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Understanding the Nintendo Wii and Microsoft Kinect consoles in long-term care facilities

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Abstract. In recent years video game consoles, such as the Nintendo Wii™ and the Microsoft Kinect™, have been introduced into residential facilities. This paper presents a review of current studies documenting the benefits and detriments the Wii could have on adults aged 60 years and over in residential facilities, concentrating on the common uses of the Wii in care facilities: maintaining physical fitness, promoting mental well-being, encouraging social interaction and both physical and mental rehabilitation. Furthermore, this paper discusses the potential use of the Microsoft Kinect in care for older persons. The Wii can have a positive impact on the physical and mental health of older adults living in care facilities, but additional work should still be conducted, including assessing the use of games outside of Wii Sports and Wii Fit and possible non-gaming application of the Wii in care for older adults. Results for the Wii display potential for use of the Kinect in care facilities but further exploration is required to assess the potential physical impact and interaction viability.

Keywords: Nintendo Wii™, Wiimote, Microsoft Kinect™, older adults, nursing homes

1. Introduction

The Nintendo Wii™, which was released in 2006, brought a new approach to interaction when playing games. Prior to the launch of the Wii, the primary method of interacting with a video game console involved multiple button pressing and moving joysticks on a controller. The Wii changed this with the introduction of the Wii Remote, a device resembling a television remote which includes built-in motion sensors that wirelessly translates its movement directly into game actions. This new method of interaction lowered the barrier of entry to video games, making games accessible to groups of people who had never previously considered playing video games. In addition to the new controller, many Wii games include multi-player components which allow gamers to play with their peers on the same console. This addition of social interaction makes the Wii more appealing to groups that typically do not play video games, such as older adults [1]. The provision of leisure and pleasant activities to older adults is a serious challenge within the domains of care and technology, in particular gerontechnology [2]. For example, the design and development of the game "Chitchatters" utilizing a qualitative approach (observation and use of probes) for older adults with dementia [3].

A recent development in video game hardware has been the Microsoft Kinect™, which was released in 2010. The Kinect is unique in the game console market because it removes the need for a controller to interact with the Xbox 360. This is accomplished by utilizing a series of cameras and microphones to track the player's body, allowing them to interact directly

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with the game [4]. By facilitating direct interaction, the Kinect has the potential to broaden gaming audiences further than the Wii, and could entice people who may not be willing or physically able to use a controller, through direct interaction with the Kinect rather than the controllers offered by the Wii or Sony PlayStation 2 (PS2).

According to the Entertainment Software Association (ESA), between 2004 and 2011 the population of gamers who are older adults, classified as over the age of 50, grew from making up 9 per cent [5] of the total gaming population to 29 per cent [6]. It is possible that part of this growth can be attributed to new gaming systems like the Wii, which make video games more appealing and accessible to older adults and the placement of video game consoles in care facilities.

In recent years video game consoles, such as the Wii, have been introduced into residential facilities. Therefore, the question posed: should video games be used in residential care facilities for older persons? De Kort et al. [7] stipulate, "[d]igital game play has the potential to support seniors in creating meaning and enjoying leisure time together or alone, and to train and uphold cognitive and motor abilities" (p. 247). While this statement gives a broad overview of the benefits video games offer to an aging society, it is to note that little work still exist in understanding the potential benefits to integrating video consoles into housing environments.

The primary objective of this paper is to present an overview of the use of commercial video game technology (Nintendo Wii/Microsoft Kinect) and the respective software (Wii Fit/Sports and Kinect Sports) which has been utilized within long-term care (LTC) facilities. Based upon the studies identified through a literature search which utilized video game technology, two research questions were identified: (1) how does the use of video game technology facilitate the physical, social and mental well being of older adults, (2) and what type of software is suitable for older adults. This review aims to present the benefits and detriments of video game technology for use within residential care facilities.

