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EDUCATIONAL AR/VR SYSTEMS FOR MILITARY PROJECTS

Bachelor's thesis
Information Technology

2018

South-Eastern Finland
University of Applied Sciences

CONTENTS

1 INTRODUCTION

Developments and improvements in computing technology have allowed for vastly improved immersion when consuming digital media. The most notable examples of such technologies are Augmented reality and Virtual reality. The immersion these technologies offer can be used to create educational systems that have more benefits than traditional digital educational systems.

In this thesis project I will be comparing the difference between AR(Augmented reality) and VR(Virtual reality) in the context of educational software. Different implementations and physical devices will be compared and analyzed. A device and a technology will be chosen to prototype an educational application for Observis Oy related to the company's Situational Awareness System(SAS).

The SAS product has a steep learning curve which raises the need for a more efficient educational tool. The goal of the project is to pick the most suitable technologies and implement such a tool. Advantages and disadvantages of AR/VR need to be considered over more traditional digital educational tools.

2 AUGMENTER REALITY AND VIRTUAL REALITY

Augmented reality and Virtual reality are technologies that offer a different view and experience to the physical world. They leverage similar kinds of technology and both aim to provide an enhanced and enriched experience to the user. Both technologies are a part of the general area of mixed reality (Figure 1). However they have different goals and are essentially different in terms of user experience.

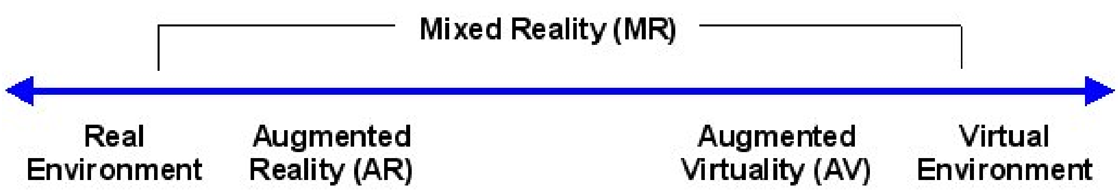

Figure 1. Reality-Virtuality Continuum (Paul Milgram et al. 2007)

2.1 Augmented Reality

Augmented Reality can be described as the technology that bridges reality with virtual environments. Real life objects are transformed or replaced with virtual equivalents. Information can be added or removed to the real environment. Key aspects of AR(Augmented Reality) are the ability to run in real time, be interactive, three dimensional and combine real with virtual information. AR is most commonly used with the sense of sight, but it can potentially be used with other senses such as hearing, touch, smell, taste, temperature etc. Augmented Reality can be considered as the next step in graphical user interfaces(GUI) evolution(Mullen and Mullen, 2011). Its current state is comparable to command line interfaces and 2d interfaces in the 1980's and 1990's. It is a vision of future computing and a field that is under research.

Augmented Reality has higher technological requirements compared to VR which has lead to the slower maturity of AR. AR enabling technologies have been developed throughout the history of which the Optical see-through has become the most popular(Microsoft HoloLens, Google Glass, Intel's Vaunt). Optical see-through is achieved by using opaque displays on which virtual overlays can be rendered. The resolution of the real world is left intact as it passes through the screen. Benefits of this approach include power fail safety, which allows users to still see the real world even during a power outage, cheaper production costs of the used displays, no parallax effect that irritates the user's eyes. Disadvantages are the reduced visibility and brightness through the opaque lenses, limitation of the field-of-view, requirement of additional tracking sensors such as cameras, gyroscopes and accelerometers. Due to the lack of maturity of other AR enabling technologies only Optical see-through techniques will be considered throughout this work(van Krevelen and Poelman, 2010).

2.1.1 AR for training and education

Augmented Reality provides new paths to conveying information. Learning experiences are more contextual by connecting and embedding information with the real world in real time. These approaches are already being utilised by Boeing. Mechanics in the company use AR goggles that aid repairs with embedded textual instructions, illustrate different steps of the repair and help users identify the required tools for a repair. Consequently training resources are reduced and transfer of information between workers is greatly improved(Johnson et al., 2010).

Learning through doing is another approach in which AR shines. Mistakes and errors made during the learning experience have no real consequences. This provides for more authentic learning experiences which cannot be achieved in any other way(Kipper et al., 2013).

2.1.2 AR Challenges

An AR framework has basic requirements to accomplish a combination of the real and virtual world. The four main requirements are sensing, tracking, interaction and display(Figure 2). Sensing refers to capturing environment events and recognising markers or other objects of interest. Tracking handles updating the viewing direction and position of the user relative to the real world. Tracking is an important component of AR as even a slight tracking error can cause misalignment between the virtual and real objects(Wang and Dunston, 2007). Registration refers to how the digital information is being delivered to the user. The registration can be achieved through different methods for different senses: videos, audio, haptic feedback, scent, etc.

