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# Augmented Reality Distributed Play for Ageless Connections

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**Abstract:** The population of the developed world is aging and building technologies which meet the needs of an aging population is critical. This paper presents findings from a research and development project focused on remote home health monitoring, specifically tools and technologies for 'aging in place', to assist seniors in living independently at home for longer. Research and development efforts were informed by a comprehensive literature review and market scan as well as an early concept design and prototype for a mobile video-conferencing application for Android. HCI and human factors research in areas such as augmented reality applications in remote health and wellness tracking, specifically the integration of QR code technology with mobile VC applications for Android—represents an opportunity to address important gaps in home healthcare services for seniors living at home in remote and rural locations. This paper will highlight what was gleaned from the literature and how it informed R&D efforts as well as important issues around privacy, security and trust around the use of technology for support aging in place.

## Introduction

The population of the developed world is aging and building technologies which meet the needs of an aging population is critical.This paper presents findings from a research and development project focused on remote home health monitoring, specifically tools and technologies for 'aging in place', to assist seniors in living independently at home for longer. The R&D included a comprehensive literature review and market scan as well as an early concept design and prototype for a mobile video-conferencing application for Android. HCI and human factors research in areas such as augmented reality applications in remote health and wellness tracking, specifically the integration of QR code technology with mobile VC applications for Android—represents an opportunity to address important gaps in home health care services for seniors living at home in remote and rural locations. This work is currently underway.

## Human-Computer Interaction and Human Factors

Literature in the area of HCI and human factors highlighted important gaps in designing useful feedback an appropriate levels of explanation for information from SMART and ASSISTIVE devices and technologies so it is useful and meaningful for a rapidly growing end-user demographic over 50+ years of age. There are also gaps and challenges around privacy, security and trust around technology use in areas of health and aging in place.

Trends around digital health services and assessment tools also point to potential bias in referrals to special care facilities for seniors who may do well at home. Research and development of augmented reality applications in healthcare have the potential to transform the way home healthcare is delivered, achieving important outcomes with societal impact, however there are important issues and challenges to be addressed in terms of technology design. Human-Computer Interaction (HCI) and human factors research in areas such as augmented reality applications for remote health and wellness tracking, specifically in the integration of QR code technology with mobile videoconferencing (VC) applications for Smart Phones represents an opportunity to conduct transformative research and contribute to the advancement of science and engineering. QR codes have been referred

to as a gateway to the IoT (zcsaede, 2017). R&D efforts are currently underway which include design considerations around privacy, security and trust, and the use of technology for supporting aging in place.

Studies have also demonstrated the impact of video chat in combatting depression and social isolation among seniors (Nauert, 2018 & Munteanu, 2016). An augmented reality application for mobile videoconferencing with QR code integration was developed with potential applications in the context of home health care for 'aging in place'. Data from a survey on current practices in home healthcare services with front line health professional will inform recommendations to improve current practices around HCI for seniors living independently in their home. R&D work in this area is currently underway and more details will be provided later in the paper.

## HCI Interfaces and Next Generation Technologies

Trends in HCI interfaces and next generation technologies include moving away from tangible interfaces to no-touch interfaces (Curran, 2016) such as Microsoft's Kinect, Apple's Siri and Google's Project Glass, with the expectation that computers will adapt to us rather than the other way around (Satell, 2013). Other trends include the extension of smart technologies such as the Smart Watch to textile and smart skin applications to increase the size of the interaction zone (Bratishenko, 2014), the use of Internet of Thing (IoT) in healthcare for remote monitoring, smart sensors and medical device integration (Gope, & Hwang, 2016), and context-aware sensors and assistive technologies for "aging in place" (Morley, 2012; Rantz et al., 2013; Wood et al., 2008).

Ultimately, the human body will be the next computer interface—as part of the wearables, living services, IoT and Smart Technologies landscape of the future (Goodman & Righetto, 2013). More natural ways to interact, including touch, gesture, and voice, will become an integral part of the user interface of the future. However, the literature also points to important limitations in multimodal interfaces, such as accuracy and privacy issues (Lee, Kim, Fukumoto, & Lee, 2017).

