Cross-benefits between virtual reality and games

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Abstract

In one hand, video games are dedicated to entertainment. In recent years, the emerging of consumers hardware dedicated to games induced great progress for realism and gameplay. Graphics rendering and physical engines, digital surround sound and new interaction interfaces are examples of areas which have benefited of these last improvements and widely contribute to the gaming experience.

In another hand, virtual reality focus on user's presence which is its indubitable feeling of belonging to the virtual environment. As this goal is very hard to reach, studies have to focus on human through several research directions like immersion (3D vision, sound spatialization, haptic devices) and interaction which has to be as natural and non intrusive as possible. Recent researches on inter-sensoriality possibilities, metaphorical interactions or brain computer interfaces are examples of what would be achieved in immersion and interaction.

At this point, we can argue that virtual reality can be a provider of new methods and resources for games. Unfortunately virtual reality room are expensive and difficult to deploy, what is probably the main reasons why virtual reality is still a laboratory experiment or confined to industrial simulator. Here is our double contribution : to combine video games and virtual reality through two different virtual reality game solutions and to design them with consumer grade components.

This paper first presents a survey of both current video game evolutions and virtual reality researches. We will also give some examples of cross-benefits between video games and virtual reality. To illustrate this last point we will describe two virtual reality applications created by our research team and dedicated to gaming. Finally, as a prospective talk we will deal with three points : some recent virtual reality systems supposedly applicable to home gaming, some good points from DG that VR developers should incorporate in VR systems and last point, some lines of enquiry so that the union between VR and DG be at last consummate.

Keywords

virtual reality, gaming experience, cross-benefits, immersion, interaction

1. Introduction

Virtual reality (VR) and digital games (DG) are two area which share many similar characteristics among which the three most important are as follows. Both of them have to focus on Human to succeed (feeling of presence for VR, entertainment for DG). VR and DG exploit the technological breakthroughs of several fields like image synthesis, electronics *etc*. Finally, they both act sometimes in a virtual realistic world like flight simulator or therapy environment[1]. Other times they allow to

operate in a fantasy world which does not necessarily respect usual physical laws.
Similarly, the pitfall to avoid is in common i.e. the race for more and more visual realism. But, firstly it does not guarantee the success of a DG and secondly realism is not the key point for a virtual environment where credibility is sufficient to arouse a feeling of presence.
This strong symmetry between VR and DG is the reason why general public is prone to confuse them; though we will see later that the frontier is still here. Moreover, during the eighty's and the ninety's some books (*Neuromancer* from William Gibson), movies like *Tron, Lawnmower* and *eXistenZ* and certain papers or reporting of scientific translation make believe that in the early 2000's it will be very common to wear a HMD and a tactile suit to play DG. In 2008 this expectation is still here. Even if during last decades there was a lot of exchange between VR and DG it's still not possible to play at home to a virtual reality game.
Our contribution, in this paper, is twofold, a presentation of two virtual reality games and some reflections on virtual reality games. We will first propose a rapid historic review on DG and a brief state of the art on VR. Then we will outline some examples of cross-benefits between VR and DG. In a third part we will describe virtual reality applications created by our research team and dedicated to gaming. Finally, as a prospective talk we will deal with three points : some recent virtual reality systems supposedly applicable to home gaming, some good points from DG that VR developers should incorporate in VR systems and last point, some lines of enquiry so that the union between VR and DG be at last consummate.

2. State of the art

The goal of this section is not to present a complete historical overview on the virtual reality and digital games, which would be out of the scope of this paper, but only the main steps and evolutions.

2.1 Digital games

First digital games appeared in the 60s with games like *Oxo* or *Tennis for two*[2]. This latest worked with an oscilloscope and was playable via analogical computers. The first game console produced by *Magnavox* and called *Magnavox Odyssey* was created in 1972 for home entertainment. At the same period the *Atari* company was founded and was at the origin of the world famous game *Pong*[3].
Since the beginning, games were designed to be played by two people using two paddle controllers or using interfaces like the *light gun* that enriched the gaming experience. First created for one single game, home game consoles quickly evolved to accept multiple games induced by the coming of several companies like *Nintendo* or *SEGA*. They proposed their own consoles with dedicated games. Once again, Atari innovated, in 1977 with his *Atari 2600,* by replacing the simple beep by a real sound based on two mono channel.
The first video game with three-dimensional content appeared in the early 80s and was called *battlezone*. During the following years, games did not stopped their development proposing better graphical content and scenario. For example, games like *Super Mario Bros*, *Final Fantasy*, *Dune II* or *Wolfenstein 3D* offered new kinds of gameplay.
Examples of 3D stereoscopic games have been released in 1995 and were playable with the Nintendo's *Virtual Boy* portable console. However most of the players were sick and the console was

not very successful.

