ICT infrastructures in the aging society

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J.E.M.H. van Bronswijk, W.D. Kearns, L.R. Normie. ICT infrastructures in the aging society. Gerontechnology 2007; 6(3):129-134. As Information and Communication Technology (ICT) penetrates dwellings worldwide, also the increasing number of older persons will become more dependent on information technology infrastructures. While ICT continues to advance quickly, the ergonomic refinement for use by older adults has lagged behind. In addition, technical problems exist, partly resulting from designers' frequent use of proprietary products having little or no interoperability with products of other vendors. Fortunately, standards are emerging to address this problem; the cellular phone appears to be evolving into the general user interface for all, including older adults, and the addition of networking to ICT will significantly enhance environments to support aging-in-place.

Keywords: ICT, aging society, ambient intelligence, home automation

We are entering the era of 'ambient culture' with the linking of home networks to wide area networks to form robust infrastructures for Information and Communication Technology (ICT). These can be exploited for the provision of services, potentially also to older people in the form of online health monitoring or home diagnostics, combined with general management of the dwelling, shopping, ordering and delivery services. It has been suggested that ambient-intelligence products will be the modern day equivalent of trusted butlers, maids, and valets[1].

Computational systems are finding their way into clothing, furnishings, personal items, transportation, and home environmental control and security. Estimations based on Moore's Law[2], which predicts a doubling of computing power every 18 months, appear to be slightly too high nowadays, but in the area of networking the growth continues to outpace predicted values. As ICT penetrates dwellings worldwide, it is changing the way we live, work, and consume services. Older persons are expected to become more dependent on robust information technology infrastructures that ensure stable connectivity and maintain quality of the services they receive.

As the world is aging, demographic projections of decades ago have become true[3]. We live longer and also longer in health. Although ongoing aging of the world population has paralleled the rapid developments in new ICT options, the two trends have not as yet converged. The rate of change in technology has been and will probably stay higher than the rate of change of the numbers of older people.

In principle, ICT provides a major opportunity to integrate older adults with full participation in our knowledge society and diminish the risk of societal exclusion[4]. ICT also offers a means to address the shortage of care professionals and the diminishing number of family carers. Removing barriers to effective ICT use may lead to better adoption and acceptance of the new technologies, resulting in prolonged independent living and aging-in-place, and increased active participation in the economy and society. This endeavour in 'ambient culture', called 'Ambient Assisted Living (AAL)' is fully supported by the European Commission and individually by many of the European Union's member states[5].

Opportunities and challenges

Increased computing power has been matched by a decrease in size and most significantly by changes in form factor. This has caused an increase in portability of computing devices, with the limiting factor becoming the size of the interface (for instance, buttons on a keyboard) rather than the hardware on the circuit boards. However, shrinking form factors may exclude older users, whose dexterity and eyesight may prevent them to take advantage of the new small-scale devices.

While ICT continues to advance quickly, its ergonomic integration for older adults has lagged behind. This lag is somewhat curious given the potentially huge market for providing advanced services which could be enabled through the networked embedded technologies that will soon be available for use in the home. In part it is the task of health professionals to identify the services to meet the needs of senior citizens, and of technologists, to create technological solutions to meet those needs. This is, however, only a small part of the overall problem of technology adoption by older adults, their community, their service providers, and the policymakers in their environment. The reluctance of older adults and policymakers to adopt technological change may be described by the ancient adage "Better a known devil than an unknown god". New technologies may promise great savings to policymakers, but in lean economic times their unproven status is seen as an unacceptable risk. Likewise, older adults may view the technological option as 'gilding the lily', replacing a perfectly good and well-known alternative (for instance, a lever switch) with an unnecessarily complicated one (for instance, a menu), which offers slight or no advantage.

By their nature, older adults are not risk averse; they do embrace new technology when it confers an advantage. Many own cellular telephones, have satellite televisions, and use computers. However, they also grew up in a generation that recognizes value and they want to ensure that their precious resources are spent wisely. Technologies that can fit in seamlessly and enhance functionality without taking away the basic simplicity and ease of use of a well-known product are accepted, in contrast to those that substitute more complexity but provide exactly the same level of functionality. It is in the best interests of designers to continue listening to older users when it comes to good gerontechnology design[6].