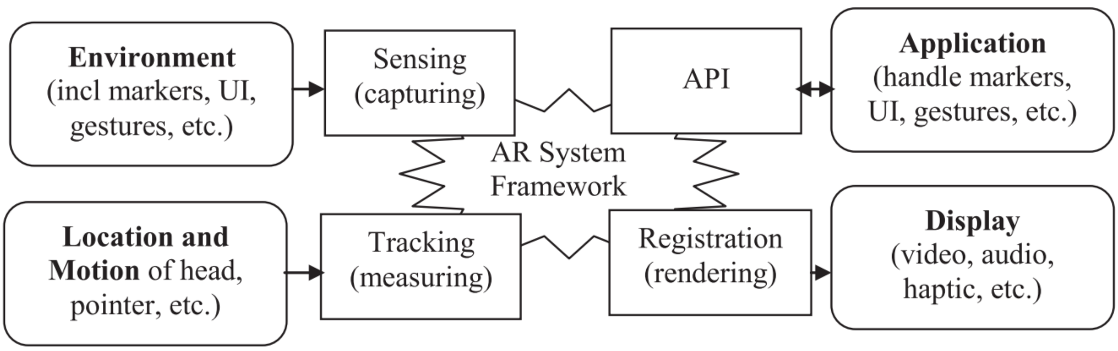

Figure 2. Augmented Reality framework(van Krevelen and Poelman, 2010)

As most developing technologies AR has many challenges that need to be overcome before it can be widely adopted. The challenges of AR arise from the framework requirements and they can be separated in five groups(Figure 3).

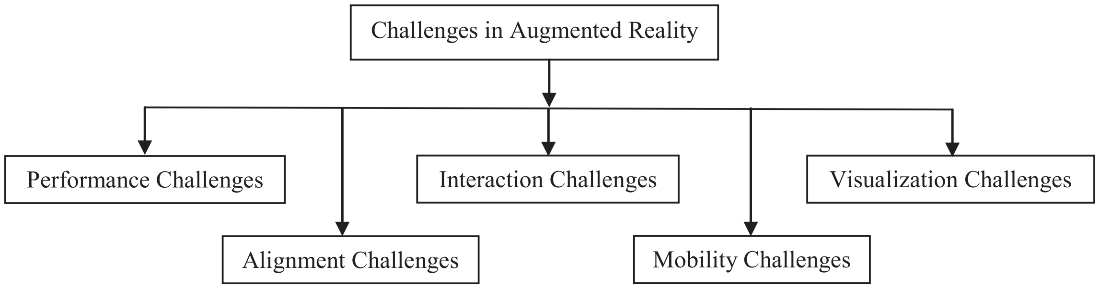

Figure 3. Augmented Reality challenges(Rabbi and Ullah, 2016)

Performance challenges arise from the need of real time processing. AR tasks such as marker detection and virtual object rendering are computationally intensive and this slows down performance. Alignment challenges come from the complexity of tracking the users movement and registration of real life objects. Any errors in those methods can cause misalignment between the rendered objects and real view.

Interaction challenges are concerned with the interaction between users and virtual or real objects. User interfaces need to be intuitive and unobstructive for the best experience. Mobility challenges refer to the need of portability for AR systems.

2.2 Virtual Reality

Virtual Reality in the broadest sense is the method or technology of substituting a physical environment with a virtually perceived environment. This is typically achieved by using an HMD with integrated motion tracking and a built-in or external rendering unit. The requirements of VR are same to those of AR with the exclusion of environment sensing(Figure 2). The virtual environment is entirely digitally constructed, thus eliminating the need for sensing as all environmental events are native to the system.

Interaction with the environment isn’t necessary for a VR experience, but it increases the possibilities and usability of a VR system. Different approaches to user interaction offer various degrees of immersion and limitations. Motion tracked controllers, hand motion tracking gloves, pointer centered to the viewport, headset location tracking in 3D space and sekeletal motion tracking are common approaches.

2.2.1 VR Challenges

VR challenges can be categorized in the same way as AR challenges(Figure 3). Performance is a very important factor in keeping the VR experience immersive for a prolonged period of time. High resolution picture rendering at a high freamerate in real-time is taxing even for the highest end of current GPUs. Lower framerate or lower resolution picture can cause dizziness, eye tiredeness and overall dissatisfaction. Alignment challenges arise from the difficulty of tracking in real-time. Users' view, location or controllers can become misaligned with the virtual environment, breaking the immersion and interactability. Interaction challenges come from the current hardware limitations on interacting. Tactile feedback, hand interaction and free movement in the 3D space are all possible individually, but combining them at the same time is not yet achievable.

Mobility challenges arise from the need of portability for VR platforms. Common solutions rely on tethering to a machine that handles the rendering and power supply. However portable VR backpacks and headsets are starting to emerge(*HP Z VR Backpack Overview*, n.d.). Visualization can be difficult due to the complexity of the physical world. Keeping proportions, lighting, textures, view depth, field of vision and other visiual perception aspects can be challenging.

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REFERENCES

Generating Bibliographies with biblatex and biber (n.d.).
URL: https://en.wikibooks.org/wiki/LaTeX/
Generating_Bibliographies_with_biblatex_and_biber

HP Z VR Backpack Overview (n.d.).
URL: http://www8.hp.com/us/en/campaigns/vrbackpack/overview.html

Johnson, L., Levine, A., Smith, R. and Stone, S. (2010). *The Horizon Report*, Educause Learning Initiative.

Kipper, G., Rampolla, J. and Kipper, G. (2013). *Augmented Reality*, Syngress.

Mullen, T. and Mullen, T. (2011). *Prototyping Augmented Reality*, Wiley.

Rabbi, I. and Ullah, S. (2016). A survey on augmented reality challenges and tracking, *Acta Graphica* **24**(1-2): 29–46.
URL: http://www.actagraphica.hr/index.php/actagraphica/article/view/44

van Krevelen, D. and Poelman, R. (2010). A survey of augmented reality technologies, applications and limitations, *The International Journal of Virtual Reality* pp. 1–6.

Wang, X. and Dunston, P. S. (2007). Design, strategies, and issues towards an augmented reality-based construction training platform, *ITcon Vol. 12* pp. 1–8.