TeleSign: A Sign Language Telecommunication System

W. Chapin, J. Kramer, C. Haas, L. Leifer, E. Macken
Center for Design Research
Center for the Study of Language and Information
Stanford University
Stanford, CA 94305

Abstract

TeleSign is a natural language telecommunication system for deaf and other users of a sign language (such as American Sign Language). It enables real-time telephone sign language communication. It operates on a 32-bit portable computer system with standard modem communication capabilities. TeleSign consists of an instrumented glove worn on the dominant hand of each signing participant. The glove measures the position and motion of the fingers. In addition, an absolute position and orientation sensor is worn on both wrists of each signer. The finger, hand, and wrist data from one signer are used to construct a corresponding dynamic three-dimensional graphic image of the hand and arm (in second-person perspective) on the computer screen of a second signer. On the screen the graphic hands and arms move in front of a graphic image of a human head and torso to provide position reference.

1 Introduction

TeleSign is a telecommunication system designed for manual languages just as the standard telephone is designed for spoken languages. An extension of TeleSign, referred to as SignMail, would permit the sending and storing of signed electronic mail messages. TeleSign and its derivatives will benefit the approximately 500,000 members of the Deaf Community in the United States who prefer to communicate using sign language and their friends and family members who want to communicate with them in that language. It will also benefit members of other deaf communities throughout the world who communicate with manual languages. With increasing awareness of the value of signed languages for deaf individuals, we expect the numbers of people who prefer these languages to increase. The TeleSign system may, in fact, be a catalyst for this increase. In the United States, for example, there are approximately two million deaf individuals and sixteen million hard-of-hearing individuals who may be interested in learning a manual language. In addition, since TeleSign allows sign language to be recorded electronically and compactly for easy access, transmission, and retrieval, research into the subtle dynamics of sign language and the effects of various signing parameters on the intelligibility will also be facilitated.

2 Need

Today, deaf individuals communicate over the telephone using a TDD, sometimes accompanied by a relay service operator. The TDD requires each user to type messages on a keyboard and read responses on a small LED screen. The procedure is slow and cumbersome, especially so for individuals whose preferred language is not a written or spoken language but is a visual language. Such languages are not word-by-word translations of oral languages. They have their own conventions for expressing meaning and relating concepts—conventions that make dynamic use of spacial information. Written forms of manual languages have not been widely accepted, so some users must first translate their thoughts into an oral language that has a written form (an effort that is comparable to translating from one oral language to a second oral language) and then type the translation. Electronic mail, used by some deaf individuals, makes the same translation requirement. Because of these limitations, deaf individuals do not experience the ease of telecommunication that hearing individuals take for granted.

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3 Alternatives

Previous attempts at telephone communication of sign language have focused on compressing live digitized video images and transmitting them in real-time. Compressing the image data to rates that can be transmitted over the conventional telephone bandwidth of 3000 Hz reproduces, at best, an abstract image of the signer. Data compression techniques that attempt to reduce the amount of information needed to describe an image by removing unimportant or redundant data also trim off salient information and thus render it difficult to decipher hand gestures. In addition, although compressing the image reduces the amount of information being sent and speeds up image transmission once initiated, the number of calculations required to perform the actual compression could introduce an undesirable and often confusing time delay in initiating image transmission.

4 Software and Hardware

The software is divided into two parts: communications and graphics. The communications portion will run identically on all host computers and will transmit raw data. The graphics portion is a scalable, real-time 3D virtual environment simulator for a wide variety of special drivers and graphics accelerators. A scalable renderer will be available for each type of computer (i.e., PC, Mac, Sun, SGI) so that images can be rendered locally to the best ability of the local computer.

All core development and testing has been done on basic personal computers with VGA graphics. See attached figure for schematic of the prototype TeleSign system.

5 Affordability and Reliability

TeleSign will be as affordable as a moderately priced personal computer. Because TeleSign will provide sign telecommunication comparable to a standard telephone, we anticipate that telephone companies may subsidize TeleSign in the same way that TDD's and other telecommunication devices and services for deaf persons are subsidized today.

Various manufacturers and models of instrumented glove devices and absolute position sensors currently exist. Reliability of at least one commercially available position sensor has been established. Instrumented gloves are still relatively new and are evolving rapidly. Their use in video games is a testament to their robustness. As the TeleSign project progresses, the state-of-the-art in instrumented gloves will also improve and more systematic data as to their reliability and maintainability will become available.

6 Summary and Conclusions

TeleSign transmits only the raw data essential to graphic reconstruction of the signer's salient arm and hand motions. We have demonstrated a prototype TeleSign system that allows sign language communication between two signers sitting at separate graphic displays, each wearing a 16-sensor instrumented glove and a 6-degree-of-freedom position sensor on the dominant hand. Since the prototype system does not use a position sensor on the nondominant hand, the two signers require occasional assistance to understand transmitted signs that are ambiguous when information from only one hand is known. When the additional position sensor is used on the second hand, we expect that intelligibility will greatly improve and that no additional assistance will be necessary.

The prototype TeleSign system uses a data rate of 3360 baud. Since 9600 baud modems are common and affordable, there is plenty of "headroom" for increasing frame rate, transmitting interface protocol, and including other types of information such as position data for the nondominant hand, image data pertaining to facial expression, head and body position, and keyboard and mouse input. We are investigating types of protocol and control information that will include the signer's hand geometry and calibration file and such features as the number of sensors per glove, types and locations of the position sensors, and the type, speed, and graphic capabilities of the computer in use.

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