tourist and the Penguin icon corresponds to the member of explanation of the tourist information center. The result that described the meaning of the remark by one's pictographs is shown below. The pictographs, which are made from pictures of a Chinatown, Chinese food, the station name board of Sannomiya Station, and the steamed meat bun, are used

Table 3 shows time and output linage and the understanding degree that were needed for the chat of each pair. We take the evaluation method that Munemori [5] suggested in a calculation of the understanding degree into account.

Table 4 shows the ratio of the image and the ratio of the image per line, and understanding degree of each experiment. The term of image includes photographs and images. “Image/line” means the number of images divided by the number of lines.

Table 5 shows the questionnaire results of experiments. The value of Table 5 shows the mean value of each 8 person about tourists or members of explanation of the tourist information center.

Table 2: The profile of the subject.

No.	Tourist	Pictograph	A member of a tourist information center	Pictograph
1	Japanese student－Male	User	Japanese student－Male	User
2	Japanese student－Male	Non-user	Japanese student－Male	User
3	Japanese student－Male	User	Japanese student－Male	User
4	Japanese student－Male	Non-user	Japanese student－Male	User
5	Foreign student－Female	User	Japanese student－Female	User
6	Japanese student－Male	Non-user	Japanese student－Female	Non-user
7	Foreign student－Female	User	Japanese student－Male	User
8	Foreign student－Female	User	Japanese student－Male	User

Table 3: Time, output linage, and the understanding degree that we needed for a chat.

Mean value
Time (minutes): 23.3
Output linage: 19.5
The understanding degree of a tourist (%): 90.9
The understanding degree of a member of a tourist information center (%): 94.3
The understanding degree of all subjects (%): 92.9%

The description part of the questionnaire is as follows.

(1) About adding a photograph and an image to a chat

-Because it was fetched an image by Web, it is easy to have come to express it.

- Because a proper noun comes as well as a nuance properly, it is good.

- It is good that I can add it, but may be clogged up in a part of the letter input in the difference of the language when it is a foreigner handling Arabic with a Japanese PC.

(2) About system

- It was easy to take the pictograph big, but it was difficult for a lot of tabs to look for it.

- Not only I open up a browser, search results should be displayed in a chat screen.

(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)
(11)
(12)
(13)
(14)
(15)
(16)
(17)

(1) Because I want to eat Chinese food in a Chinatown, how is it good in a train if I go?
(2) You can eat if you get on a train for Sannomiya Station.
(3) How does it take time by a train?
(4) It is 2:00 (misunderstanding).
(5) How much is a price to Sannomiya?
(6) It is 250 yen.
(7) Which direction should I go to from the station?
(8) You walk from Sannomiya.
(9) Which direction should I have walked in?
(10) That exists a direction, where many shops are existed, from the station.
(11) Then there is a Chinatown.
(12) Thank you.
(13) How does it take time on foot from the station to the Chinatown?
(14) You arrive on foot in five minutes.
(15) What kind of delicious dish is it eaten?
(16) A steamed meat bun is delicious.
(17) I like steamed meat buns.

Figure 3:Example of chat.

- I want operation of the pictograph input to be possible with drug and/ or clicks.

- It is difficult to express progress of time.

- If there was a brief cartoon film pictograph, it was better.

-You should make a tab used well.

- There were many pictographs, which I did not use.

- I wanted the enlarged function of the photograph.

- I want relevance in the content of tab and the tab itself.

- It was difficult to show a direction.

- The destination of the image is hard to find.

4.3 Discussion

(1) Pictograph chat

- About the interpretation of the pictograph

Table 4: Rate of image (%), image/line (%), and understanding degree (%).

No.	Rate of image (%)	Image /line (%)	Understanding degree (%)
1	9	29	89
2	6	22	88
3	14	50	91
4	15	67	93
5	2	5	95
6	11	32	93
7	15	69	96
8	19	77	98
Mean value	11.4	43.9	92.9

The understanding degree of chat was 93%. By the former experiments of general purpose, the understanding degree of chat was 91% and input line par minute was 2.3 [2].

-About Diamond Touch Table

The average of the evaluation to show in the following assumes it the mean of a tourist and the member of explanation of the tourist information center.

Question item (3) - 3 of Table 5 (We can see the pictograph of our partner in input field. I predicted that the partner wanted to tell and was able to consider it to my sentence making.) was evaluated 3.8. During an experiment, a subject assisted an input of the partner, and a subject also replied it to see an expression of the partner. It may be said that there was a merit to make face-to-face communication by Diamond Touch Table.

