MOBILE VIDEOPHONES FOR SIGNED LANGUAGE COMMUNICATIONS

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Abstract: Information and Communication Technologies (ICTs) provide various kinds of information and communication services. For some people, however, their capabilities affect the accessibility to these services and terminal equipment. It must be ensured that the information and communication services of the Information Society are designed to be accessible from all. In this report we show certain results of our on-going project on signed language communication services by mobile videophones. The mobile videophones have an interesting feature of portability, but have certain difficulties in signed language production and perception due to the small size of displays. In this report we show the experimental results for Japanese Signed Language perception by small sizes of pictures. From the present results and previous experimental results, we discuss possible information and communication services by a signed language using mobile videophones from the user's point of view: How well a user can perform his/her intended information activities under a particular use situation. This concept leads to another term, User-Based Quality of Service (UbQoS), which uses measure parameters of user's attitude to the services at a particular situation, and includes human and social factors in addition to usual technological ones.

1 INTRODUCTION

ICTs (Information and Communication Technologies) provide a very wide range of information and communication services. For some people, however, their capabilities affect the accessibility to these services and information and communication devices (terminal equipment). Deaf people, for example, can not use the ordinary voice telephone service, and blind people can not directly read materials visually displayed. Furthermore, people with restricted movement experience difficulties in manipulating terminal equipment. It must be ensured that the information/communication services of the Information Society are designed to be accessible and usable from all (Cullen, &Robinson, 1997).

The specific aim of this on-going project is identifying technological, human and social issues for providing communication services by a signed language for deaf and hearing people. A signed language uses body movements, hands, arms, face, head, and body posture, instead of sound, and listeners (receivers) use their eyes instead of their ears to understand what is being said. Therefore, a signed language has a quite different modality from the usual spoken language, and is a visual-gestural language (Schein, & Stewart, 1995). We then need an appropriate visual communication system for transmission of a signed language (distant signed language communication).

In this report, we mainly deal with some mobile videophones for distant signed language communications. The mobile videophones have the feature of portability, and then an individual user can access to networks and information/communication services any time, and from anywhere. They have some potentialities for providing useful information/communication services by a signed language.

On the other hand, the mobile videophones have usually small displays with around two inches. The display characteristics together with other technological parameters such as picture quality will affect the Quality of Service (QoS). In addition to these technological parameters, others are important for measuring the quality of service such as user characteristics for physical, cognitive and language capabilities including communication situations, and

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social issues that support the services. For example, when a user uses a mobile videophone, he/she needs to hold the device by one hand. This use situation causes an essential restriction: A signer has to use only one hand for signing instead of usual two-handed signing. This posture is one of causes of human stress and fatigue. One-handed signing also causes difficulties in both production and perception of Japanese Sign Language (JSL) (Kamata, Shionome, Yamamoto, & Fischer, 2003). Another example is a remote signed language interpreting (video relay) service. The service inherently requires human and social resources, in addition to technological one.

In this report we first focus upon the display size of mobile videophones and show the results for perception experiments of JSL. We next make general discussions on information/communication services by a signed language based on the present study results and previous experimental results for one-handed signing (Kamata, Shionome, Yamamoto, & Fischer, 2003). We further consider the quality of services from the user's point of view. We must take into account those factors which are not considered for the usual QoS such as user characteristics for physical, cognitive and language capabilities including communication situations, and human and social factors that support the services. We then introduce another measure, which we name User-Based Quality of Service (UbQoS), for considering these factors.

2 TERMINALS, MEDIA, NETWORKS AND COMMUNICATION SERVICES

Visual communication systems can provide new communication opportunities to people those who use a signed language in their daily lives (Pereira, & Lindström, 1994). Certain features of communication systems specify the characteristics of these communication services.

(1) Network access means including terminal used by a user. We assume in this discussion that mobile videophones are used as terminals.

(2) Media type. We can now use various media for information transmission through communication systems such as voice, text, still pictures, and motion pictures (video, or motion images). In this report we only focus on videophone images (motion images).

(3) Media quality is very important parameter for the usual QoS. Temporal and spatial resolutions are important parameters. Another one is the time delay between the video and its associated voice (audio-video delay).

(4) Applications: In this report, we focus on the videophone applications for signed language communications, such as interpersonal communication, a remote access to web site information, and support services in daily life activities such as entertainment/leisure, work, education, and emergency.

