Evaluating Fidelity in a Surgery Simulation

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1 Abstract

Virtual Reality (VR) has been shown to be a useful training tool for teaching residents to perform surgery by using simulations. Many of these VR simulations have realistic display and interactive features, such as stereoscopic displays and haptic feedback. Although these help provide a more realistic experience for the user, or a high level of fidelity, it is not clear how these individual components of fidelity affect a resident's learning. Our objective was to understand how fidelity can affect a resident's ability to learn while performing complex tasks inside a VR simulation. VR allows us to achieve varying levels of fidelity, and we designed a study ...... (study information here) ...... The results of our study indicate.... (results information here)......

2 Introduction

Over the past decade and a half, VR simulation in surgical training has become more widespread. Many of these provide a high level of fidelity (the level which the computer world reproduces the real world). Display fidelity is affected by factors such as screen resolution, stereoscopic, field of view, etc. Interactive fidelity is affected by how natural the user can interact with the system, i.e. using natural hand movement, haptic feedback, etc. Despite the use of VR simulations with high levels of fidelity, it is not clear how different levels of display and interactive fidelity can affect the resident's ability to learn.

Other researchers have explored fidelity's role in medical simulations. Norman et al. conducted a meta-analysis [2] on studies that compared learning between high fidelity systems (HFS) and a low fidelity systems (LFS). They found that in most cases that there was no significant advantage to using the HFS. However, both aspects of fidelity, display and interaction, were grouped together into either HFS or LFS, and included other studies that were not VR related. This makes it difficult to understand what aspects of VR fidelity can affect a user's learning ability.

With this in mind, we conducted a study.....(study information here and contributions)........

3 Related Works

In the previously mentioned study [2], which compared HFS and LFS affect on learning, they also compared performance between residents that participate in simulations, and those that don't. They found that there is a significant correlation in better performance and participating in simulations, but these findings include non-VR simulations which means it can't apply to just VR.

Other researchers have explored changes to fidelity by examining changes to the different components. McMahan et al. explored performance in a video game [1] while changing display and interactive fidelity components separately. This was the inspiration for this paper, but where they are measuring performance during the use of their game, we measure what a user has learned after the simulation. In their study they find that both display and interaction fidelity significantly affects performance and strategy, as well as subjective components such as engagement and usability. They found that engagement and usability had a positive correlation with high degrees of both display and interaction fidelity. However, their low interactive fidelity differs from the one we used. Where they used a mouse and keyboard, we used ... (study details here, I don't think we will use a mouse and keyboard for interaction in our study. Instead we will use the razer hydra for our low fidelity interaction, and use another device for our high interaction fidelity that has haptic feedback.)....

In addition to examining the different components of fidelity, other researcher have examined performance by just changing display fidelity. Ragan et al. observed that increasing the display fidelity [3] has a positive correlation on performance. The task that the users performed in their study involved counting objects on screen. Their focus was on performance, and again we are interested in the amount a user can learn after completing the simulation. (Other comparisons here, we are going to probably follow their experiment for our display fidelity, as the displays in their study and ours are more closely related than the previous study)

4 Conclusion and Future Work

Although technological advancements in recent years have raised both display and interactive fidelity, we have demonstrated that ......(I don't know yet, haven't run study).....

This study shows that different levels of both display and interactive fidelity has (significant/ no-significant?) effect on the teaching ability of a VR simulation. When we consider the other literature, we see that we (confirm/don't confirm) Norman et al. findings on HFS and LFS teaching ability [2], and we show that (something about the other two studies, don't know until we run a study).

For future work we plan on expanding the surgical simulator for other scenarios, to see if we can duplicate our results. We would also like to compare our simulator to an application that has much lower fidelity than the ones described here. This would be maybe a 2D interactive program that runs through the same scenario as the one described in this study. We would then compare the individual components of fidelity to see if there is any objective or subjective difference. We will then use these future studies to show the impact both display and interactive fidelity have on learning, and produce guidelines to help people design medical simulations.

References

[1] Ryan P. McMahan, Doug A. Bowman, David J. Zielinski, and Rachael B. Brady. Evaluating display fidelity and interaction fidelity in a virtual reality game. *IEEE Transactions on Visualization and Computer Graphics*, 2012.

[2] Geoff Norman, Kelly Dore, and Lawrence Grierson. The minimal relationship between simulation and transfer of learning. *Medical Education*, 2012.

[3] Eric D. Ragan, Regis Kopper, Philip Schuchardt, and Doug A. Bowman. Studying the effects of stero, head tracking, and field of regard on a small-scale spatial judgment task. *IEEE Transactions on Visualization and Computer Graphics*, 2012.