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Designing for Older Adult Users of Handheld Technology

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Abstract— **There are few interface design guidelines for handheld devices used by adults sixty years and older. Yet, this growing user group would benefit from the portability offered by such technology in promoting health management and social interaction. In this paper, we describe a usability framework for conducting studies on the use of a PocketPC by older adult caregivers. The usability framework provides a basis for conducting studies taking into account the user profile of an older adult, environment factors, usability quality factors, and technology objectives.**

I. Introduction

The human interface for most technologies, excluding special devices, has been designed for a younger user [1]. This trend continues today as human interface designs evolve for handheld devices. Unfortunately, a handheld interface that is considered usable by a younger adult may be difficult if not impossible to use by older adults primarily due to normal aging factors. Smaller screen and keyboard sizes, in particular, may pose as barriers if interfaces are not properly designed for aging vision, cognition, motor skills, and hearing.

Many older adults, sixty-five years plus, find themselves increasingly homebound and isolated with age-related diseases or caregiving responsibilities compounding the problem. Portable technologies would greatly improve quality of life beyond the home environment by offering access to healthcare resources, socialization, and life-long learning opportunities, among others. Yet, few studies have been conducted on how to design user-friendly interfaces for handheld devices to promote their use by older adults.

With the explosive growth of aging adults in the U.S., there is a great need for technologies that would promote quality of life while aging in place. This is especially pertinent to caregivers of Alzheimer's disease (AD) patients who often find themselves cut off from family and friends.

In the U.S., 4.5 million adults sixty-five years or older have Alzheimer's disease (AD) with 70% percent living at home. As the disease progresses, it places emotional and physical stress on caregivers as they assume responsibilities that include managing daily routines and making important medical decisions [2]. Portable technologies, as provided by the PocketPC, offer innovative solutions to link caregivers to the outside world.

Our research focuses on the usability of handheld devices, specifically the PocketPC, in order to provide virtual mobility to aging caregivers of Alzheimer's disease (AD) patients. When supplemented with Internet capability, the PocketPC offers support in performing daily activities, maintaining social connections, scheduling appointments, and accessing a wealth of resources made available through proprietary and commercial software applications. PocketPC devices are light-weight, relatively inexpensive, and can be used to communicate through wireless or wired communication technologies. Increasingly, new software applications are being built bringing additional resources such as global positioning service (GPS), medication and healthcare management, email, scheduling, games, and much more.

II. Past Research

Though research on the usability of handheld technology by older adults is limited, initial research shows it to be viable. A study by Sterns [3] showed that older adults can readily use a Personal Digital Assistant (PDA) handheld device as a memory aid for addresses and appointments, to improve medication adherence, and as an organizational and communication tool. His results showed that all of older adult participants were able to use basic features and applications designed for medication reminders (p. 834). A study conducted by Siek, et al. [4] found that there are no major differences in performance between older (75-85 years) and younger (25-30 years) users when physically interacting with a PDA and completing conventional (e.g., pressing buttons) and non-conventional (e.g., scanning bar codes) tasks (p. 267). Darroch, et al. [5] found little difference in reading performance by older adults and their younger counterparts with font size above 6 point; however, older adult subjects preferred the larger font sizes. Another study conducted by Goodman et al. [6] showed that multimodal presentations of information are effective for older adult users of handheld devices when used as a pedestrian navigation aid. The study pointed out that portable technology can prove useful for older adults in maintaining their mobility and independence (p. 19).

Though limited in scope, these studies are foundational in identifying the PocketPC as usable technology by aging caregivers. We propose to initiate a series of usability studies in designing the PocketPC interface such that it takes into account the needs of an older adult user.

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III. USABILITY ASSESSMENT FRAMEWORK

We have developed a usability assessment framework to initiate a series of studies involving AD caregivers and PocketPC technology to promote aging in place. This framework is composed of several major components including: user profile, technology objectives, environmental factors, and usability quality factors. The framework plays an important role in defining measurable outcomes for each usability study that is conducted. Each of these components is briefly described.

A. Older User Profile

An older adult profile is needed in order to understand the potential usability barriers that a senior may encounter during the use of a particular technology. Included is demographic information, such as, age, gender, technology skill level, education, and other data typically gathered during a usability study. For handheld technologies, additional assessment factors will include: vision, cognition, motor skills, and hearing. Each of these aging factors is briefly described to gain an understanding of the potential impact on technology use (a more thorough discussion can be found in [7]-[9]).

1) Vision - The aging eye has a reduced ability to focus on close objects due to a reduction in the elasticity in the lens. There is a decline in visual acuity affecting the ability to see objects clearly. The lens of the eye yellows and thickens thus impacting color perception. There is decreased light sensitivity affecting adaptation to changes in light levels, and increased sensitivity to glare from light reflecting into the eye. Depth perception is reduced making it more difficult to judge the distance of an object [10].

