Optical See-Through vs. Spatial Augmented Reality Simulators for Medical Applications

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ABSTRACT

Currently healthcare practitioners use standardized patients, physical mannequins, and virtual patients as surrogates for real patients to provide a safe learning environment for students. Each of these simulators has different limitation that could be mitigated with various degrees of fidelity to represent medical cues. As we are exploring different ways to simulate a human patient and their effects on learning, we would like to compare the dynamic visuals between spatial augmented reality and a optical see-through augmented reality where a patient is rendered using the HoloLens and how that affects depth perception, task completion, and social presence.

Index Terms: H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems—Artificial, Augmented, and Virtual Realities; I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Virtual reality; I.3.8 [Computer Graphics]: Applications—; I.68 [Simulation and Modeling]: Types of Simulation—Combined, Visual; J.3 [Computer Applications]: Life and Medical Sciences—Medical information systems

1 INTRODUCTION

Healthcare practitioners use physical mannequins, computer based virtual patients, and human actors (standardized patients) to simulate medical conditions for teaching and training in a safe environment. Each of these patient simulators has its own capabilites and limiations but so far none of those on its own can fully replace a real human. For medical applications it is important for the patient to physically occupy a shared space, to be touchable for diagnostic and therapeutic purposes, and to initiate and react back physically, verbally, and emotionally. The current gold standard in the medical field does not have these element combined. Augmented reality can help in filling this gap by using the existing space and augmenting dynamic imagery on top of it.

1.1 Proposed Research

We are exploring using both Spatial Augmented Reality (SAR) and optical see-through augmented reality to enhance learning for nursing and medical students, observe their behavior, and measure their social presence during the interaction with a physical-virtual patient. We are specifically focusing on the patient's face as touching the eyes or the mouth requires more precision than touching other parts of the body.

1.2 Related Work

Binber and Raskar present techniques involving both hardware and software to implement SAR installations [1]. Adcock, Feng and Thomas explored SAR systems to convey expert remote guidance in physical tasks [2]. Valkov et al analyzed the relation between the 3D positions of stereoscopically rendered objects and where users touch the surface [3].

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2 OWN RESEARCH

We developed a new type of interactive touch sensitive Physical-Virtual Head that reacts verbally and non-verbally to touch [4, 5] and we are working on extending it to a full patient body.

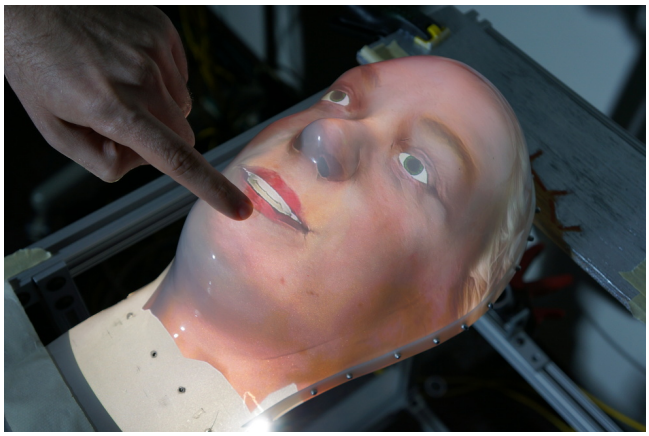

Figure 1: Related Work: Phyisical-Virtual Patient Head showing interaction to touch.

2.1 Physical-Virtual Patient Simulator

The Physical-Virtual Patient (PVP) occupies a physical space as a physical mannequin does and has the visual flexibility of a virtual patient, it can also react to touch and change the patient's temperature and pulse at differnt body loactions. The PVP is composed of a top semi-transparent shell that represents the physical patient. Under the shell one or more projectors project imagery on the non-parametric surface (i.e. the shell of the human head or body). Virtual cameras represent physical projectors and render the scene from the same position and angle as the real projector, then sends the imagery to the projectors. Infrared cameras and infrared lights track the fingers that touch the shell, interpret that touch, and send it to the simulation component to determine the appropriate behavior of the patient (View Diffused Illumination). The simulation component sends the appropriate graphics changes to the projectors.

2.2 Pilot Study

We ran a pilot with nursing students assessing a patient where we changed the way the graphics are displayed. Students from College of nursing interacted with a stroke patient. The patient was presented as spatial augmented reality using the PVP Head vs a Physical Mannequin with Virtual Patient rendered on a nearby screen. We are planning to run the study again with a larger number of participants to assess student learning compared to the current methods, and to measure their social presence with the patient.

Figure 2: Pilot Study: Physical-Virtual Patient in a clinic virtual environment.

3 Research Objective

Our research questions:

- How do the dynamic visuals compare between Spatial Augmented Reality (using the Physical-Virtual Head) and Optical See-Through Augmented Reality (using the Hololens)?

- How does that affects the users' task completion, perception of realism, and their social presence?

- What are the tradeoffs for using Spatial Augmented Reality vs Optical See-Through Augmented Reality for medical applications?

- How does using the Physical-Virtual Head, or the Hololens compare with the current simulators that medical and nursing students use.

4 Proposed Method

4.1 Proposed Experiment 1: Physical-Virtual Head vs HoloLens (tug the eyelids)

Students are asked to tug the lips and eyelids of the spatial Physical-Virtual Head and of the Visual head augmented over the same physical shell using the HoloLens. The user's finger is tracked during the movement to record the path and speed it takes to touch the surface. The user is then asked to rate the realism of the head.

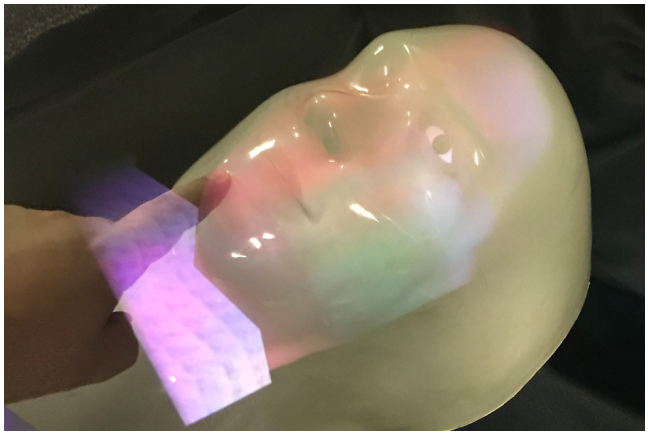

Figure 3: View from the HoloLens where imagery is augmented over a plastic shell of a head.

4.2 Proposed Experiment 2: Physical-Virtual Head vs Mannikin (Stroke Experiment)

We are planning to run a study in Spring 2017 with students from a local college of nursing where students are asked to assess a patient with neurologic symptoms. Students get to talk to the patient, and then touch the head as part of the exam. Half of the students are exposed to spatial augmented reality (PVHead) and the other half is exposed to the physical mannequin. The students are asked questionnaires to measure their social presence, realism, learning, self-efficacy, and simulation efficacy.

4.3 Proposed Experiment 3: Physical-Virtual Toddler Sepsis

We are developiong a full body version of a Physical-Virtual Toddler patient to be used in a scenario where the patient has post-surgical shock. The general idea is to manipulate the represenation of medical cues (mainly the dynamic visuals). We will use the results of Experiment 1 and Experiment 2 to better define the experiment with the full body toddler. Social Presence, realism, and learning are the main measures

5 Conclusion

In Summary, the Doctoral Consortium would help me to discuss my research goals and approaches by getting feedback regarding how to fine tune the experiments proposed, what to measure and how to measure it. specifically I would like to discuss measuring the difference in Spatial vs Visual Augmented Reality.

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