2. Method

Data synthesis methods were implemented and presented in Table 1. A comprehensive search of literature was undertaken using electronic databases (PubMed [Medline], JStor and Scopus), ACM, the Internet, and Google/Scholar, and article reference lists. Several search terms were included: "Nintendo Wii", "elder care", "elderly", "geriatric", "Kinect", "senior", "fitness", "group care", "Wii", "Nintendo Wii Remote", "Wiimote", "Nintendo Wii Balance Board", "Wii Sports" and "Wii Fit". The university network was primarily used for sourcing articles. The search was utilized from January 2000 to mid-January 2012, for English language articles. Non-peer-reviewed sources were not included in the search, but were reviewed for suitable articles. Contributions to reviewed conference proceedings were included. For a further and more specific search, a combination of keywords was used in the Pubmed and Scopus research databases. The following combinations of keywords were selected: Wii OR Kinect; AND older adult OR senior OR elderly OR geriatric; AND care OR health OR fitness.

Table 1
Exclusion and inclusion criteria for literature search.

Exclusion	Inclusion
Stroke	Physical activity
Parkinson's disease	Fitness
Cerebral Palsy	Elder care (senior care, geriatrics
Coronary	Long term care facility
Cost efficiently	Nintendo Wii
Newsletter	Nintendo Wii balance
Editorials	Well-being
Framework policies	Exercise
	Nintendo Wii Fit
Community dwelling	Nintendo Wii sports
Balance	Nursing home
Rehabilitation	

2.1. Data synthesis

The Preferred Reporting of Systematic Reviews and Meta Analyses (PRISMA) guidelines were used for systematic data synthesis [8]. Employing PRISMA was primarily for the methodological approach, following the recommended guidelines for in/exclusion criteria, data collection process and a summary of items and measures.

2.2. Data collection process

Collection of information included the study design, sample size, methods of effective measurements, and outcomes. Accepted articles included the inclusion criteria; Nintendo Wii console, Nintendo Wii Sports, Nintendo Wii Fit, long term care facilities, Nintendo Wii Balance, sheltered housing, nursing homes, exercise and elder care. Selected articles were based on title and

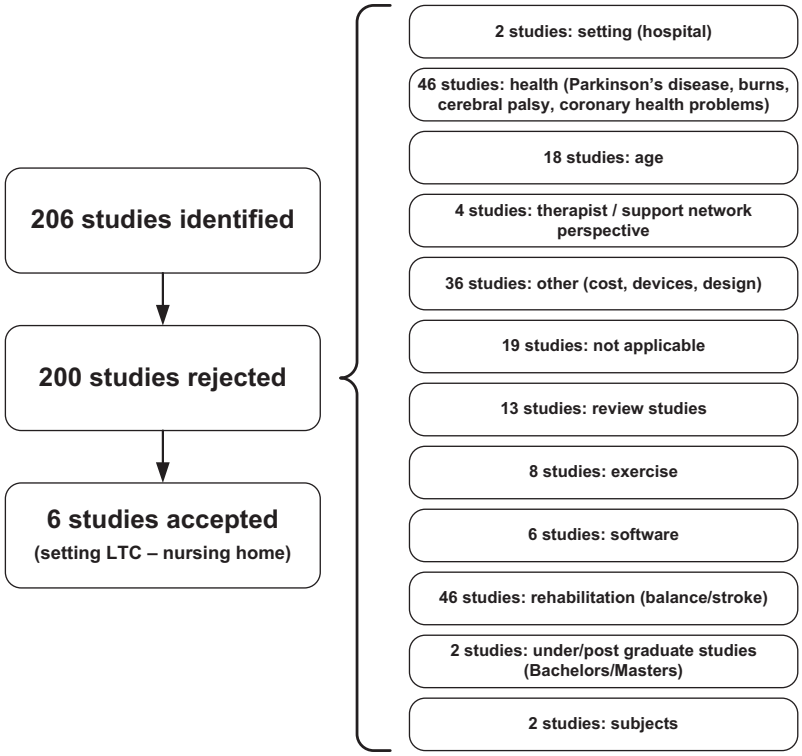

Fig. 1. Search process and eligible studies for inclusion based upon ex/inclusion criteria.

a review of the abstract to identify the suitability for inclusion. Excluded articles included age, health (stroke, Parkinson's disease, burns, cerebral palsy, coronary) reviews, setting, clinical perspective, subjects (children/young adults/intergenerational interaction), other (cost efficiently, devices newsletters, editorials, and frameworks), fall prevention strategies, virtual rehabilitation, balance and exercise, and non-peer reviewed contributions (Table 1).

