# Aging in Digital Places

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## Contents



**Abstract**

This book chapter reviews current research in the area of digital game technology for rehabilitation, socialization, quality of life (QoL), design, and cognition. In recent years, there has been substantial progress in these areas. With technology advancement, there is the potential to facilitate aging in place, resulting in the continuation and maintenance of independent community-based living at varying stages of the life course. As technological developments improve, the concept of integrating digital game technology into the lives of an aging population is becoming more popular than ever before. However, during the implementation into the home, issues of physical space and technology integration may occur. There are many types of dwellings (apartments, houses, or bungalows) where older adults reside which contain a variety of fixtures and furnishings. Implementation of technology into these different dwellings may be difficult due to the added furniture already installed. This chapter initiates discussion within these areas and provides recommendations for future technology integration.

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## Introduction

The inevitable issue of the aging population, one which shows no decline in the coming decades, has been highlighted by researchers and governments. Across Europe it is anticipated by 2025 that 22 % of the population will be aged 65 and over, and by 2050, this will have increased to 33 %. This translates as 60 million people in 2004 reaching to 134.5 million by 2050. Further in 2004, 4 % of the population were aged 80+ and this is expected to reach 10 % by 2050. It is suggested that European society will comprise of 32 % of the population living alone by 2050, and the proportion of those who are aged between 65 and 79 years will live with a partner or spouse (63 %) and will decrease to 31 % for those over 80 years (European Commission Information Society and Media 2010). With this in mind, academics in the fields of gerontology, engineering, design, and health have started to explore the utilization of digital technology among the older adult population. Interest is growing on effective use and practicalities for integration of digital technology by older adults within their home to support aging-in-place strategies and to maintain personal independence in the community.

During the aging process, it is possible that one may develop a chronic disease such as diabetes, glaucoma, high blood pressure, osteoporosis, dementia, Alzheimer's disease, or a combination of diseases which will limit one's ability to live an independent life. Blanson et al. (2010) highlight facets associated to self-care and patient empowerment: (1) gaining a good insight into their own health condition, (2) retrieving personal information to support choices of self-care activities, (3) fitting self-care activities in daily life and developing self-care habits, and (4) involving the environment to support self-care (family, community, and friends). Fisk et al. (2009) have provided four age-related characteristics: sensation is the awareness of stimuli such as color or hearing a high-pitched sound. Perception is knowledge of challenging features in an environment or the elucidation of information based on the results from sensation, for example, recognizing the sound of an alarm. Cognition is a human process whereby the brain stores sensory information from the ears and eyes and by transformation; it is stored and recovered when needed, for example, thinking, problem solving, and decision making. Movement control necessitates the coordination of muscles for motion based on perception and cognition, for example, taking an object from a shelf or double-clicking a mouse. These human characteristics can be affected as a person ages and cause activities of daily living to become more difficult. The notion of aging in place is crucial as persons advance across the life trajectory to ensure they are able to live in their community and maintain a sense of independence. This chapter provides an overview of work conducted in the area of digital technology use for older adults with emphasis on

reviewing the work of digital games and how assistive technologies can facilitate maintenance of independence within the home.

## Digital Technologies

Over the last decade, technology developments, be it software or hardware, have occurred in quick succession. For example, digital game hardware (Sony® PlayStation 3 and 4, Nintendo™ DS, DSi DS/Lite, Wii, Microsoft™ Kinect®), mobile phones (Apple iPhone®, Nokia Lumia, Android, and Blackberry® Q10/Z10), software development (operating systems, mobile "apps"), and tablets (iPad®, Microsoft®, Nexus 7) enable users of all ages to access, engage in, and enjoy a variety of entertainment mediums (watching movies/TV programs, playing games, using social networking sites).

The Nintendo Wii console can detect 3-D movement via light-emitting diodes (LEDs) in the sensor bar which is placed on top of the television enabling user engagement via a wireless remote comprising of accelerometers and infrared detection (Wisniowski 2006; Castaneda 2006). If the user is playing the *Wii Sports* golf game, they would generally hold the remote as a golf club and swing the remote in a motion similar to how a golf player would actually swing a golf club on a golf course. As the user executes these movements, the game responds appropriately to the executed action; therefore, in playing the golf game, the user will hit the ball with their club (shown on screen) – by swinging the remote. In contrast to this the Microsoft Kinect is a motion-sensing device for the Xbox-360 console and enables users to engage without holding a controller via voice and gesture movement (Whitworth 2010). Moreover, interaction with a smart phone or a tablet is executed through the touch of a finger or sliding two fingers on the screen to enlarge or minimize a segment of the picture. This interaction approach has the potential to facilitate user engagement easier than before. With the development of Microsoft's next-generation Kinect sensor, it is suggested there is the ability to combine one's health with gaming hardware by monitoring one's health without discomfort to the wearer (Woollaston 2013). This could be executed via the Kinect recognizing color changes in a person's face to ascertain how quickly the blood is circulating (Woollaston 2013).

