Supporting Medical Communication with a Multimodal Surface Computer

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Abstract
This research explores the utility of a multimodal surface computer for supporting medical communication between older adults and health care providers. Research involves a field study of health care communication practices, the design of a multimodal surface computer application, and an in-context evaluation of the technology at a local retirement community.

Keywords
Multimodal Interaction, Older Adults, Surface Computing

ACM Classification Keywords
H5.2. Information interfaces and presentation: User Interfaces.

General Terms
Design, Experimentation, Human Factors

Introduction
Globally, the proportion of people over age 60 compared to younger population segments is growing at a rapid rate [10]. As we age, we experience an increase in health conditions that require ongoing medical attention. Managing medical care is challenging for everyone, but this is particularly difficult for older adults with declining physical, visual, hearing, or cognitive abilities. As medical practices begin to adopt digital patient record systems, communication of health care issues may be further complicated for older adults who are intimidated or overwhelmed by technology. While technology in medical settings undoubtedly changes practices for health care teams [3], the introduction of digital record systems also affects medical interactions for patients [7]. The introduction of computer display systems into doctor-patient interaction presents opportunities to develop shared interfaces that support the needs of older adult patients.

My dissertation focuses on how a multimodal surface computer supports communication between older adult patients and health care providers. Compared to traditional computer workstations, large multitouch surfaces seem particularly appropriate for older adults. Interacting with digital media is accomplished in a direct and natural way without the encumbrance of a
keyboard or mouse. The horizontal form factor of a tabletop is familiar and affords sitting with other people while interacting with shared media simultaneously. The ability for multimodal technology (e.g., [6][9]) to recognize speech in a collaborative setting is particularly promising for supporting interaction among older adults, doctors, nurses, and family members.

**Current Progress**
The Shared Speech Interface (SSI) project [6][7] begins to explore the idea of reifying speech on a multimodal surface. SSI is an application for an interactive multitouch tabletop display designed to facilitate medical communication between a Deaf patient and a hearing, non-signing physician. The Deaf patient types on a keyboard, and the hearing doctor speaks into a headset microphone. Speech recognition software transcribes the doctor’s speech. As the two people communicate, their speech appears on the display in the form of movable speech bubbles (see Figure 1).

Communication through SSI is slower than a human sign language interpreter, but SSI provides Deaf patients with an enhanced sense of privacy and independence. A micro-analysis of communication reveals that the system allows the Deaf patient to watch the doctor when she is speaking and encourages the doctor to exploit gesture in communication [7]. Finally, the system provides interactants with a shared real-time interactive transcript of conversation that allows both the doctor and patient to review prior dialogue.

Beyond the Deaf community, this approach of reifying speech on a shard display also stands to benefit the Hard of Hearing community. Exploring a multimodal surface computer with older adults who may have hearing loss as well as declining cognitive and physical abilities is the focus of my dissertation. While a range of research studies examine surface computing for general audiences, only a few studies examine the technology for older adults (e.g., [1]). Recently, I conducted a laboratory study with 20 older adults (age 60 to 88) to examine the accessibility and appeal of a surface computer for health care support. We found that older adults were able to successfully learn and perform gesture-based actions on the surface computer. However, some gestures that required two fingers or fine motor movement were problematic (see Figure 2). Importantly, older adults reported that the surface computer was less intimidating, less frustrating, and less overwhelming than a traditional computer. Finally, the idea of using a surface computer for health care support was well received by older adult participants.

**Field Study: Understanding Communication**
Currently, I am conducting a field study at the health center of a local retirement community. The goal of this research phase is to understand the current practices and challenges of health care interaction for older adults and to inform the design of a multimodal surface computer to support interaction. Through the method of cognitive ethnography [4][5], I am examining the practices, materials, and broader cultural context that shape interaction involving older patients, their health care providers, and family members. One central question guiding this research involves how people organize themselves and artifacts in a shared conversational space. To understand this, observations and video data will focus on the organization of various actors in face-to-face conversation (e.g., body orientation), the role of verbal and nonverbal communication (e.g., eye gaze, gesture), and the

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*Figure 1.* Doctor (left) and Deaf patient (right) communicate using Shared Speech Interface (SSI). Moveable speech bubbles appear on the surface computer.

