cPost-it: Context-Based Information Sharing System*

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Abstract. In this paper, we propose cPost-it, which allows users to share various types of media data in public places by exploiting context such as the user's identity, location, time, intention, and object's identity. The proposed system consists of three key components, i.e., 'cPost-it Client' allowing users to retrieve (augment) digital messages on the real-world objects, 'cPost-it Object' augmenting shared digital information, and 'cPost-it Server' managing the information. The cPost-it provides location based service (LBS) by retrieving the embedded information from the physical objects. Also, it provides the personalized information by exploiting the user's identity, location, time, etc. According to the subjective evaluations, the proposed cPost-it framework may play important roles in sharing information for the ubiquitous computing environment.

1 Introduction

In general, it is inconvenient for many and unspecified users to share messages in public places through the current information sharing systems such as a whiteboard or post-it. For example, the handwritten message on a whiteboard or the post-it (plain text or at most visual data) can be removed accidentally or be attached to an object in a mess. As a result, a new type of information sharing system may be required to efficiently share digital information in the public places.

To solve these problems, many researches have reported on the ways of sharing information in the form of digital messages such as text, voice, picture, and video with PDA (Personal Digital Assistant) and to access the information according to user's location. The NaviCam [1][2] displays information about an object on handheld devices by analyzing the mark on the object with a camera. The CyberGuide [3] provides a tourist with guiding information about a place or building according to the user's location obtained using GPS (Global Position System). The Stick-e Note [4] allows to save a file with condition such as location, temperature, and weather in a desert or field. Then, the file automatically opens when the condition occurs later on. The commotion [5] and GeoNotes [6] provides mobile users with filtered information which users will specify in advance according to user's location from user tracking

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systems. The CoolTown [7] provides information services by creating a tighter link between the real world entity and its virtual representation. However, these systems have following problems when they are used in public places to share information. At first, while it is convenient to retrieve the augmented information from an object, it is inconvenient for user to immediately augment messages to entities in real world for sharing messages. Also, these systems mainly exploited location information such that they have limitation in providing information using various types of contexts.

In this paper, we propose cPost-it, which allows users to access digital messages with a PDA in public places, i.e., augment or retrieve the message on real-world entities by exploiting the context such as user's identity, location, time, etc [8]. The proposed system consists of three key components; cPost-it Object, Client, and Server. The cPost-it Object links the information to the real-world entity by providing the cPost-it Client with the URL of the cPost-it Server through IrDA. Then, the cPost-it Client provides user's context to the Server and gets the augmented information on the object through the PDA. The cPost-it Server manages the request from the client and provides personalized information according to the user's context.

The main features of the proposed cPost-it are as follows: At first, it provides a natural way to augment as well as retrieve information to a physical entity through a short range wireless network such as IrDA. In addition, it fully utilizes user's context to retrieve personalized digital messages when the users approach the object of interest. It also helps users to access classified information by providing messages in a good order based on the context such as users' profile. As a result, cPost-it can play important roles in sharing information for the ubiquitous computing environment.

This paper is organized as follows: In Section 2, we explain the proposed context-based information sharing system for public places. The implementation and experimental results are explained in Section 3 and 4, respectively. Finally, the conclusion and future works are discussed in Section 5.

2 The Context-Based Information Sharing in Public Place

The cPost-it is context-based Information sharing system for many and unspecified users in a public place. Users immediately augment digital messages into real-world entities. Simultaneously, they retrieve the personalized information according to the user's identity, location and time.

2.1 Messages for cPost-it

Most messages in a public place are paper-based handwritten documents. However, the digital messages will increase as the PDA users increase. For example, many people may carry a PDA to get a digital pamphlet of an exhibition or to exchange a digital business card. Therefore, it is expected that the paper-based handwritten documents in public places would be replaced with digital information, e.g., text, voice, picture, video, etc.

The digital information has advantages of being handy to copy or carry as well as safe. Further, it is relatively easy for users to transfer their emotion efficiently by using voice with video as well as handwritten note. Above all, messages are aug-

mented, retrieved, updated, or deleted on the fly by networking and remote database technologies. Therefore, it is expected to play important roles in sharing information in public places in the near future.

The cPost-it is an efficient information-sharing method which provides the users in a public place with digital messages. Table 1 shows the comparison between a paper-based handwritten message and a digital message.

