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An Exploration into Multidimensional Human to Computer Interactions and Scientific Applications

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Abstract

The concept of AR & VR (augmented and virtual reality) is an emerging field of technology that is currently being explored, but it is a medium that is very much still in it's infancy in terms of software development. Products such as the Microsoft Holo-Lens, Oculus Rift, Samsung VR, and even the Google Glass have allowed for a brief glimpse into what the technology could potentially be. The applications of the technology are still very limited to trivial activities such as web browsing, watching videos, as well as light gaming. The boundaries could be pushed a lot further as technology in many S.T.E.M. industries are currently catching up to what is new and being used by general consumers. Through the use of motion sensor technology as well as projection mapping techniques the theory behind augmented reality can be applied to a branch of science to explore what could not be ordinarily explored through traditional means of interfacing with standard computational systems.

1. Introduction

Augmented and virtual reality technology is a field of study and experimentation that has existed for a little over 40 years since the first conception of the HMD (head mounted display) invented by computer scientist Ivan Sutherland in 1968 when experimenting with augmented reality. Since then technologies in augmented reality have plateaued as virtual reality gained momentum in development in hardware and software. This was because it was tremendously easier to enclose our senses in a synthetic computer generated system than it was to overlay digital data in the reality that we currently reside.

As technology flourished over the next several decades with the advent of more flexible HCI (human to computer interaction) technologies such as the touch screen, complex sensor systems, as well as facial and body recognition. This series of events has allowed for augmented reality to gain tremendous traction as we are seeing this concept become more common in museum exhibitions, concerts, and in HMD products.

Surely, the potential applications of AR/VR can be pushed a lot further. Neuroscientists at the Applied Technology for Neuro-Psychology Laboratory in Verbania, Italy experimented with using AR technology to further explore the human brain in three-dimensional space. Due to the complex nature of the neural-framework there was a greater demand for hardware and software upgrades in the field. "Given our increasingly comprehensive understanding of the dynamic complexity of the brain, we require increasingly sophisticated computer hardware and software to both contribute to and communicate our understanding of the brain" (Riva, 1998, p.1).

2. Exploration of Multidimensional Human-to-Computer Interactions (HCI)

The interface of a computational system is fundamental in the interaction process between humans and computers. It is becoming much more widespread as technology advances and surrounds almost every aspect of our lives. Humans and machines are becoming more interconnected through a digital frame-work known as the IoT (Internet of Things). The coexistence between humans and computers are also becoming much more apparent as we rely more on technology to accomplish our daily tasks from sending and retrieving emails to maintaining national electric power grids.

While these systems consist of numerous internal states and events, the only face the user sees is the interface: always a highly abstracted description of the underlying system. Every user interface is a façade, a fabricated story about the actual operation of the underlying machine (ti.arc.nasa.gov). All other elements of the software are hidden away behind the central interface and what is left is the mode in which we click through a screen. All other irrelevant information is disposed of as to allow for consistent fluid interaction.

Human-to-computer interaction has evolved over the past few decades and we are entering into an era of multidimensional interaction. With recent advances in AR this is a stepping stone into a brand new age of HCI methods. An AR system supplements the real world with virtual (computer-generated) objects that appear to coexist in the same space as the real world (Azuma, 2001, p.1). An augmented reality system is determined to maintain three essential properties. 1) That it combines real and virtual objects in a real time environment; 2) runs interactively, and in real time; and 3) registers (aligns) real and virtual objects with each-other (Azuma, 2001, p.1).

Since augmented reality and even virtual reality systems are at the moment underdeveloped; certain issues are noticeable in the software. Many are due to visualization and graphics issues, limitations in sensor detection hardware, and latency problems in data transfer especially through devices that rely on wireless or data servers, but these issues are constantly being troubleshooted and the technology is increasingly capturing the imaginations of the masses as AR and VR is seen much more in TV, films, and video games.

3. Particle Physics & Augmented Reality

Quantum physics, biochemistry, and microbiology are fields that study and examine subatomic and submicroscopic elements. A crutch is that these elements are still very much understood in a two dimensional framework. Just think back to high school chemistry when you are staring blankly at Bohr's model of the Nitrogen atom on a page trying to figure out what it is exactly that you are looking at.