Infrastructural integration

Reaping the ambient culture harvest of societal inclusion and both better and more accessible services, including health care, calls for open systems. This concerns reference architectures, standards and platforms for enabling systems and services for independent living, smart workplaces and mobility. According to the European Commission[5], the sub-systems should support seamless integration and plug-and-play operation of sensors, devices, other sub-systems and integrated care services into cost-effective, self-maintaining, reliable, privacy-respecting and trusted systems. The specification includes sub-systems for communication, leisure, energy management, indoor environmental quality control, home automation, and open source assistive technology networks.

Requirements

Integration of smart home environments requires heterogeneous ICT networks, supporting wireless personal area networks (Zigbee, Bluetooth, RFID), wireless local area networks (WIFI), as well as wired local networks. The entire system is then managed by intelligent agents that can operate autonomously if and when the network is temporarily unavailable. The intelligence supporting the required adaptability and self-learning is incorporated within these (software) agents. Control of the integrated system is through a variety of user interfaces, including existing devices already used by a number of older adults, particularly cellular phones.

Unfortunately, most of the aforementioned networks currently support only proprietary products, while agent technology is in its nascence for home ICT applications. Lack of systems interoperability is unnecessarily slowing down progress in this field[7]. Another roadblock to adoption stems from the undesirable influence of radio frequency interference on the performance of heterogeneous wireless networks.

Emerging standards

As wideband and wireless ICT find their way into homes worldwide, increasingly sophisticated ICT services are becoming available. These include nutritional monitoring, safety and security, telehealth, environmental control, location awareness, communications, and 'edutainment'. Each of these services relies upon robust and adaptable network infrastructures to ensure stable connectivity and maintain reliable quality of service to the recipients. Because ICT infrastructures vary considerably around the globe, the task of closing the technology gaps presents unique challenges. Technical standards such as those being developed by the 3rd Generation Partnership Project (3GPP) specifically tackle these issues[8]. They concern, in particular, heterogeneous wireless communications networks and how these will facilitate the key technology drivers to address evolving e-Inclusion market needs.

In Europe, strategic initiatives have been implemented to formulate interoperative standards for the many converging technologies supporting smart homes and the ICT services delivered to them. Such programmes include the SmartHouse Standards Steering Group (SHSSG)[9] with its Smarthouse Code of Practice[10], including universal plug and play (UPnP) for applications. Domotics aspects of standardisation are included in EN 50090 - of CENELEC's TC 205 - Home and Building Electronic Systems (HBES) standard[11], and the KNX consortium's open technology platform independent standard for home & building control[12]. These focus on so-called Class 1 (low rate data transfer) architectures, which include control systems working with such functions as environmental and non-video-based security control. Class 2 and 3 systems, for which new standards are in development, concern moderate rate switched data transfer (for instance, telephone) and high rate switched data transfer video transfer (for instance, video and hi-fi sound).

Cellular phones

Cellular telephones probably will develop into the main control devices of ICT-based services. They have emerged as the new fully networked computer, and currently exceed the computing power of desktop personal computers in 2001[13]. These multifunction devices, which record and

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display movies, provide voice and data connectivity, global positioning services and more, appear to represent the wave of the future[14-16]. Cellular telephones are inexpensive, portable, and relatively simple to operate; however, the quality of the current interface demands refinement for elderly users. Their potential as a voice activated interface to larger networked systems is all too obvious and these devices have been shown to render a number of services, including way-finding for persons with dementia[17], as well as appearing in the popular press as a substitute for credit cards for the active purchasing of goods and services[18]. Cellular telephones' ability to perform peer-to-peer communication via Bluetooth or other protocols such as WLAN, LAN, GSM, UMTS or GPRS means that their software and data are manageable through the network by devices whose characteristics can easily be mass-individualized. Currently, cellular telephones' caller lists can be edited from the owners' personal computers if they so desire, and the onboard software on cellular telephones is routinely patched and upgraded without the user's awareness by telecommunications companies to maintain network security.