Table 1. Comparison between information systems for public places

	Paper-based handwritten Message (Whiteboard/Post-it)	Digital Message (cPost-it)
Format	Plain Text or Drawing	Digital Multimedia
Capacity	Limited (the number or size)	Unlimited
Access	Off-line (uni-directional)	On-line (bi-directional)
Features	Accidental Remove	Safe Message Delivery
	Hard to Copy	Easy to Copy

2.2 Context for cPost-it

The cPost-it uses 5W1H (Who, What, Where, When, Why and How) as a context to provide the proper service. We define 5W1H as a unified context so that it can be applicable to all context-based applications. We suggest a unified context, in the form of 5W1H, which provides the information that is sufficient for several applications [8][9].

Table 2. The Context of cPost-it

5W1H	Definition	Example
Who	Name of User or Group	sJang, ubiContext, All
When	Time(YYMMDDHHMM)	200306091200
Where	URL of Database	http://cPost-it.kjist.ac.kr/MeetingRoom
What	File Name, Entity's identity	Message.wav, ubiHome, PAVV
How	Frequency of daily usage of each message	New, Frequent, Normal, Seldom
Why	User's Intention	To Attach, To Check, To Retrieve, To Edit, To Delete

Table 2 shows the role of 5W1H as a context for cPost-it. "Who" is a user's identity which represents the name of the user or group the user belongs to. The cPost-it grants permission to access messages based on identity. "When" is information about the time when the message was augmented into the entity and when the message will be deleted automatically. "Where" represents URL of database containing augmented messages of the entity. "What" is an augmented message or identity of a real-world entity into which messages are augmented. "How" is the frequency of daily usage of each message. It shows how often a message has been referred per day. "Why" is the user's intention, e.g., attaching a message onto the object, briefly checking data of the messages, editing messages which the user selects, and deleting messages.

2.3 Architecture of cPost-it

The cPost-it, as shown in Fig. 1, consists of three parts: Object, Client, and Server. The cPost-it Object plays a role in linking digital information to real-world entities by providing the cPost-it Client with the URL of the cPost-it Server through IrDA. Then, the cPost-it Client provides the user's context to the Server and gets the augmented information on the object through the PDA. The cPost-it Server manages the request from the Client and provides corresponding information according to the user's context. If the user with a cPost-it Client is in working area of a cPost-it Object, the Client receives URL of the cPost-it Server which contains related information augmented to the Object through a short range wireless network. When the Client connects to the Server, it transmits the user's identity, and current time as the user's context. Then, the Server immediately retrieves personalized messages, augments digital information onto the entities immediately, or displays augmented messages in a good order according to the user's context.

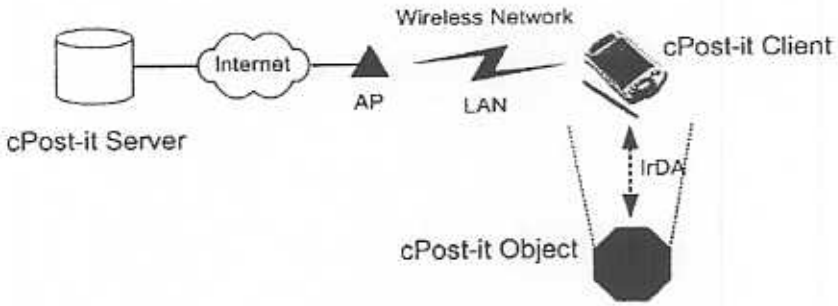


Fig. 1. The concept of cPost-it

To provide context-based services, the context of the cPost-it flows as shown in Fig.2. After receiving URL from cPost-it Object, the Client sends context, i.e., "Who", "What", and "Why", to the Server. The cPost-it Server merges incomplete context with "When" and "How" to build a 5W1H form. "When" and "How" are automatically generated corresponding to "What" and "Why". The Server returns the result of information services according to the context. For handling the context, cPost-it functions as a ubiSensor and ubiService by adopting ubi-UCAM, a unified context-aware application model [9].