2.3. Data items and summary measures

The ultimate outcomes for this review include: utilization of augmented reality for the purpose of fall/balance prevention and exercise strategies and how the implementation of specific information such as exercise programs can potentially be of benefit for individuals in conjunction with technology.

3. Results

Overall there have been six studies which have utilized the Nintendo Wii console for the purpose of well-being, physical/social activity [9–11]. When conducting this study, there were only eight studies published referring to or utilizing the Microsoft Kinect console. These studies have been excluded because they do not fit the in/exclusion criteria. However, it is anticipated in the future additional studies will be published exploiting this technology.

The format for the results section will provide an overview of two sections which relate to the use of the Wii console in care for older persons: (1) activities where the Wii was used, including physical fitness, mental fitness, social interaction, and (2) software that were played in care for older persons.

3.1. Activities for promoting physical fitness, mental well-being and social interaction

The most common activities identified from the studies included: maintaining physical fitness, promoting mental well-being, encouraging social interaction. Utilizing the Wii console throughout residential care environments has the potential to integrate and maintain physical fitness. Four articles were sourced which focused on the types of activities where the Wii was used in care for older persons [9–12].

The primary psychological benefits of the Wii came as a result of the console, allowing older adults to virtually participate in activities that they were no longer physically able to take part in. Jung et al. [11] suggest the virtual environment of the Wii gave older adults the unique opportunity to have ownership and control over their surroundings, which had a positive effect on their mental state. Overall, the articles sourced found the Wii had a positive psychological impact on older persons. Some, such as Jung et al. [11], established that the older persons playing on the Wii console had higher self-esteem and better mental well-being than their peers who engaged in traditional care activities for older adults.

Another area that was not explored in the sourced articles is the use of the Wii for non-gaming activities in residential communities. In addition to games, the Wii has the ability to be used as a web browser, photo projector and a communication channel [15]. This opens up many potential uses for the Wii in care facilities. One possibility is using the web browser to deliver personalized or community-specific news. An alternative use of the Wii is facilitating communication with friends and family through e-mail or using voice communication and avatars to talk to friends, family and other residential communities. Another possible application of the Wii could be to share photos and stories with other members of the residential community. Further investigation is required to determine if the non-gaming capabilities of the Wii would fit within residential care facilities.

Part of the encouragement for social interaction derives as a result of the use of avatars in Wii games. Avatars provide a virtual projection of a person into a game world. Jung et al. [11] noted, by allowing players to build their own avatars, the Wii gives older persons the unique opportunity to interact with other people using an appearance of their own choosing, which enhances their confidence. This boost in confidence allows the older persons to more easily interact with people in the virtual world than with people in the real world.

The multiplayer focus of the Wii encourages people to play in groups, thus encouraging older persons to interact with people they would not normally associate with, including peers and family members, building upon intergenerational relationships. Jung, et al. [11] observed gaming sessions using the Wii console reduced the hostility between individuals and encouraged greater interaction than traditional residential care activities. Examining the effect of interaction on the Wii between older persons and individuals, De Schutter and Vanden Abeele [16] concluded the Wii provided a unique opportunity for older persons to interact with younger generations. Overall, the articles found the Wii had a positive impact in encouraging older persons to socialize. This impact is noted by Harley et al. [9] who concluded, "residents have clearly been able to actively construct socially meaningful engagement for themselves around using the Wii".