Previous work in the area of digital games and gerontology has explored the attitudes of older adults and their gaming preferences and their needs (Marston 2012, 2013a, b; de Schutter and vanden Abeele 2010; de Schutter 2010; Voida and Greenberg 2009, 2010; IJsselsteijn et al. 2007; Pearce 2008), yet there is still little work within this arena. Prior to twenty-first-century game consoles, game studies focused on the utilization of games to build and enhance the quality of life (QoL) by introducing digital games into one's recreational pastime, in addition to testing cognitive functioning and physical reactions of older adults (Goldstein et al. 1997; Farris et al. 1994; Whitcomb 1990; Schueren 1986; Weisman 1983). As previously highlighted with age, the potential of chronic illness and dementia can occur as one

ages, and researchers have explored the use of games primarily focusing on the cognitive effects and reaction time of digital games on older adults (Basak et al. 2008; Boot et al. 2008; Ball et al. 2002; Clark et al. 1987). The combination of game studies, gerontology, and health is growing. Studies are demonstrating how an entertainment medium initially perceived for young men and boys may (Laurel 2001) be transferred into a variety of settings such as clinical and residential – long-term care (LTC) (Marston et al. 2013) – settings and the home (Voida and Greenberg 2009, 2010). Introducing digital games into the lives of older adults has the potential to have a positive impact on one's life and has the capability to bring families together through intergenerational gaming, socialization/engagement with friends and family, and learning a new skill.

The focus of digital game research has concentrated on three outlets: design, cognitive functioning, and health rehabilitation. This area of health rehabilitation research via digital games initially commenced with the PS2/EyeToy (Flynn et al. 2007). However, there has been increased interest since the release of the Wii and more recently the Kinect console. Marston and Smith (2012) published a narrative review which discussed how commercial and purpose-built software/hardware technologies can be used within a health rehabilitation setting (stroke and fall prevention). A series of recommendations were proposed highlighting the need for digital game technology to coincide with traditional therapy as early as possible. Moreover, technologies should be accessible in both clinical and home environments thus to enable support networks to provide motivation, engagement, and positive reinforcement to the individual while undertaking their exercises. Initiation of longitudinal studies could inform awareness to the potential benefits. A minimum of one year is recommended to gauge the effectiveness of such technology over a long-term basis (Marston and Smith 2012).

## In-Home Monitoring

A wristband created by "Jawbone" (cf. Fig. 1) enables the wearer to track a variety of daily activities, including the number of hours slept via the "sleep and nap tracking," which includes a wake up gently function, and a "24/7 activity tracking," which includes what food and drink is consumed and the number of calories taken and level of intensity and distance traveled, and reminds the wearer to move around (Stone 2011; Pierce 2012). These features provided by the UP lifestyle wristband which in conjunction with the UP app can be accessed by the users' smart phone (iPhone and Android) to aid additional motivation, and the wristband has to be recharged every 10 days. Users of the wristband can share their data and challenge one another (Lanks 2012; Pierce 2012) via the social networking app. It is suggested that these technologies have the ability to be integrated into one's home to facilitate both physical and emotional monitoring of one's health via easy modes of tracking either via the next-generation Kinect or the UP wristband. The exploration of physical space within one's home is an area which is lacking of research and knowledge by researchers and designers alike. Technologies such as the Wii and Kinect consoles

**Fig. 1** UP wristband by Jawbone (Photograph taken by author, permission given by author and wearer – Dr. K. Delbaere)

implemented into the home environment have the opportunity to transform the home into a "smart" environment enabling monitoring and safety via individually purposely adapted space. Additionally, this space can be improved and modified to address changes in personal needs or health status. Through adaptation of the individual space, the person may engage with the current technology with peers and family members.

An alternative concept which is the utilization of wearable monitoring sensors to assess and measure physical activity or fall risk is becoming a common focus of research (Zijlstra et al. 2011). It is beyond the scope of this chapter to discuss the in-depth area of fall risk and prevention. However, wearable monitoring via body-fixed sensors (BFS) (Zijlstra and Aminian 2007) and general sensor monitoring may facilitate current and future aging populations in particular adults residing within their own homes. Therefore, the integration of sensors could aid researchers to understand more about fall detection but more importantly raise the alarm for the person who had fallen.