With the arrival of the *Internet* in 90s, a new gaming experience is proposed to the players who can play against human distant players into persistent virtual universes. An example of such a game is *Ultima online* created in 1997.

Gaming interfaces evolved at the same time than the video games' democratization. It exists two categories of interfaces : some dedicated to home gaming and others dedicated to arcade.

Coin-operated entertainment machines have been very popular when they appeared in the middle of the 70s. Their main advantage is that they are dedicated for one-single game. It means that games have better graphical content, and interfaces are related to the gaming context (the player can use a wheel, a weapon,...) and sometimes the machine environment is adapted for a better immersion (decor, vibrations,...).

The first home gaming interfaces were very simple like a small box with a single push button and/or a knurl to decrease the manufacturing cost. Quickly the mouse (1972) and the joystick (1980s) have appeared and became popular because of the better interaction with games. Latter, interfaces that could only be found when playing with coin-operated entertainment machines were available for home gaming (guns, wheels, pad). Currently the tendency is to provide less and less intrusive interfaces in order to increase the gaming experience like the *EyeToy*[4] (Sony), the *Wiimote*[5] (Nintendo), the *Gaming amBX*[6](Phillips).

2.2 Virtual reality

Virtual reality, like digital game takes advantage of several other scientific areas like cognitive science, computer graphics, electronics etc. A reality system aims at immersing one or more users in an artificial environment where he will be able to feel and interact in real-time thanks to sensory-motor interfaces. The experience will have to be credible enough to gull user’s senses in order to create, as an ultimate goal, a feeling of presence of the virtual objects, but also a feeling of his self-presence in the virtual environment. This feeling of presence can be achieved relying on five pillar which are immersion, interaction, real-time, emotions and cognitive science. It may be interesting to make clear the function of each pillar. The immersion is the sensory stimulation which permit the perception of the virtual environment and then its comprehension. The interaction enable the user to not remain spectator of the experiment but to act on it. By real-time we mean we have to maintain the coherence of the perception-action loop. The emotions bring by the experience help the user to accept the experiment by distracting his attention from real world environment including the interaction devices and from the shortcomings of the application. The last pillar is the cognitive science which enable to understand (amongst other things) how Human apprehend their environment, that's a very useful point in order to improve the immersion and interaction efficiency.

The application scope of VR are numerous : simulator for the army and the industry, tool for the treatment of phobias, education and culture with the reconstitution of antic site, art etc.

The first VR installation date from 1956, Morton Heiling created the *Sensorama*[7] which enable to live a multi-modal experiment. In 1966 Sutherland presents *The sword of Damocles*[8] an installation which combine head tracking and Head Mountain Display (HMD) to render a point of view dependant

wireframe virtual environment. In 1975, Myron Krueger proposed an installation named *Videoplace* where the user can use his avatar to interact with a simple virtual environment thanks to a camera. In the middle of the eighty's, Jaron Lanier found *VPL* the first company which commercialize some equipment dedicated to virtual reality like data gloves and HMDs. The Cave Automatic Virtual Environment[9], created in 1992 is composed of a small room of about five square meters where each wall and the ground are screens displaying synchronised images. Then it offers an almost complete visual immersion. At the end of the last century appeared the first autostereoscopic displays which enable a true stereoscopic vision without the use of special glasses.

2.3 The virtual reality games

In this section we will try to answer the question “what is the difference between virtual reality game (VRG) and classical digital game ?” Both virtual reality and digital games can work on the five pillars introduced in the 2.2 section but each pillar can be used at different level. For example in VR, immersion level is very high but the emotion level is quite low whereas it's quite the contrary in DG.

As example of VRG we can notice DisneyQuest open in 1998 which was an indoor interactive theme park which contains several VR attractions like *Aladdin's Magic Carpet Ride*. It's interesting to notice that, all over the world, all that kind of parks have closed due to low attendance. We can also notice that most of VRG only appeared in theme park like Disney or Futuroscope in France. There is also some few examples in game center with arcade video game like *Alpine Racer* or *Aqua Jet* which try to bring more realism thanks to more natural interaction devices but, for example, none of them propose stereoscopic vision. In conclusion we can argue that digital game with a high level of immersion and interaction is very uncommon and home VRG is completely missing.