The dynamic pace of technological innovation thus requires the safeguarding of privacy in a proactive manner. In order to achieve this goal, researchers and system designers, including HCI specialists, are encouraged to practice responsible innovation that integrates privacy-enhancing technologies directly into their products and processes, based on principles of Privacy by Design (Cavoukian, & Jonas, 2012). Scientists and specialists in HCI, computer science and social science are encouraged to work together at developing bias-free data-driven systems and devices to support end-users across the spectrum—whether to enhance learning in networked environments, using context-aware sensors in health applications, or IoT and assistive technologies for 'aging in place'.

Collaboration between specialists in different fields is desirable along with Privacy by Design considerations which include value sensitive design, taking human values into account as well as privacy-enhancing aspects of technologies, and responsible practice for addressing factors such as accountability, research integrity, data protection, privacy, and consent (Cavoukian, & Jonas, 2012; Cormack, 2015).

## Designing for an Aging Population

A major societal concern that is addressed by recent HCI research is that the population of the developed world is aging. Currently most websites, apps, and digital devices are used by adults, younger adults as well as by those aged 50+, so they should be designed accordingly (Johnson, 2018). HCI researchers are looking at age-related factors that affect older adults' ability to use digital technology, and working on technology design guidelines that reflect older adults' varied capabilities, usage patterns, and preferences.

The 50+ age group is pretty savvy with digital technology: it is the fastest growing demographic online and according to Home Care Magazine, 46% of baby boomers use a cell phone, 65% are active on social media, and a whopping 75% are digital buyers (Burkhardt, 2016). Research has shown that the ability and motivation to use new technologies are strongly determined by work experience and education, and the difficulties people experience around the use of technology are related to past performance rather than age (Tacken et al., 2005).

Rapid development of digital proficiency in an aging population has even led to the development of a new research discipline. Gerontechnolgy is a scientific field that blends the study of aging with technology, and includes the following five aspects: enhancement, prevention, compensation, care and research (Jansson, & Kupiainen, 2017). With over 10,000 people turning 65 every day in America, this is a market about to explode, and building technology for an aging population is at a critical tipping point (Cormack, 2015); however, HCI literature points to important unsolved issues with usability and AI in designing for an aging population (Pan, & Zhao, 2018).

## Designing for Dynamic Diversity

Research and development of health-related applications, including mobile or mHealth related applications, is crucial in managing the health and well-being of an aging population. There is a trend in new mHealth related apps that help to manage health and well-being through smart systems and Internet of Things (IoT) devices (Pan, & Zhao, 2018). The success of smart systems is tightly linked to features such as ease of use and user-friendly graphical interfaces (GUI). Adaptive Interfaces represent a new way to improve the GUI usability, adapting and customizing automatically features of the UI to the user characteristics, to accommodate users with different skills and impairments (Gullà, Papetti, Menghi, & Germani, 2018).

There is an urgent need to address the issues of designing for dynamic diversity with an aging population in mind (Vasilyeva, Pechenizkiy, & Puuronen, 2005). Interestingly, User Centered Design (UCD) principles have been described recently as inadequate for addressing the needs of an aging population since the principles were developed for user groups with relatively homogeneous characteristics. “Older people” encompass an incredibly diverse group of users, and even small subsets of this group tend to have a greater diversity of functionality than is found in groups of younger people (Gregor, Newell, & Zajicek, 2002).

Among a sample of 65 year olds, a laborious interface was the main reason for terminating use of a health-related application within the first year (Nauert, 2018). It is no longer enough designers of user interfaces to only improve user experience by paying attention to usability, utility, and interaction aesthetics. Instead, the best user experiences may come from services that automatically personalize their offers to the user and context, and systems that leverage more detailed understanding of people and their daily lives in order to provide new value (Dove, Halskov, Forlizzi, & Zimmerman, 2017).

New trends in HCI research focus on designing natural, social and safe user interfaces to reduce the digital marginalization of older adults. Despite growing technical literacy, for some marginalized adult user groups, interactions with emerging technologies (digital devices) may present insurmountable barriers that only widen the digital divide in a society that is information centric (Munteanu, 2016). Two major research questions have been identified in the literature on designing user interfaces for seniors (Neves, Franz, Munteanu, Baecker, & Ngo, 2015). What are the challenges that older users experience with user interfaces? Which solutions have been proposed by researchers and designers to address the identified challenges in user interfaces for seniors? Seniors have vastly different requirements than younger users, and solutions that meet their requirements require some level of participatory or human-centered design.