To facilitate social interaction within residential facilities, the game *Kinectimals* allows the player to interact with a virtual pet of their choice from: a cheetah cub, a tiger cub, a panther cub, a lion cub or a leopard cub [17]. It has the potential to be used to promote mental well-being in older adults that are not physically or mentally able to have a real pet. Kinectimals has the potential to be used in a group scenario, promoting social interaction between older persons interacting with the same virtual pet. However, given the lack of actual contact the player can have with the pet, and the confinement of the pet to the television screen, further studies are needed to assess the benefits or harm that a virtual pet could have on a older persons community. Given the similarities between these games and games on the Wii that are used in residential care facilities, there is potential for Kinect games to be used for similar purposes (social programs, exercise programs, and rehabilitation) care facilities.

Similar to the Wii, the Kinect has potential for non-gaming usage in residential care. Some possible applications include: video communication with friends, family and other residential communities, sending e-mail using text-to-speech and speech-to-text (allowing older persons who are unable to use a keyboard, or unable to read a computer screen, to send and receive e-mail), and creating personalized services (for instance, television, music, medical reminders) through face and voice recognition [17]. Further investigation is required to determine the potential for both gaming and non-gaming capabilities of the Microsoft in care facilities.

3.2. Software

Wii Sports was utilized in four of the six studies [9, 11,14,20] and facilitates the choice of five different games: tennis, baseball, bowling, golf, and boxing, using their avatar against both human and computer-controlled opponents. Table 2 presents the studies which used the Nintendo Wii Sports or Fit software throughout their investigations.

Table 2
Videogame technology used in long-term/residential facilities

Author	Population	n	Age (years)	Duration (weeks)	Design	Intervention	Outcome
Harley et al. 2010	Activity engagement	30	60–94	10 sessions over 1 year, 2 hrs	Longitudinal	NW Sports (bowling)	Users were introduced to technical illiteracies in a non-threatening manner. Social isolation was addressed via the provision of peer connections. New roles were created and encouraged individuals to take ownership.
Clark and Kraemer 2009	Fall risk/ Balance	1	89	6 sessions, 1 hr	Case report	NW Sports (bowling)	Results showed the Berg Balance score improve and the Time-Up and Go Test suggesting a reduce risk of falling. The authors suggest using the NW bowling may facilitate a decrease in fall risk.
Hsu et al. 2011	Adding technology to exercise regime	34	52–97	4 wks	Randomized, single-blind crossover	Standard exercise and Wii Sports (bowling)	Results showed overall improvement, but significant difference was identified for enjoyment between the exercise and Wii groups. Participants who reported improvement on the Wii intervention, less likely complained of stiffness or shoulder complaints, but were more likely to complain of hand symptoms.
Jung et al. 2009	Psychological, social, physical impact	45	56–92	3 session 6 wk, 1.5 hrs	Longitudinal field experiment	NW Sports (tennis, bowling, baseball, boxing) and Cooking with Mama	Results showed that playing Wii had a positive impact on the overall well-being of older adults. Mediation effects were found for psychological well-being variables like loneliness and belonging. The elder in the single-player Wii group exhibited more positive affect compared to those in the multiplayer group. Through this study, Wii was proven to have a positive contribution to the overall well-being of the elderly. Explanations and implications for future applications of Wii in interventions for the elderly are were discussed.
Nitz et al. 2010	Balance	10	30–58	10, twice weekly (30 min)	Pilot	NWF	Further work is needed to confirm statistical powered studies. However the WF showed immediate effect on balance and strength.
Pigford et al. 2010	Balance	1	87	2, 5 sessions	Case report	NWF and CT combined	Improvement with the patient during the training program and a cessation of falls occurred in the following weeks.

Additionally, the articles focused on the increase activity participation by the participants in the respective studies, many of whom were currently unable to physically take part in the actual sports. The simulation capability of the Wii enables older adults to experience tennis or bowling past the point where they are physically able to participate in the real sport [21]. One perceived aspect to this simulation is the physical interaction required by the Wii controller, which simulates the motion of the sport adding to a greater sense of immersion than other consoles [11].

