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Augmented Approaches to Engineering

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AUGMENTED APPROACHES TO ENGINEERING

Abstract

This paper presents the results of research into the integration and application of augmented reality (AR) and virtual reality (VR) systems into the fields of engineering and engineering education. The research discusses the current iterations of these systems, and the programs that are being developed to run on them. Also being discussed is the potential benefits that implementing these systems can give to engineering education by improving spatial skills for use in engineering education and engineering design. This paper also touches on the current state of the AR and VR markets, and their current focus on entertainment based consumer electronics. The data on spatial skills in engineering education was first reported by Jorge Martín-Gutiérrez's research on AR and its effects on spatial awareness in first year engineering students. This paper follows this research and that of others in this field to report on the future impacts that these technologies can have as well as the reasons behind implementing them.

Acronyms:

Computer Assisted Design (CAD)

Augmented Reality (AR)

field of View (FOV)

Virtual Reality (VR)

American Society of Mechanical Engineers (ASME)

Augmented Approaches to Engineering

Engineers are constantly working on and innovating new ways to improve our everyday lives. Computer Assisted Design (CAD) has become an integral part of an engineer's everyday life, defining the new standard for how drawings and designs are made. However, CAD itself has several binding limitations such as the platforms that it is currently able to run on and the complexity of the user interfaces, which impede CAD's abilities to be fully utilized by all users. Most industrial level CAD software must be used on high-end workstation-based computers that are expensive to manufacture, and are stationary to one desk or office. This research will explore the possibilities that integrating virtual reality based systems into the fields of engineering can bring, the limitations that are currently inhibiting the use of these technologies, and some steps towards resolving these drawbacks. This research also covers the basic workings of the various technologies that go into making AR, Virtual Reality (VR), and CAD possible.Overall, adapting these technologies into the field of engineering could help to improve the design process.

Aside from simply expanding the engineer's creative assets, Augmented Reality (AR) is also helping to train young engineering students, as was reported in Jorge Martín-Gutiérrez's study of freshman engineering students that underwent a remedial course utilizing AR as a learning asset. Through Gutiérrez's study, AR has even been found to improve the spatial skills that are paramount in working successfully as an engineer. Research was conducted by searching the Scopus, ASME, and Google Scholar databases for past research on this subject matter and other relevant information from the websites and biographies of some of the sources' authors. This research is limited only to the papers that are accessible with the clearances given by the Missouri University of Science and Technology's library database subscriptions. The press

releases of several key hardware and software developers such as AutoDesk, and Microsoft also supplied a lot of relevant information on this topic.

Software

Most fields that involve creating a physical product (e.g. engineering, architecture, etc.) used to require the designer start the concept with traditional drafting and design. But in the last handful of decades, technology has begun to replace the need to start drafts by hand with a pencil and paper. Now the standard for many design based industries is to apply CAD systems to create and improve upon their products. With modern computational power, a product or assembly can undergo low level testing before it is even fabricated. Unfortunately, due to the heavy system requirements that many CAD programs require, only expensive workstation-based desktops can run them. While there are laptops that can run some of these programs, they are typically large, expensive and have a short battery life. But the integration of CAD to AR and VR would allow for a practical and cost effective means to bring these programs into the field.

While there are many different engineering CAD programs available, from SOLIDWORKS to AutoDesk's Inventor, not many of these programs are natively supported on current VR or AR headsets. However, some companies, such as AutoDesk and Microsoft, are investing in the development of CAD based AR. The program that AutoDesk is developing for Microsoft's Hololens headset is called ENTiTi, and it hopes to combine many of the key aspects of desktop CAD and the portability of headset based augmented reality. This program allows the user to project a model or models from a series of file formats, and edit them in real time, seemingly in real space. Programs like this are the first real step towards integrating AR as a proper platform for engineering.

Hardware

For the hardware involved in AR and VR, most think simply of the headsets that have started to spring up in consumer electronics over the past few years; however, there is far more to this technology than just the headsets, as AR can also be a camera's feed being interpreted by a computer and outputting a virtually generated image on the screen that appears as though it is in the camera's line of sight. It was through this type of AR that the spanish researcher Jorge Martín-Gutiérrez conducted his research on the effects of AR in assisting engineering students with spatial reasoning. According to Martín-Gutiérrez:

> An engineer should be capable of creating a mental image of an object and see mentally the different perspectives of it for finding out the relations between this object and another one or any other person in space. These skills are very important in the whole process design since the starting phase until the final prototype so improvement of spatial abilities and their successful application is an important research theme on engineering education. (Gutiérrez et al., 2012, p.1).

This concept brings to light the importance that spatial skills can have on the AR and VR user experience. Gutierrez states how one of the key concepts to engineering is an engineer's spatial skills and spatial understanding. This is an idea that he focused his research on, working to show how the implementation of AR systems in engineering education can improve the results of spatial skills tests that students take. Spatial skills are known to be an important contributor to an engineer's success, and AR based systems have been shown to improve these. however, the results of this study could possibly be improved upon using AR that takes the more ubiquitous first person view method. The AR device can "give feedback to the user, [and] allows to close the interaction loop originated by the visual information captured and interpreted by the camera."

(Betancourt, A., 2015). This method allows for the user to interact more intuitively with the models being displayed through more relevant input styles versus the traditional mouse and keyboard approach.

Current VR and AR inputs differ from device to device, but there is an increasing trend to move towards a dual handed controller setup. This allows for a more natural interaction in a three dimensional work plane. However, some devices, such as Microsoft's Hololens, require only your hands to interact with the device, as it tracks your hands without any external sensors. This technology's potential to further engineering's design future grows with every year, and it is only a matter of time before its use is as ubiquitous as the modern computer is today.

Conclusion/Discussion

VR and AR have been in the spotlight as the most promising upcoming consumer electronic, with just about every tech giant placing their bids into one iteration or another. From Facebook's Oculus to HTC's Vive headsets, VR is spreading across the market like wildfire. However, each piece of hardware runs its own operating system, making it nearly impossible to move software from one device to another. Companies do this to maintain a competitive edge, but it is just an obstacle to the developers, whose programs could benefit from cross platform compatibility. cross platform compatibility is one of the obstacles that CAD developers such as AutoDesk need to overcome. because of this the most promising headset for implementation in engineering is Microsoft's Hololens.

The future of VR/AR is not simply bound to that of entertainment, as it can also be a tool of the modern designer. By using VR/AR, designing could be brought out to the field, allowing for more mobility and design accommodations on the fly. This technology still has a way to go before it is ready to be implemented in everyday engineering, and engineering education fields.

This as well as the improvements to input methods allowing for more people to be able to use and benefit from the use of CAD.

This research highlights the importance of integrating these technologies. However,most AR, VR and the software they will run are just starting to make their way into the world. Much research and development is still needed until AR and VR are up to the levels of practicality that modern computers and CAD based systems are. It is in engineering's best interest to integrate these systems into their careers, improving on a several decades old technology, bringing it into more modern times.

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