The Use of Portable EEG Devices in Development of Immersive Virtual Reality Environments for Converting Emotional States into Specific Commands †

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† Presented at the 3rd XoveTIC Congress, A Coruña, Spain, 8–9 October 2020.
Published: 25 August 2020

Abstract: The application of electroencephalography electrodes in Virtual Reality (VR) glasses allows users to relate cognitive, emotional, and social functions with the exposure to certain stimuli. The development of non-invasive portable devices, coupled with VR, allows for the collection of electroencephalographic data. One of the devices that embraced this new trend is Looxid Link™, a system that adds electroencephalography to HTC VIVE™, VIVE Pro™, VIVE Pro Eye™, or Oculus Rift S™ glasses to create interactive environments using brain signals. This work analyzes the possibility of using the Looxid Link™ device to perceive, evaluate and monitor the emotions of users exposed to VR.

Keywords: mental health and wellness; emotions; empathy; immersive environments; virtual reality; electroencephalography; neurogaming; neurofeedback

1. Introduction

In the last few years, virtual reality (VR) has become more popular [1]. VR is a technology that allows users to generate, through a computer, three-dimensional (3D) virtual worlds identical to the real world. It can create immersive experiences, in real time, and it is possible for the user to interact with the environment as if it is the real world [2–4]. Since the 1970s, VR has been used in several applications, such as in industry, education, medicine, and scientific research. Since then VR has been used in developed tests, training and treatment approaches [5,6].

Technological development has allowed VR devices, in addition to having better image and sound quality, to have reduced size and weight. These characteristics allow for its use to provide greater mobility on the part of the user, adding the movement of the human body to the exploration of the surrounding space [5,6].

The technological evolution of VR equipment and the creation of immersive environments that simulate real environments and situations, open doors to its applications in more complex areas, such as neurogaming and neurofeedback therapies. Brain activity studies obtained by the application of electroencephalography (EEG) electrodes have allowed users to relate cognitive, emotional, and social functions with the exposure to certain stimuli. The portability and mobility that current VR devices allow are incompatible with traditional EEG equipment, require user immobilization and a panoply of wires and equipment that limit their use and interfere with the user experience [7–9].
In order to make the collection of EEG data less invasive, and to ensure that this collection is made without the user being aware, portable devices have been developed, which can be attached to Virtual Reality glasses [7,8]. One of the devices that embraced this new trend is the Lookxid Link™, which, in addition to having all the features offered by a regular VR headset, also has an EEG attached. This device detects EEG signals and uses an API that converts electroencephalographic patterns into commands that can be applied to the VR environment [10]. The EEG in the VR headset can bring several advantages, such as following the cognitive state of the user and measuring the user’s brain activity [7,8].

Lookxid Link™ is a system that adds EEG channels to HTC VIVE, VIVE Pro or Oculus Rift S, to create interactive environments using brain signals. In this equipment, the sensors that are used are AF3, AF4, AF7, AF8, Fp1 and Fp2 of the International System 10-10, located in the Pre-Frontal Cortex [10].

The Pre-Frontal Cortex (PFC) is the anterior area of the frontal cerebral lobe that is divided into the primary motor cortex and the pre-motor cortex that are located posterior to the PFC [11]. The PFC is responsible for executive functions (planning, decision making, inhibitory control/weighting, attention and working memory—ability to retain information for the execution of an action), social behavior, emotions, affection for others and intelligence, as well as other cognitive controls [11–13].

Emotions appear as a response to the perception of an object or situation, and human beings communicate more easily through emotional expressions [14,15]. Emotions have been studied to understand the interpretation and processing of emotions at the cortical level. To recognize emotions through EEG signals, it is necessary to pay attention to several aspects, such as the characteristics of the time domain, the frequency domain and the time frequency of the EEG signals, in order to have a correlation of information between the different channels of EEG [14]. Negative emotions are believed to be closely related to the right hemisphere, while positive emotions are processed by the left hemisphere [16,17].

2. Objectives

This work analyzes the possibility of using the Lookxid Link™ device to perceive, evaluate and monitor the emotions of users exposed to immersive environments in VR, converting the signals captured by the different EEG channels into commands that influence the stimuli generated by the system, according to the emotional state of the user.

3. Methods

This article is a bibliographic review regarding the use of portable EEG devices in the development of immersive virtual reality environments for converting emotional states into specific commands. The information was collected using research platforms, namely PubMed—NCBI, the EBSCO Information Services, B-on and Google Academic.

For this research, the terms used were virtual reality, electroencephalography, Lookxid Link™, neurofeedback, emotions and neurogaming.

However, no articles were found in which Lookxid Link™ was used as an object of investigation.

4. Discussion and Conclusions

Lookxid Link™, despite having only the prefrontal electrodes, as does the EEG coupling in the VR headset, the mobility and artifact problems no longer exist, these being the great advantages of using this equipment instead of two separate units [10].

With the use of Lookxid Link™, it is possible to monitor and control the electroencephalographic signals and consequently the emotions that the user may be feeling [10]. The individual’s relaxation provides an increase in the theta rhythm in all EEG channels, while if the user is attentive it will lead to an increase in beta in all channels [18]. If the user is afraid, there will be an increase in beta waves on the left side [19].
Author Contributions: Conceptualization, C.S. and P.V.G.; methodology, C.S., P.V.G. and A.M.; validation, P.V.G., A.M. and A.C.; investigation, C.S.; writing—original draft preparation, C.S.; writing—review and editing, C.S. and P.V.G.; visualization, C.S., P.V.G and A.C.; supervision, P.V.G. and A.M.; project administration, C.S.

Funding: This research received no external funding.

Acknowledgments: This research was carried out and used the equipment of the Psychosocial Rehabilitation Laboratory (LabRp) of the Research Center in Rehabilitation of the School of Allied Health Technologies, Polytechnic Institute of Porto.

Conflicts of Interest: The authors declare no conflict of interest.

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