

# Development of Image-based Tele-consultation System Employing Semi-Real Time Communication

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## Abstract

Recently, development in computer technology and communication network infrastructures makes it possible to tele-communicate for multimodal expression. We reexamine principles of the information which is interchanged through the image-based tele-consultation, in order to develop the system where the media based on such principles are combined. This system is intended for the consultation on medical images among experts at remote site. This system adopted communication method which has the advantage of both Real Time Communication (RTC) and non-RTC. We called this system "semi-RTC". The specifications of this system are information by e-mail and information expressed by the Position Annotated Image Reporting (PAIR) system. This remote communications are experimentally performed with this system using various medical images. Compared with normal e-mail communications, rich expressions became possible by using this system. Such expressions can be created by the methodology unique to computers, and the applications in various fields are expected in the future.

## Keywords:

Semi-Real Time Communication; Position Annotated Image Reporting system; e-mail; tele-consultation

## Introduction

For a long time, language media have been playing a dominant role in the remote communications by humans which started with signs and symbols. Language media impose little burden on humans[1] and ideas of sender transmit to the receiver by language.

It is said that "Language media are most suitable for transmitting the high-order information on which a human has made a decision, and their combination with other media, such as body motions, makes themselves easily understandable in the way appealing to intuition, while strictly following the logics"[1].

In "face to face" communications, multimodal expressions are made without any particular recognition. Recent development in computer technology makes it possible to handle not only language media but also videos which use the way for multimodal expressions.

Language media are roughly divided into two groups, one is audio language media and another is written language

media. Each of them has different characteristics, and the audio language is frequently employed for Real Time Communication (RTC) while the written language is employed for non-RTC. However, when the conventional methodology is applied and either one of the media is employed, neither the audio language nor the written language is hardly considered to have ideal properties for the image-based tele-consultation, because the image-based tele-consultation requires satisfactorily high expression and recordability.

Due to upgrading of communication network infrastructures in recent years, the amount of information to be transferred per unit time shows the remarkable progress than ever, and environments are being improved to transmit highly informative media in addition to the written language media which have little information. The remote communications which use general household network circuits are now shifting from the communications which handle only characters to the communications which handle the combination of voice with videos[2].

Remarkable progress achieved by information technology extends the range of choices of information media which can be handled on networks. Nevertheless, insufficient study about the communication media misses the original purpose and consequently creates unnecessary traffic increase. Therefore, we reexamine principles of the information which is interchanged through the image-based tele-consultation, in order to develop the system where the media based on such principles are combined. This system is intended for the consultation on medical images among experts at remote site, for the purpose of concomitance between high expression and recordability.

This system adopted communication method which has the advantage of both RTC and non-RTC. We called this system "semi-RTC".

## System concept

The following are the properties required for the information sharing in the image-based tele-consultation.

1. Appeals to intuition and makes it easy to understand, while strictly following logics[1]

This is inevitable as the condition for sharing information smoothly. As the method to fulfill this, the approach where the language media are mixed with other media is considered. This approach makes expressions redundant, however, it can be expected that a receiver can easily extract

signals alone with the help of intuitive understanding even when signals are mixed up with noise.

2. The recordability which provides the way for secondary use is secured.

The data obtained in order to accomplish a certain purpose accumulate to create the database, which is used for various analyses applying the techniques, such as data mining. Furthermore, receiver become easily understand data because receiver can read back the data if necessary. The medical information interchanged through the tele-consultation will be very useful for future medical treatments.

In order to satisfy the aforementioned conditions, the written language is employed as the dominant language for our communication system.

### System specifications

The specifications of this system are as follows:

1. Sending and receiving information by e-mail  
The information interchange by e-mail has been penetrated into the general public. In Japan, not only PCs but mobile phones are actively used for e-mail information communication. The communication by e-mail now ranks along with the communications via voice telephone and fax. In terms of security, e-mail services will improve in the future and become safe enough to handle confidential correspondence on the Internet. Thus, e-mail is considered to be suitable for handling highly confidential medical information. A sender can sufficiently maintain control over information transmission, and no problems are expected to arise when recordability is considered.

2. Information expressed by the Position Annotated Image Reporting (PAIR) system  
The PAIR system is the system we developed before for the purpose of providing the information which includes images from a hospital to a patient. In this computerized system, radiodiagnostic reports can be browsed on a Web browser, and, when the medical information is forwarded to a patient, an annotation is made as required to the positional information which is described in technical terms[3]. This system makes the expressions plain enough for those who have no particular expertise. This PAIR system was designed and developed to computerize the paper-based information forwarded from a hospital to a patient, with the aim of making the provided information sufficiently understandable for a patient. In this PAIR system, the information flowed only in one direction. Compared with the application of normal e-mail, the application of the PAIR function for our system provides the way to create the dynamic expressions associated with imaging media, which is expected to help a receiver separate signals from noise

while accomplishing sufficient recordability.