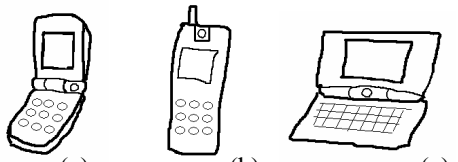
One of the important issues for a user is whether or not he/she can perform, in a particular situation, an intended information/communication activity. Quality of Service (QoS) is usually measured by technological parameters such as frame rate and spatial resolution for transmitted video signals. This measure, however, does not explicitly include factors for users and their use environments (communication situations): Sensory and cognitive abilities, user preferences, purpose of the activity, and the environment in which information and communication activities are performed. We here show an example of voice on-demand service. Voice on-demand services (telephone answering service) with automatic speech recognition (ASR) are widely used to access to information. Some hard of hearing and deaf people can not recognise the message nor do they respond to the message. The use situation is very similar to that of the ordinary hearing people in a noisy environment. Hearing people hardly recognise the voice or speech information in a noisy environment. From these cases, we can see that the quality of information and communication activities also depends on the use environments, or the use situations.

From these examples, we introduce another term, User-Based Quality of Service (UbQoS), for taking into account parameters of human and social issues that are not considered in the usual QoS. That is, UbQoS includes parameters for quality or usefulness of activities that a user really wants to perform in a particular situation.

In this report, we focus upon deaf people who use a signed language in their daily lives, and are not able to use the usual voice/speech telecommunication services. The aim of our project as mentioned earlier is identifying fundamental issues to improve communication environments where deaf and hearing people are using mobile videophones. In the study, we consider three types of videophones commercially available in Japan as shown in Figure 1. Usual mobile videophones (Figs.1(a), and1(b)) have display size of around two inches and weight of around 120g. PDA (Personal Digital Assistants) type one shown in Figure 1(c) has a larger display (3.5 inches) and is heavier than usual ones (280g).

We then clarify the communication situation where they use: (1) Mobile videophones. (2) Visual/video communication media. (3) A signed language as a language medium of communication. (4) Applications in the field of interpersonal communication (signed language conversation), video relay, and remote access to information (Mobile Internet service).

In the following chapters, we consider the following factors for signed language communication services using mobile videophones: (1) Physical interface of mobile videophones for signed language communication. (2) Language and cognitive interfaces of one-handed signing. (3) Cognitive interface for mobile videophones with small size display. (4) Social and human supports for applications and services. (5) Value of communication services.



(a) (b) (c)

Figure 1: Commercially available mobile videophones in Japan. (a) Folding type with a display of 2.35 inches and weight of 133g, (b) Straight type with 1.8 inches, and 110g, (c) PDA type with 3.5 inches, and 280g.

3 SIGNED LANGUAGE PERCEPTION EXPERIMENT

Mobile videophones have small displays with size of around two inches as shown in Figure 1. In this chapter, we show certain experimental results for the perception of signing pictures displayed by small size screens.

3.1 Display Size and Information Perception

The display sizes of mobile videophones are around two inches. These sizes are smaller than usual PDAs. Other available mobile terminals are notebook PCs with around 7-10 inch display. Much larger displays are used for desktop PCs.

One of the most important questions is that how well we can perceive the information through these small displays. We make a perception experiment to clarify this question for JSL.

3.2 Experiment

3.2.1 Procedures

Ten deaf adults (five men, and five women) of ages of fifties and sixties (M=59.8 years) were joined the experiment. All participants are prelingual deaf and use JSL in everyday life.

We first recorded 30 signing sentences on a digital video recorder (SONY, DSR-300A). A signer is a prelingual deaf (male) of age of sixties, and is a member of the same deaf community as participants. We chose 10 signing motion pictures among 30 ones. We then generated total number of 50 signing stimulus (10 sentences x 5 display sizes) using a video editing software (Ulead, Video Studio 5.0, and Finalsoft, Simplayer WMP3 TE). The display picture sizes are 1, 2, 3, 4, and 6 inches.

The experiment consisted of two phases: Intelligibility and preference tests.

At the first phase, We showed one signing sentence with a specific picture size on a CRT (SONY, CPD-E230, 1024x768), and asked every participant to evaluate subjective intelligibility for the sentence between 0% (not at all) to 100% (completely).

The second phase is the evaluation of preference for signing stimulus with different picture sizes. We have used Nakaya`s modified version of paired comparison method (Research Committee of Sensory Evaluation, 1973). Each participant watches two signing pictures, say A on one CRT display and B on the other, with different picture sizes and the same sentence. A participant can watch each signing picture repeatedly as many times as he/she wants, and is asked to compare two signing pictures. The evaluation scale is a bipolar 7-point rate (A is very good, A is good, A is slightly good, A and B are the same, B is slightly good, B is good, B is very good).

