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A Preliminary Study of Presence in Virtual Reality Training Simulation for Medical Emergencies

Raquel VICIANA-ABAD, Arcadio REYES-LECUONA,
Carmen GARCÍA-BERDONÉS, Antonio DÍAZ-ESTRELLA.
Departamento de Tecnología Electrónica, University of Málaga, Spain.

Abstract. In this paper, a preliminary study of presence in a training simulation for medical emergency based on virtual reality is presented. We explore the influence of interaction mechanisms, as well as the complexity of behaviours in the subjective sense of presence. As expected, it has been found that as the type of interaction is more natural, and the patient behaviour modelling is more complex, the achieved sense of presence is greater. However our results also show that the degree of presence depends more upon the complexity of patient modelling than on how natural the interaction is. Hence, we postulate that a proper patient modelling could elicit a high degree of presence, even with traditional interaction mechanisms.

1. Introduction

Although some Medical Emergency Training Simulators (METS) based on Virtual Reality (VR), can be found in literature [1][2], human performance related issues, such as the sense of presence, have not been studied enough. It is widely considered that presence is a key element in order to elicit the typical stress of emergency situations. In this context, we agree with some studies that consider the complex behaviour of the world as a key element in increasing the sense of presence [3][4], even more than using sophisticated VR peripherals.

In order to analyse the influence of all these factors in the elicited degree of presence, we have carried out a set of experiments, showed in this study. In the following sections, the methodology, results and conclusions for those experiments are presented.

2. Methodology

2.1 Tools.

The experiments have been performed with UVIMO, a configurable METS developed for this research. UVIMO provides a virtual environment (VE) of a stressful emergency situation with realistic scenes and multimodal interaction. Sense8 WorldToolKit has been used as the simulation and graphics engine. A Virtual Research V8 Head Mounting Display (HMD) for stereoscopic visualization, a Virtual Technologies Cyberglove and position sensors (Ascension Tech. Flock of Birds) for sensing the user hand and head are also used. In Figure 1 a typical scene of UVIMO is shown, with a patient, a medical instrument and the image of Cyberglove than can be used for managing the interface.

UVIMO can be configured as a 2D VE without movement tracking or 3D VE with movement tracking allowing visual navigation. In addition, the patient can be modelled in two ways, firstly by a complex engine, based on an expert system which emulates the

Figure 1. Scene from UVIMO.

patient's behaviour in continuos time with a specific medical problem, or with a basic behavioural engine based on discrete stages.

2.2 Experiments

The experiments were done with two specialists in anaesthesiology who were subjected to different experiences with a virtual patient. The modelled patient was presenting an acute myocardial infarction, with a clinical history of ischemic cardiac myopathy and diabetes. The subjects were asked to treat him within UVIMO using several configurations.

Because of the complexity of the actions implied in UVIMO, it was found that the latency and spatial accuracy of these systems leads to a feeling of inability to interact in real time and a loss of presence in the VE. For this reason, the interaction was finally managed by an assistant, who played the role of a nurse, receiving orders from the subject.

Hence, in order to define these experiments, we considered two independent variables: the mechanisms for visual interaction within the VE, and the behaviour complexity of the patient modelling, according to Table 1, in which the design of four experiments is shown.

The four experiments were conducted twice by each subject. The degree of presence was measured using a presence questionnaire proposed by Slater et al. [5], extended by Nunez [6], which was filled out after each exposure. This questionnaire has six questions, each rated on a scale of 1 to 7. The index of presence was defined as the total number of high scores (6 or 7) for all the questions and all the subjects. In addition, postural movements and the attitude, showed by the subjects during the experience were noted.

3. Results

The results obtained from the four experiments described above are shown in Table 2. As expected, a more realistic VE, with the best patient modelling and visual interaction, elicits a higher degree of presence. But, it can also be seen that the improvement achieved by a more complex modelling is higher than that related to a more natural interaction.

Table 1. Description of the experiment conditions

		Visual interaction naturalness	
		Low	High
Patient modelling complexity	Low	▪ Non immersive 2D screen. ▪ Simple patient modelling based on a discrete stage algorithm	▪ 3D immersive HMD. ▪ Simple patient modelling based on a discrete stage algorithm
	High	▪ Non immersive 2D screen ▪ Complex patient modelling based on an expert system with continuous time.	▪ 3D immersive HMD. ▪ Complex patient modelling based on an expert system with continuous time.

Table 2. Results of presence questionnaire

Complexity of patient modelling	Low	Low	High	High
Naturalness of visual interaction	Low	High	low	High
Index of presence	**1**	**8**	**12**	**19**

Regarding the subjects' behaviour during the experience, we report that they tend to move their arms in an agitated way during critical situations. They also became more authoritarian towards the assistant during such moments.

4. Conclusion

In this preliminary study, the hypothesis that factors related to content and complex behaviour are more important than other ones related to visual realness and natural interaction has been verified when using a METS.

It has been found that complex patient modelling, as well as more natural visual interaction, enhance the sense of presence. However, the former has been shown to be more important than the latter. That is to say, it is more important to properly model patient behaviour than to provide complex specialised VR peripherals. We propose that in this kind of training simulator, the significant information for the subject is the most important element to be taken into account in order to achieve more presence in a METS.

Furthermore, although sophisticated VR devices provide a more natural means of interaction, slight mismatches between sensed information and the consequent reaction in the virtual world result in the illusion of presence breaking down, as happened with the Cyberglove. Hence, special care must be taken when using specialised VR peripherals.

Finally, the behaviour shown in these experiments by the subjects being tested may be brought about by the presence itself. So, it would be very interesting to record it in a more systematic way, in order to use it as a further measure of presence.

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