ARE HAPTICS-ENABLED INTERACTIVE AND TANGIBLE CINEMA, DOCUMENTARIES, 3D GAMES, AND SPECIALIST TRAINING APPLICATIONS OUR FUTURE?

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Abstract: Interactive augmented reality via tangible media and cinema enabled with responsive environments through haptic devices providing the physical feedback from a virtual space to the real space to the interacting audience is becoming more common especially now that computer graphics and other visual stimuli are becoming so photorealistic and where they fail, the brain makes up the missing details. This covers games, cinema, virtual reality applications and education applications. It seems that so common that we will all live in a couple of decades in an interactive virtually-enhanced world where we won't be able some times to tell apart the virtual and the real. How will this affect the upcoming generations and child education? Will we be out of touch with the reality like in the Matrix (Wachowski and Wachowski, 1999)? While possibly accepting the upcoming inevitable change, can we improve on it early on and turn it to our advantage? If so, how? We present the initial research steps as a part of this work to start answering these questions.

1 INTRODUCTION

Position Statement. In many technological societies today, people are constantly enhancing their sensory input with virtual things, objects, and characters through either video, gaming, virtual reality, augmented reality, or any other graphically-enhanced human-device interaction. Devices such at more-and-more sophisticated gaming consoles, such as Wii, or haptic devices along with high-definition displays, stereoscopy, or virtual-reality glasses are becoming increasingly cheap and accessible to medium-lower income families and educational institution facilitating access to them by the children and a younger generation overall. Not to mention the traditional PCs, laptops, cellphones, PDAs are fitted with cameras and all sorts of gadgets that are now defacto standards. In a couple of decades, we will live in a virtually-enhanced world where it will be difficult at times to separate reality from computer generated enhancements. It is imperative that such "enhancements" will impact the way the children are educated and what they will have taken for granted and the norm. While there will absolutely be the cases of various intentional or not intentional abuse of technology, we believe we still can make the advances very useful in education and perhaps even combat the negative effects of it. Thus, we present, as space permits, the effects of such virtualization, and how it can be used effectively, and our very first steps if the research in that direction using 3D graphics techniques, interactive cinema methodologies, and others of how they can further improve education and training of children and adults in various subject areas.

Audience. The intended audience of this work covers a wide spectrum of people who may engage in the interactive (or even passive at the moment) activities in front of any types of screens, displays, enhanced glasses as well as enabled controls in PCs, TVs, gaming consoles (e.g. Wii), mobile phones, and personal digital assistants (PDAs). We cover the education, entertainment, and training spectra. All involve the audience interaction with the surrounding visual environment with computer-generated imagery. We will first discuss the general issues in a human society and then narrow the scope down to more concrete sectors.

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Related Work. There is a significant number of the related work materials we reference here that would require a lot of space to describe. They all mostly relate to the techniques of interactivity, computer graphics, dynamic physically-based real-time soft-body simulation, haptics technology, augmented reality, tangible media and so on. Some of them are recited here: (Song and Grogono, 2008a), (Wikipedia, 2008), (Conti and Khatib, 2005), (Kocher, 2008), (Clua et al., 2006), (Matusik and Pfister, 2004), (Davenport et al., 1991).

2 "COST" AND "BENEFITS"

Haptic devices are becoming more accessible. Families acquire larger and bigger television systems including home theaters. Not to mention ever-enhancing gaming consoles and PC games in general, the Wii gaming console reaches out not only to game geeks, but also to couples, to entire families, and more interestingly to the female market with their exercise programs and the like.

Stereoscopy plays another role of creating holograms or visual stereo effects in the cinema and computer programs for animation and games.

Augmented reality is a natural way to bring virtual objects into the real world where we live. With advances of the AR techniques development, AR has been applied on medical imaging, where doctors can access data from patients; aviation, where tools show pilots important data about the landscape they are viewing; training, in which technology provides students or technicians with necessary data about specific objects they are working with; in museums, where artifacts can be tagged with information such as the artifact's historical context or where it was discovered (EDUCAUSE Learning Initiative (ELI), 2005); military and people's everyday life. For example, through AR handheld devices such as tablet PC's, PDA's, or camera mobile phones, users hold the device up and "see through" the display to view both the real world and the superimposed virtual objects. With the GPS in one's PDA or a cellphone, one can move around and see the virtual objects, models, animations, or game from different views as the AR system performs alignment of the real and virtual cameras automatically (Cawood and Fiala, 2008). The latter is can be useful to guide people in the unknown area towards their desired destination they have prespecified.