The Wii Fit game was utilized in two of the six studies [12,13], utilizing a specialized piece of hardware, known as the Wii Balance Board, to guide the player through a series of exercises. The software allows basic user information to be recorded such as BMI and progress throughout the exercises, indicating to the user how proficient they are during the exercise program.

Overall, these articles found that the Wii Fit provided good motivation for older adults to exercise. Pigford and Andrews [13] found the interactive environment, goals, and feedback provided by Wii Fit help to motivate their participants and improve performance in exercises that are usually found repetitive. Several studies used Wii Fit in balance rehabilitation and iden-

tified the peripheral could be an inexpensive replacement for existing systems. Pigford and Andrews [13] contend the Wii Fit has similar affects to hundred thousand dollar balance rehabilitation equipment. Most articles found Wii Fit to be an effective supplement to existing exercise programs. As Nitz et al. [12] concluded the Wii Fit had a significant impact in improving the balance and mobility of their participants.

To date, there are three games which have the potential to be used in residential care: Kinect Sports, Kinectimals and Fitness Evolved. Kinect Sports is a game that simulates 6 sports: bowling, boxing, track and field, table tennis, volleyball and soccer [24]. Fitness Evolved is a game that guides the player through a series of fitness routines, including: stretching, kickboxing, yoga, tai chi and palates [25]. Similar to Wii Fit, but without the need of extra peripherals, Fitness Evolved has the potential to supplement or replace fitness programs in care facilities. Similar to Kinect Sports the interactions with Fitness Evolved are almost identical to the actual activities, so further investigation is required to ensure that the physical requirements of Fitness Evolved are appropriate for older persons who are unable to participate in existing exercise activities due to health problems.

4. Discussion

This paper has presented two areas (1) physical, social and mental well being, and (2) software, which have been identified from the six studies utilizing the Wii console within LTC and nursing home facilities. Overall the results have shown a positive response to the use of the Nintendo Wii console within this environment. In particular, the facilitation of spatial ownership, peer socialisation, role creation during game play [9,11] and enjoyment [10]. At present there no or limited studies which have utilized the Kinect console and based on the in/exclusion criteria have not been selected for this paper.

The nature of interaction undertaken on the Wii console requires the user to physically move the controller to perform actions, rather than pressing multiple buttons or moving a joystick. This approach changes in the way players interact with the console naturally resulting in physical exercise. Conversely, one study reported how the participants did not complain of stiffness or shoulder discomfort, however, they were more likely to experience hand complaints [10]. Furthermore, the Kinect console adopts the approach of natural gesture movement, potentially offering users the option to engage with the environment more easily. However, additional study is required, whereby the focus of flow experienced by prospective users in comparison to the Wii console is needed.

The general type of software which has been utilized comprises of games within the Wii Sports/Resort and Wii Fit programs. Although this content may suit a broad audience for some people the available choices may not be what they would prefer to play. Taking this into account, it is suggested identifying what type of activities which may include hobbies and interests individuals prefer. Marston [22] conducted a series of workshops which enabled the participants to create their own game concepts based on their hobbies and interests. However, the identification of software in particular the content and applications available via the Kinect may provide future users with greater choice for physical, mental and social interaction.

Some games are specifically tailored to promote physical activity [11]. The Wii Fit game simulated an upper-body workout with positive physical results [12]. The physical effects of playing Wii games displayed the Wii could be used as a substitution for existing physical exercise programs in care for older persons, and even had the added benefit of providing mental stimulation [1]. These findings echo [23], who outline their Wii program had similar physical affects to the Up and Go and 12-min walk programs currently offered in their residential care facility. The beneficial effects of incorporating the Wii into the physical fitness of adults living with community dwelling were found by Wollersheim et al. [20], who concluded:

> "[T]he improvements indicate that, when Wii is incorporated into the daily lives of the elderly in these facilities, with time the psychological changes are likely to translate to an actual improvement in the elders' quality of life, and even evident physical and health improvements" (p. 51).

