SafeHOME: Promoting Safe Transitions to the Home

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Abstract. This paper introduces the SafeHome Simulator system, a set of immersive Virtual Reality Training tools and display systems to train patients in safe discharge procedures in captured environments of their actual houses. The aim is to lower patient readmission by significantly improving discharge planning and training. The SafeHOME Simulator is a project currently under review.

Keywords. Simulation, Home Health Care, Discharge Planning, Virtual Reality

1. Introduction

Seventy percent of hospitalized patients are discharged directly to home, and twenty percent of those are readmitted within thirty days. Discharge plans that are comprehensive and support self-management can promote safe transition to home and reduce readmissions. Using Virtual Reality (VR) simulations built on the patients home will support healthcare providers and patients with discharge planning. Discharge care and transition service staff and their patients can jointly design tailored strategies for safe return home, thereby preventing many of the readmissions through better planning.

In the SafeHOME Simulator project we will use previously developed methods to capture a full 3D color replica of a patients home for display in VR [1]. We will apply this methodology to the challenge of preparing patients for the transition to home by creating a simulation platform that allows displaying the replica of the patient's home on a range of VR display devices – from a tablet computer to a fully immersive CAVE.

This work affords three innovations in healthcare simulation. First, it is patient-focused, designed to improve patient confidence and reduce post-hospital decline. Second, it is context-focused, using the home context as a planning platform for tailoring discharge instructions. Third, it provides visual cues and proprioceptive experiences evocative of the home experience in contrast to existing simulations that focus on single situations such as psychomotor skill development. Thus the fidelity of the experience and the likelihood that the patient will rehearse and remember strategies is increased.

The SafeHOME Simulator is a context-focused simulation platform designed to bring the home into the clinical environment. We expect the SafeHOME Simulator to enrich the process of discharge planning and better equip patients with the strategies needed for safe transfer to home and the ability to recognize and manage new hazards.

2. Background

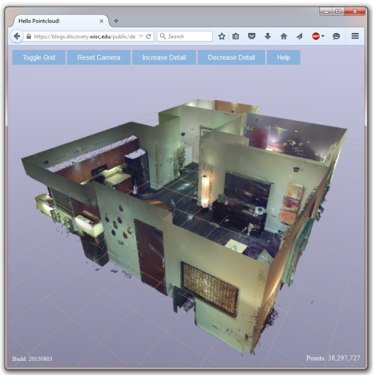
Growing evidence indicates that transitioning patients are often unprepared for the self-management role they must assume when they return home [4]. Co-occurring challenges include uncertainty about self management due to conflicting or unclear discharge instructions [3]. The patient's experience of returning home is complicated further by anxieties, confusion, and distorted sensations. Thus the SafeHOME Simulator targets the root causes of safety problems and other adverse events that lead to either post-discharge problems or readmission. Often, the patient safety problem is not so much affected by the fact that patients do not know what to do to avoid risk; it is that they do not see themselves at risk [4]. The SafeHOME Simulator will add visualization to patients perception of risk; we can thus increase their awareness of vulnerability by jointly identifying hazards in the home as well as mutually planning to build safety strategies into the care.

Ostwald et al. documented the adverse events experienced by half of patients with stroke, discharged to home [5]. Half of the Adverse Effects (AE) were likely amenable to lifestyle modification or self care. Clear discharge instructions that alert patients and family caregivers how to recognize AEs and how to prevent or manage them are warranted; however the retention of such verbal instructions, even under the best of conditions, is well-below 50%. Zeng et al. demonstrated that still-image presentation of patient education instructions improved comprehension by 10% among well participants [7]. They specifically included contextual information (time of day, renderings of common household items) but did not tailor the information to a specific person or place. The SafeHOME Simulator has four specific advantages: 1) attention to the contextual factors in addition to the behavioral and cognitive aspects of aftercare; 2) enriched visual and psychomotor engagement; 3) training in an environment familiar to the patient; 4) a training environment large enough engage the patient, discharge planner and other caregivers.