2.3.1 cPost-it Object

The cPost-it Object is an object where messages are augmented. So it links the information or messages in the digital world to the entities in the real world. As shown in Fig. 3, the cPost-it Object is a real entity with a smart sensor. An entity can be a public place or object such as a meeting room or projectors, sofas, and other equipment. Therefore, anything can be used as an entity of cPost-it Object where digital information is augmented. Since an entity is unable to actually manage digital messages, it should be mapped into a database where the messages are stored. A smart sensor, ubiSensor, is a device that has the capability of sensing a short range wireless network such as IrDA and processing simple information such as a URL. It is bonded with

entity of the cPost-it Object. When a user triggers the signal of a cPost-it Client in the working area of the Object, the smart sensor senses the signal and sends URL (Where) of the database to the Client

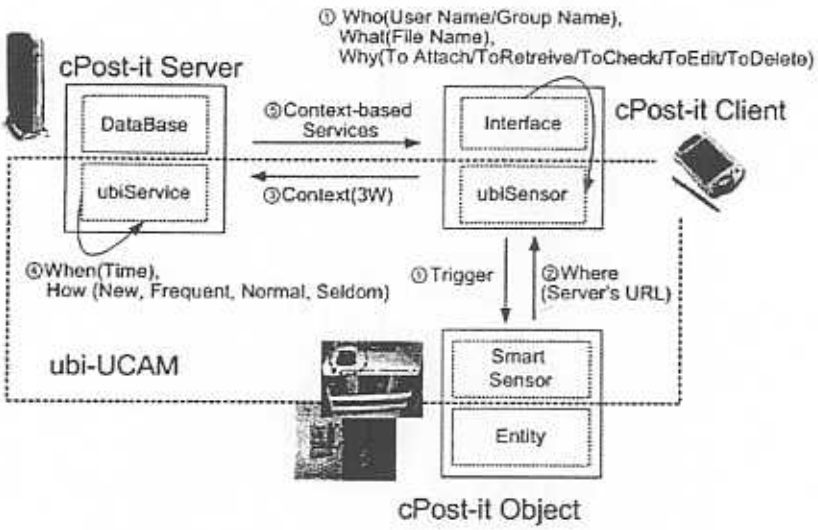


Fig. 2. The architecture of cPost-it

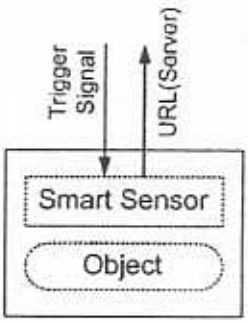


Fig. 3. The component of cPost-it Object

2.3.2 cPost-it Client

The cPost-it Client provides an interface for the user with a PDA to attach a new message to real-world entities or to retrieve messages from the entities. As shown in Fig. 4, the cPost-it Client consists of ubiSensor and interface. UbiSensor gets the URL of cPost-it Server, which actually manages shared messages, from the Object, and then automatically makes a connection between the cPost-it Client and Server. After establishing the connection, cPost-it Client delivers 3W – "Who", "What" and "Why" to the Server. Then, it passes the results from the Server to the user. Interface transfers

part of the context such as "Who", "What", and "Why" from a user to ubiSensor and displays the user's result. "Who" specifies the message-accessing rights which are represented by name of the user or group. Especially, every user belongs to an "All" group to access the message for many and unspecified persons. "What" represents the file to be shared as a digital message. "Why" indicates the user's intention, i.e., to attach, to check, to retrieve, to edit, or to delete the messages.

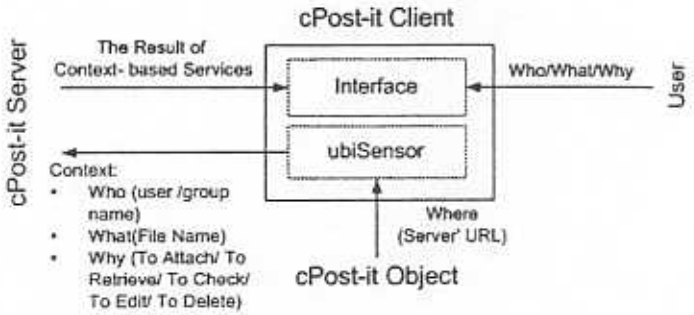


Fig. 4. The component of cPost-it Client

2.3.3 cPost-it Server

The cPost-it Server plays a role in managing messages of a cPost-it Object and providing proper services according to the user's context. As shown in Fig.5, the cPost-it Server consists of database and ubiService. Database saves the augmented digital messages of a cPost-it Object which is virtually connected to the cPost-it Server. Specifically, it stores every digital message with extra information such as file name, file-accessing rights, time, and the usage frequency. UbiService plays a role in making query of database according to context. It comprises Context Integrater, Context Manager, Interpreter, and Service Provider. The Context Integrater assembles a 5W1H context by merging the 3W (Who, What and Why) of a cPost-it Client and 1W1H (When and How) generated by itself. The Context Manager searches the context in context conditions that will trigger some services and delivers the context to the Service Provider. The Service Provider executes the services that are mapped to the context according to the user's description. The Interpreter registers the context condition and description about sequence of services to run, as defined by the administrator of cPost-it, into the Context Manager and Service Provider [9].