It is to be noted, there are differences between community dwellings and LTC facilities, and with this in mind, future work could investigate the feasibilities of using such technologies for social, physical and well-being amongst a range of adults and environments.

The articles focus on the use of Nintendo Wii console, including the Wii Sports/Fit, in residential care facilities. The use of these game titles could be explained simply because these three titles are bundled with the Wii hardware (Wii Sports is bundled with the Wii console and Wii Fit is bundled with the Wii Bal-

ance Board). However, as discussed by Marston [22], the most popular genres of games for older adults (in order of popularity) are puzzle, adventure, platform and shooter. There are many Wii titles that fall under these genres which might be preferred by older persons over Wii Sports and Wii Fit. Further investigation is required to determine if additional Kinect and Wii games might be beneficial in a residential care environment.

Similar to Wii Sports, Kinect Sports has potential to be used in residential care as a replacement for other exercise/sports programs. However, given the Kinect uses full-body interactions which are close to the movement required to play the actual sport, the physical exertion required to play Kinect Sports may not be appropriate for older persons who are unable to play real sports due to health problems. Further studies are needed to assess the physical requirements of Kinect Sports and if it can be used in geriatric care.

The potential benefits of deploying the Nintendo Wii™ and the Microsoft Kinect consoles into residential care facilities enables older adults to implement or maintain physical fitness through a series of programs primarily facilitated by the Nintendo brand (Wii Fit, Wii Sports/Resort). In addition, social and well-being can be a positive factor, allowing up to several people to play one game, building up a competitive aspect and potentially implementing a league table.

However, when learning to use the Wii, the older adults must learn how to use the buttons and pointing capabilities of the Wii Remote. The opportunity to interact via gesture and speech recognition offered by the Kinect console may allow some adults the ability to engage with the environment easier than the Wii console and the more traditional game pads. For some older adults this learning process may be too complicated even though they understand the motion as this relates to the real world for example; if you play golf in the real world you swing a club, this action is virtually the same during game play, with the exception of a button press. In contrast, the Kinect requires no controller and only requires the player to learn a few simple gestures to interact with menus, which could potentially lower the investment required to get older persons playing games. This notion is supported by de Kort et al. [7], who concluded, "if the investment of seniors to play a digital game (for instance, complex controls that need to be learned) is higher than the return (for instance, enjoyment) then the utility of digital game play will remain zero" (pp. 248).

Limitations were observed which include the limited sample of participants identified from the respective studies, which may have affected the results and conclusions, and it is suggested future work within this area(s) to include larger sample sizes are needed to provide a substantive result. The study designs of the studies are primarily pilot and it seems there has been little or no follow-up work utilizing a prospective or randomized controlled trial (RCT) design to report a precise use of this work. It is suggested this area is broad and the results presented in Table 2 cover several areas whereby technology has been implemented for the physical and social well-being.

This paper has identified three gaps, based on the studies presented in the results section, these are:

1. Use of games outside of Wii Sports and Wii Fit;
2. The possibilities for using network play to connect residential communities; and
3. The possibilities for non-gaming use of the Wii in care facilities.

Little work has been published in the area of understanding what type of activities older adults would like to see in games. Furthermore, Marston [22] identified several areas which showed potential for designing and developing games for an ageing society. However, further work is required in this area to gain a greater understanding of the needs and requirements of older users which would include the nature of interaction but also the social, physical and mental attributes which may be facilitated by video game technology.

5. Conclusions

This paper has outlined some of the current work that has been conducted to assess the use of commercial video game technologies in LTC facilities, concentrating on the common uses: maintaining physical fitness, promoting mental well-being, encouraging social interaction and both physical and mental rehabilitation; including the Wii Sports and Wii Fit games that are being played.