Problems. There are a number of inherent problems with the virtualization of our realities.

Abuse in terms of being addicted to the machines producing the virtual enhancements, games, and so on resulting in psychological dependence and the corresponding medical consequences and health problems, reduction of motor functions, physical lack of exercise. The same reason applies to being out of touch with others and being antisocial preferring the virtual people and characters and being ignorant and cold about the real people and friends. Losing human values and acquiring virtual values with no substance as well as social aspects and virtual characters in preference of the real, especially for introvert people can impair the entire new generation. Lack of touch of physical touch with another person can make it foreign to acquire a family.

Some virtual environments, particularly games, can "train" violence and make it an ordinary behavior that could potentially spill into the real. This was known for long time.

Will learning to drive or to pilot with crashes knowing that's just a virtual crash, not real, make safer drivers and pilots? Does it promote the learners to be more careless and reckless? Do they lessen the value of life?

Current augmented reality products more focus on individual users and may not lead themselves to team activities or group learning. Furthermore, even though it may raise the pedagogical value, the students are also in the risk of becoming infatuated with such technology.

Most of these problems are actually not new at all as they were pointed out as soon as first addictive computer games started coming out and children preferred a lot more to stay home and play the games instead of going outside and playing with others or doing other activities.

Solutions. Technological advancement is inevitable from the hardware and software points of view. Can we turn it to our advantage and make it beneficial?

Interactive feel and touch should, while approaching reality, never reach it, to allow conscious controls and cues with the interaction interface to hint the virtual from the real.

It's been shown in scientific research that the children that played computer games had better logic development. Education can be effective just as games if not more, more efficiently delivered.

Anger management in the virtually-enhanced environment can release the anger there to virtual characters, instead of to the real people.

Participative i.e. active, rather than passive, involvement of the audience with the virtual or augmented realities helps teaching and learning: It is possible that some humans hired as teachers do not actually have the skills to teach effectively, so they can be (1) complemented with the virtual education as well as (2) trained themselves to be better educators using the same virtual and augmented reality tools. This is in a way similar to tradition expert systems approach, where the expert system does not entirely replace a human expert (e.g. doctors) but rather reminds or suggests alternatives or helps to train novice doctors the expertise until they become more acquainted with the profession. The virtual educator in this setting with not only display knowledge in text and graphical user interface (GUI), but actually would appear and be responsive in the complete environment with vocal and emotional support, which are even today technologically quite possible. Such an educator can evaluate and correct the real novice educator about gestures, facial expressions, speech, and effective communication according to the social norms at the time by evaluating several sensory inputs, such as a video and audio signal with some pattern recognition techniques, e.g. for face and speech recognition followed by natural language understanding and natural language generation techniques as well as generation of the facial expressions by the virtual educator. Responses and expressions and voice can be compared with a good set of stored ones or the bad ones, measuring their distance and then making a suggestion based on that measurement.

Learning and training can take even further steps, some may seem superfluous today and unnecessary, as the authors agree, but may very well become a part of our lives in the future.

The haptic devices can grow in the virtual reality worlds to the sizes of training gear in a gymnasium. This can counter the lack of exercise effect. A the moment such a technology or a similar exists, but expensive and mostly found in space agencies or the military.

Haptic gloves and joystick-like devices can simulate some responsive feedback environments on a smaller scale, e.g. a hand of a surgeon touching a softbody organ. Such sense of touch can also be propagated while interacting with the virtual characters in the environment.

Learning through games can be entertaining and effective. Hide-and-seek in the augmented reality can develop a better sense of the environment, say when both virtual and real people take part in hide-and-seek with the augmented glasses, it adds an extra twist and places to look where one would not normally look for someone hiding, yet not loosing a touch with the reality at the same time.

3 APPROACH TO THE PROPOSED RESEARCH

With our research we study and contribute the effects of virtualization of different aspects and enhancing them with the interactivity while trying to maintain the balance of the virtual and real. At these very early and preliminary stages of the research we cannot tell how it will play out in the end but we lay out a path towards better augmented and virtual reality interactive and responsive systems for education and training via interactive cinema (interactive documentaries can teach the subject of history, law, politics, negotiation, business, etc.) or games for younger generation.

Focus. The research on haptics-enabled interactive and tangible cinema, documentaries, 3D games, and specialist training applications, involves theoretical and practical experience in film and video production, extensive 3D computer graphics knowledge and the related programming skills, and experience in digital multimedia field. The author has been very lucky through their PhD program to be able to blend the multiple disciplines throughout the research to experience first hand. As mentioned, the research area will cover various fields, people who enable the research at this present moment need to have some expertise and qualifications in these areas to design, develop, and experiment with such a fusion of environments.