The specifically designed mail software which satisfies the two aforementioned points is developed under the following environments.

- Development system:  
PC with the Microsoft® Windows® XP
- Development language:  
Microsoft® Visual Basic® Ver6.0
- Using Component: BSMTDP DLL  
<http://www.hi-ho.ne.jp/babaq/>

### System outline

In this system of ours, both sender and receiver use the specifically designed mail software which we developed specifically for this system. For images, a digital camera can be used to take a picture directly or a scanner can be used to scan an analog photograph after a picture is taken. However, any methods can be used as long as an image is saved as a file in a sender's PC. The sender embeds positional information in the picture as needed, and send it. A receiver checks the embedded positional information by reading texts, adds texts or positional information, and returns the edited picture back to the sender. By repeating the aforementioned processes, both sender and receiver can share information.

(See Fig.1)



Fig.1. specifically designed mail software outline

### Discussion

This system of ours substantializes the semi-RTC where the written language media are employed. The leading expression methodology in our system is the PAIR system, which has been used in the clinical field when a medical

report is provided in a CD-ROM[4]. In our system this time, the PAIR system technology is employed to upgrade the normal e-mail communications to interactive communications, with the intention of establishing the higher-order remote communications.

The audio language media are superior in immediacy, and have been dominant in the tele-consultation over years, because the environments necessary for the tele-consultation are easily established by using telephones. Additional innovations in information technology pave the way for media to be combined, which makes the audio language media more significant as the information communication method[5]. Therefore, the tele-consultation systems which have been developed currently generally employ the systems where the audio language is combined[6]. Especially, in time-sensitive situations, the system which has the audio language employed is expected to be extremely effective. On the other hand, the written language media naturally have superiority in recordability because they require recording media. Additionally, a sender can confirm the recorded contents, therefore, if the timing for transmission can be controlled, information of good quality can be conveyed with minimal noise sources.

For those reasons, written-language-based non-RTC is considered to be extremely effective for the general imaging consultation. Even when immediacy is required, RTC is hardly necessary in principle as long as the information is not live. The target of our semi-RTC system is to establish the environments for multimodal communications which are the advantage brought by the RTC while employing the written language media which are superior in recordability. table 1 shows the suitability of each communication methods.

**Table 1. Features of individual tele-communication methods**

	Immediacy	Expression	Recordability for Secondaly use
Non RTC (E-mail)	×	×	○
Semi RTC (Our system)	×	○	○
RTC non-voice (chat with images)	○	○	×
RTC voice (TV phones)	○	○	×

Open circle is suitable(O), and X mark is unsuitable(X)

Semi-RTC can be defined as the system where an information receiver can freely control and use all the events which are controlled by the time axis in the RTC. Such expressions can be created by the methodology unique to computers, and the applications in various fields are expected in the future.

In this system, remote communications are experimentally performed using various medical images. Compared with

normal e-mail communications, rich expression became possible by using this system. Compared with videos, it is easier to understand because a receiver can select necessary information. In addition, the information can be processed when the information is delivered to a receiver, which makes it possible to accomplish the information interchange close to RTC, even if our system isn't RTC. Its controllability over information transmission minimizes the noise created by an information sender, and makes the information quality high enough to be durable for secondary use.

**Table 2. Consultation categorized by sender and receiver**

	Doctor→Patient	Doctor→Doctor	Patient→Doctor
Situation	Explanation about a test and its result	Consultation on diagnosis and results	Complaint and consultation
Compare with medical knowledge of a receiver and a sender	S>R	S≐R	S<R
Problems with a receiver	Provided information should match with the level of medical information that a receiver has		Due to the difficulties in selecting information, necessary information can not be conveyed to a receiver.
Solutions	When the missing knowledge Can be identified, environments should be improved to cover the missing knowledge*.		A receiver actively interrupts to gain knowledge and explicit S≐R

\*PAIR system[4]

This time, from the viewpoint of recordability, we develop a system, starting with the written language media. In Table 2, the situations which arise in the tele-consultation are categorized in accordance with the levels of the medical knowledge that sending and receiving parties have. As this system is intended for the information sharing in the communication from a doctor to another doctor, no particular problems are found. However, when it comes to the tele-consultation between a patient and a doctor, in many cases, the interactive, real-time information interchange becomes necessary, and audio linguistic approaches are frequently required. In addition, even in the communication between doctors, the audio language, which has superiority as an interface, is inevitable in RTC.

From now on, we intend to develop the communication systems which have intrinsic solutions for the specific purposes that various kinds of medical information separately have, without being prepossessed by conventional, ready-made concepts of media.

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