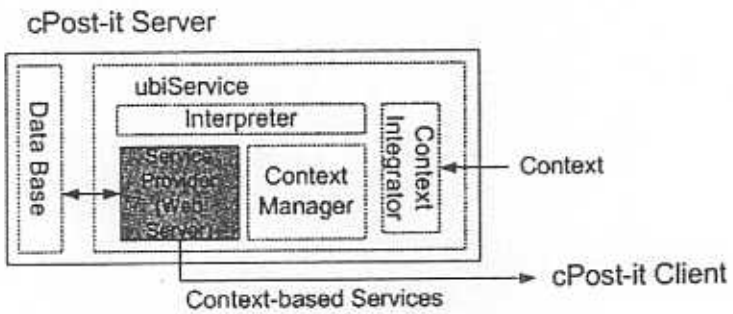


Fig. 5. The component of cPost-it Server

3 Implementation

The proposed cPost-it is implemented as shown in Fig. 6. Initially, messages such as reservation notices, materials for presentation, and private notes were augmented to the door of meeting room and lounge, and manuals were attached to the projector and audio system in the public place as cPost-it Objects. The cPost-it explicitly gets a part of context from user and operates augmented messages through the Web browser. The cPost-it Server for managing augmented messages of the meeting room, lounge, projector, and audio system was implemented as a Web server that supports context-based information services.

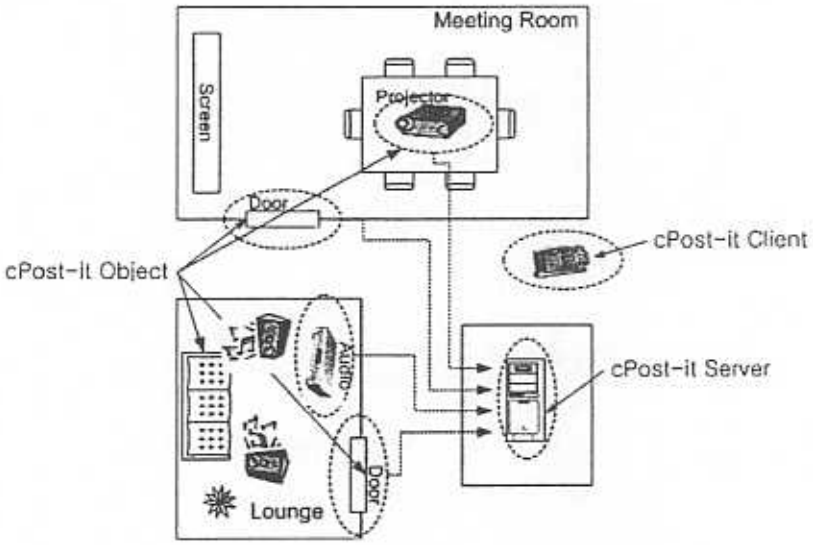
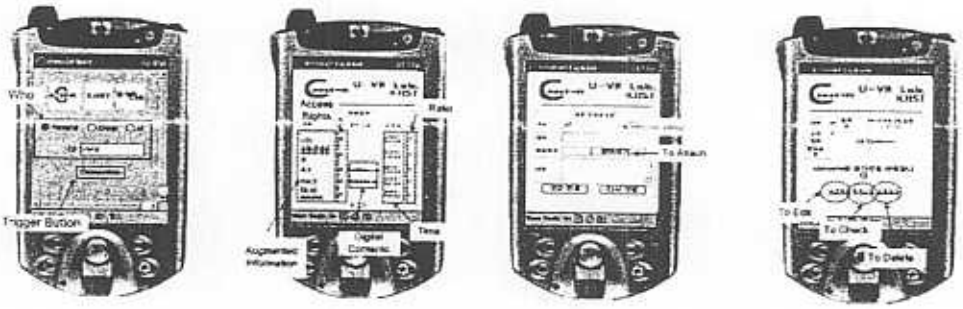