One has to have a vast background in computer science, programming and algorithms, computer graphics; and some cinema. Then, bridging the computer science and visual and digital arts, defining topology of media as well as the tangible aspect of the media and its responsive environments as a form of interactive digital art. A strong creativity in interactive media is another factor that enables the research and experiments such as we describe. Research projects, such as CitySpeak (Lewis and OBX Labs, 2008), allow putting interactive art of text into the scale of masses in the installations in public places such as airports and train stations, with a graphically impeding visualized text that any person could contribute to by interacting with it via SMS messaging. One also has to have an extensive cinematography background, which enables them to judge the efficacy and aesthetics of moving images, and therein lies their interest in the potential of “new visualization” with the new media. Such background and extensive experience is a great help for the research not only in the theory aspect of cinema and documentary, but also in the production practice techniques of the careful design on the scenarios of the movie, which will suit the interactive cinema techniques.

It is a vast undertaking to accumulate all this knowledge and experience in one person. To be feasible and efficient, one who is conducting the research has to bring together people across several disciplines. The author is grateful to have gathered a supervisory committee of five such people to enable the present research.

Real-time Responsive Virtual Environments and Tools. In this work we explore a variety of inexpensive techniques for human-computer interaction in various fields as well as advanced 3D modeling and animation in a rich spectrum of application domains. Thus, we attempt to come up with a set of tools, techniques, methodologies using haptics-enabled and other interface devices such that the toolbox/framework developed is affordable and applicable with least number of the modifications to the domains, such as classical cinema and documentaries, specialist training applications (e.g. surgeons, divers, and astronauts in preparation of operations and missions that involve difficult physical activities), interactive 3D games using haptics-enabled devices and their applications for home cinema production, 3D games development, and other application domains.

The first area of focus for the research is leaning towards the real-time softbody simulation (Song and Grogono, 2008a; Song and Grogono, 2008b) in haptics-enabled environment for specialist-training and interactive cinema. We begin by using a joystick-like and a sensor glove-like haptic devices to interact and deform a softbody in an OpenGL (OpenGL Architecture Review Board, 2008) 3D environment that provides feedback back to the user restricting their movements based on the elasticity and shape of the modeled virtual objects (e.g. the softbody tissue of an organ) acting as inverse sensors. We then proceed to the game and cinema scenes to enrich them with the interactive features.

The current research approaches concentrated on the user interaction are more concentrated on involving the users to participate in the screen play altering the script, make the decision for the characters in the movie scene, similarly as it is done in role-playing games (RPGs).

Another goal of our research is to extend that and give the users the opportunity to interact with the computer graphics model or cinema scenes at the more realistic level with feedback. The audience would feel the force, temperature, and elastic deformation of the objects or could experience the characters surrounding environment of the film, rather than stay at the observing level.

Therefore, the intended research gradually and incrementally will focus on the mentioned aspects and will include the following: *enhanced softbody simulation*, *specialist training*, *augmented reality*, and *interactive cinema* as the applications of our approach.

Interactive Cinema. Interactive cinema is the evolutionary approach to traditional movie, which gives the audience an active role in the showing movies. Compared to traditional movie,the interactive cinema allows viewers to interrupt the movie from time to time, and to choose among different possibilities of how the story goes on. Viewers may interact with the haptic devices to feel the feedback forces and touch the objects in the scene. This new and emerging technique will give viewers a realistic experience and enroll as part of the scene for the film. The film elements in interactive cinema are controlled by real-time conditions and algorithm behaviors.

Interactive cinema, evolving from the mathematical models and procedural programming, becomes alive when some of its parameters are controlled by a viewer. The real-time challenges of the aspect are the most interesting to solve in a less expensive way than traditional approaches.

The focus is on continuous story play environments, story authoring systems, and scenarios for interaction. Enhanced with haptic devices and stereoscopic effects, the feeling of the interaction will consume the audience to be an integral part of the storyline in the movie, which is a lot much more than a game.

The perceptual experiences can be different each time the movie is played. The interactive movie approach is more suited for smaller rather large audiences in traditional cinema theaters as the interactivity aspect in movies does not scale very well. The home and small audience aspect, the technologies studies and developed in this work should be affordable by regular home users, small education groups in schools, colleges, universities, etc.

