Chapter 1

Future Trends of Virtual, Augmented Reality, and Games for Health

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Abstract. Serious game is now a multi-billion dollar industry and is still growing steadily in many sectors. As a major subset of serious games, designing and developing Virtual Reality (VR), Augmented Reality (AR), and serious games or adopting off-the-shelf games to support medical education, rehabilitation, or promote health has become a promising frontier in the healthcare sector since 2004, because games technology is inexpensive, widely available, fun and entertaining for people of all ages, with various health conditions and different sensory, motor, and cognitive capabilities. In this chapter, we provide the reader an overview of the book with a perspective of future trends of VR, AR simulation and serious games for healthcare.

1 Introduction

The recent re-emergence of serious games as a branch of video games has introduced the concept of games designed for a serious purpose other than pure entertainment. To date the serious games industry is a multi-billion dollar industry and is still growing steadily in many sectors including education and training (Ma, Oikonomou and Jain, 2011), healthcare (Garcia-Ruiz et al. 2011, Arnab, Dunwell and Debattista, 2013), engineering, military applications, city planning, production, crisis response, just to name a few. Serious games have primarily been used as a tool that gives players a novel way to interact with games in order to learn skills and knowledge, promote physical activities, support social-emotional development, and

treat different types of psychological and physical disorders amongst others. Many recent studies have identified the benefits of using video games in a variety of serious—even critical—contexts. Games technology is inexpensive, widely available, fun and entertaining for people of all ages, with various health conditions and different sensory, motor, and cognitive capabilities. If utilised alongside, or combined with conventional educational or therapeutic approaches it could provide a more powerful means of knowledge/skill transfer, promoting healthy behaviours, restoration and rehabilitation.

This book Virtual, Augmented Reality and Serious Games for Healthcare 1 offers an insightful introduction to the development and applications of games technologies in healthcare settings. It includes cutting edge academic research and industry updates that will inform readers of current and future advances in the area. The book is suitable for both researchers and healthcare workers who are interested in using games for medical education and rehabilitation, as well as game professionals who are trying to gain a thorough understanding of issues involved in the application of VR, AR, and games technology into the healthcare sector.

2 Chapters included in the Book

This book includes 26 chapters. Chapter 1 provides an introduction to serious games and VR, AR simulation for healthcare. It presents brief abstracts of all chapters included in the book. The book is divided into six sections: Applications in Healthcare Education, Nursing Training & Promoting Healthy Behaviours, Applications in Neuropsychology, Applications in Motor Rehabilitation, Therapeutic Games aimed at Various Diseases, and Virtual Healing.

Section one includes six chapters that present various VR simulations and serious games applications in medical education and healthcare training. Chapter 2 applies educational theories in using VR simulations and serious games for healthcare training enhancement, and suggests how to assess their value within an educational context. The authors categorise training tasks based on levels of abstraction: from kinematic and dynamic aspects to higher knowledge level of reasoning, planning, and assessment. They describe a framework for evaluation of speed and accuracy of these multi-level tasks in order to validate the effectiveness of VR simulations

before inclusion in medical curricula. Chapter 3 presents a haptic-based VR head and neck model for teaching human anatomy and dental training that focuses on sensori-motor dynamical and kinematic skills. Chapter 4 reviews recent human computer interaction techniques in visualising molecular and structural biology for education and research. VR interactions range from spatial manipulation to sensory perception of biological reactions. This is named in virtuo analysis, which provides many benefits comparing traditional in vivo, in vitro, and in silico approaches. In Chapter 5, a volumetric visualisation system of heart from cardiac magnetic resonance imaging is presented. The system features Kinect-based gesture recognition, 3D holographic display, and sonic feedback, and it also visualises the blood flow through the heart revealing the functionality of cardiovascular circular system, which is critical for medical education. Chapter 6 and 7 discuss the challenges of adopting e-health services and disruptive innovation in the healthcare sector, from the management and governance perspective, and how visualisation technologies can support sustainable healthcare.

Section two covers the use of VR and games for nursing training, improving health literacy, and promoting healthy behaviours. Chapter 8 provides a comprehensive overview with emphasis on community health nursing, which differs from that of a nurse clinician. Traditional nursing education that focuses on individual patient care in hospitals may not suitable for community health nurses. VR simulation and serious gaming provide a viable, cost-effective, and interactive environment for community health nursing trainees. Both Chapter 9 and 10 present a number of virtual worlds in Second Life, e.g. the Nightingale Isle, which facilitates medical simulations and ambulatory care role-play experiences etc. to support nursing students; the HealthInfo Island where users can play games to improve health information literacy on topics of heart attack, stroke, and medical terminology.

The applications of VR and serious gaming in promoting healthy behaviours are discussed in Chapter 11 and 12. Chapter 11 proposes a novel approach that aims to design exergames which interact with the player's built, topographic, and social environment in a meaningful way and presents strategies on how to integrate research on health-oriented urban design and planning to the design of exergames. The authors also discuss

potential health benefit of location-based games, such as Zombies Run and Google's Ingress, which are more addictive due to the connection of the game elements with the real world. They encourage players' physical activity such as walking, running, and cycling during game play. As obesity and lack of physical activities become a growing problem of our society, this type of exergames have lots of potentials to engage people into light or moderate physical activities. Chapter 12 presents findings on how and to what extent rewards and incentives in exergames are persuasive and compelling to entice players in adhering to the game over time using the game statistics of SpaPlay, an online social game designed to motivate players to adhere to healthy eating and exercising behaviours.