The risk of falling can occur through the avoidance of physical activity leading to reduced muscle strength, joint mobility, and cardiorespiratory function in addition to psychological factors resulting in the fear of falling (FOF). Finally, if one has little or decreased experience relating to the performance of certain activities, this can result in deconditioning yet increases in unsafe performance of activity (Zijlstra and Aminian 2007). The respective authors stipulate that to prevent such physical decreases, interventions should be executed to improve motor functioning and facilitate one's safe activity performance (Zijlstra and Aminian 2007).

Integrating fall detection sensors into the home could prove beneficial to enable ease of the individual who is prone to falling based on the ability that the alarm would be automatically activated if the person fell which is more so than the traditional alarm system (Zijlstra et al. 2011). However, as the respective authors have highlighted, there is little published work which concentrates on the assessment of "sensor-based fall detectors" within a "real-life" environment (Zijlstra et al. 2011). Further, Zijlstra et al. (2011) notes that there is an importance to identifying the validity, sensitivity, and specificity of such detection sensors and there is still limited

"real validation" of technologies to detect "real-life falls" which would aid in suitable "fall detection method." Additionally, Zijlstra and Aminian (2007) suggest the BFS maybe suitable to address a consistent reporting to researchers and clinicians in addition to being a suitable automatic fall alarm system.

The notion of aging in place can be executed by persons undertaking exercise programs or sports games via digital games/consoles or purpose-built software which facilitates ambient assisted living (AAL) through exercise. Therefore, one should consider the implications of implementing such technologies into one's physical environment such as the living space.

## Personal Living Space

The utilization of personal living space to facilitate self-care/health-care requirements has become a focal point of research in the last few years. With the evitable increase in older adults, this concept may prove fruitful for future users and generations to maintain not only personal independence but also to maintain positive QoL and well-being during daily activities. Utilization of this type of technology is generally comprised of sensors, information, and communication to the user which in turn respond to the necessary requirements of the person. In addition to the smart home concept, the notion of digital games and devices such as smart phones and tablets may prove beneficial and support for persons who wish to age in place. Researchers at RWTH Aachen University have identified and implemented a novel approach to facilitating smart home technology to be enjoyed by all persons. The Future Care Lab features a purpose-built living room comprised of everyday objects implemented with technology to explore the sustainability of design, human interaction, and architectural facets against a social science background enabling users to engage with the environment and facilitate prospective user needs and requirements (Kasugai, et al. 2010). In the Future Care Lab, the large multi-touch display can facilitate the notion of space between persons, resulting in the reduction of distance or enhancement of the environment. Additionally, integration of this type of technology into personal living space can provide a sense of social ability especially for persons who are isolated or suffer from chronic illness thus resulting in limited or no social networks. Therefore, enabling persons to communicate face-to-face via this technology may provide a sense of social connectedness (Penninx et al. 1999).

Engaging in digital games may require individuals to address specific characteristics to the physical location during implementation. For example, a person who wishes to engage with the *Wii Fit* may have to move items of furniture (coffee table, chair, or sofa) prior to starting the program. Personal living space can vary depending upon the type of dwelling (apartment, house, or bungalow) and depending upon geographic location of residence. A definition of "place" can combine a series of relationships and social meanings which are surrounded by the physical space and can include the type of behavior which is supported by the environment ascertaining the various actions and interactions (Harrison and Dourish 1996).

For example, a study focusing on console gamers in Australia (Flynn 2003) identified that the purpose of this activity was to be social with friends and family while exercising additional activities such as talking with friends on the phone. This study highlighted that the setup of the living room posed problems to the gamers primarily associated with moving of furniture. Flynn (2003) noted that this domestic space functioned as a multipurpose living space – playing games, watching television, and socializing with friends and family. Similarly, a study comprising of 10 participants across seven households sought to identify the relationships with physical games such as the *Dance Dance Revolution* (DDR) (Konami) within the home. The participants primarily consisted of graduate students and technical professionals, who either lived in college dormitories or rented a bedroom within a house. The respective authors reported how some of the participants suggested placing casters onto tables to allow for easier movement prior to commencing their game playing:

> Usually I have to move the table back a bit 'cause otherwise I'm standing too close to the TV. . . the table is kind of constantly getting moved back and forth 'cause my roommate does exercises over on that end. He'll push it this way and it gets shoved back when I'm gaming. (Sall and Grinter 2007)

Further, one participant reported to prefer to sit in a particular chair which would be moved closer to the television for their gaming session and then moved back to its original place once they were finished (Sall and Grinter 2007). The authors highlighted the necessary locations of digital devices within the space to enable the game(s) to be played. Additionally, the movement of furniture prior to game play was a necessary part of the course and was primarily associated to the game peripherals or was restricted due to the length of the device wires (Sall and Grinter 2007).