Results show that the Wii can have a positive impact on the physical and mental health of older persons in care facilities. However, due to the limited suitability of studies utilizing the Kinect console it is still difficult to establish the benefits of this hardware/software within this particular environment. Additionally, this paper has outlined several areas for future work to continue and build upon the implementation of games for older adults, including the analysis of games outside of Wii Sports and Wii Fit. Furthermore, the possible use

of the non-gaming applications of the Wii and Kinect in LTC facilities.

This paper has highlighted the potential for use of the Kinect in care for older adults, using both gaming and non-gaming applications accessible through the console. Both the Kinect and Wii share similar attributes, but, further exploration is required to assess the potential physical and social impact and interaction viability of the Kinect in older care, home and clinical environments. Due to the Kinect being released autumn 2010, limited work or no has been published in this area, but it is suggestive, this nature of Kinect technology, offers potential users a different approach to engagement and well-being.

References

[1] Y.L. Theng, P.F. Teo and P.H. Truc, Investigating Sociability and Affective Responses of Elderly Users through Digitally-Mediated Exercises: A Case of the Nintendo Wii. In: Forbrig P, Paternó F, Mark-Pejtersen A. (eds.) HCIS 2010, *IFIP Advances in Information and Communication Technology* **332** (2010), 152–162.

[2] D.G. Bouwhuis, Not care but leisure, *Gerontechnology* **5**(2) (2006), 63–65.

[3] H. van Rijn, J. van Hoof and P.J. Stappers, Designing leisure products for people with dementia: developing 'the Chitchatters' game, *American Journal of Alzheimer's Disease and Other Dementias* **25**(1) (2010), 74–89.

[4] R. Kay, I. Wright, S. Reynolds and A. Chakravorty, Taking Games Beyond What and Tilt. Gamasutra. 2010 July 27. http://www.gamasutra.com/view/feature/5935/taking_games_beyond_whack_and_tilt.php [accessed September 2011].

[5] Entertainment Software Association. Essential Facts about the Computer and Video Game Industry. 2004. http://www.theesa.com/files/EFrochure.pdf (accessed October 2005).

[6] Entertainment Software Association. Essential Facts about the Computer and Video Game Industry. 2011. http://www.theesa.com/facts/pdfs/ESA_EF_2011.pdf (accessed August 2011).

[7] Y. de Kort, W.A. IJsselsteijn and H. Nap, Senior gamers: Preferences, motivations and needs, *Gerontechnology* **8**(4) (2009), 247–262.

[8] D. Moher, A. Liberati and J. Tetzlaff, Altman DG for the PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement, *British Medical Journal* **339** (2009), b2535.

[9] D. Harley, G. Fitzpatrick, L. Axelrod, G. White and G. McAllister, Making the Wii at home: Game play by older people in sheltered housing, *Lecture Notes in Computer Science* **6389** (2010), 156–176.

[10] J.K. Hsu, R. Thibodeau, S.J. Wong, D. Zukiwsky, S. Cecile and D.M. Walton, A "Wii" bit of fun: The effects of adding Nintendo Wii$^{\mathrm{TM}}$ Bowling to a standard exercise regimen for residents of long-term care with upper extremity dysfunction, *Physiotherapy Theory and Practice* **27**(3) (2011), 185–193.

[11] Y. Jung, J.L. Koay, S.J. Ng, L.C.G. Wong and K.M. Lee, Games for a Better Life: Effects of Playing Wii Games on the Well-Being of Seniors in a Long-Term Care Facility. In: IE '09 Proceedings of the Sixth Australasian Conference on Interactive Entertainment, 2009. Article No. 5.

[12] J.C. Nitz, S. Kuys, R. Isles and S. Fu, Is the Wii Fit$^{\mathrm{TM}}$ a new-generation tool for improving balance, health and well-being? A pilot study, *Climacteric* **13**(5) (2010), 487–491.

[13] T. Pigford and A. Andrews, Feasibility and Benefit of Using the Nintendo Wii Fit for Balance Rehabilitation in an Elderly Patient Experiencing Recurrent Falls, *Journal of Student Physical Therapy Research* **2**(1) (2010), 12–20.