2) Hearing - There are several changes in both the outer and inner ear that are age-related thus impacting the ability to hear sounds. Age-related loss of sensitivity is especially pronounced for high-frequency sounds ([11]; as cited in [7]). The aging process is responsible for a lessening discrimination of similar sounds that may differ in intensity or frequency. In addition, Olsho et al. [12] found that seniors may have problems with object localization with low frequency sounds.

3) Cognition - There are several cognitive factors to take into account when designing technology for older adult users. These include problem solving, working memory, attention, and concept formation. An aging adult's performance on working memory tasks declines with age, with a reduced ability to discern details in the presence of distracting information [13].

4) *Other Psychological Factors* - In addition to the cognitive changes that occur as a function of normal aging, there are many psychological aspects of aging that may impact usability assessments. For example, the style of coping with stressors change with age, from the problem-solving approaches common in early and middle adulthood, to a more emotional-focused style. Such a style tends to be more passive, and with many older adults can result in simple acceptance of what seems to be a final reality as opposed to manipulation of the environment [14]. With the older family caregivers involved in the present project, the stresses attendant upon the caregiving role result in severe strain on already changing coping resources. Thus, any added behaviors of a technical or mechanical nature are likely to exacerbate the cognitive demand, and may require other interface characteristics to be enhanced. For example, a man caring for his wife (who is beset with AD) may be attending to basic needs of the individual and the home for much of the day. Adding a new task, such as interacting with the PocketPC, increases burden and stress.

5) Motor Skills - Older adults have decreased motor coordination such that it becomes difficult moving and clicking on a screen. For those who have a chronic disease such as arthritis, using a mouse or stylus may be difficult in manipulating interface objects. An older adult typically takes longer to complete a movement than younger adults [15], and movements tend to be less smooth and less coordinated [16].

6) *Literacy*- Age can have an impact on literacy such that comprehension of written material progressively declines [17]. Reductions in older adult working memory capacity have been correlated with decreased performance on language comprehension tasks [18]. Researchers have found that literacy declines dramatically with age, even after making adjustments for level of education and cognitive impairment [19]. They have also found that a negative association between literacy skills and age appears to increase after age sixty-five [20]. As one ages, it becomes more difficult to simultaneously remember and process new information and to comprehend text [21].

7) Technology Skills – Eisma et al. [22] point out that for many seniors computer-related technology isn't a regular part of the everyday life. Though computer use is growing in popularity for this user group, there are still many who have had limited exposure to newer technologies including handheld devices. There may be cultural and language barriers to overcome in older adult acceptance of technologies. (Technology to older adults may have meaning in terms of fax and copiers, answering machines, and VCRs but lack understanding when mentioning the Web, personal computer, or a PocketPC.)

Older adult research often focuses on an adult who is sixty years or older. This spans a very large range with significant variations not only in age, but education level, technology skills, normal aging factors, and the progression of age-related diseases. As such, the profiling of the targeted aging caregiver subjects will be critical to the validation and reliability of usability results obtained.

B. Environmental Factors

The environmental factors take into account the hardware, software, and the environment in which the technology is used. Hardware and software applications should be defined in terms of limitations or constraints that could pose as usability barriers to the targeted user. In general, an older adult would have greater difficulty than a younger adult seeing text on the screen of a handheld device running on battery mode when a small font overlays a patterned background.

1) *Handheld Device* – A handheld device is portable and lightweight making it easy to carry from one environment to another. A limitation of the handheld device may be its screen size (measuring about 2 x 3 inches) depending on the design of the interface components. The use of a stylus may also be difficult to use by an older adult with arthritis especially when the interface requires precise tapping or writing on the screen. The wireless capabilities of the handheld device may be an advantage in providing communication capabilities, but the audio component may pose as a barrier to use.

2) *Software Applications* – Mobile 5.0 operating system on the PocketPC provides built-in applications for scheduling, email, note taking, and games, among others. Depending on design components; such as, font size, font style, foreground and background color combinations, and vertical and horizontal scrolling, and use of white space, among others, the application may pose readability and other usability barriers. Custom software applications pose the same usability issues in terms of bringing caregivers virtual resources, social interaction, and health care information or barring them from use.

3) *Usage Environment* – The portability of the handheld device allows it to be used virtually anywhere. Yet, the portability aspect of the device adds to the complexity of the usability studies to be undertaken. Various usability studies need to be conducted to account for environmental scenarios; such as, lighting and screen glare, battery power and screen display, dead battery during application use, and background noise and audio capability, among others.

