The Right UI for Elderly People; a review of recent and current research

J. Kivirinta *

* Oulu University of Applied Sciences, School of Engineering, Oulu, Finland
t2kijo00 (at) students.oamk.fi

Abstract

In this paper, recent and current research regarding the User Interfaces (UI) targeted to elderly and disabled people is discussed. These UIs include e.g. touch UIs used in mobile phones and tablets, but also other more unconventional UIs for various devices created to improve individual's quality of life and independency of support personnel. Because a UI is only a façade for underlying system, in this context usually Ambient Assisted Living (AAL) framework, a novelty and prominent AAL framework is introduced. Research has shown that the population of developed countries is ageing. A variety of disabilities caused by ageing can make difficult or even prevent using commonly available devices. New kind of thinking in UI design can prevent senior citizens’ exclusion from today’s ICT-based society, and enable prolonging their autonomous living at home instead of hospitalizing.

Keywords: user interface, multimodal, elderly people, ambient assisted living, ambient intelligence,

Introduction

Proportion of elderly population grows steadily in developed countries, which is a sign of achievements in extending life span. Person’s normal ageing is indicated by slow gradual cognitive decline, by a variety of functional losses, and by slowly progressing age-related diseases such as Alzheimer's disease.

Two-thirds of approximately 54 million Americans that are classified as disabled are over the age of 65. Disabled means they have a physical, cognitive, or sensory impairment -- or a combination of the three. So, the fastest growing disabled group is not people aging with a disability; rather, it is people aging into disability. These people have lived normal lives; however, as they pass the 60-year mark, they begin to experience age-related accidents and diseases [1].

The problem of providing effective healthcare for older people is one that is also likely to exacerbate over time. The proportion of older people in the population is increasing in developed countries such as the U.S., Japan and Britain because of the demographic structures of these countries, and this has led to problems in supporting the quality of life in this aging population. In Britain, healthcare improvements and lower birth rates have resulted in those aged 65 years and older representing 16% of the population, and this is expected to rise to around 19% in the first quarter of the this century [2]. Furthermore, United Nations predict that the number of older adults in Europe will represent 38% of the population in 2050 [3]. Besides economic, politic and social challenges this means there is need to promote assistive technologies in order to increase autonomy and well-being of elderly people.

Current devices such as computers and mobile phones allow people to easily access the Internet resources including information and services. Concurrently, more and more information and communication related to our daily lives is available only on the Internet, making interaction with these devices unavoidable. Mobile phone manufacturers have contributed to this transition by creating devices having user interfaces that provide new, more efficient ways of accessing network services. The majority of the current mobile devices force users to use a button based touch screen UI, commonly including a variety of gestures like swiping. Computers are controlled using a combination of mouse and a button of clickable elements such as push buttons. Combining factors are high information density and required fine-tuned motoric capabilities, which do not hinder younger users, but often render the UI inappropriate for aged people. The same tendency can be seen also in other devices used to control common home equipment and apparatus: an increasingly complex functionality is fitted to physically small space.

The more sophisticated functionality a device is equipped with, the fewer elderly users could be expected, as aging has been identified a major factor getting people hard to catch up with the advanced technologies [4]. More intuitive and human-friendly way of interacting with the electronic devices should be considered.

Ambient Intelligence provides a good means to support and facilitate the daily activities of elderly or otherwise vulnerable persons. Technological innovations, such as ubiquitous computing, wireless sensor networks and wearable devices all contribute to autonomy and well-being by enhancing safety at home, and by maintaining social network, mental and physical stimulation. However, the success of intelligent assistive technologies for elderly people depends on their capability to conveniently fill user’s needs. Provided services must be usable by users with different degree of understanding, lifestyle, behaviour, needs and expectations, and they must adapt to human changes. The key issue is UI: is it simple, easy and inviting, or difficult, complex, even frightening.
Recent technological innovations especially in wireless field make it possible to create intelligent ubiquitous systems that can seamlessly integrate to daily life. To gain users’ acceptance for new systems, a proper UIs according to application must be developed. Plain technology is not enough.

Assistive Design Strategies

What might seem perfectly intuitive to a young engineer designing assistive devices might be completely unintuitive to a disabled or elderly person. If designers don’t understand the complex nature of disabilities, they cannot meet the disabled users’ needs. Universal Design “an approach to creating environments and products that are usable by all people to the greatest extent possible” has seven principles [5]:

1. Simple and intuitive use. It is easy to understand, regardless of the user’s experience, knowledge, language skills, or concentration level.
2. Equitable use. Does not disadvantage or stigmatize any group of users.
3. Perceptible information. It communicates necessary information effectively to the user, regardless of ambient conditions or the user’s sensory abilities.
4. Tolerance for error. It minimizes the consequences of accidental or unintended actions.
5. Accommodation of preferences and abilities. It accommodates a wide range of individual preferences and abilities.
6. Low physical effort. It can be used efficiently and comfortably and with a minimum of fatigue.
7. Space for approach and use. It provides appropriate space for approach, reach, and use regardless of the user’s body size, posture, or mobility.

