

# Multimedia Informal Communication by Wearable Computer based on Real-World Context and Graffiti

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## ABSTRACT

*The informal information can be so intuitive, emotional, personal, honest and subjective that it is very difficult to get them from the formal media. In this paper, we demonstrate a multimedia informal communication support system whose basic architecture is a combination of a wearable computer, a see-through head mounted display, a bone conduction speaker, and a 3D-pen. The user can create a "multimedia" graffiti such as a handwritten memo or a voice memo and place it in a real-world "multimedia" context such as at a certain location (by GPS), environmental sound, the real object (by RFID) and so on. The multimedia informal information is thus shared with others on the peer-to-peer self-organized network. We demonstrated the prototype system and conducted a preliminary evaluation.*

## 1. INTRODUCTION

We have been studying systems that will truly support creative and intelligent work [1]. They range from systems for knowledge workers [2] to ones for car designers [3, 4]. Here, we focused on the informal communication that is essential to getting truly valuable information for our creative life.

The rapid progress of information technology has spurred development of various communication support systems. For example, groupware and CSCW (Computer-Supported Cooperative Work) support formal communications in situations such as conferences and presentations [5, 6, 7].

On the other hand, the importance of informal communication has only lately drawn considerable attention. The informal communication support systems that have been developed to date have tried to provide their users with a comfortable virtual face-to-face environment in order to promote the exchange of the informal information. But they failed as pointed later.

In this paper, we analyze the features of informal communication and the problems of the previous research. Then, based on the analysis, we propose our ubiquitous informal communication support system for embedding "multimedia" messages in a "multimedia" real-world context.

## 2. RELATED WORKS AND PROBLEMS

### 2.1 Importance of Informal Information

The key characteristics of informal information are:

*Personal:* The information depends on the individual's own knowledge, and it is not easy to find in the outside world.

*Fragmented:* The information itself is fragmented and depends on the context, the situation, and the implicit knowledge. Without related information, it is not meaningful or significant.

*Temporary:* The information suddenly appears and disappears. The situation in which the information is needed does not persist.

We obtain hints, explanations of important concepts, new knowledge, and even the keys to novel discoveries through informal communications. Thus, we believe it is very important to promote informal communications.

### 2.2 Conventional Systems

We surveyed the previously developed systems for supporting informal communication. They can be categorized in a matrix whose columns distinguish distributed from non-distributed environments and whose rows distinguish synchronous (on-line) from asynchronous (off-line) communications.

### 2.3 Problems

Most of the conventional systems try to offer a chance for face-to-face exchanges even in a distributed environment. In other words, they are designed based on the paradigm that the informal communication must be face-to-face.

On the contrary, we have seen that huge web bulletin board systems are popular places for informal communication. They do not provide their users with a virtual face-to-face environment, but just support the exchange of simple text messages and a context maintenance mechanism called "threads".

One successful example is the "Two channel" Web site in Japan, which is a huge Web-based bulletin board where millions of pieces of informal information are actively exchanged.

The prevalence of such communications would seem to overturn the conventional paradigm that the informal communication must occur in a face-to-face environment. Thus, we began to doubt this paradigm. Our research thus originated from questioning it.

The Web-based bulletin board system is anonymous and has a simple writing and reading interface, the "thread" context maintenance mechanism, and a huge stock of information. These features must be more important for informal communications than those of the face-to-face environment that many researchers have believed in.

However, there is a difficulty in searching for the appropriate thread and message. Moreover, simple text-based information is very poor in terms of its expressive power.

## 3. REQUIREMENTS ON INFORMAL COMMUNICATION SYSTEM

To design a system that truly supports informal communication, one must analyze informal communications and clarify how to promote them. The requirements for an informal communication support system can be summarized as follows.

**[Requirement-I] The informal information is “Contextual Graffiti.”**

The informal information consists of (i) the context and (ii) the information attached to the context. The information attached to the context can be regarded as a kind of scribbling or graffiti. Thus, we call informal information “Contextual Graffiti”.