After some time you can pick out the electron orbits, the numerous electrons labeled with a negative charge, and inside the nucleus a collection of protons and neutrons labeled with positive charges. If you are an avid daydreamer, maybe you could even imagine the electrons spinning in it's orbit, otherwise it would just be a flat pixelated greyscale diagram static on a page.

The diagrams of subatomic particles taught to students are seen as very flat and do not provide further insight into the 360 degree rotational view of the particle itself. Physical three dimensional models can be seen constructed of foam and wooden sticks at science fairs, but what if this information could be translated into the AR digital medium? Institutions such as CERN for example still operates with an interface that is very heavily grounded in mathematical and statistical forms of representing data and gathered information in 2D space.

What if this technology could be pushed further to enhance the workflow of scientists as well as supporting more medical and scientific minded students in a more educational setting? With the use of AR technology and allowing for gestural maneuverability as a method of interaction with a digital three dimensional model could provide a more tactile experience of the construction and deconstruction of an element. With atoms containing elements that can continually be broken down to the level of Quarks, Leptons, and Bosons; being able to interact with these elements can only create a more immersive, educational, and insightful experience.

Quantum and Particle Physics after all is a field of study that is looking into understanding realms of dimensions greater than the three planes we are currently perceiving at the moment; four if you include time. Even String theory a hypothetical framework of Quantum Physics that can only exist if there are ten dimensions according to the mathematical calculations that are made by theoretical physicist Brian Greene (Greene, 2008).

So how can we continue to understand a field of study that operates in more than 3 to 4 dimensions while only seeing and manipulating it in two dimensions of space? Being able to break free of this limitation will allow for us to potentially make greater discoveries. Through the use of experimental augmented reality technology this concept could potentially be turned into

an actual functioning system with practical applications.

4. Scientific & Educational Applications

A major progression in scientific thought has led to breakthroughs in mechanical engineering, medical leaps, as well as history altering scientific discoveries. As this information is further being explored and passed on to the newer generation of students and scientists so does the technology that translates this information.

As with the early example of the neuroscientists in Verbania, much of the neural connections when displayed through a virtual or augmented medium can shed some light on complex components of the brain as well as allowing for different modes of understanding, interacting, and viewing of the model. Just in a completely different angle or lens which in science can always be helpful in coming up with and developing revolutionary ideas.

In more professional applications augmented reality can be another medium to display complex data visualizations in a larger space beyond the screen of a monitor. The concept of augmented reality can be used for the purposes of engineering and scientific research especially when working remotely or telecommunicating with robotics systems. Mechanical Engineers at the Jet Propulsion Laboratory in Pasadena, California were able to remotely control a robotic arm with very minimal delay. "Ground control of space robots has potential operational benefits in future space missions…Possible future applications include ground-controlled remote maintenance/repair servicing of spacecrafts including Space Station Freedom…and ground-controlled remote assembly/construction work on the moon or Mars" (Kim, 1993).

Augmented and virtual reality is also a tool that can be helpful to students as an educational tool, whether it be through demonstration or personal exploration. AR and VR is pushed and consistently advertised to be a mode of transporting the senses to a completely different realm of understanding. An example of this would be a VR headset from ViewMaster who aims for their product to be used by children to explore the vast reaches of space, travel through France, or travel back to the land of the dinosaurs.

This technology could in turn further progress scientific exploration and better understanding of the fundamental building blocks of life and the origins of the universe. Curing diseases and discovering new elements in the process. Numerous other fields of studies can also benefit from this, such as geology, botany, and other planetary sciences when it comes to conducting planetary soil and mineral sample analysis as we progress into the age of space exploration.

The uses of AR technology are still being discovered and developed and within the next decade we might witness a multitude of uses for it as the software for it is becoming more open source and crowdsourcing is becoming more prominent and encouraged in this ever expanding field of experimental technology.

5. Conclusion

As technology and science advance we as humans who interact with such systems have to constantly progress along with them. What was once thought as revolutionary the keyboard and mouse is slowly being replaced by completely digital means of interfacing with machines. It is truly an exciting future for designers, engineers, and scientists alike as this technology is only the beginning of what could potentially be a new era of computers, machines, and even reality.

6. References

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