DEMO: Using gameplay data to classify cybersickness level in virtual environments

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***Abstract*—Virtual Reality is an upcoming trend in games and entertainment applications as the use of head-mounted displays becomes accessible for the mass market. These systems aim to provide immersive experiences, but they still do not offer a completely seamless experience, mostly due to sickness symptoms that can be experienced by the players. Cybersickness is one of the most critical problems that make the game industry fearful of higher investments. In this demo we developed a plugin for a commercial game engine to collect relevant data in a virtual reality game to use as a database to future research approaches to enhance user experience in head-mounted displays.**

***Index Terms*—head mounted displays,sickness theories,motion sickness,virtual environments,user experience, cybersickness**

I. Introduction

We are experiencing the inclusion of a new entertainment way in most of the systems. Virtual reality is an important area to deliver immersive 3D graphics in entertainment applications, serious games, and applications to training people (in health, technological, military or scientific domains).

In the meantime, most of head-mounted Displays users feel one or more symptoms of sickness, primarily if the user uses them for an extended time [8]. According to Ramsey et al. [12], on average, eighty percent of participants who experienced virtual reality with HMDs felt discomfort after the first 10 minutes of exposure to the virtual environment. Therefore, more extensive virtual reality experiences tend to cause more considerable discomfort than shorter experiences. However, this discomfort may vary from individual to individual, as some people are more sensitive than others when using these devices.

In the bibliography there are some theories [7], [9] about ways and causes of visual discomfort in virtual reality that points to sensory confusion between the vestibular and vision systems as the responsible for most frequent problems that cause discomfort to HMD users. Jerald et al. [5] associate the sensory conflict to high latency resulting in an incorrect content presentation related to the movement made with the HMD device and possibly generated sickness.

II. Objective

In this demo we intend to develop a pipeline, including a game, plugins and methodology for building a dataset for cybersickness identification.

III. Materials and Methods

We developed a driving simulator prototype using Unity3D with a virtual reality environment controlled by a joystick. The virtual reality device used was the HMD Oculus Rift CV1. The game prototype collects data every second that we consider essential for future analysis. This data is collected at two-game moments: before and during gameplay (Fig. 1). The system collects in the first phase the gameplay user profile data, such as genre, age, virtual reality experience level, current user discomfort, flicker sensitivity level, the dominant eye of the user, user posture (standing or sitting). During the gameplay data is collected every 1 second. We divided into two parts the data collected during gameplay: manually imputed data and automatically captured data, where:

- Manual Data: game type, static frame existence (container), the presence of a haptic response, degree of control, depth of field simulation, level of mobility and if the game has an automatic camera rotation.
- Automatic Data: level of discomfort captured from user voice, field of view size (Fov), acceleration vector, angular acceleration vector, acceleration magnitude value, speed vector, speed magnitude value, angular velocity vector, angular speed value, player speed in Kph (kilometers per hour), game frame rate, user region of interest, player movement discrepancy and HMD position and rotation data.

The gameplay experience automatic ends after 3 minutes, and the user will able to see their preliminary discomfort result (Fig. 2). To calculate this preliminary result, we use considered:

- Gender - women, and men see in different ways [1]. According to Biocca et al. [2] women are more likely to experience cybersickness compared to men.
- Experience in VR - According to Reason [13] sickness susceptibility is a product of the individual's overall experience with motion sickness.
- Flicker - it is a phenomenon of visual physiological discomfort, causes physical and psychic fatigue in lighting users connected in the vicinity of the disturbing load [15]

Fig. 1. Prototype's gameplay with container activated.

Fig. 2. User's discomfort result.

A. Tests pipeline

We designed a test pipeline to store all information from user experience before and during the gameplay. There are two stages in our test: the first all user profile data are collected. Then, we collect every second the gameplay data before defined and the individual is free to leave the experience any time.

During the gameplay, the application reacts to voice commands from individuals. Before the game starts, the user is advised to report their discomfort by speaking numbers from 0 to 3 as Kennedy's simulator sickness questionnaire scale [6], where 0 is related to none, 1 to slight, 2 to moderate and 3 to severe discomfort. However, differently, in earlier works [4], [11] the SSQ evaluation assessment it was done before and after exposure to the virtual environment. In our tests the assessment is done at the exact moment of the experiment.

In order to do a complete test case and create a robust gameplay database we believe is important to make some variations of the same pipeline, as follow:

- sitting and standing gameplay [14].
- with and without a static frame [3].
- with Oculus Rift CV1 and HTC Vive HMDs [10].
- different virtual scenarios.

We tested our prototype in a pilot study with six sited users(five males and one female), with static frame enabled (container), using Oculus Rift CV1, with ages between 18 and 35 years.

IV. Conclusion

In this work, we study some strategies that can minimize the causes of discomfort in virtual environments. Through the current bibliography, we have gathered the main ways of measuring discomfort in virtual reality environments. As result,we develop a plugin for a commercial game engine that works with most of virtual reality games and collect relevant data during the gameplay experience. With this data, it is possible to create a robust database for cybersickness identification.

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