In other words, contextual graffiti consists of a “Context” and “Graffiti,” as shown in Fig. 1. The informal information is generated directly from the user’s behavior; e.g., the user writes graffiti on a context.

For example, the act of saying contextual graffiti, “The restaurant in front of me is terrible,” consists of giving a location description (given by GPS data) as the context and saying “...terrible” as graffiti. To generate informal information, the user in this case could simply say “terrible” at his/her location.

**[Requirement-II] Graffiti and Context are “Multimedia.”**

Graffiti has various formats. These include handwriting, voice, photos, etc. Similarly, it has various contexts. These include GPS location data, images, temperature, sound, voice, person, bar-code, RFID, etc. That is, both graffiti and context must be multimedia.

Moreover, graffiti can be created anytime. Whenever the informal information arises, the user should be able to create multimedia graffiti on any multimedia context immediately.

**[Requirement-III] All graffiti attached to the current context should be immediately shown in an ambient manner.**

The graffiti attached to the current context should be immediately recognizable. Note that the notification of the matched graffiti should be done in an ambient manner [8, 9].

**[Requirement-IV] The conceptual graffiti must be able to be shared with others.**

Needless to say, graffiti should be shared with others. Others’ graffiti that is attached to the user’s current real world context should be sent to the user.

## 4. DESIGN OF PROTOTYPE

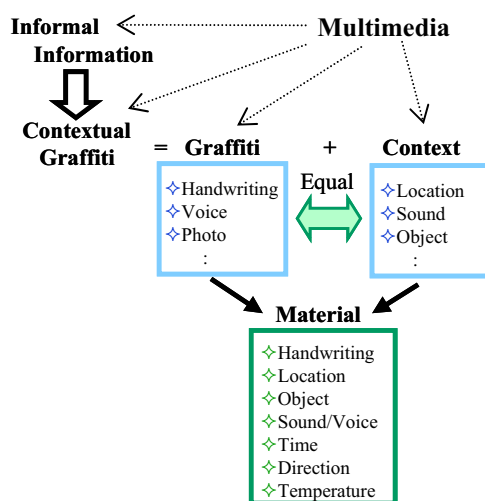
### 4.1 Information Design: Multimedia Contextual Graffiti

First, we decided how to represent multimedia contextual graffiti. As mentioned above, it consists of a context and graffiti (Fig. 1).

Although the context may be regarded as different from the graffiti, the two aspects can be treated uniformly. For example, let’s consider the following situation. The user wants to create a voice graffiti, “It will continue for more than 10 min.” on a real-world context (for instance, a warning alarm that sounds at the railroad crossing). In this case, the user puts voice graffiti on the sound context. In this case, “voice” and “sound” are essentially same and can be treated in the same manner.

Eventually the representations of graffiti and context become the same; i.e., the same information can be context or graffiti. It depends on the situation. We call such information “material”.

Fig. 1 summarizes the terms we have discussed so far. We say that “multimedia informal information” consists of “multimedia graffiti” and a “multimedia context” and that both “graffiti” and “context” are “materials”.



**Fig. 1 Information Design: Graffiti, Context, Material**

### 4.2 Hardware Design

Informal communication can happen anytime and anywhere, so we designed a wearable computer to support it.

Moreover, the informal information must be given in an ambient manner. The visual and auditory output plays a central role. A see-through head mounted display (HMD) was selected for the visual ambient output (Fig.2 (a)). The bone conduction speaker was the best choice available for the auditory ambient output because it doesn’t impair a person’s hearing of environmental sounds (Fig.2 (b)).

The interaction method of the wearable computer must be easy and must be usable for writing graffiti. We created a 3D-pen that enables users to write a memo in the 3D space in front of him or her. It was realized with two 2D-pen sensors (mimio personal, see Fig. 2 (c)).



