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Usability Issues of Virtual Reality Learning Simulator in Healthcare and Cybersecurity

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Abstract

The virtualization and the digital environments are common learning platforms in several different domains, such as in flying airplanes or controlling nuclear power plants. However, virtual reality is no longer expensive special hardware; the basic installations for virtual and augmented reality can be done within household budgets and with common customer products. In this paper, we study the aspect of usability issues in a scenario, where a new virtual learning environment is built to teach correct prevention mechanics and strategies against common physical and cybersecurity threats in healthcare, namely in a hospital. Our proof-of-concept studies indicate that the concept is functional and that on hardware level components exist. The problems are in the usability and user immersion aspects, which are discussed in this paper and further studied in the proposed research setting.

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Keywords: Virtual reality; usability; user experience; case study; cybersecurity

1. Introduction

The advent of virtualization of hardware systems, and virtual environments mimicking different types of scenarios and real-life concepts, has unlocked a large potential for simulating different types of scenarios for learning. For example, a proficient virtual environment can simulate the hardware of different types of networks

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with different cyber security threats, or offer a simulation of an entire building such as hospital or ship (for example [1]), where different scenarios can be emulated safely and cheaply. Since many of these simulators can be built very cost-efficiently, and do not necessary require massive investments in special hardware, it has been established that these sort of systems are efficient learning tools, and are applied for example by armed forces [2], energy industry [3] or software developers [4] for different sorts of purposes.

In this paper, the objective is to discuss the research approach for the user experience and the usability aspects of a mixed-method virtual reality environment applied in the cybersecurity domain. The objective of this paper is to assess these issues and prior practical applications, restrictions and solutions, which affect the immersion/efficiency-ratio between the virtual environment and the actual real-life tools. This paper presents a number of proof-of-concept studies which establish the baseline for further research in the development of the proposed healthcare and cybersecurity learning simulator. Based on these proof-of-concept studies and their results, we also introduce our intended research framework for testing the usability of a VR/AR-system. The research questions for our work in the development of the learning environment are the following:

"What aspects of usability are most important in the mixed-method learning environment combining virtual reality and real applications?"

"Which user interface solution provides the best combination of immersion and usability?"

These research questions are approached with a brief study into the prior research in the area, definition of a set of usability test scenarios, and research setting, in these scenarios can be tested in the laboratory environment with end-user target infrastructure and analyzed and assessed for further development.

Rest of the work is structured as follows: The Chapter 2 discusses the prior works related to our study, while Chapter 3 discusses our research method and the test setup. Results are introduced in the Chapter 4, and their implications are discussed in the Chapter 5. The conclusions and summary are presented in the Chapter 6.

2. Related research

The assessment of the ubiquitous applications such as virtual environment, and the usability aspects related to VR, have been discussed by Scholtz and Consolvo [5]. Their study defines a framework for ubiquitous software and their usability attributes in different scenarios. For example, "walk up and use"-systems should have high interaction and conceptual model score in usability, while ambient systems should have high score for invisibility and uninterrupted usage. The paper also identifies several problems, which are related to the ubiquitous systems; the users focus on the systems and the device interface, not on the activities and the users were distracted by the lack of options. In addition, the users preferred embedded user interfaces over portable user interface solution in usability, but the portable was considered to be more impactful and have more utility.

The usability aspects of virtual environment include different user interface control schemes and tools from brain-computer-interface (BCI) (for example [6]) where the input is read directly from the users cortex lobe to simple hand-held devices, which enable user to touch and manipulate virtual objects (for example [7]). The Sherman book also defines several types of virtual realities, from virtual environments, to augmented reality, telepresence, teleoperation and others. In other studies regarding usability and VR, for example Poupyrev et al. [8] already discuss that the intuitive VR solutions should model the user hand as the pointing and manipulation tool, with some extended features such as extended grip and distance. In medical training, McGrath et al. [9] argue that there are benefits on virtual environments, which increase significantly when transitioning from screen-projected simulations to the actually immersive VR environments. Overall, the studies of virtual reality user aspects are not very novel, even if the technological advantages have made high-fidelity virtual reality accessible technology.

Like every other software service or product, the aspect of usability hygiene factors [10], intuitivity, immersivity and usability are important for the efficiency of any learning system [11, 12]. For example, Sutcliffe and Kaur [13] list that disorientation or inability to properly manipulate objects may affect VR user experience to a large degree, so that even certain HCI methods for assessing usability may not work properly in the definition of the actual usability problems. However, in more recent study, Meldrum et al. establish that functioning VR training and exercises might even be preferred by the users over the traditional exercise regime. However, they also observe that the VR system they analyzed had a negative correlation with the age of the users [14]. Finally, a study by McMahan et al. [15] studied the technical infrastructure and their limitation to the VR learning environments; the study indicates that