3.2.2 Results

The mean values of intelligibility of JSL sentences for different picture sizes are shown in Table 1, and are plotted in Figure 2. The error bar in Figure 2 indicates one standard deviation. We have applied t tests between intelligibility values for different picture sizes, and the result shows significant differences between each pair of picture sizes except two cases: between 3 and 4 inches, and between 4 and 6 inches. We also applied F test to check subject difference in the group, and the result shows no significant difference, $F(9,90)=1.4698$, $p=.1713$.

Table 1: Intelligibility for signed language sentences with different picture sizes

Picture size(inch)	1	2	3	4	6
Intelligi-bility(%)	24.25	70.25	84.00	92.00	95.50

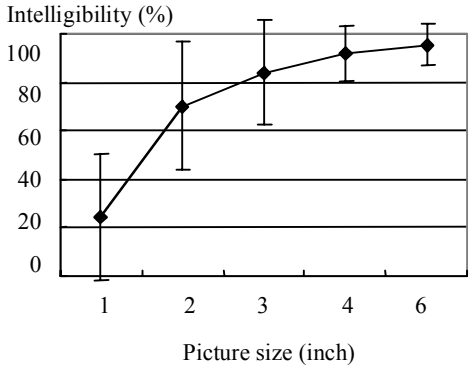


Figure 2: Intelligibility (mean and one standard deviation) for JSL sentences with different picture sizes

Table 2: Degrees of preference for different picture sizes

Picture size (inch)	1	2	3	4	6
Degree of preference	-1.96	-0.840	0.380	0.960	1.46

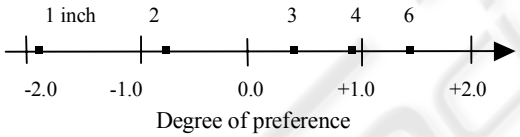


Figure 3: Degrees of preference for different picture sizes, 1,2,3,4, and 6 inches

The preference values for five different picture sizes are shown in Table 2, and Figure 3. We have applied t tests between values of preference. The result shows that every difference between preferences values is statistically significant, $p<.01$, except two cases: between 3 and 4 inches, and between 4 and 6 inches.

4 DISCUSSIONS

The purpose of our study is to clarify design issues of information/communication services using a signed language, and mobile videophones. We discuss these ones together with other experimental results discussed elsewhere (Kamata, Shionome, Yamamoto, & Fischer, 2003).

4.1 Display Size

The mean value of intelligibility decreases according as picture size becomes smaller. The results for t test show that intelligibility values for picture sizes of 1 and 2 inches are significantly different from others, and sizes of 3, 4, and 6 inches form a group. These results lead to a plausible conclusion that picture size of 3 inches is a critical for a signed language (JSL) perception in the mobile videophone terminal.

The other experiments on subjective preference of signing pictures also show that the size of 3 inches is critical. The degrees of preference for picture sizes of 3, 4, and 6 forms a group and others, 1 and 2 inches, are isolated from those ones.

From these two experimental results, we can say that real mobile videophones with picture size of around 2 inches cause certain kinds of cognitive stress in perceiving signing pictures.

Another videophone is a PDA type mobile videophone with 3.5-inch display as shown in Figure 1(c). This is allowable picture size from the experimental results.

4.2 One-Handed Signing

One of the most preferable and useful features of mobile videophones is the possibility of mobile access to the network, and the portability of equipment. Hearing person can use a mobile phone with either vocal/speech or text communication by holding it by one hand. This is not the case for those who intend a signed language communication. When a user produces signed language, he/she usually needs to hold the videophone by one hand and to make signing by the other hand (one-handed signing). This situation is quite unusual, because they usually produce a signed language by two hands.

We have made another experiment to clarify two questions relating to the use situation (Kamata, Shionome, Yamamoto, & Fischer, 2003): (1) Can people make one-handed signing without difficulty? (2) Can people understand one-handed signing? The experimental results show that deaf people can do it without great difficulties, and they may follow rather common rules for expressing one-handed signing for two handed signs. On the other hand, hearing people who do not have much experience of one-handed signing have difficulties with the production. Furthermore, a similar situation happens in receiving (perceiving and understanding) one-handed signing. Hearing people who do not have much experience have difficulties in understanding one-handed signing. Deaf people and some hearing people who have plenty of one-handed signing experiences can

converse with each other by one-handed signing through the real mobile videophones.

Another issue that we have to take into account is the posture for holding a mobile videophone during the one-handed signed language conversation. They have to keep a certain distance between the body and the video camera of the videophone so that the camera can fully capture signing movements. The posture fundamentally gives a user a considerable stress that is one of the causes of fatigue.

The use situation for a PDA type mobile videophone is different. A user holds it by a hand or put it on somewhere. In the later case, he/she can use two hands in signing, but its portability is less than the usual mobile videophones.