Adaptive design comprises a basic UD base platform and a variety of hardware modules and program modules that better meet the specific needs of a variety of users. AD extends UD principles and is applicable to cases where designers can’t create a single device usable by everyone.

Ambient Assisted Living

The concept of Ambient Assisted Living is understood as [6]:

• to extend the time people can live in their preferred environment by increasing their autonomy, self-confidence and mobility;
• to support maintaining health and functional capability of the elderly individuals;
• to promote a better and healthier lifestyle for individuals at risk;
• to enhance the security, to prevent social isolation and to support maintaining the multifunctional network around the individual;
• to support carers, families and care organisations;
• to increase the efficiency and productivity of used resources in the ageing societies.

Following are two examples of research efforts in this area.

Home Assurance System

HAS is a system capable of transmitting information to family caregivers in near real time via a secure Web site. The system can collect data using wireless motion sensors and window or door sensors already common in many homes. If desired, these small wireless sensors can monitor specific areas, such as the refrigerator door or movement in the bathroom. Additional sensors can monitor the temperature and detect water leaks, smoke, or carbon monoxide. The system sends sensor activations offsite, where a computer-processing centre translates them into useful activity summaries (Figure 1) that family caregivers can access via the Internet. From collected information it is possible to detect activity patterns and alert the family when a home is unusually quiet [7].

Ambient Assisted Living

The concept of Ambient Assisted Living is understood as [6]:

• to extend the time people can live in their preferred environment by increasing their autonomy, self-confidence and mobility;
• to support maintaining health and functional capability of the elderly individuals;
• to promote a better and healthier lifestyle for individuals at risk;
• to enhance the security, to prevent social isolation and to support maintaining the multifunctional network around the individual;
• to support carers, families and care organisations;
• to increase the efficiency and productivity of used resources in the ageing societies.

Following are two examples of research efforts in this area.

Home Assurance System

HAS is a system capable of transmitting information to family caregivers in near real time via a secure Web site. The system can collect data using wireless motion sensors and window or door sensors already common in many homes. If desired, these small wireless sensors can monitor specific areas, such as the refrigerator door or movement in the bathroom. Additional sensors can monitor the temperature and detect water leaks, smoke, or carbon monoxide. The system sends sensor activations offsite, where a computer-processing centre translates them into useful activity summaries (Figure 1) that family caregivers can access via the Internet. From collected information it is possible to detect activity patterns and alert the family when a home is unusually quiet [7].

Ambient Assisted Living

The concept of Ambient Assisted Living is understood as [6]:

• to extend the time people can live in their preferred environment by increasing their autonomy, self-confidence and mobility;
• to support maintaining health and functional capability of the elderly individuals;
• to promote a better and healthier lifestyle for individuals at risk;
• to enhance the security, to prevent social isolation and to support maintaining the multifunctional network around the individual;
• to support carers, families and care organisations;
• to increase the efficiency and productivity of used resources in the ageing societies.

Following are two examples of research efforts in this area.

Home Assurance System

HAS is a system capable of transmitting information to family caregivers in near real time via a secure Web site. The system can collect data using wireless motion sensors and window or door sensors already common in many homes. If desired, these small wireless sensors can monitor specific areas, such as the refrigerator door or movement in the bathroom. Additional sensors can monitor the temperature and detect water leaks, smoke, or carbon monoxide. The system sends sensor activations offsite, where a computer-processing centre translates them into useful activity summaries (Figure 1) that family caregivers can access via the Internet. From collected information it is possible to detect activity patterns and alert the family when a home is unusually quiet [7].

Mobiserv

Mobiserv is an expandable, open-standard based personal intelligent platform consisting of various devices, middleware, and services. The Mobiserv platform consists of the three parts (Figure 2):

• A social companion robot – an autonomous robot (Figure 3), containing processing power, data storage capability, various sensors, machine learning/experience gathering/adaptation, a touch screen, speech synthesis, and speech recognition;
• Wearable smart clothes – implementing various functionalities such as monitoring of vital signs or sleeping patterns, and detection of falls;
• A smart home environment – including smart sensors, optical recognition units, and home automation elements, to detect among others eating and drinking patterns, activity patterns, and dangerous situations. [8]

![Figure 3 Companion robot](image)

**User Interface considerations**

Elderly people’s problems with normal UIs can be classified to [9]:

1. Slow response to complicated mouse actions including dragging, fast double clicking and operating multi-level menus.
2. Lack of the ability to understand the terms in the software interface and, because of their poorer memory, repeated practice of the software operation process needed.
3. Difficult identification, due to dim eyesight, of the interactive interface with complicated icons and graphs.