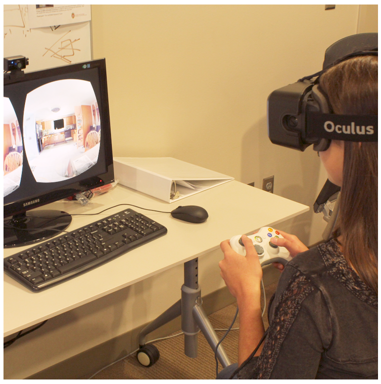
Of greatest interest to our work is the finding that knowledge and skills developed in a simulation environment transfer from the simulated environment to every-day worlds. Evidence demonstrates that behaviors learned in virtual environments, even those with very impoverished (i.e., not realistic looking) visual cues, transfer to the actual world. Chittaro et al. created a serious game mimicking the US Airways flight that safely landed in the Hudson River [2]. Participants randomized to first-person video game training experiences outperformed those who received standard verbal instructions accompanied by an information card. This project provides a model for process and outcome variables that we will use in this project: calibration for participant experience in VR, assessment of indicators of engagement and immersion, and knowledge of anticipated behaviors. Seymor's study with surgical residents [6] demonstrated that simulation exposure resulted in fewer mistakes (as rated by experts) and faster completion time compared to standard training. This work illustrates the need for expert appraisal of the transference of behavior. Hence, we will use an expert review of participant behavior in our project.

3. Research Methods

During this project we will employ the methods described in [1] to capture a patient's home environment at great detail. A 3D point cloud model is created after processing the captured data which can then be displayed on a number of different display systems.

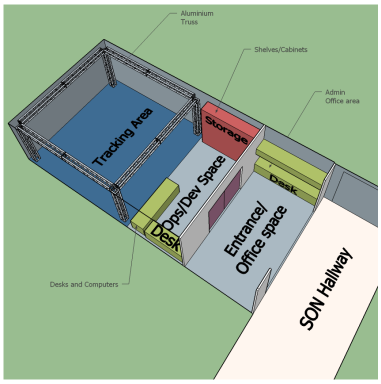


(a) Webviewer/tablet.



(b) Oculus Rift.

(c) CAVE.



(d) AVS.

Figure 1. A selection of VR displays used in the SafeHOME Simulator.

The SafeHOME Simulator will include four visualization platforms for the display of home interior: 1) a tablet computer; 2) a head-mounted display (HMD); 3) an immersive VR CAVE; and 4) an Advanced Visualization Space (AVS) (see Figure 1). We will implement a scalable infrastructure for this simulation that is platform independent. Figure 1b shows a user interacting with a home data set using the Oculus Rift, a consumer-grade HMD, while Figure 1d shows a sketch of the planned AVS.

The AVS is purpose-built for the SafeHOME Simulator. Multiple participants are tracked simultaneously using a motion capture system; HMDs allow multiple participants to visualize the same scene from various individual perspectives, and passive haptic feedback is possible. While the cost to install the AVS is be higher than that of a single monitor or HMD, it will, at the same time, be significantly lower than installing and operating a CAVE. The large, open space allows for complex discharge planning and is accessible for people with severe limitations (eg wheelchair bound patients).

A single visualization platform would not fit every patient situation. It is clear that different visualization platforms have different advantages, and the choice of the platform for a specific discharge planning event should be driven by the situation and the advantages afforded by the platform. The literature supports the need for clear, provocative visual cues, the opportunity to problem solve in a realistic manner, the ability to have cotraining involving the identified patient and the caregiver, and many other factors. Note that the goal is *not* to select one platform but to determine the features of each platform most closely aligned with factors determined to be relevant in the discharge process. The "best" SafeHOME Simulator platform in a given discharge planning instance is the one that meets critical needs and is implementable.

We will both use Unity and a custom created software to run the project. Unity is a game engine with cross-platform support which enables the deployment of the SafeHOME Simulator on all described display systems while also allowing fast content and scenario creation. It is thus very flexible and easily maintainable.

The overall project is currently under review for funding. Design and construction of the AVS, which will play a major role, has already started and will be operational within six months. Future uses of the AVS, in addition to this project, will include VR perception research, training of students, internal collaborations and public outreach events.

4. Discussion

Despite the excitement about VR-based simulation in healthcare many challenges remain. First, little is known about what aspects of the simulation contribute to learning and transfer of learning. The primary reason why existing VR scenarios do not scale to the clinical needs of a broad range of patients awaiting discharge is that they are very specific to a given task in a given environment. In traditional, task-based simulation all participants receive the same visual cues; nuances and context are lost. The range of risks for readmission is substantial; it is impossible to build a simulation to specifically address each one. We believe our context-focused simulation approach, in which the simulated environment is the re-creation of the actual home, will allow the maximum tailoring to the individual patient.

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