Smart characteristics

Many of these telephones are being engineered to be opportunistic and sensitive to the communication cost matrix existing at their locale and to automatically transfer a caller to a less expensive wireless network to reduce calling costs[19]. This increased intelligence and sensitivity to the local and wide area network conditions characterizes new generations of wireless enabled systems which are capable of forming associations with other networked devices using Advanced Location Based Services[20] either surreptitiously or in plain view of their owner. This very characteristic of forming associations with other devices via wireless technologies presents both the greatest concern and potential as more personal information is placed on networked devices. Clearly, security of such systems must be of paramount concern as the number of networked nodes increases[21]. A more user-centered view of designers of interfaces may well speed up the adoption of the new technologies[22].

Adoption of the cellular phone as the main control device by older adults is hampered by their current complexity and abundance of technological functions ("feature loading"). This seems more of a problem than declines in sensory and motor functions with aging. Initiatives taken to make the cellular phone better and easier to use for older adults are still to be included in mainstream technological development[23].

Adding networking

Computational systems are finding their way into virtually every facet of the built environment, including furnishings, transportation, home environmental control and security, and even personal items and clothing. Embedded systems for common household appliances add functionality to familiar products and make products as yet unimagined possible.

An example of a simple embedded system with a familiar form factor is an electric toaster that recognizes the user via the RFID device in his/her watchband and responds by toasting the bread exactly as preferred. No more arguments among family members about the setting of the toaster! Because of their small size and tight integration with the built environment, adding networking to embedded systems, such as the hypothetical electric toaster, provides an attractive way to interact[24] with these devices, which may also be accessed by 'translators' that allow intercommunication among devices offering other services[25].

One such approach to large scale networking is the Open Grid Services Architecture (OGSA) which represents a merging of Web services with Grid computing[25]. In our hypothetical toaster example, the machine may communicate by networks with the refrigerator to determine if sufficient bread remains for tomorrow's breakfast. If there is not sufficient bread, it might electronically notify the market to add bread to the next order.

Such a delivery service will only be viewed as useful when it appears transparent and is communicated to the user by its function (a delivery service) and not by its technology (a networked embedded system), unless 'networked embedded systems' have become desirable lifestyle elements, which is not anticipated.

Aging-in-place

The socio-economic viability and sustainability of regional and national aging-in-place schemes (as an alternative to sheltered accommodation) is predicated upon appropriate and adequate ICT infrastructures to support networking and embedded systems. These systems will gradually scale to first provide classical essential services such as community alarms and telehealth monitoring, and later to new additional services, such as virtual presence, fall detection, and orientation aids[26,27]. The integration of networks with embedded systems in the home environment extends the continuum of healthcare into the home and permits monitoring in the 4th phase of life, when frail health conditions demand additional services such as way-finding for persons with dementia[26], or enhanced supervision[27].

Of particular importance is the means through ICT to engender and support social inclusion among the large proportion of aging-in-place residents who live alone. Heterogeneous ICT networks may deliver services on demand, and promote communication with family members who are living at a considerable distance, including children and grandchildren. As mentioned before, we are entering an 'ambient-culture' period. Mass-individualization of the new services will only be possible with increased interoperability of the different networks and universal plug-and-play of all applications. Standardization is well under way, but still needs to be emphasized in daily engineering practice. Technological innovation is not the only change that lies ahead. In the ambient-culture era, the very meaning and implementation of care will also shift from a passively received service to an actively acquired benefit[28]. Interesting times lay ahead.

