The application and development of VR interactive technology in serious games

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Abstract:
Traditional game design skills can be used in all kinds of fields such as education, architecture, city plan and virtual cultural heritage and we call this kind of game as serious games. However, the user experiences that traditional serious games have brought to us lack the properties of interaction between reality and virtual world. With the development of VR interactive techniques, all kinds of interactive sensing devices sprouted out, such as Microsoft Kinect sensor, Leap motion and Oculus Rift. The serious games which use these new technologies have a good sense of immersion and interactivity. To create an immersive and hand-free controlling serious game and evaluate its effects we designed a serious game related with virtual cultural heritage based on Kinect and we tested the application of Leap Motion and Oculus Rift on traditional car racing game. In this paper we analyzed and discussed the application of a few typical interactive devices and introduced our serious game prototype base on Kinect.

Keywords: serious games, VR, Kinect, BCI, virtual cultural heritage

0. Introduction

Nowadays an increasing number of people especially young people are enjoying computer games and virtual environments for entertainment. And the quality of real-time computer graphics, increased realism and immersion has been greatly improved in computer games. These new technology makes computer game possible and more suitable and easy to use in education, learning and training fields and it is what so-called “Serious Games”.

“Serious Games” seems to be a new phenomenon developed in recent years. But actually games have been used outside of entertainment field long time ago. The term of “Serious games” are defined as “games that do not have entertainment, enjoyment or fun as their primary purpose” [1]. We don’t have to pursue the historical origins of this term. But with the development of computer software and graphics hardware technologies “serious games” are developing rapidly. A market study shows that the worldwide Serious Games market is worth 1.5 billion dollars in 2010 [2].

“Serious games” can be used in wide range of fields, such as government &NGO, defense (Ex. Math, Science, and current events etc.), healthcare (Ex. Surgery Simulations, Check-up routines), marketing (Ex. Product placement, use of company characters) and communication, industry (Training, Skills acquisition) and education (Ex. Math, Science, current events etc.). However, although the widespread use of “Serious games” has been well known, the use of games to support cultural heritage purposes, such as historical teaching and learning, or for enhancing museum visits, has been less considered. One of the reasons is traditional computer game mode cannot enable players or users to experience normally 3D virtual worlds well.

Now the popularity of VR interactive technologies makes them an ideal medium for educational or training purposes. As a result there has been a trend towards the development of more complex serious games, which

combined interactive hardware and immersive presentation technologies. These new types of serious games can be more immersive and interactive, which will increase greatly users' experience and interest to join in it.

Typical examples that interactive serious games can be used is to present complex virtual cultural heritage worlds and interactive with them for entertainment, historical teaching and learning, especially for enhancing museum or ancient cultural sites (relics) visiting.

In this paper we explore the main types of interactive devices that can be used in serious games and propose a prototype serious game for cultural heritage based on the project of 3D in-world Telepresence With Low-Cost Camera-Tracked Gestural Interaction [3] in Curtin University, Australia.

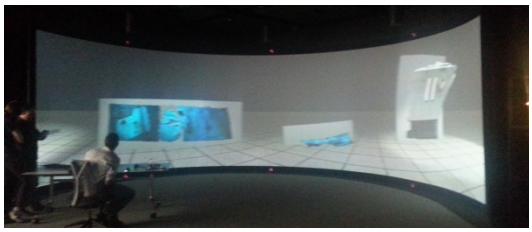

Figure1. 8-meter-wide cylindrical display in HIVE Curtin University

1. The interactive technologies that can be used in serious games

1.1Camera-Tracked Gestural Interaction

Kinect:

Kinect is a motion sensing input sensor device developed by Microsoft for the Xbox 360 video game console, which can capture, track and decipher body movements, gestures and voice [4]. The Kinect consists of a microphone array, a color camera, a depth camera and an inclination sensor. Therefore, it is classified also as a RGB-D sensor, with RGB describing the three-color components and D the depth. Kinect provide us a new kind of interaction between human and computer, and it is described as a revolutionary product.