Fig. 6. Implemented cPost-it System

3.1 The Implemented cPost-it Client

The implemented cPost-it Client, based on Window CE with embedded Visual C++, runs on a PDA such as Compaq iPAQ H3600. The PDA supports IrDA network to get URL from a cPost-it Object, and wireless network such as 802.11b to access augmented messages in a cPost-it Server. To operate the augmented messages, a user inputs a part of the context through the Interface, as shown in Fig. 7(a). The user can specify his/her name or name of the group, which he/she belongs to, as "Who". After cPost-it Client connects to the Server through URL received from the Object, the Client displays the augmented information according to "Who" in the form of a Web page, as shown in Fig. 7(b). Selecting the file name as "What", the user operates the augmented messages such as "To Attach", " To Check", "To Retrieve", "To Edit", and "To Delete" as "How" through interface as shown in Fig 7(c) and (d).



(a) (b) (c) (d)

Fig. 7. Implemented cPost-it Client; (a) Initial Interface (b) Example of augmented information in the form of Web page (c) Example of selecting a file to be attached (d) Example of operations for an augmented message

3.2 The Implemented cPost-it Object

As shown in Fig. 8, we use a meeting room, lounge, projector, and audio system as cPost-it Object to augment digital messages. Compaq iPAQ H3130 or H3600, as smart sensor, are implemented to support IrDA network and data processing for the URL of the cPost-it Server.

3.3 The Implemented cPost-it Server

The cPost-it Server is implemented by adding the Web Server module to ubiService. It consists of database (MS-SQL 2000 Server) and ubiService and runs on a Desktop PC (CPU: Pentium III 800, Memory: 256M, OS: Windows2000 Professional). One cPost-it Server manages the augmented information of four cPost-it Objects: a meeting room, lounge, projector, and audio system.

Context Integrator in ubiService generates the context in the form of 5W1H by merging "Who", "What" and "Why" from the cPost-it Client and "When" and "How" that are generated by itself. Context Manager passes the context to Service Provider if the context satisfies the conditional context as shown in Fig. 9(a). As shown in Fig. 9(a) and (b), Service Provider contains the description to trigger web services such as attaching, checking, retrieving, editing and deleting according to the user's context.

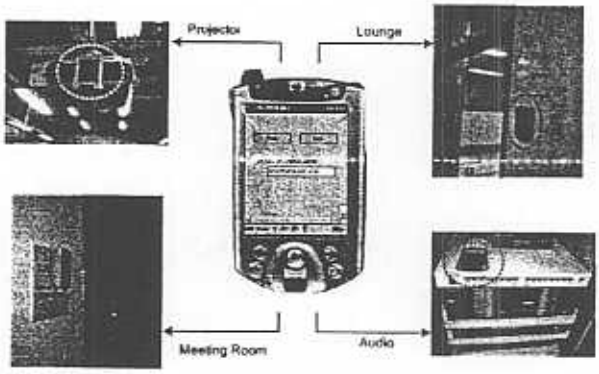


Fig. 8. Example of implemented cPost-it Object

Who	What	Where	When	Why	How	Service List
Name	File	URL(Client)	Time	To Attach	-, F,N,S	AddMessage (who,what,when,how)
Name	*	URL(Client)	Time	To Check	N,F,N, S	CheckMessages (who,how)
Name	File	URL(Client)	-	To Retrieve	N,F,N, S	RetrieveMessage (who, what, how)
Name	File	URL(Client)	Time	To Edit	-	EditMessage(who, what)
Name	File	URL(Client)	Time	To Delete	-	DeleteMessage (who, what)

(a)

AddMessage: Insert (FileName, AccessRight, Time, Frequency) into DB values What, Who, When, How
CheckMessages: Select * From FileName Where AccessRight = Who and(or) Frequency = How
RetrieveMessage: Select File Where FileName =What and AccessRight = Who and(or) Frequency = How
EditMessage: Select File Where FileName = What and AccessRight = Who
DeleteMessage: Delete File Where FileName = What and AccessRight = Who

(b)

Fig. 9. Implemented cPost-it Server; (a) Example of context condition and service description (b) Example of service modules

3.4 Personalized Information Sharing

As shown in Fig. 10, when a user carrying cPost-it Client approaches to the door (the cPost-it Object), the augmented information (personal notes, video manuals of appliances, public place notices, etc.) are retrieved on the PDA according to the user's identity. Also, cPost-it provides a user with personalized information services such as classified messages by exploiting the user profile about the message of interest entities.