References

1. Marzano S. Ambient culture. Pp 35-52, in: Aarts EHL, Encarnação JL, editors. True visions. The emergence of ambient intelligence. Berlin: Springer; 2006
2. Ceruzzi P. Moore's Law and Technological Determinism: Reflections on the History of Technology. Technology and Culture 2005;46(3):584-593
3. Bourgeois-Pichat J. The economic and social implications of demographic trends in Europe up to and beyond 2000. Population bulletin of the United Nations 1976;(8):34-88
4. Placencia-Porrero I. The information society in demographically changing Europe. Gerontechnology 2007;6(3):125-128
5. European Commission. ICT - Information and communication technologies. Work programme 2007-08. Challenge 7: ICT for Independent Living and Inclusion. Released December 22, 2006; http://cordis.europa.eu/fp7/ict/; retrieved June 10, 2007
6. Coleman R, Myerson J. Improving life quality by countering design exclusion. Gerontechnology 2001;1(2):88-102
7. Brandt P, Bruijning J. XML for plug-and-play applications in service delivery. Gerontechnology 2007;6(3):147-154
8. Bachel R, Gunreben P, Das S, Tatesh, S. The long-term evolution towards a new 3GPP air interface standard. Bell Labs Technical Journal, 2007;11(4):25-51
9. SmartHouse Standards Steering Group; www.ictsb.org/SHSSG_home.htm; retrieved June 8, 2007
10. CENELEC. Smarthouse Code of Practice; www.cenelec.org/NR/rdonlyres/BC593263-E884-425C-899B-77FFAE9719E2/1619/CWA50487.pdf; retrieved June 8, 2007
11. CENELEC. EN 50090-8:2000; Home and

Building Electronic Systems (HBES) - Part 8: Conformity assessment of products
12. KNX Association; www.knx.org; retrieved June 8, 2007
13. Neuvo Y. Cellular phones as embedded systems. Solid-State Circuits Conference, 2004. Digest of Technical Papers. ISSCC. IEEE International, 15-19 February 2004. Volume 1 pp 32-37
14. Nokia Inc. Show what you mean; 2006; www.nokiaaccessibility.com/hearing.html; retrieved January 25, 2006
15. Vodaphone Group Inc. Vodaphone speaking phones; 2006; http://online.vodafone.co.uk/dispatch/Portal/appmanager/vodafone/wrp?_nfpb=true&_pageLabel=Page_BOS_Content&pageID=AV_0617; retrieved January 1, 2006
16. Cingular Wireless Inc. (2006). TALKS by Cingular Wireless and the Nokia 6620; 2006; www.cingular.com/about/talks_program; retrieved November 25, 2006
17. Patterson D, Etzioni O, Fox D, Kautz H. The activity compass. In: Proceedings of UbiCog '02: 1st International Workshop on Ubiquitous Computing for Cognitive Aids, Gothenburg; 2002; www.cs.washington.edu/homes/djp3/AI/AssistedCognition/publications/compass03tr.doc; retrieved January 26, 2006
18. Mallat N, Rossi M, Tuunainen VK. Mobile banking services. Communications of the ACM 2004;47(5):42-46 2004; http://doi.acm.org/10.1145/986213.986236; retrieved June 26, 2007
19. Ibach P, Horbank M. Highly available location-based services in mobile environments. Proceedings of the International Service Availability Symposium. Munich; May 2004
20. Ibach P, Tamm G, Horbank M. Dynamic value webs in mobile environments using adaptive location-based services. System Sciences, 2005. HICSS '05. Proceedings of the 38th Annual Hawaii International Conference on 03-06 January 2005, Hawaii; p 208b
21. Hoof J van, Kort HSM, Markopoulos P, Soede T. Ambient intelligence, ethics and privacy. Gerontechnology 2007;6(3):155-163
22. Belda-Lois J-M, Poveda R, Barberà R, Such J, Ruiz-Rodríguez J-R. Emotional engineering techniques for ambient assisted living Gerontechnology 2007;6(3):178-180.
23. Bronswijk JEMH van. The Secufone, a cellular phone that monitors and protects your health. Gerontechnology 2005;3(3):171-172
24. Milanovic N, Richling J, Malek M. Software technologies for future embedded and ubiquitous systems, 2004. Proceedings Second IEEE Workshop on Software Technologies for Embedded and Ubiquitous Computing Systems (WSTFEUS), Vienna, Austria, 11-12 May 2004; pp 40-44
25. Kearns WD, Fozard JL. High-speed networking and rapid integration. Gerontechnology 2007;6(3):135-146
26. Hua H-M, Liu B-J, Wang T-E. A decision support system for medical emergencies of older adults in Taiwan. Gerontechnology 2007;6(3):169-174
27. Kang G. Wireless e-health (WeHealth) for the aging society in China. Gerontechnology 2007;6(3):175-177
28. Kleissen RFM. Care structured as a learning process. Gerontechnology 2007;6(3):164-168