(a) See-through HMD (b) bone conduction speaker (c) 2D-pen sensor

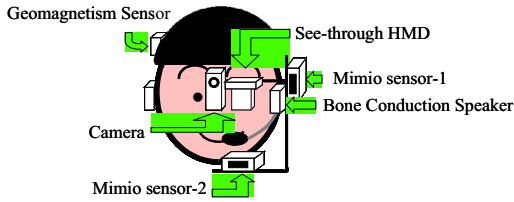
**Fig. 2 See-through HMD and 2D-pen sensor**

Many sensor units are needed for the “material” data. Fig.3 shows the current sensor list.

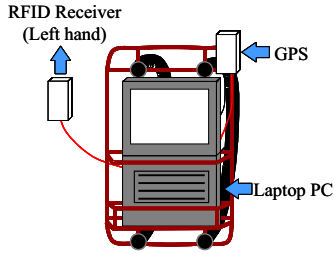
- ◇ Handwriting : 3D pen
- ◇ Location : GPS receiver, MAC address
- ◇ Object : Camera image, RFID
- ◇ Sound/Voice : microphone
- ◇ Time : (GPS clock)
- ◇ Direction : Geomagnetism Sensor
- ◇ Temperature : Temperature Sensor

**Fig. 3 Sensors for “Material”**

We have developed the prototype system. Fig.4 shows the system diagram. Current system consists of a head-part and a back-part. Fig.5 is the photo of the current version.



(a) Head-part



(b) Back-part

Fig. 4 Current prototype system diagram



(a) Head-part



(b) Back-part

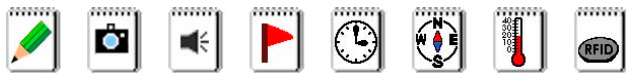
Fig. 5 Photo of current prototype system

### 4.3 User Interface Design

#### (1) Interaction Principal

Our system had to enable users to make contextual graffiti easily. To do so, we devised a unique interaction principal.

Icons are prepared for each material as shown in Fig. 6 and 7. These icons are displayed at the bottom of the HMD's display (Fig.6). The icons hold the latest information. For example, the "Pen" icon always holds the latest hand-written memo, and the "Sound" icon always holds the latest user's voice or environmental sound.



Pen Camera Sound Location Time Direction Temp RFID

Fig. 6 Icons for "Material"

To make contextual graffiti, the user simply drags an icon onto another icon, as is shown in Fig. 7. The former is "Graffiti", the latter is "Context". The interaction is very simple, intuitive, and powerful.

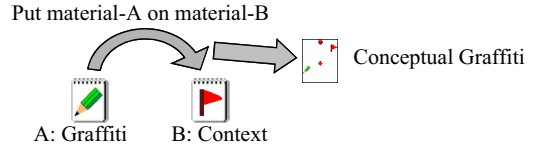


Fig. 7 Drag Icon on Icon

#### (2) Basic Interaction

Figure 8 shows an example of the user's view through the see-through HMD, in which the user writes graffiti "The red signal is long". The user attaches the graffiti to the location of the intersection by dragging the "Pen" icon onto the "Location" icon.

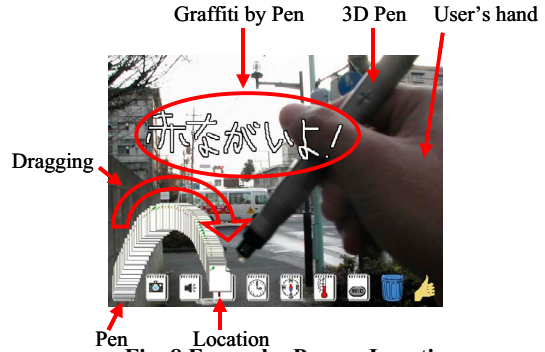


Fig. 8 Example: Pen on Location

Figure 9 shows another example of the user's view through HMD, in which the user writes "The detour is here". The user attached this graffiti to the warning sound of the railroad crossing by dragging the "Pen" icon onto the "Sound" icon.