Section three includes three chapters on the topic of VR applications in neuropsychology. Both Chapter 13 and 14 focus on neuropsychological assessment. In Chapter 13, the authors argue that traditional neuropsychological tests lack ecological validity and it is controversial to generalise the results to describe individuals' daily life cognitive functioning. Virtual reality technology provides a more objective, precise, and ecologically valid approach to neuropsychological assessment. They also review the progress made in using VR-based tools to measure cognitive functions such as attention, memory or executive functions. Particularly, Chapter 14 and 15 elaborate the characteristics of the Virtual Multiple Errands Test (VMET), a VR simulation developed using NeuroVR--a free virtual reality platform for assessment and neuro-rehabilitation.

The next section provides an overview and individual case studies of VR and games applications in motor rehabilitation, especially post-stroke rehabilitation. Chapter 16 presents the European project REWIRE that provides a broad architecture involving patients, therapists, clinicians, hospitals and health providers for motor rehabilitation at home. The authors investigate exergame design based on Gentile's motor skills taxonomy and describe the implementation details of the REWIRE games with an emphasis on patient motion tracking. More particularly, the use of Nintendo Wii in motor rehabilitation is reviewed and discussed in the next Chapter. Chapter 18 and 19 focus on motor rehabilitation after stroke: the former reviews upper limb rehabilitation games whereas the latter describes a 3D visualisation system for biomechanical analysis of lower limb rehabilitation. Finally, Chapter 20 presents a maze game for training users at maintaining balance over various types of soil (broken stone, stone dust, sand, concrete and wood) with its physical setup and peripherals, including intelligent shoes, and reports the result of its initial evaluation.

Section five includes a serious of therapeutic games aimed at various diseases such as cystic fibrosis, Parkinson disease, and autism. Chapter 21 describes a system comprised of a Positive Expiratory Pressure (PEP) mask, a computer-connected pressure monitor and a suite of games of varying types, which encourage young sufferers of cystic fibrosis to participate in daily therapy. The authors also report finding based on game statistics and subjective feedback in order to determine long-term effects of this gaming therapy. Chapter 22 proposes a wearable Augmented Reality (AR) system for Parkinson disease rehabilitation. The users can perform different tasks in context–specific scenarios. By segmenting and overlaying users' hands and objects of interest above the 3D environment, patients have the ability to naturally interact with both real–life items as well as with augmented objects using their bare hands. The findings of a comparison study are report, where the tasks were carried out both in the real world and using the AR system in order to assess patients' performance. In Chapter 23, Garzotto, Valoriani and Bartoli explore the benefits of motion-based touchless interaction, where games are controlled using body movements and gestures without wearing additional devices, for autistic children with low-moderate cognitive deficit, low-medium sensory-motor dysfunction, and motor autonomy. They found that motion-based touchless gaming led to improvements of attention skills for the subjects.

Finally, section six consists of three chapters on virtual healing. In Chapter 24, Stone et al. provides a holistic discussion on the use of virtual restorative environments – the reconstruction of locations and scenes that, by virtue of their natural beauty and peacefulness, can significantly help to reduce the body's reactivity to stress and restore cognitive or attentional capacities, especially for amputees and patients recovering following surgical procedures. More specifically, Chapter 25 describes VR Graded Exposure Therapy (GEXP) as treatment for pain-related fear and disability in chronic low back pain. The final chapter looks at sound, a key aspect of VR, AR, and serious games that, because of the dominance of the visual sense, is often overlooked in the creation of healthcare applications. The authors discuss the importance of high-quality audio in rehabilitation applications and describe the equipment and processes of creating quality natural sound recordings.

3 Future Trends of VR, AR, and Games for Health

3.1 Location-based excergaming

Emerging and pervasive technologies bring lots of potential for location-based excergames (a.k.a. ubiquitous gaming), especially live action role playing games that take place both virtually in game worlds and in the real world, as people moving around in physical space to accomplish game-related missions that register in the game world, e.g. Geocaching, Botfighter, Zombies Run, and the recently launched Ingress. It is expected that location-based excergaming will develop over the next decade, particularly, on mobile platform, with wearable devices such as Google glass or smart watch. Readers who are interested in this trend should definitely read Chapter 11.

3.2 Mobile Apps

Although there are no healthcare apps for smart phones in this book, it is undoubted that mobile apps on mobile and tablets are changing the way providers and patients approach healthcare and the way of medical education, and that they will become more popular in the future. Some apps are designed for the healthcare providers, e.g. mobile app triage, handy databases about drugs and diseases, and monitoring patients' blood pressure, glucose levels or asthma symptoms; others are for patients, ranging from gathering diagnostic data to self-administration of medicine; and more for general public to promote active, healthy lifestyles.

3.3 Social media gaming for public health

Social media will have a growing role for health related games. Using social media to support exercising and brain fitness, to increase adherence to treatment, and to raise awareness of certain diseases is becoming more important due to the popularity of social gaming and the effectiveness of social interaction. This aspect of serious games is explored in Chapters 12. We believe that putting social psychology into health game would be another direction for future development of healthcare applications.

4 References and Further Readings

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