Figure 2. Testing Kinec1 in racing car game

The auditory and visual information serves as commands to interact with digital contents presented in games or software programs. In other words, users are not bound by keyboards, mice or joysticks and thus have intuitive and virtual experiences with digital contents. The kinesthetic and gesture-based interaction enabled by Kinect definitely is the dream application that computers are envisioned to support. We used Kinect in our serious game prototype and we will introduce the detail in the paper.

Leap Motion:

The Leap Motion controller is a small rectangular device that can be connected to a computer using a USB. It can then sense hand movements in the air above it, and these movements are recognized and translated into actions for the computer to perform. And in this way users can use their real hands to control virtual objects in virtual game environments. The Leap Motion controller is said to be highly sensitive to very small movements, and is capable of mapping movements of the entire hand above it [5].

Figure 3. Leap Motion Controller

1.2 Brain computer interfacing (BCI)

Emotive:

Although research on Brain-Computer Interfaces (BCIs) started during the 1970's only the last few years it became possible to introduce brain-computer interfacing as an alternative controller to simple users through commercial non-invasive EEG headsets [7].

Figure 4. Myo gesture armband

Brain computer interfaces (BCI) have received widespread attention in recent years since they enable the user to control their environment directly from their brain activity, bypassing the need for speech, gestures, or any other form of muscular activity. BCIs are currently mostly considered for augmenting or re-establishing communication and motor control capabilities of patients suffering from severe brain injuries or muscular disorders. In addition, they open up alternative possibilities for human-machine interaction which can also cater for healthy users [8]

1.3 Muscle-sensing Technology

Myo gesture armband:

Myo is a muscle-sensing band [Figure 5]. It consists of eight muscle-sensing modules that you strap onto the widest part of your forearm, which then lets the device detect your hand gestures [6]. These include squeezing your fist, spreading your hand, waving your hand left or right, rotating your fist, or something as minute as a quick pinch with your thumb and another finger (which can be set to activate or pause the Myo). On top of that, there's the combination of a gyroscope, an accelerometer and a magnetometer to detect your arm motion.

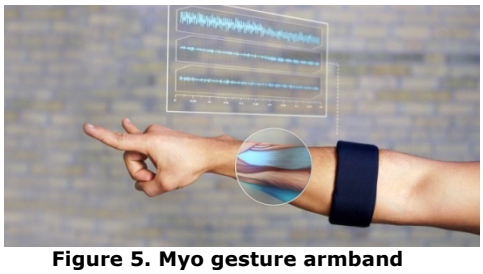

Figure 5. Myo gesture armband

1.4 Presentation Technology

Oculus Rift:

New presentation technologies or devices such as Oculus Rift [Figure 6], Samsung Gear etc., bring us revolutionary new tools and technology for interactivity and immersion.
The Oculus Rift is a light weight headset that allows a user to step into the game and look in any direction [9].

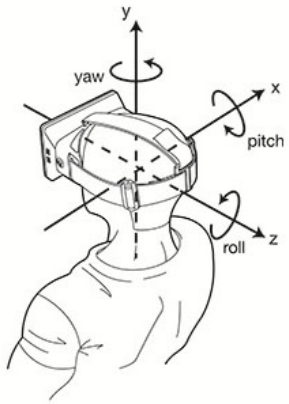

Figure 6. An illustration of the three axes

Dome Presentation:

Historically dome environments have been restricted to large planetariums their purpose was primarily for public education in astronomy, illustrating the positions/motion of planets, stars, and constellations [10]. Now immersive environments can be used in cultural heritage.