Following chapters present a variety of research trying to answer the questions related to subject.

**Improvements to conventional UI**

Conventional UI for typical modern day device in this context consists of a combination of graphical display, buttons and pointing device. A variety of studies have been done to find UI solutions that take older users into account [10]. Improvements include e.g. an option for larger UI elements and fonts, and simpler menu structures.

Lately touch screens have in many devices taken place of physical buttons and pointing devices. Although touch screens have strong benefits, there are also some drawbacks. For example, the users need to watch a screen all the time until they finish the current operation. Even if careful, sometimes an inaccurate touch causes incorrect function to launch. Using the device in the open air is difficult because the LCD displays are difficult to see in the sun.

A tactile feedback is proposed as solution for these problems [11]. Each element type on screen, such as button and list, has respective vibration feedback. For text elements, also audio feedback is activated. By dragging his finger on the screen, user gets hints of elements on top of which his finger currently is. Texts are read out loud.

This kind of UI requires user to use his fingers to control it, and therefore is optimal only for certain kind of applications. Other application areas need different approach.

There has been and is currently going on a large variety of research focusing on assistive technologies targeted to improve quality of life of ageing people.

Voice commands are one natural way to control devices, but reliable recognition of given command can be a problem. Moreover, voice commands require user to remember a variety of keywords. For some purposes just pointing or touching items can be an option. Camera or NFC can be used to detect user’s actions. In addition to hand, also eye direction and movement can be used as commands. Different kinds of gestures are one option to give commands. E.g. a wheelchair can be controlled using head gestures.

Multimodal user interfaces try to answer the questions presented above.

**Multimodal User Interfaces**

Multimodal interaction is a characteristic of everyday human discourse: speak, gestures, eye and body and movement combined to an efficient flow of communication. Enriching HCI with these elements of natural human behaviour is the primary task of multimodal user interfaces. In practice, multimodal systems combine natural human input modalities—such as speech, pen, touch, hand gestures, eye gaze, and head and body movements—in a coordinated manner with multimedia system output [12]. Many studies have explored multimodal interaction from different viewpoints [13].

By giving users the ability to make use of different modes of communication (known as multimodal interaction), it is possible to develop “natural” and context-sensitive interaction. One of the added values that interactive multimodal systems can bring is mode-switching [14]. Mode-switching allows the users or the system to change to another mode of interaction when necessary. Simple example is a TV, which user can control either with traditional remote control or by hand gestures (Figure 4). Intention-reading techniques proposed by [15] can be used in gesture-controlled multimodal systems to help the system know what the user wishes to do. An intelligent system can even recognize unconscious wishes.
Analysis and Conclusions

Studies have shown that proportion of elderly population grows steadily in developed countries. This causes economic, politic and social challenges. Elderly people need support and caring because of decreased capabilities and illnesses, but because of heavy costs and reduced quality of life, institutionalisation cannot be considered as a general solution. It is seen that elderly people should be able to live at home as long as possible, which has brought a need to promote assistive technologies in order to increase autonomy and well-being of elderly people. Fortunately this is recognized also at the highest political level, and e.g. European Union is funding a variety projects focusing on research and implementation of assistive technologies [16].

Research efforts range from projects trying to improve the conventional UIs to better fill elderly users’ needs to projects that aim to create assistive platforms, which combine medical, assistive, communication and entertainment equipment to multimodal ubiquitous intelligent system.

Improvements in UIs, e.g. increased font size and larger buttons, can be a first phase, but to really add value the whole UI must be re-engineered having elderly users in mind. In addition to common vision and touch based UIs, also other kind of must be developed, such as UIs providing tactile and audio feedback, and voice and gesture controlled UIs.

Behind the UIs there must be a system that unobtrusively monitors the premises and can autonomously take intelligent actions when the person is incapacitated. Wireless sensor technology can be used to assist elderly people in their daily live, to monitor the activity and health of a person, and to trigger alarms in accidents or medical emergencies. Several ambient assistive platform projects try to tackle this challenge.

The technology itself is not enough. Even the technologically most advanced system will not gain users’ acceptance if it’s not convenient to use. It should also be noted, that the large variety of research in this area may end up in scattered, competing solutions unless proper standardization process is involved. Without at least continent-level standardization the cost for public sector and consumers will become too high.

Continuous research on possibilities provided by related new technological innovations is needed in order to harness them to support well-being and autonomy of elderly people. However, the most important area of research is human counterpart: what kind of user interfaces are inviting for individual’s having decreased cognitive capabilities and disabilities.

References


