A Quality of Experience Evaluation of an Immersive Virtual Reality Application Developed to Assess Spatial Auditory Ability

Adrielle Nazar Moraes
Dr. Niall Murray, Dr. Ronan Flynn, Dr. Abhishek Bhattacharya
Department of Electronics & Informatics, Athlone Institute of Technology

INTRODUCTION

In recent years, virtual reality (VR) technology has proven to be a powerful tool to create immersive environments with high quality visual and auditory experiences. Moreover, it can be used as an effective application to perform and design sound localization tasks [1]. Hence, it is possible to apply 3D audio technologies within many contexts in order to evaluate and measure sound localization abilities. Within this context, many companies seek new methodologies to increase the quality of spatial, specially the gaming industry [2]. Furthermore, given the fact that humans are able to learn how to accurately and precisely perform sound localization with given sound cues [3], the advance of most existing methodologies can optimize the current diagnosis and intervention techniques for people with hearing processing disorders like Central Auditory Processing Disorder (CAPD). People who suffer with this condition, even without hearing issues, are incapable to process sounds properly, which may be stressful and frustrating to accomplish tasks with complex sounds [4]. Consequently, the assessment of the Quality of Experience (QoE) of spatial sound localization applications is an important topic regarding the crucial role that this skill plays during the performance of basic tasks such as driving, listening to music, or keeping a conversation in a noisy environment. The development of a new application within the QoE perspective can contribute regarding the relationship between QoE factors in respect with the classic methodologies, user interaction with the system, and context influencing factors.

AIMS AND OBJECTIVES

This project aims to develop a QoE evaluation to quantify and optimize the existing evaluation methods of assessment of spatial auditory ability.

The main objective of this project is to develop an application in a VR environment to test and evaluate spatial auditory ability within the QoE domain. The application will be used to optimize and improve the existing methods for the assessment of 3D audio localization skills.

This work proposes to assess the sound localization ability regarding the four main properties of 3D audio: azimuth angle, elevation, distance depth, and width. This will be accomplished by performing tests applying psychophysiological assessment methodologies and questionnaires to quantify different parameters related to the QoE of the user. Moreover, this work will provide an indicator based on how the task is being performed by the user to evaluate the QoE.

EXPERIMENTAL METHODOLOGY

The virtual environment presented on the Figure 1 was built using the Unreal 4 engine. Each sphere represents one of 24 regions that a sound source can spawn. As visual feedback was implemented to orientation purposes, the north is represented with a different colour than the other spheres.

The stimuli consists in a white pulse Gaussian Noise of 200ms duration. The sound cues were positioned randomly. Nevertheless, to avoid issues caused by caused by front/back confusion, the user is allowed to move his head in the direction of the perceived sound source. In order to play accurately the stimuli, it has to be reproduced with a pair of properly equalized stereophonic headphones.

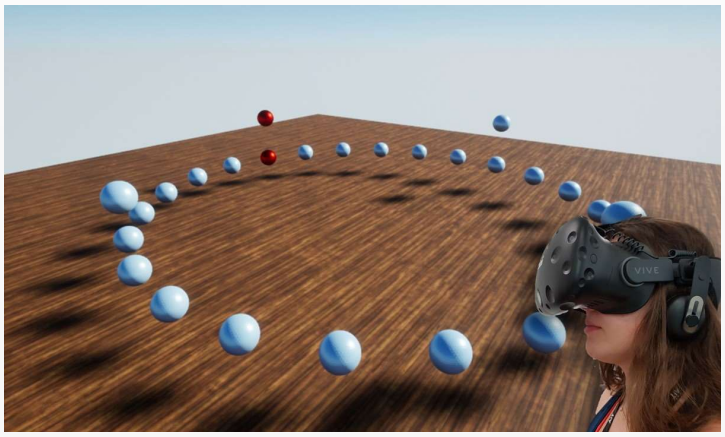

Figure 1: Virtual Environment Developed for the sound source localization task.

The main task is to localize and select which region (sphere) the sound is coming from with the pointer as fast and accurate as possible. Head position and reaction time are measured whilst the user is performing the task. At the end of the test, participants are asked to fulfil a questionnaire.

Important data can be gathered through reaction time, head movement, gaze, or cognitive load measurement analysis [2]. All data will be analysed to obtain information about the current psychic state of the user, his level of stress, and mental effort to perform the task.

CONCLUSION

The use of 3D audio in a VR application produces a realistic and more immersive representation of the surrounding by enhancing the level of realism and awareness. Furthermore, the use of combined visual and auditory cues can improve the ability to localize a sound source.

From the QoE perspective, this application can provide more detailed information regarding the sound localization task, and its contributions can be applied within the health context, adding relevant data to the existent assessment and intervention methodologies for auditory disorders.

ACKNOWLEDGEMENTS

This research is supported by the Science Foundation Ireland and ADAPT Centre. It is co-funded under the European Regional Development Fund under Grant Number 13/RC/2106.

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