4.3 Quality of Signed Language Communication Services

From the abovementioned discussions, we can say that the mobile videophones have great benefit for signed language communication, and on the other hand have some difficulties in use with physical and cognitive issues.

In this section, we show certain services by a signed language, and consider the quality for the services (User based Quality of Service, UbQoS). UbQoS can take into account the usual technological parameters, and other factors: user's attitude to services, language and cognitive interface, and human and social issues for supporting the services.

4.3.1 Distant Signed Language Conversation

The benefit of the use of the mobile videophones is to make it possible a distant signed language conversation for deaf and hearing people. Deaf people need to make real face-to-face conversation due to the characteristics of signed languages in case of having no distant communication means. They now can have a means for signed language conversation anywhere and any time. The communication circumstances will be very similar to those for hearing people with voice/speech communication by mobile phones.

Although the ISDN videophones provide an opportunity of distant signed language conversation, the equipment is not portable, and can not make mobile access to the network. A portable PC terminal can be used as a mobile videophone, and has a larger display than the mobile videophone. However, the PC is less portable than the mobile videophone. A PDA type mobile videophone has some advantageous features except portability: The display size (3.5 inches) is larger than usual ones (around 2 inches). It also provides two-handed signing situation.

Another important issue is the communication fee for mobile videophone service. Signed language conversation costs much more than the usual text and voice/speech communications. This is one of typical issues for social consideration.

4.3.2 Remote Interpreting Services of Signed Language

The most advantageous feature of the mobile videophone is the portability. Certain use situation for a remote signed language interpreting service (video relay) is very important for deaf and hearing people. One of typical situations is the case where police officers need to communicate with deaf person, for example, at a traffic accident. It is very difficult to build a social system to arrange signed language interpreters at any place and any time. Remote interpreting services (a relay centre service) is very attractive. In this application, the portability of the mobile videophones provides very flexible communication means in an emergency case.

Although the remote signed language interpreting service needs human and social resources to manage it, the service should be considered as a kind of fundamental social security/welfare service.

4.3.3 Mobile Internet Access

Mobile phones provide Internet services, and a user can use e-mail and access to Web sites. Deaf people use mobile e-mail for text communication. Some mobile videophones have a function of capturing motion pictures (for example, signing motion pictures) and storing it, and of sending the stored data to the party. Although the duration length of motion pictures for this service is now economically limited by about fifteen seconds due to the communication cost. Mobile videophones will provide, in near future, signed language based e-mail service. Some simple methods have been discussed elsewhere (Kamata, Yamamoto, Abe, Fukuda, & Abe, 2001).

Deaf people can access to the network and get the desired information from Web sites. The language medium of information, however, is Japanese in either text (written language), or speech at almost all of the Web sites. When one wants to get information by the medium of a signed language, information contents must be translated and represented by a signed language. This needs certain language processing by either human or machine, and includes both technological and social factors.

4.3.4 User-Based Quality of Services

We have shown some possible services based on the mobile videophones and their use situations. The most important issue is that a user can perform an intended information activity in a particular situation using a mobile videophone terminal.

We mainly focus upon signed language communication with the use of mobile videophones. Generally speaking the communication environment for deaf people is restricted, and they usually have to use a spoken language as an information medium of communication. Mobile videophones and other terminals provide new opportunities for signed language communication. The quality of these new communication services varies according to some factors: purpose of use, use situation, information contents, and other technological parameters.

The mobile videophones have an advantageous feature of portability and are very attractive, and at the same time have certain difficulties in use due to the small display size and others mentioned. There should exist a trade-off between small display, portability, purpose of the use, and the value of service. One example for the trade-off is the signed language communication in an emergency case mentioned in the previous section. This service is important and valuable in a certain situation even if the picture quality is not fully good enough for communication. This example shows that the quality of service from the user's point of view is not completely determined only by technological parameters discussed previously. This situation will be well discussed by the concept of User-Based Quality of Service (UbQoS). It reflects user's attitude to the service and other factors.

5 CONCLUDING REMARKS

The present study firstly has dealt with the effect of display size of terminal equipment (mobile videophones) on information perception in a signed language, and, secondary, the effect of terminal function, language and cognitive, and social issues in signed language communication. Designing of information/communication services based on a signed language is very important especially from the point of social security and welfare. As we have mentioned in this report, the mobile videophones have certain difficulties in use for signed language communication, specifically with physical, and language and cognitive factors. The measure of quality for the service has many technological, human and social factors, and is quite complicated. We have introduced the term UbQoS for including these factors. As mentioned in this report, activities in a particular situation, such as communication with the party and getting certain information, were very valuable even if the picture quality of communication system was not perfect enough. We need further thorough consideration from various viewpoints such as technological, human, and social ones.

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