Most of the studies will be conducted in a usability lab simulating home use of the PocketPC by an aging caregiver. In each study, it will be important to identify interface design component and other environmental factors that could impact usability by older adults.

C. Usability Quality Factors

Usability has been defined by researchers and practitioners alike in terms of five quality components: time to learn, speed of performance, error rate, retention over time, and subjective satisfaction ([23] p. 16). These are commonly used in usability testing to uncover potential barriers associated with the interface design.

1) Time to Learn – The time it takes for a typical user of the targeted group to learn how to use the device in order to learn how to use the actions relevant to a set of tasks. The time to learn is an important quality factor for older adults with little or no technology background. The time to learn may be increased significantly when interface components are not intuitive, lack design consistency, and do not account for aging factors.

2) Speed of Performance- The time it takes to complete the benchmarked tasks. This quality factor may prove to be less important than for younger adult users. Older adults may be willing to wait longer for a response when accounting for age-related changes in vision, cognition, and motor skills.

3) Error Rate – The number, type, and severity of errors made by a typical user when completing the benchmarked tasks. Given that older adults may be focused on the utility of software applications, the error rate may prove significant in terms of long-term acceptance of technology. When error rates are high, there is more than likely an impact on time to learn and retention over time due to aging and cognition.

4) Retention Over Time – The knowledge that is maintained after a period of nonuse. This quality factor must account for normal aging and cognition given that working memory declines with age. Measurement results may indicate training requirements associated with learning new technologies. This quality factor may be highly related to utility in terms long-term use of handheld technology. When the user does not retain instructions during training sessions, he or she may be less likely to use the device in a nonlab environment.

5) Subjective Satisfaction - The user's feedback on how well he or she liked various aspects of the user interface. This quality factor, in our usability studies, will include both usability and utility assessment components. Nielsen [24] points out that utility and usability are equally important in the assessment of interface designs. For older adult users of technology, utility plays a significant role in its acceptance. Given the older adult's stage of life, the value added through the technology objectives will determine whether the PocketPC is a viable technology for AD caregivers.

Depending on the measurement objectives of each study, one or more usability quality factors will be used to assess both usability and utility from an older adult perspective. In general, speed of performance may be less important when compared to retention over time and time to learn factors. These may be viewed from a utility perspective as to be more meaningful in adding to quality of life. We expect that usability study results may prove useful to determine both documentation and training requirements to minimize time to learn, error rates, retention over time, and performance speed.

D. Technology Objectives

The technology objectives are in important component of the usability framework given that there are different uses associated with handheld devices. The use of a handheld device to gather sales data during a field visit, for example, is significantly different in terms of its usage objective when compared to an older caregiver managing an AD patient.

There are several major technology objectives associated with our research project including information dissemination, health management, scheduling appointments, and social interaction. Each of these technology objectives will impact usability by an older adult when taking into account the other framework components. For example, social interaction may require the use of a stylus and built-in keyboard in order to send an email message to another person. The older adult user may perceive the precise tapping required by the stylus pen as a barrier to using the handheld device for email communication. Performance speed and error rates may play a role given that Internet connectivity may have a cost associated with it. A customized keyboard design may

change the perception of usability by allowing the user to touch larger buttons without the use of a stylus. Keyboard mistrokes may be reduced and typing speed improved. In the case of scheduling an appointment, the user may have a higher tolerance for errors and slower speed of performance when compared to interactive communication by email messaging.

IV. CONCLUSION AND FUTURE RESEARCH

The complexity of conducting rigorous usability studies with a high rate of reliability requires an understanding of the components that impact usability from an older adult perspective. The framework proposed in our research is integral to performing tests on the usability of the PocketPC and its supporting applications by older adult caregivers of AD patients.

Each of the components of the proposed usability framework will be documented as part of the usability test reporting structure that is put in place. The Common Industry Format (CIF) developed by the U.S. National Institute of Standards and Technology and implemented as a standard by the American National Standards Institute (ANSI) will be the basis for documentation.

Perhaps the most complex component, the user profile, requires an understanding of potential usability barriers that may be associated with normal aging or age-related diseases. Vision, cognition, hearing, and motor skill changes, due to normal aging, will impact the use of handheld technology given its limited screen and keyboard sizes, screen resolution and glare, use of stylus pen for date entry, and short battery life, among others. As important, is the psychological profile of an aging caregiver taking into account the stress and isolation associated with daily caregiving activities. The involvement of health professionals is key to understanding the user profile of an aging caregiver and the potential usability barriers that it might impose.

The focus of our usability studies will be on older adult participants who do not have diseases that would severely impact the use of technology. Each of the participants in this usability project will have been interviewed by mental health, social work, and medical professionals. Although future studies may very well aim to implement this technology with physically or cognitively impaired individuals, it is not the current focus of our research activities.

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