The Post-it guarantees to keep the individual notes and to share personalized messages among just group members. Because all messages are categorized into three parts; 'Personal', 'Group', and 'All', it provides the users in public places with proper messages according to the access permissions which users specify. As long as user's access right is preserved, the private messages can be safely shared in public places.

In addition, all services of cPost-it are protected by the security mechanism of a Web server.

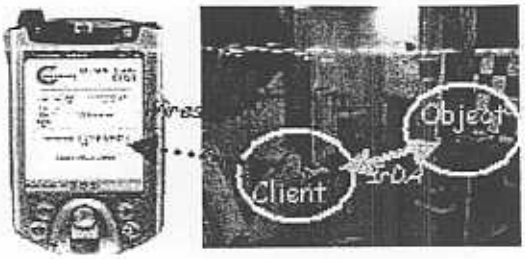


Fig. 10. Example of personalized information services

4 Experiments

To show usefulness of the proposed cPost-it, we conducted experiments with implemented cPost-it. Twenty volunteers, who are familiar with operating PDA, tested cPost-it.

For quantitative studies, we measured the working area of cPost-it Object. We also observed the waiting time to upload and download a message to and from the cPost-it Server. Besides, we analyzed the frequency of usage of each message type according to public places. The infrared sensor of the cPost-it Object worked within one meter if the cPost-it Object and the Client were in a line. However, we measured different working areas of the meeting room, lounge, projector, and audio system according to position and angle of smart sensor of cPost-it Object. As an experimental result, smart sensors, fixed on the meeting room door and lounge, worked within about 0.61meters. The working areas of the projector and the audio system were 0.87 and 0.92 meters, respectively. The cPost-it Object in the form of door showed narrow working area because the infrared sensor was facing up. There was difficulty in keeping cPost-it Client and the Object in a line. Meanwhile, the sensor of the projector and audio system was in a better position to be connected to cPost-it Client.

We measured the waiting time to upload and download a 100 KB message in a public place where wireless networks supported 2Mbps bandwidth. Since, the size of most messages in the public place, except video messages, was 300KB~2MB, the time to upload and download a 100KB message could indicate how long a user would have to wait for the response of cPost-it. As for the experimental result, it took about 234ms to upload a 100KB message to cPost-it Server and about 212ms to download 100KB message from it. Therefore, a user would have to wait for about 2 seconds to access a 1MB message from cPost-it.

To analyze the ratio of usage of digital information according to public places, we observed the format of messages used by twenty users in the meeting room and lounge over a period of two days. In the meeting room, the text and picture messages were frequently used for information about reservations and presentation materials, as shown in Table 3. In the lounge, however, short voice messages, easily created with a

PDA, were highly used as well as text. Further, many users liked to share multimedia messages such as a favorite music, pictures, and movies.

Table 3. The ratio of digital information according to public places

	Text (txt,doc)	Hand-written drawing(jpg,gif)	Sound (wav,mp3)	Video (asf, wmv)
Lounge	35%	16%	45%	4%
MeetingRoom	60 %	20%	8%	12%

For qualitative analysis, we investigated the degree of satisfaction about three context-based services; augmented message service which provides user with a natural search, individually accessing service which guarantees private information, and information-sorting service which provides a hot message. As shown in Table 4, most users were satisfied with the natural search enabling a user to instantly recognize location of a message through augmented object, and the ordered information helping a user open the hottest message in an augmented object. Especially, many users were positive about accessing messages according to user's information such as users name, group name, and anonymous group which guaranteed privacy in a public place. However, some users complained about having moved themselves into the working area of cPost-it Object to access messages. Also, inconsistent messages, mis-augmented into the object due to the faults of others were encountered.

Table 4. User satisfaction about context-based services

	Augmented Message Service	Individually accessing Service	Information-Sorting Service
Good	80%	90%	75%
Normal	15%	5%	20%
Bad	5%	5%	5%

5 Discussions

In this paper, we proposed cPost-it, a context-based information sharing system in public places that enables many and unspecified persons to immediately attach digital messages, in the form of multimedia, to a real-world entity. Moreover, messages can be retrieved, modified, or deleted according to user's context. According to experimental results, cPost-it guarantees the user to efficiently represent meaning of messages by using suitable multimedia format, and to naturally access messages which are augmented into a real-world object. Massive messages can be augmented into cPost-it Objects by networking and remote database technologies regardless of size and number of messages. Additionally, cPost-it provides various personalized information services according to the user's context. However, we need to evaluate the cPost-it over longer time period with many users to prove the usefulness of cPost-it and for improving its performance.

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