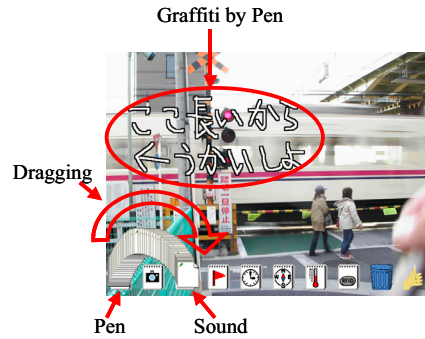


Fig. 9 Example: Pen on Sound

#### (3) Extended Interaction

For more accurate and complex graffiti, the operations can be extended as follows.

##### (i) Fixed material

An icon holds the latest material. In many cases, this is convenient and sufficient. However in some cases, we would want to refer to past material. To fix the content of the icon, the user simply drags the icon to a vacant area as shown in Fig. 10. The fixed material appears, and it can be treated as a usual icon.

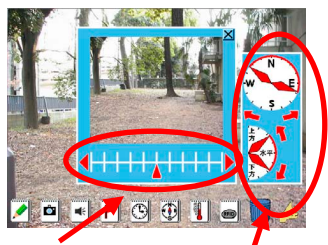
##### (ii) Modification of Material

The content of the icon is automatically segmented by the system. In some cases, the user may want to indicate a specific portion of the material. When the user touches the icon, the interface window appears as shown in Fig. 11. The user can

indicate the specific portion by selecting the specific time period by using the “time line” or by directly changing its values.

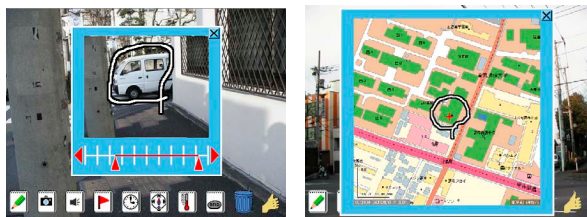


**Fig.10 Fixed Material**



by time line    by direct change  
**Fig. 11 Timeline and Direct Change**

Figure 12 shows direct indications of the target object image by drawing a circle on a camera image (Fig. 12 (a)) and of the location by drawing a circle on a map (Fig. 12 (b)) .



(a) Camera Image                      (b) Location (Map)  
**Fig. 12 Drawing Circles on different visual content**

## 5. EVALUATION AND SUMMARY

We conducted two experiments for the preliminary evaluation. One was done in the laboratory, the other was done outside of the lab.

In the former experiment, four subjects were asked to write graffiti by pen (Task 1) and to make contextual graffiti (Task 2) ten times for each task. The purpose of the experiments was to evaluate the usability of the handwritten graffiti and the usability of dragging the icons. We worried that the 3D pen might be difficult to use, yet we found that the subjects could easily operate it.

In the latter experiment, two subjects were asked to walk around, make several contextual graffiti as they did so, and confirm that the correct graffiti were displayed according to the scenario. They performed this task ten times. The scenario consisted of 14 steps. Figure 13 is a snapshot of the experiment.

The average rate of successful operations was about 94%. This result shows that our system works under actual field conditions.

These experiments were only preliminary, and their results were used to evaluate only a small part of our system. A comprehensive experiment and evaluation are still necessary.



**Fig. 13 Snapshot of Experiment-II**

This research originated from the simple question “why does a huge web-based bulletin board system promote the informal communication much more than the latest informal communication support systems which provide virtual face-to-face environments?”

First, we analyzed the features of the informal communication and clarified the requirements, i.e., (i) the informal information is “Contextual Graffiti”, (ii) both graffiti and context must be multimedia, (iii) all graffiti attached to the current context should be immediately shown in an ambient manner, and (iv) the conceptual graffiti should be able to be shared with others.

We have demonstrated the prototype system and shown the effectiveness.

Now we are planning a comprehensive experiment in everyday environments. However, before we can attempt this, we have to miniaturize our system so that it is no longer bulky.

## 6. REFERENCES

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