It is likely professionals from the fields of engineering, architecture, and computer science will be required to provide additional information regarding the adaptation and/or manipulation of the physical environment. Safety is the primary concern, and the removal of rugs and any other objects which are causing obstruction or are putting one's safety at risk should be considered to ensure a safe gaming environment. Bogost (2005) notes digital games are developed for engagement via consoles which are required to be connected to a television rather than personal computers (PC). Further, it is likely older adults will be required to purchase or update their television sets to receive information or play digital games due to the change over from analogue to digital transmission.

Over the last decade, televisions have grown in size and in some instances can take up the full length of a wall within the family room, and one aspect of aging which should be taken into consideration is the deterioration of eyesight. With this in mind, the effect of physical impairments as one ages should be considered by stakeholders if designing environments to sustain aging in place. Simon (2009) contends the Wii has the ability to bring families together similar to that of the television in the 1950s. The rationale for the Wii is "a family-making machine"

(Simon 2009) providing persons of all ages the opportunity to socialize within one space – this usually being the living or family room. Further, the majority of the games and the marketing tactics of Nintendo do demonstrate how the Wii can be used for this purpose. For example, Marston (2010) discussed the marketing exploits by Nintendo, illustrating how the company demonstrates both the Wii console and the dual screen (DS) handheld can be used in a multiplayer and family format. Additionally, this concept can be transferred to the Kinect, whereby users have the ability to watch one another, but further, when playing games such as *sports* – golf or bowling – they are not necessarily playing within the VE but within their own living space.

Taking this concept a step further with regard to smart home technology and previous work undertaken by Kasugai, et al. (2010), the implementation of such large multi-touch screens into the home could be difficult in the current housing environment because of housing layouts. The layouts may not be big enough for large screens, due to personal and sentimental objects such as photographs and ornaments causing obstruction in addition to large physical objects (sofas, chairs, and tables) being placed in the most suitable positions. The availability of technology such as tablets to control one's television choices is available coupled with the additional gaming technology which may or may not reduce the obstruction of physical space. Many homes are occupied with large sofas and cabinets storing ornaments, and as many homes were built at varying periods of the twentieth century, their interior style could cause difficulties for implementing technologies with a streamlined appearance while providing a monitoring and safety element. However previous works display the usefulness of utilizing digital game technologies for monitoring persons as they age (Demiris and Hensel 2008; Basak et al. 2008; Boot et al. 2008; Flynn et al. 2007; Whitcomb 1990; Clark et al. 1987; Weisman 1983). The conception of future technology requires exploration and studies to gain a full in-depth understanding of how such concepts can be utilized with ease into different living environments.

## Recommendations

As presented in the section "In-Home Monitoring", aging populations are at possible risk of falling and may experience FOF within the home. These functional and psychosocial challenges heightening the risk of falls could be alleviated by advancement in technology and integration of sensors into the home. To facilitate further understanding of the roles of these technologies and their effects on aging in place, Zijlstra et al. (2011) propose future research focus on large cohort study undertaken within "real-life" environments with sensor-based fall detection systems.

Furthermore, in the future, stakeholders, academics, technologists, and governments should consider how room design and layouts may need to be altered if the introduction of smart home and gaming technologies is to play greater roles within the lives of older adults. Further, introduction, implementation, and acceptance should be considered especially for persons who are technophobic or who have

had limited or no technology experience. It is proposed that a requirement of such technology integration may necessitate the living space to be less cluttered or the ability to integrate said furniture into the virtual environment. Finally, utilization and implementation of the next-generation Kinect and/or UP wristband in conjunction may be more sought after. This could provide users a more suitable approach to accessing their personal information relating to their daily activities, moods, heart rate, health, and well-being. To identify the suitability of these technologies within the home, a pilot study should be conducted, followed by a larger and longer case-control or randomized control trial. By conducting these types of studies, researchers would be able to assess and identify how effective the in-built software is at tracking one's movement and health needs.

In conclusion, this chapter has attempted to provide an overview of research conducted in the areas of game studies with a focus toward aging populations and AAL technology. As technology develops and becomes part of the family home, designers, engineers, and researchers will have to explore, assess, and evaluate the suitability of such technologies within the home. The current work displays a positive mood to such technology, yet further investigation is required on a larger scale, comprising of different dwellings, users (of all ages), and technological experiences to fully gain an in-depth understanding of this area.

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