[14] R. Clark and T. Kraemer, Clinical Use of Nintendo Wii$^{\mathrm{TM}}$ Bowling Simulation to Decrease Fall Risk in an Elderly Resident of a Nursing Home: A Case Report, *Journal of Geriatric Physical Therapy* **32**(4) (2009), 174–180.

[15] Nintendo Inc. 2011. Nintendo Wii Console and Online Features. Nintendo America website. http://www.nintendo.com/wii (accessed August 2011).

[16] B. De Schutter and V. Vanden Abeele, Designing intergenerational play via enactive interaction, competition and acceleration, *Personal and Ubiquitous Computing* **14**(5) (2009), 425–433.

[17] Microsoft, 2011. "Kinectimals". Xbox.com website. http://marketplace.xbox.com/en-US/Product/Kinectimals/66acd000-77fe-1000-9115-d8024d5308b3 (accessed August 2011).

[18] H.R. Marston and S.T. Smith, Interactive videogame technology to support independence in the elderly: A narrative review, *Games for Health Journal* **1**(2) (2012), 139–152.

[19] Y.-J. Chang, S.-F. Chen and J.-D. Huang, A Kinect-based system for physical rehabilitation: A pilot study for young adults with motor disabilities, *Research in Developmental Disabilities* **32**(6) (2011), 2566–2570.

[20] J.L. Koay, J.S. Ng and L.C.G. Wong, Nintendo Wii as an intervention: improving the well-being of elderly in long-term care facilities. Nanyang Technological University Digital Repository, Singapore, http://dr.ntu.edu.sg/handle/10220/6217, 2009.

[21] D. Wollersheim, M. Merkes, N. Shields, P. Liamputtong, L. Wallis, F. Reynolds and L. Koh, Physical and Psychosocial Effects of Wii Video Title Use among Older Women, *International Journal of Emerging Technologies and Society* **8**(2) (2010), 85–98.

[22] H.R. Marston, Design Recommendations for Digital Game Design within an Ageing Society, *Educational Gerontology* **39**(2) (2013), 103–118.

[23] D. Hermes, S. Hitch, A. Honea, J. Stephenson and J. Bauer, Benefits of the Wii Fit as an Exercise Program for Older Adults, Proceedings of the 6$^{\mathrm{th}}$ Annual GRASP Symposium, Wichita State University, Wichita, KS, USA, 2010, 119–20, http://soar.wichita.edu/dspace/bitstream/handle/10057/3201/GRASP_2010_119-120.pdf?sequence=1 (accessed January 2011).

[24] Microsoft, 2011. "Kinect Sports". Xbox.com website. http://marketplace.xbox.com/en-US/Product/Kinect-Sports/66acd000-77fe-1000-9115-d8024d5308c9 (accessed August 2011.

[25] Microsoft, 2011. "Your Shape: Fitness Evolved". Xbox.com website. http://marketplace.xbox.com/en-US/Product/Your-Shape-Fitness-Evolved/66acd000-77fe-1000-9115-d8025553084f (accessed August 2011).

[26] J.-H. Annema, M. Verstraete, V. Vanden Abeele, S. Desmet and D. Geerts, Videogames in therapy: A therapist's perspective. In: Fun and Games '10. Proceedings of the 3rd International Conference on Fun and Games. New York, NY, USA: ACM, 2010, pp. 94–98.

[27] H.C. Higgins, J.K. Horton, B.C. Hodgkinson and S.B. Mug-

gleton, Lessons learned: Staff perceptions of the Nintendo Wii as a health promotion tool within an aged-care and disability service, *Health Promotion Journal of Australia* **21**(3) (2010), 189–195.

[28] L. Pareto, J. Broeren, D. Goude and M. Rydmark, Virtual reality, haptics and post-stroke rehabilitation in practical therapy. In: Proceedings of 7th ICDVRAT with ArtAbilitation. Maia, Portugal, 2008, pp. 245–255.