(2) The consideration about the additional function of the pictograph

The average of the evaluation to show in the following assumes it the mean of a tourist and the member of explanation of the tourist information center.

Question item (3) - 1,2 of Table 5 (Adding images to pictographs was convenient and it was easy to understand the sentence when images were added to pictograph) was evaluated 4.5. As for the ratio of the image for pictograph and the ratio of the image for the output linage, understanding degree tended to become high if the ratio of the image was high. As for the coefficient of correlation, that there was equilateral correlation with 0.46, 0.51 was confirmed each. From the questionnaire description part above (verse 4.2), it evaluated good.

(3) Discussion about the experiment environment

About question item (1) – 3,5 of Table 5 (There were targeted pictographs that I wanted to use and I was able to understand the things my partner was trying to say), a tourist evaluated them 3.9, 3.4 each, and the member of explanation of the tourist information center evaluated them 2.7, 3.0. About question item (2) – 1 of Table 5 (The input operation was convenient), a tourist and a member of explanation of the tourist information center evaluated it very high. Because Diamond Touch Table has multi touch function and the system is operated by multi-user simultaneously. About question item (2) – 4 of Table 5 (I was able to look for the targeted pictographs smoothly), a tourist evaluated it 3.3, and a member of explanation of the tourist information center evaluated it 2.0. For both questions, the evaluation of the member of explanation of the tourist information center was low. Therefore, the expression of the answer side is more difficult than that of the question side. It is thought that pictographs specialized in a guidebook are necessary. But, too many numbers of pictographs are difficult to treat.

Table 5: Questionnaire results of experiments.

Questions	A tourist	A member of a tourist information center
(1) Pictograph		
1. I was able to understand the meaning of all pictographs in the system.	3.8	3.6
2. Sentence making (using pictographs) was easy.	3.1	2.8
3. There were targeted pictographs (pictographs that I wanted to use).	3.9	2.7
4. I was able to understand the things my partner was trying to say.	3.6	3.5
5. I was able to make sentence what I want to say.	3.4	3.0
(2) Diamond Touch Table		
1. The input operation was convenient.	4.3	4.5
2. Elimination and sort of pictographs was easy.	4.3	4.1
3. Pictograph was easy to see.	4.0	4.1
4. I was able to look for the targeted pictographs smoothly.	3.3	2.0
(3) System		
1. Adding images to pictographs was convenient.	4.5	4.5
2. It was easy to understand the sentence when images were added to pictograph.	4.5	4.6
3. We can see the pictograph of our partner in input field. I predicted that the partner wanted to tell and was able to consider it to my sentence making.	3.6	4.0

１：I disagree strongly, ２：I disagree, ３：I don't agree nor disagree, ４：I agree , ５：I agree strongly

Specialized pictographs were requested with limit. There was no difference between the combination of the subject by this experiment.

(4) Discussion about the difference in interpretation

About the question item (4) of Table 1 (Which direction should I walk in if I arrive at the station?), a tourist asked as Figure 4, and the member of explanation of the tourist information center answered as Figure 5. Both subjects understood "which direction I should have gone" about the question of Figure 4. By the answer of Figure 5, there existed various answers like "go straight the hospital right", "go the hospital in the south", or "went along the bottom of the hospital". There existed some interpretation. We understood that we were hard to express an act to be twisted. It is difficult to express the act to be twisted in Figure 5. The pictograph, which is showed as "bending to the left" "bending to the right" is requested.

Figure 4: A question tourist.

Figure 5: The answer of the member of tourist information center.

5 CONCLUSION

We have developed a meeting type pictograph chat system that we assume to use at the tourist information center. Two users can operate the system simultaneously. We show the consideration of the result of the experiment below.

(1) It was easy to come to express a style by using a photograph and images such as a building and a place, and the scenery as a pictograph. Then, it was easy to have come to tell content to a partner. In addition, the average understanding degree was high with 93%, and understanding degree tended to become high if the ratio of the photograph and image was high.

(2) A pictograph specialized in a guidebook to "go to the north" and I "turn to the right" is necessary to do a guidebook.

(3) We were able to confirm that user predicted that the partner wanted to tell, because they met each other. So, user can support the input of the partner. This operation is one of the merits of the system.

In the future, improvement of the interface (ex. adding a map function), the making of a pictograph specialized in a guidebook moderately, and an example sentence indication function will be requested. The system will be used on a tablet PC.

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(Received July 26, 2010)
(Revised February 8, 2012)

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