During the duration of this project the knowledge of how to adapt inexpensive haptic devices, algorithms, techniques, and methodologies to interactive cinema in order for it to be more accessible to digital media artists, augmented reality researchers, and computer scientists alike to further research in the area, and make it accessible to audiences at home and school. The knowledge acquired from making the installations, setups, software development and re-use, and the mathematics behind would be made available as a guideline of how to make such setups in order to solicit feedback and improve the process and select the appropriate tools and techniques.

Such contributions are important in the age of digital media not only for artists and small audiences, but also for educational purposes of children through interaction, as it is widely known the children develop better their abilities when one interacts with them more. Telling interactive stories, teaching decision making in various life situations are specifically important applications of this research.

Enhanced Softbody Simulation. The research and development of the 3D simulation of softbody deformation still has a lot of aspects that can be explored in the softbody deformation simulation area because it has emerged as a new challenge in computer graphics, and, therefore, was not fully exhausted yet. Meanwhile, the application of softbody deformation in computer graphics has significant value for medical research and media arts achievement. The resulting models from the simulated models, will help to create feedback environments that will map the virtual feedback to physical through an haptic interface. In our real physical world there exist not only rigid bodies but also soft bodies, such as human and animal's soft parts and tissue, and other non-living soft objects, such as cloth, gel, liquid, and gas. Soft body simulation, which is also known as deformable object simulation, is a vast research topic and has a long history in computer graphics. It has been used increasingly nowadays to improve the quality and efficiency in the new generation of computer graphics for character animation, computer games, and surgical training. So far, various elastically deformable models have been developed and used for this purpose.

Specialist Training. Surgical training is one of the most promising fields in medicine where computer graphics and virtual reality techniques are emerging. The computer generated visual virtual environment imitates the reality of medical operations and organ construction to fulfill the training purpose. This new application improves surgical outcomes and decreases the research costs. However, the reality and accuracy of the software always require high-end knowledge of physics, mathematic and heavy computation. It makes it difficult for users to interact with virtual objects in real-time.

Furthermore, another medical application of elastic object deformation is computer-assisted surgery, which guides the surgeon during the real-time surgery operation. An haptic simulator will help novice surgeons to practice their suturing skills. The surgical simulation system includes the research topics of the real-time interaction with 3D elastic objects, physics aspects of the deformation behaviors of elastic objects, photo-realistic visualization,and haptic force-feedback algorithm. Users interact with the digital model through physical suturing tools that are attached to an haptic device. The digital model deforms relative to the weight, pressure, impact, such as pushing, pulling, cutting applied on the tissue. The goal of this research is to give surgeons the force feedback accurately through the haptic model. A similar approach can be used in training astronauts to manipulate the instruments for their space servicing missions in environments that are generally more difficult to operate in especially when wearing a highly-resistive space-suit gloves under pressure. Commonly, astronauts do the training for that underwater requiring special tanks and the necessity of the availability of the spacesuit. Having an haptic environment with the simulated geometry will allow the astronauts a more accessible training tool to practice their dexterity and strength skills prior getting into the spacesuits more often.

Augmented Reality. In the past few years, Virtual Reality, which has attracted a great deal of media attention is to immerse a user inside an imaginary, computer-generated "virtual world". The user is cut off from any view of the real world outside. Later, some attention has been paid to the field of Augmented Reality, in which the user can see the real world around him, with computer graphics superimposed or composited with the real world. The real and virtual objects coexisted. User wear an optical see-through Head-Mounted Display or other digital devices, such as PDA and mobile phones which allow user to see a combination of the real world and a virtual world. Within the academy, educators are providing students with deeper and more meaningful experiences by linking the educational content with real places and objects. Moreover, PDAs or other portable devices can use GPS data to provide users with visual, audio, or text-based information about the place and objects in our real world.

3D Games. Games are a natural place for the topics of interactive cinema, education, and responsive environments to be used. There has been a lot of focus in the industry to make the games with fancy stereo animation or augmented reality or virtual environment spaces, and cinema re-done in to the game plots. The games are a natural outcome of the above listed topics and techniques, so we trim the discussion about the games here.

4 CONCLUSIONS

It seems that our lives are becoming more and more entangled with the augmented or virtual interactive environment spaces enhanced with advanced computer graphics techniques. As any technology can be used for peaceful and educational purposes, we are striving to identify the right technology in the haptics world affordable by the masses for the entertainment, creation, and education through the study of film, computer graphics, augmented reality techniques, as well as their application in the industry.

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