Also, we must make mention of serious game which is a VR research study and use DG statecraft but the aim in that case is not entertainment but for example to provide a safe virtual environment dedicated to training, teaching etc. You can find a good overview about serious game here[10].

3. Cross-benefits

In this section we present some examples of cross-benefits between virtual reality and digital games.

3.1 Benefits from virtual reality to games

There are numerous benefits from virtual reality to games essentially because virtual reality is a gathering of multiple scientific domain instead of a single one. These various research area are improved by needs of VR applications. Part of these enhancements generally transit into mass market once the developing cost is reasonable.

For example, computer graphics have beneficed from expectations of simulator applications. Indeed, they need a realistic and real time rendering. This has induced developments of physically-based engine that have been progressively transited in DG (F*ar Cry*, H*alf-Life 2*). Similarly, we can cite, in sound rendering, this research[11] on perceptual audio rendering technology which has been adopted by the game company Infogrames/Atari to improve their game audio engine.

Virtual reality focused research on telepresence[12] with applications dedicated to collaborative and distant work quite sooner than the success of massively multiplayer online games. In medical domain,

transmission of hight amount of data in short time like video flow is very important.
As Virtual reality is requiring immersive interactivity between the user and the virtual environment, many haptic devices have been developed. Hence, several tools have been designed for DG including vibrating or feedback elements[13].

3.2 Benefits from games to virtual reality

First VR should thank DG to be at the initiative of numerous improvement in real-time computing. As described in the last section, a digital game is a good provider of emotions (fear, happiness, curiosity...) needed by the fourth pillar. The player has to surpass oneself in order to take up the challenges against himself or other people and, as a consequence, the player motivation and involvement increase.
Currently, games benefit from a good popularity thanks to the young population enthusiasm for entertainment. This popularity has stimulated the creation of cheaper and lighter virtual reality systems that spread out labs. Moreover, now that people are interested in virtual reality, it provides a community that can validate *in vivo* through the different concepts and interfaces selected for a VR application. At last, the democratization of digital games have led to the creation of various open source libraries like *Ogre 3D*[14] that can facilitate the creation of virtual reality applications also VR libraries are available[15].
Hardware is continuously improved by DG: equipments become quickly highly capable and cheap. At the beginning virtual reality installations were made with specific hardwares like a dedicated graphic card or an expensive video projection systems. Now a virtual reality room can be created using consumer grade components. Many hardware developments designed for games have been reused in research areas because of its simplicity and low cost. For example some virtual reality installations use a the Nintendo *Wiimote* for interactivity[16] or several *Sony Playstation 3* to provide a computational cluster[17].

4. Our two virtual reality games

In this section we present 2 examples of VRG. We made some assumptions about the conception, for example, a low cost immersive system. We will also discuss our belief about these choices.

4.1 JIM3D

Jim 3D[18] (Interactive game using 3D mosaic) is a classical point and click game inspired from the famous game *MYST3* wherein the player can move from scene to scene and in each scene the user have a free 360° rotation viewpoint. To increase the feeling of presence of the player we added some new development.
Using a rendering algorithm based on three cylinders, we are able to create stereoscopic pairs to increase the immersion of the player. The cylinders, which are set on the vertices of an equilateral triangle, represent the scene from slightly different viewpoints. The user is virtually placed at the center of this triangle and two cylinders are selected according to his view direction and associated to his eyes (one image for left eye, the other for the right eye). Besides the visual system, we use a 8-speakers-based sound system that surrounds the player which is placed at its center. The playable

sounds are either environmental sounds to define the ambiance of the game or spatialized sounds to help the user to localize an object in the scene.
The scenario of the game consists in a series of riddles that the player must resolve to go forward in the game. Thus, interaction metaphors have been designed to help the user to easily interact with the different parts of game. The interactive tools is made of two LEDs that can be placed on one finger of the player : he can use it to rotate the viewpoint using a gesture similar to a catch & drop, and he can activate an action by pointing an object of the scene.

4.2 ISSI

The goal of the project ISSI[19] is to create a virtual reality installation similar to a CAVE system. It is composed of several interfaces build with grade consummer components: the display system is made of 4 transparent screens (made with tracing paper), a sensitive carpet to detect the position of the user, a compass placed on the head of the user to detect his orientation and headphone to diffuse a spatialized sound.
In the actual scenario you are playing the role of a prisoner who want to evade from his cell. The choice of a cell for the interactive context has been decided to have a virtual environment that match the size of the installation. Thus, each screen of the installation is nearly a wall of the cell. Moreover, the user's feeling of presence is increased by the situation: a breakout involves stress as the goal is to quickly escape. Then, his attention is completely focuses on the virtual environment rather than the installation or external disturbing information.
To increase presence, visual effects relative to the virtual body, have been added. The first one is an interactive image of the user's personage reflected by a mirror. Thus the user can have an overview of what he looks like according to his position. The second effect is the shadow of the prisoner that moves according to the position of the user. In addition to the increase of the realism of the scene, the user's feeling of presence will be more important as virtual elements interacts with his actions even if they does not help to progress in the scenario.