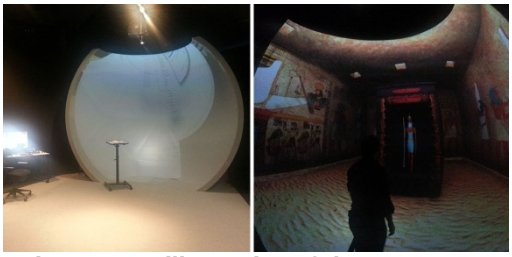

Figure 7. An illustration of the Dome at the HIVE, Curtin University

1.5 others

Interactive technologies such as those mentioned above are increasingly popular and they all can be used in Serious games and providing interesting new forms of interactive and immersive entertainment and education. But we should not neglect some common devices which can also play important roles in Serious Games. An outstanding example is the smartphone, which has been combined into a few sensors such as the Accelerometer, Gyroscope, Compass and the Inclinometer. These sensors combined with software can be used to design location-aware interactive games.

2. Our Study

Serious games can employ devices and presentation systems that are primarily and originally designed for home entertainment. For example, we developed a prototype camera-tracking application using a Kinect camera sensor and multi-camera Unity windows for teleconferencing. For archaeology, urban design and architectural presentations we required the display of interactive 3D content that incorporated but was not blocked by a speaker (or an avatar that mirrored the gestures of the speaker) [3]. The application can be used for the presentation of many different types of 3D environments, but especially for virtual heritage projects. In order to increase the level of entertainment we also considered integrating serious game applications into the system, and we designed a prototype as proof-of-concept [Figure 8].

Figure8. An illustration of the teleconferencing project.

The prototype allowed users to interact with the physical movement of objects in a virtual environment and to complete contextually-related tasks. It can be applied to achieve the aims of education in cultural heritage or museum interaction. In this game prototype, players can move either artefacts (such as the pictured the virtual vase) or teleport to different building areas simply by raising or pointing their arms, and the presenter or presenters can place them in specific positions, perhaps even combine them into a new shape or a building. Both First person and Third person camera modes are available.

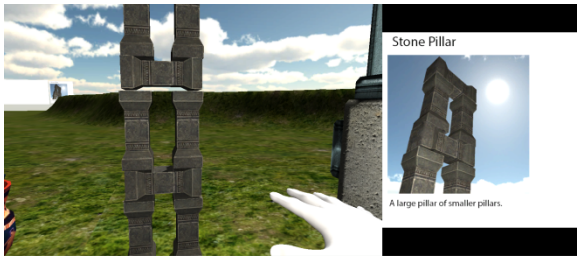

Figure 9. An illustration of game interface

Gesture and Skeleton Detection：

Gestures are detected using a Microsoft Kinect Camera. The user's body is tracked and the associated skeleton data is mapped to the avatar within the game (Unity3d game engine). In this way the user can see a virtual representation of their body controlled by the Kinect depth camera sensor, to immerse the user into the game-

environment [Figure 10]. The user can control the avatar, there will be future options to we will control the game-world camera in real-time, and trigger game events by specific gestures.

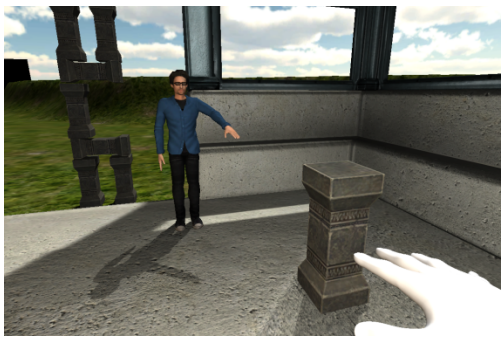

Figure 10. An illustration of the third person game prototype

Figure 11. An illustration of the Kinect skeleton model

Interactive control in the game：

After calibrating the user to the avatar's skeleton we can control the avatar by gestures. Taking into account the accuracy and difficulty of moving objects of the game directly, we handled game objects by remote control (Figure 12).

