Fundamental Needs in Wearable Computing: Specificities for the Third Age

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Abstract: Older adults have specific needs reflected by their everyday activities and use of technology. We briefly present elders' cognitive, physical, and sensory characteristics, then describe their impact on fundamental needs. Based on this information, we discuss dedicated services that exploit wearable computers, and the proper design of such systems. Our most significant contribution is to provide the first overview of third age persons' specific needs in wearable computing.

Keywords: Design, Needs, Third age, Universal access, Wearable computer

1. Introduction

To properly support everyday life or immersion in virtual worlds, wearable computers must fit human diversity. Disabilities are sometimes considered but culture, gender, and age are frequently overlooked. Here, we examine the case of older people because of their growing number, and of common ignorance in the field about their specificities.

Due to evolutionary selection pressure, reductions in genome-based plasticity and biological potential accompany ageing. Older people increasingly depend on culture-based resources (e.g. material, technical, psychological, social) that become less and less efficient, leading to selective optimization with compensation, and growing difficulties to balance losses and gains due to ageing [1]. Wearables are therefore potentially appropriate and useful.

The work presented here is part of a project that aims to support families with wearable and ubiquitous systems [2]. Complementary papers will notably focus on children.

Hereafter we highlight the cognitive, physical, and sensory specificities of the third age (from 60 y.o.), then describe their impact on needs and on the definition of dedicated services. Finally, we discuss proper designs of services that exploit wearable computers.

2. Characteristics vary widely

Cognitive, physical, and sensory abilities decline with a high inter- and intra-individual variability. For example, although blindness becomes more common, some people keep excellent eyesight; decline may plateau then accelerate, etc. As a consequence, the older population is especially heterogeneous, with problems emerging from concurrent disabilities.

In addition to below-mentioned references, readers are also invited to consult Baltes' works [1].

Intellect maintained, memory impaired

Cognitive abilities decline unequally. Intellect is globally maintained but attention, memory, and learning are impaired.

Intellectual abilities seem preserved until late old age [3], especially for routine or narrow but deep expertise like chess (for champions). Losses mainly appear in challenging situations however tasks are easily impaired by simultaneous operations or disturbances [4], notably due to memory losses.

Ageing has a moderate impact on *short-term memory* (holding information) but a strong one on *working memory* (holding and processing) [3]. On the contrary to the *recognition* of familiar objects, content *recall* is quite affected [3]. Similarly, *prospective memory* (*remembering to remember*) is preserved but *spatial memory* (routes, positions) worsens [3]. Older people can learn new skills but need to bypass memory-related limits.

Due to reduced memory, learning from long spoken messages worsens [5]. Simultaneous access to speech and text confuses and degrades information retention [5]; text alone appears the most effective. Elders difficultly acquire *automated responses* [3], which implies additional cognitive efforts when manipulating unfamiliar tools.

Control decreased, fatigue increased

Motor abilities decrease, fatigue increases, and physiological activities are perturbed.

Mobility is reduced due to losses of flexibility in limbs, and an increased prevalence of arthritis [4]. Postural sway increases, strength decreases [4]. Fine manipulations are hampered by lengthened response times, imprecise movements, and loss of control on forces applied [3]. Overall, tiredness and fatigue augment [4].

Besides, physiological activity turns more irregular: blood sugar levels abruptly change, fluids are less controlled, the sleep cycle is disturbed, etc.

Perception & communication hampered

Visual and aural abilities decline due to a degradation of our natural “sensors” and of associated processes.

Vision-related problems are numerous [3][4]. Visual acuity and contrast sensitivity decrease. Colour perception is altered in the blue-green range. The visual field narrows. Focus adjustment and perception of rapid objects worsen. Visual processing, localization, and adaptation to changes in brightness slow down.

The reduction of aural abilities [4] impairs the detection of sounds, particularly high frequencies, due to a loss of flexibility in eardrums. This aggravates misunderstandings of speech, especially women's. Also, noise and synthesized speech hamper comprehension more frequently.

Besides, elders' speech turns less distinct due to (1) a decreased ability to hear and correct oneself, (2) motor impairments of the tongue and lips, or (3) strokes [3]. Pauses and the time required to say a word lengthen; hesitations, word losses, and restart of phrases are more numerous [3].

3. Needs may be gratified

Due to the characteristics of the third age, fundamental needs (as defined by Maslow [6]) are expressed in specific ways. Fulfilling physiological, safety, belonging, and self-esteem needs can be supported by wearable computers.

Supporting physical and mental health

Physiological issues can guide the creation of services based on monitoring and stimulation. However they complicate processing for medical and affective computing.

Age reduces abilities to maintain homeostasis, notably in regard to body temperature and sleep; it affects physical and mental health. Effects include cardiovascular problems, diabetes, and dementia. For these, wearables can monitor lifestyles and provide early detection of changes in physiological states or behaviour (e.g. irregular peaks or reduction of activity, medicine not taken).

