Low Cost Virtual Reality for Medical Training

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ABSTRACT

This demo depicts a low cost virtual reality set-up that may be used for medical training and instruction purposes. Using devices such as the Oculus Rift and Razer Hydra, an immersive experience, including hand interactivity can be given. Software running on a PC integrates these devices and presents an interactive and immersive training environment, where trainees are asked to perform a mixed bag of both, simple and complex tasks. These tasks range from identification of certain organs to performing of an actual incision. Trainees learn by doing, albeit in the virtual world. Components of the system are relatively affordable and simple to use, thereby making such a set-up incredibly easy to deploy.

Index Terms: H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems—Artificial, augmented, and virtual realities

1 INTRODUCTION

Virtual Reality is well poised to be the platform of choice for digital experiences in the near future. The utility of Virtual Reality in rehabilitation [1], treatment [2], medical training and education [3] has been thoroughly explored. However, most specialized virtual reality systems are prohibitively expensive for widespread adoption in schools and institutes of Higher Education. Although low-cost head mounted displays provide believable Virtual Reality experiences, the major limitation is specialized haptic feedback, accurate hand tracking and positional tracking. In this demo, we use the Oculus Rift head mounted display in conjunction with Razer Hydra hand controllers to create an immersive training environment for medical education.

Figure 1: The set-up used- Oculus Rift, Razer Hydra and a laptop

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For anatomy and biology students, there is a particular need to understand the human body and its parts both spatially and structurally. This set-up enables students and trainees to learn using their motor skills and hand movement in a virtual world where they're required to perform a set of operations. Such a training environment also acts a great supplementary learning tool to other conventional teaching media such as books and videos- which fail to provide an immersive learning experience.

To use the set-up, all that a trainee is required to do is wear the head mounted display and hold the hand controllers in his / her hand. All initial orientation and subsequent training instructions appear on the Oculus Rift display, and is therefore controlled directly by the trainee or user. Obviously, a mirror of what the trainee is seeing is also available on the laptop screen. This may be used by a trainer or supervisor to instruct or help the trainee, whenever needed.

The trainee is required to perform several tasks in the virtual world. These tasks come up as on-screen instructions. The idea is to mimic a practical training interaction, where a trainer may ask the trainee several pertinent questions. The trainee may be asked to perform tasks such as identification of where an incision needs to be made for a particular type or surgery or actually performing a particular incision. The training ends when the trainee or user has satisfactorily performed all the tasks required. A video demonstration of this is available at- https://www.youtube.com/watch?v=2DDEIlVOV0M

Figure 2: Trainee using the set-up

2 SYSTEM DESIGN AND FEATURES

The software was prepared using the Unity game engine. An appropriately detailed 3D model of the human body was used. To enforce strict constraints, surgery-based training was chosen, where precision is paramount. Two different types of interactions were designed- one, identification of a body part or where an incision needs to be made, and two, actually performing an incision. In Unity, small invisible cubes (for contact detection) and sets of such cubes arranged in the shape of incision were used (for patterned contact). Some accuracy was obviously lost because of this generalized representation of incision locations and patterns.

The viewpoint of trainees remains fixed. Users can only look around from that point. Although this is not an appropriate representation of how things should be in the real world, doing this becomes important if the head mounted display does not support positional tracking. Another probable cause of concern is the missing haptic feedback. While haptic feedback goes a long way in building motor skills for specific tasks, haptic feedback systems are extremely expensive and complicated to use. Hand tracking in this set-up does not include any form of haptic feedback. Therefore users, while attempting incisions often cut too deep or shy away from touching the skin at all. The way this issue has been addressed is by warning users whenever they're close to cutting too deep. This helps users understand when and where they went wrong.

The software also supports hiding and/or showing of certain parts of the human body during run-time. This becomes important for specific questions and tasks and happens automatically. The ability to do this also gives rise to a wider array of questions and tasks that a trainee may be asked to do.

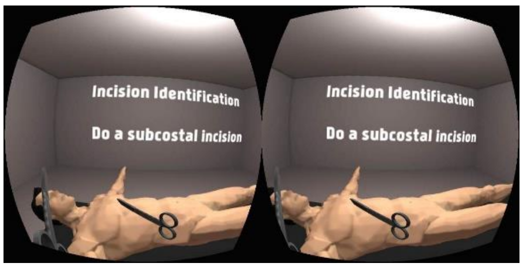

Figure 3: Trainee being instructed to perform an incision

3 Research Lab

This demo was created at the Immersive Visualization Lab in Jaipur Engineering College & Research Centre, Jaipur (now shifted to JECRC University, Jaipur). The Immersive Visualization Lab was established in September 2013, under the guidance of Professor Bharat Soni (currently Vice President of Research and Economic Development at Tennessee Tech University). The aim of the lab is to explore the domains of Virtual / Augmented Reality, 3D visualization and interactive input for advanced applications and research. Professor Aalok Pandya (JECRC University) is the co-ordinator of the lab.

Several undergraduate and graduate students and faculty participate in the lab's research activities. The lab houses equipment pertinent to the domains of Virtual Reality, Audio synthesis and engineering, electronics and 3D visualization. Most equipment is easily accessible and off-the-shelf. The conscious aim of lab members is to use easily available technology to build prototypes and functional projects that have distinct use cases, particularly in the fields of education, scientific visualization and interactive tours.

The lab does demonstrations of its work to visitors and interested students. Regular workshops are organized for undergraduate students interested in joining the lab. Subsequently, several students decide to take up independent projects using equipment and resources at the lab.

In the past year, Immersive Visualization Lab has taken up various innovative projects, some of which were funded by government agencies such as the Department of Science and Technology, Rajasthan. Several recent projects revolve around the use of smartphones and tablet computers for visualization. Another recent research describes a mathematical derivation for the reconstruction of a hologram using coupled projectors.

In the near future, among other things, the lab hopes to bring virtual reality training to engineering education, so that engineering instruction and quality of education may be improved.

4 Conclusion

The prototype clearly illustrates viability of a low-cost virtual reality training system. When used in the medical training context, it helps trainees and students understand human anatomy in complete three dimensions. Although presence of haptic feedback is missed, hand tracking alone adds a whole new level of three dimensional interactivity. This is supported by Oculus Rift's immersive visual fidelity and head tracking. Trainees feel immersed in the scenario and can undergo training independently or under the guidance of a trainer or supervisor.

Several different use cases and varied applications in high school education and other forms of practical training may emerge from this concept. The fact that the system is relatively low-cost and easy to use may also help in its wide adoption.

References

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