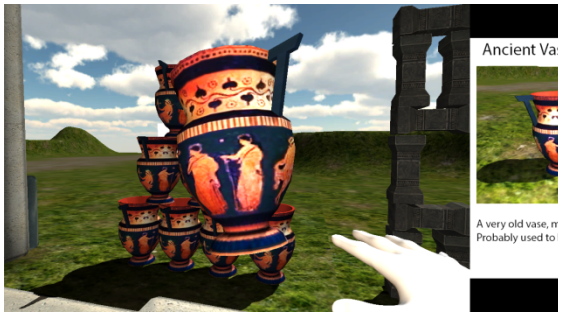

Figure 12. An illustration of the first-person game prototype

3. Conclusion and Outlook

In this paper we explored a range of different interactive devices that can be used in Serious games and we developed our Serious game prototype with a Kinect and virtual heritage content. The game engine Unity was used for the display of the scenes, easily creates game interfaces.

It is suitable for all kinds of interactive devices such as Kinect, Leap Motion, Oculus Rift and so on. The developed Unity application can be deployed to different hardware platforms such as PCs, Xbox and mobile devices (both Apple iOS and Android). In addition, we also introduced the use of Kinect to realize a serious game prototype in Camera Tracked Games and Immersive Digital Environments project.

In addition to motion capture and BCI technology, display technology can also assist in promoting the development of serious games. In this paper we introduced possible display systems such as the Oculus Rift， large scaled cylindrical displays (e.g. the Cylinder stereo Display in Curtin University) immersive displays (e.g. dome system in Curtin University) and Panorama technologies. There is no doubt that rapid technical progress is being made and many new products will be available in future.

Serious Game has a broad market space and tantalising development prospects, and with the development of robust, simple and affordable interactive devices, the distance between the virtual and the real are narrower than before. It is because of the interactive device's increasing ability to act as a link between virtual worlds and reality, so it is suitable for many different applications and training, simulation or other interactive 3D virtual scenes. These applications can also play a very important strategic role in interactive museum, and virtual cultural sites and provide content for home entertainment systems. So we can expect in the near future for many more advanced interactive devices and related applications to appear in the field of Serious games.

4. Acknowledgements

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5. References

[1] Michael, D., Chen, S.: Serious Games: Games That Educate, Train, and Inform, 1er edn. Course Technology PTR, USA (2005)

[2] Alvarez, J., Alvarez, V., Djaouti, D., Michaud, L.: Serious Games: Training & Teaching –Healthcare – Defence & Security – Information & Communication. IDATE, France (2010)

[3] Erik Champion, 3D in-world Telepresence With Low-Cost Camera-Tracked Gestural Interaction, ACMMULTIMEDIA 2015

[4] Stapleton, Andrew J. "Serious games: Serious opportunities." *Australian Game Developers" Conference, Academic Summit, Melbourne*. 2004.

[5] Potter, Leigh Ellen, Jake Araullo, and Lewis Carter. "The leap motion controller: a view on sign language." *Proceedings of the 25th Australian Computer-Human Interaction Conference: Augmentation, Application, Innovation, Collaboration*. ACM, 2013.

[6] Hewitt, John. "The MYO Gesture-Control Armband Sense Your Muscle's Movements, ExtremeTech (online magazine), Feb. 27, 2013."

[7] Vourvopoulos, Athanasios, Fotis Liarokapis, and Panagiotis Petridis. "Brain-controlled serious games for cultural heritage." Virtual Systems and Multimedia (VSMM), 2012 18th International Conference on. IEEE, 2012.

[8] Van Vliet, Marijn, et al. "Designing a brain-computer interface controlled video-game using consumer grade EEG hardware." *Biosignals and Biorobotics Conference (BRC), 2012 ISSNIP*. IEEE, 2012.

[9] Desai, Parth Rajesh, et al. "A Review Paper on Oculus Rift-A Virtual Reality Headset.", International Journal of Engineering Trends and Technology (IJETT) – Volume 13 Number 4 – Jul 2014 ISSN: 2231-5381 http://www.ijettjournal.org Page 175

[10] Bourke, Paul. "Using a spherical mirror for projection into immersive environments." Graphite (ACM SIGGRAPH), Dunedin, New Zealand (2005): 281-284.