Decline can be slowed down with cognitive, physical, and social stimulations provided or monitored by wearable devices. Stimulations can be induced through help to do usual tasks, or through the provision of new tasks (such as simple games).

Preventing falls and alerting

Falls are recognized as a critical risk due to muscle weakness, arthritis, balance or visual deficits, depression, and cognitive impairment [7][8]. Risks are great even for seemingly minor accidents:

> “[Older people's] skin will just tear, it's like tissue paper. It loses its elasticity as you get older, the slightest knock can tear it”, ambulance crew [8].

Alert phones provided to the elderly are only reactive: alerts are sent to caregivers after sensors detect a fall. With additional sensors and personalized information, wearables can be proactive, sending alerts based on physiological or behavioural hints before events unfold. Similarly, alerts can be sent during crimes, which is a key concern, at least in the United Kingdom [8].

Multiplying human contacts

Due to reduced mobility, energy, memory, and communication abilities, contacts rarefy[1]. However they remain a significant need:

> “ One of the most important aspects of the mobile warden service is personal contact. [...] alarms were often used not for emergency calls but for company”[8].

Wearables and related equipment can increase mobility as well as reduce the need itself. For example HAL exoskeletons physically support and guide walking movements [9]. Wearables can also go beyond cellular phones, and inform about activities and emotions, increasing feelings of connexion and presence as well as awareness about acquaintances.

Losses of memory prevent the recognition of faces and hamper conversation. Systems can

1 Still, we acknowledge the role of cultures and social structures. For example, in Japan focus is on life with the family whereas in the United Kingdom it is on independent life.

help remember faces and names; wearables can in addition remind them at appropriate moments using cameras or proximity markers (e.g. RFID) to identify people.

Clarifying communication can support face-to-face and distant contacts. For instance, noise can be filtered, sounds transposed to more audible (low) frequencies, and speech displayed as text on mobile displays.

Reciprocity and bi-directionality appear important to maintain a feeling of real contact. For this, users may exchange different kinds of information based on their personal values and interests.

Ensuring self-esteem

Key concerns are to maintain or regain independence and freedom to take risks [8], and to avoid *looking* dependent or old [4]:

> “Senior citizens [...] do not want attention called to the need for extra help; thus they prefer to experience inconvenience rather than be labelled 'old.'” [4]

4. Dedicated design is possible

To create systems for the third age, we must consider form, acceptance, integration, adaptation, perception and memory. For good reviews of general issues, see [3][4].

Solving global issues

The limitations of the third age influence the weight and location of components, as well as form-factors. Because of their importance, cognitive demands shall be reduced even at the detriment of other aspects. Reducing these demands and fostering acceptance may be achieved simultaneously [10].

Acceptance depends on aesthetics and social perception. Visible elements should not be stigmatizing, and privacy should be respected. For lifestyle monitoring, data should be processed locally. Besides systems may be designed to avoid attracting attention to the need for specific help: minor functions may be provided beside major ones so that users can deny needing major support.

The difficulty to create automated responses motivates stable or shared designs. Because learning new systems is difficult, an interface layer with a small set of permanent visual agents may be exploited, new services being seamlessly integrated. Because elders are likely to check for help [4], this layer should simplify access to manuals and tutorials.

Finally, because needs may fluctuate daily (especially in case of dementia), several levels of functioning are recommended. This is possible with multi-level interfaces, artificial intelligence, and adaptation to users' states. For example systems may avoid interrupting users to preserve working memory, and remind people of tasks during periods of lucidity.

Adapting interfaces

For displays, good lighting and contrast are required. On the contrary to mobile projectors, semi-transparent glasses are inappropriate. Sounds should be adapted to hearing needs and, if speech output is provided, pre-recorded voices should be used instead of synthetic ones. With or without Parkinson disease, reduced dexterity and precision prevent the control of numerous mobile devices due to size and sensitivity. Handwriting recognition may become unusable for character sets such as Chinese ones. Providing information in multi-sensorial (e.g. visual/aural) and multi-dimensional (e.g. colour/size) ways may counter varied effects of combined deficiencies [4].

Besides, to compensate memory losses, delays should be avoided, messages shortened or removed, and a single window used for a given task. The interface may remind of the on-going task and previous step.

Finally, because users may be inexperienced, assumptions about their understanding, abilities, wishes, and goals must be rethought. For example, completion time may be disregarded.

5. Perspectives

We described cognitive, sensory, and physical characteristics of older people, and discussed services and features important to design dedicated wearable computers.

One risk of support is that it may deskill, demotivate, and render users dependent. This should not prevent the developments because of their potential value for the third age. However, it highlights designers' necessity to remain careful.

As a by-product, these design considerations may help improve products for all types of users.

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About the document

This document is an updated version of:

Duval S., Hashizume H. (2007) Fundamental Needs in Wearable Computing: Specificities for the Third Age. *9th Virtual Reality International Conference* <http://www.laval-virtual.org/>, 155-158.

The content was preserved, but the format has been changed. Updates include corrections of typos, addition of information in references for easier access, and addition of comments in the following section.

Comments

No comments.