The literature identifies the following domains of human-computer interaction as relevant in the design of user interfaces for an aging population: 1) ambient-assisted living, 2) conceptual user interfaces, 3) mobile user interfaces, 4) user input devices, and 5) website user interfaces (Neves, Franz, Munteanu, Baecker, & Ngo, 2015). Unfortunately, designing useful feedback mechanisms and appropriate levels of explanation for machine learning outputs to be meaningful to end users, especially for recommender systems, has yet to be explored in gerontechnology research. As the population steadily ages, so does the need for alternative health and wellness options, including home telehealth and virtual visits as part of comprehensive healthcare services.

The challenges of building technologies for an aging population underscore the need for new design principles, beyond Standard User Centered Design, in designing for dynamic diversity among seniors and ‘aging in place’ (Kolkowska, Kajtazi, 2015; Vasilyeva, Pechenizkiy, & Puuronen, 2005). Another area explored in the literature review of relevance for remote home health monitoring was social technology use among older adults. The research links social technology use among older adults and improved physical and psychological health, reduced loneliness in particular. Five technology-based behaviors were assessed in one particular study of technology use

among seniors: using e-mail, social networking sites, online video/phone calls, online chatting/instant messaging, using a smartphone (Chopik, 2016). Positive attitudes toward technology among seniors were reported as well as better self-rated health, fewer chronic illnesses, higher subjective well-being, and fewer depressive symptoms (Chopik, 2016). The literature underscores the need to consider other mediating factors in the integration of new technologies into an individual's daily life including: a willingness and acceptance by the end-users, support (individual, family and community level), comfort in using technology and self-confidence in trying new technologies and devices in their daily lives (Zamir, Hennessy, Taylor, & Jones, 2018).

The literature points to benefits for seniors in engaging in leisure activities, including opportunities for self-expression, personal fulfillment, physical health benefits, and greater mental wellbeing among others (Lazar, & Nguyen, 2017). Close relationships are a large determinant of physical health and well-being, and technology has the potential to cultivate positive relationships among older adults.

The current research calls for careful and mindful consideration of the societal impact of designing tools and devices to support seniors living in their home for longer, using powerful machines, Artificial Intelligence and algorithms in Smart Technology applications. The complexity of human factors and designing for privacy should be accounted for as part of sustainable research and development in HCI—our research looks at ageless connections; bridging current gaps in home healthcare services via a game-based augmented reality application for distributed play and remote communication.

## Ongoing Research and Development

To date, our research on seniors aging in place in the context of home healthcare monitoring has included a comprehensive literature review as well as a prototype for an augmented reality (AR) distributed card game, with distributed play for ageless connections between older adults and their grandchildren. Augmented reality with QR code technology integrated in mobile video-conferencing is a gateway for virtual consultations and remote healthcare monitoring between physicians and patients, as part of aging in place imperatives.

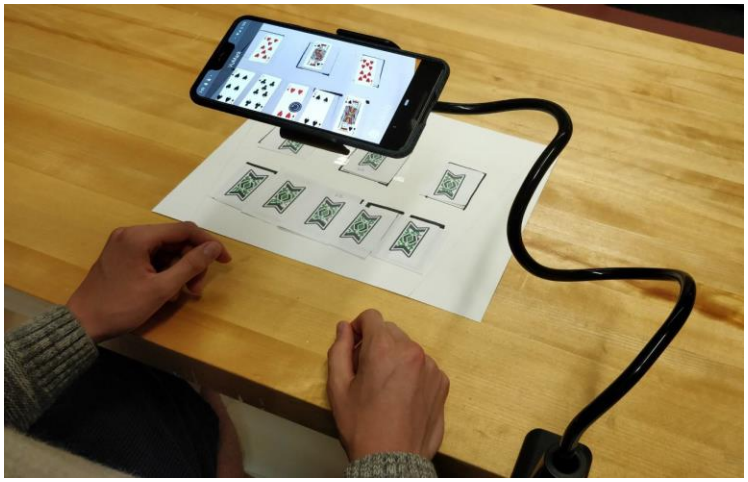

Fig 1. Augmented Reality Distributed Play for Ageless Connections

A survey is being conducted in order to gather data around current practices in home healthcare services, including the use of technologies in remote check-ins with seniors in their home. This data will fill a gap in our knowledge of levels of use and acceptance of technologies in home health care delivery services. Survey data will help to inform future phases of the research on assistive technologies for aging in place.

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