*Figure 2.* Man (age 84) performs a two-handed gesture to enlarge an x-ray image on a surface computer.
incorporation of artifacts in conversation (medical records, diagrams, or care logs to document progress).

System Design: A Shared Conversation Space
Findings from ongoing fieldwork, the laboratory study on surface computing for older adults, and prior work on SSI will inform the design of a multimodal medical communication system. For example, there are a range of issues to consider in the physical setup of the device. While older adults in our usability study did not have difficulty reaching across the horizontal display (80cm diagonal), a few participants said that the size of the display may be intimidating. I plan to explore smaller portable multitouch displays (e.g., HP TouchSmart), which could also be oriented at a variety of angles to make reading text on the display easier. Additionally, legroom when sitting at the computer is critical for older users, thus a thin form factor like the DiamondTouch (see Figure 3) may be better than a rear-projected system (e.g., FTIR technology [2]).

A key aspect of interface design involves how the system will capture and represent speech. We are exploring ways to capture and transcribe dictated speech from multiple concurrent speakers, and perhaps the system will perform keyword recognition instead of full speech dictation (as with SSI). Keywords may appear in the form of speech bubbles that can be moved around, deleted, and even replayed. The application should also allow users to load diagrams or images that are relevant to conversation. I plan to start with a basic application will enable me to identify features that are necessary for further use. For example, we may find that users want to print out or email images from their session, so we can add those features after initial use in the field.

In-Context Evaluation
While SSI provides an initial evaluation of how a multimodal surface computer might support medical communication, we need to understand how well this approach works under more authentic conditions. I plan to install the multimodal system in the health center of the retirement community of study. Through an in-context evaluation of the system, I will assess whether the system is quick and easy to learn and provides enough benefit to make it worthwhile for patients and medical staff.

Observations of the doctor and patient interacting through SSI indicate that pointing to and referencing the shared transcript of conversation was important in communication. The SSI project begins to examine how interactive visual representations of speech affect conversation as it occurs in real time, but there are many unanswered questions about interaction with two hearing users. For example, does the interactive transcript of dialogue change the way participants speak to each other? Do they look down at the display rather than making eye contact? Do participants find it helpful to have an interactive record of their conversation? I plan to video record interaction with the system over several months and examine patterns of speech, gesture, and eye gaze to answer the above questions.

Compared to traditional physical artifacts such as paper documents (medical charts) or images on film (x-rays), digital artifacts can be resized, duplicated, and annotated without altering the original object. Digital materials, however, have limitations such as a lack of tactile feedback and may be difficult for older individuals to manipulate. I will compare participant interaction with digital materials on the surface computer to similar
interactions with paper materials to understand how digital materials affect interaction in this context.

A successful system should also provide direct benefit to older adult patients such as increased efficiency in communication, feelings of independence, and confidence in interaction. I will assess these qualities of the system through questionnaires and interviews with the older adult participants, any family members involved in communication, and health care professionals meeting with patients.

**Broader Impacts**

The population of older adults is growing at a rapid rate, generating a need to design appropriate and accessible health care technologies for this user group. My research addresses design issues for surface computing and explores the use of this technology in a critical real-world context. Multimodal surface technology promises to change the way patients interact with medical providers, but the technique also stands to benefit other populations with different communication needs. For example, a student learning a foreign language could access text-based representations of speech along with audio clips of the instructor speaking the phrases. Shared access to a persistent visual representation of spoken dialogue may also benefit individuals who need help with language rehabilitation (e.g., individuals with Aphasia or Apraxia). My dissertation work examines how surface computing can support health care communication for older adults and provides a foundation for exploring other populations who may benefit from this approach.

**References**


[2] Han, J. Y. Low-cost multi-touch sensing through frustrated total internal reflection’. In Proc. of UIST '05, 115–118.