4.3 Critical analysis

The different interactive tools created for these previous VR games have been designed to be the less intrusive as possible. Thus the player is just wearing and using light elements like stereoscopic glasses, sensitive rug, LEDs *etc*.
Our system have been made with consumer grade components and with home made devices. The main reason is that we are able to control each step of the virtual reality game and propose a low cost (less than 5000€) solution. However we are aware that our installation need some improvement to be used outside of the research domain but, as detailed in the following part, we try to suggest new ways to develop virtual reality games.

5. Discussion

In this chapter we will present some recent interesting innovations in VR with which we should pretend that's what people will use in virtual reality games in 2015... The second part deals with some

futures cross-benefits between VR and DG. Then we will give some lines of enquiry which seem significant to succeed in offering some virtual reality games.

5.1 Some virtual reality innovations that you will not play with...

but your children or grandchildren maybe will... The aim of this section is not to denigrate all theses researches which are all very interesting but to point the fact that it could be easy to make people dream by pretending they will soon be able to play with... As example we could notice some research about one of the most important point in VR : how to reproduce the feeling of self-motion ? Here is three interesting solutions among others which enable to physically move in a large space : the VirtuSphere[20] which is a sphere which rotates through the motion of the user, CirculaFloor[21] which uses a set of movable tiles and Powered Shoes[22] which is a motor-driven roller skates.

Other interesting research concerned the area of the brain machine interface, we can cited the brain computer interface[23] which enable to establish a direct communication between the brain and the virtual environment.

5.2 The best practices in DG to apply to VR

DG companies practice some studies to know their public in order to be able to adapt their products. VR is a bit too attached to physic and should follow the example of DG and sometimes forget physical law to produce some more fanciful and aesthetic environments. In the same way it should be interesting to give more freedom to the user to interact with his environment. Is the height on interaction would not be to allowed the user to interact with the VR application itself like the player community of a game do when they create add-ons or new maps for their favorite game ? To introduce players in one game universe, DG create an ambiance through a narrative cinematic introduction movie and maintain it with the help of dedicated interlude like replay scene. We think ambiance is an interesting means to improve the feeling of presence in a VR experiment.

5.3 Lines of enquiry for virtual reality games

We have seen in the last section that researches on movement restitution in virtual reality have been very active during the past years. The benefit of these researches is dual: firstly, it focuses on the immersion quality letting users to achieve a natural movement. As consequence user self-motion perception agrees with the proprioceptive feedback. Secondly, it can reduce the feeling of head spin and queasiness due to motion sickness. It is a crucial point because players use to play several hours consecutively but immersive systems are well-known[24] to cause headaches and feeling of sickness.

To reproduce the self motion feeling following a low cost way, it seems interesting to think about the role of the multimodality. Hence, the movement impression could be given with visual and audio stimuli[25].

About immersive installations we suggest to develop low cost multisensorial systems (visual, audio, tactil...) to achieve an immersion level with enough credibility. Nevertheless lot of studies have to be done to define the minimal immersion level required to create a virtual reality experience.

The future of visual interfaces that will be used in home virtual reality gaming is definitely interlinked with autostereoscopic screens. First, player have the habit of playing games on computer or television

screens, next, projective systems and Head Mounted Displays are very intrusive and at the origin of discomfort. Autostereoscopic screens are still expensive but cost will decrease like the LCD screens have done.

Virtual reality interaction tools have to be simpler and cheaper for future games. For example interaction could be done using only webcams to detect and interpret the gesture of the player or detect player's emotions and intention with eye tracking algorithms. Of course this is not an easy task as it requires more research to achieve such a level of complexity and robustness but it could allow to use any objects of everyday life to interact with a game.

Finally it is evident that future virtual reality game system must be offered as plug and play system to be easy to use.

Conclusion

Our contribution is twofold, we propose some reflections and lines of enquiry about virtual reality games that we applied in two virtual reality games workshop. We definitely think that virtual reality games is a wonderful area of research on itself and can benefit to both VR and DG.

In the future, we want to go further in our reflections initiate in the section five, open these reflections to augmented reality and mixed reality games and finally to put them into practice through games.

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