WizardOfVR: An Emotion-Adaptive Virtual Wizard Experience

Kunal Gupta
kgup421@aucklanduni.ac.nz
University of Auckland
Auckland, Auckland, New Zealand

Yuewei Zhang
University of Auckland
Auckland, New Zealand

Yun Suen Pai
Keio University Graduate School of Media Design
Yokohama, Japan

Mark Billinghurst
University of Auckland
Auckland, New Zealand

Figure 1: WizardOfVR: A personalized emotion-adaptive VR Wizard experience. Left: "Player View" searching for the Bitter root plant; Right: "Spectator View" showing live gameplay along with the SanityMeter displaying real-time emotional states

ABSTRACT

We demonstrate WizardOfVR, a personalized emotion-adaptive Virtual Reality (VR) game akin to a Harry Potter experience, which uses using off-the-shelf physiological sensors to create a real-time biofeedback loop between a user's emotional state and an adaptive VR environment (VRE). In our demo, the user initially trains the system during a calibration process using Electroencephalogram (EEG), Electrodermal Activity (EDA), and Heart Rate Variability (HRV) physiological signals. After calibration, the user will explore a virtual forest with adapting environmental factors based on a 'SanityMeter' determined by the user's real-time emotional state. The overall goal is to provide more balanced, immersive, and optimal emotional virtual experiences.

CCS CONCEPTS

• **Human-centered computing** → *Virtual reality*.

KEYWORDS

Emotion Adaptive, Virtual Reality, Physiological Information, EEG, HRV

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1 INTRODUCTION

Previous neuroscience and psychology research on human behavior indicates that the experience, actions, and expressions of emotional states influence the human cognitive processes [Ekman and Davidson 1994; Fredrickson 2001]. This makes humans' affective and cognitive states subject to change while interacting with technology. This is especially true for Virtual Reality (VR) games that provide enjoyable and immersive gaming experiences for players, which may reshape their emotional experiences, resulting an enhanced sense of being in the game [Munafo et al. 2017]. Understanding and designing interfaces, interactions, and environments based on end-user's emotional responses is a critical challenge but essential from a human-centred computing perspective.

Recently, there has been a lot of research investigating how to recognize emotions in VR using various modalities [Marín-Morales et al. 2020], but only a few demonstrated real-time applications reflecting this back into the VR experience [Bernal and Maes 2017; Dey et al. 2018]. Using physiology-focused real-time emotion adaptive techniques, we demonstrate WizardOfVR, where a user can experience a Harry Potter-themed VR environment in a more immersive and interactive way. In the experience, the more unpleasant the user feels, the lower their SanityMeter drops, resulting in a magical distortion of their view. This distortion disappears when the participant starts to feel positive emotions and their SanityMeter increases. This system allows the user to experience the world of WizardVR and prompts them to think of positive thoughts in unpleasant conditions.

2 DESIGN AND USER EXPERIENCE

When designing the application, we focused on not just creating an engaging and enjoyable system but also on facilitating seamless adaptation of environmental elements depending on the user's emotional state. In the WizardOfVR demo, the user plays the role of a wizard, searching and collecting Bitter root plants from the Forbidden Forest to brew a magical potion. We used a 'SanityMeter' (SM), an emotion visualizing scale, displaying the continuous valence score ranging between unpleasant and pleasant emotional states indicated by low (0) and high (100) SM scores respectively. In the experience, users encounter various scary sounds and black magic artifacts that could lower the SM score and eventually induce distorted vision. This can be countered by thinking positively, resulting in an increase in the SM score. Other environmental components like fog density, height, audio and brightness also adapt to the user's emotional states.

3 IMPLEMENTATION

For this system, we used the HP Omnicept [1] head-mounted display to display a VR environment developed using Unity3D [2]. EEG signals at a 125Hz sampling frequency (SF) were collected from gold cup electrodes attached at the FP1 and FP2 locations with the OpenBCI [3] Cyton-Daisy biosensing board. The Shimmer3 [4] sensor was used to collect EDA and HRV data at 128 Hz SF. The use of this system is divided into two parts, 1) Calibration, and 2) WizardOfVR (see figure 2). The calibration trains personalized machine learning based emotion recognition models using EEG, EDA, and HRV signals. For this, we followed the approach of AffectivelyVR [Gupta et al. 2020], where the user is shown 3 emotional 360-degree videos in VR while collecting their physiological signals. After each video, the user rates their emotional state using the Self-Assessment Manikin (SAM) scale [Bradley and Lang 1994], and this is used to label the data. This process will produce personalized, and accurate models along with a selected feature list that will be used for the next stage. This entire process of setting up the sensors, and calibration takes approximately 8 minutes.

In the second stage, the VR Adaptive Engine will store the emotion recognition model from the calibration stage, collect physiological data, pre-process it, and extract features from every 10 seconds of game activity. The selected features from the calibration phase will be used to test against the model to predict the emotional state of the user with an accuracy denoted by F1-Score (F1S). We labeled the positive, neutral, and negative emotional states 1, 0, and -1 respectively and used the following equation for SM Score computation (for the first prediction, an initial SM Score of 50 is used instead of the Previous SM Score):

$$SMScore = PreviousSMScore + (PredictedState \times (F1S \div 3))$$

[1]https://www.hp.com/us-en/vr/reverb-g2-vr-headset-omnicept-edition.html
[2]https://unity.com/
[3]https://openbci.com/
[4]http://www.shimmersensing.com/

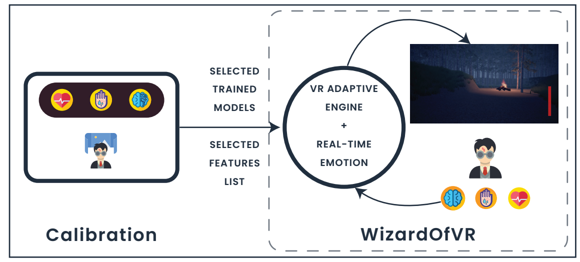

Figure 2: WizardOfVR: System Flow

With an objective to keep the experience both engaging and challenging, we regulate emotions by manipulating the fog density (FD), fog height (FH), visual effects and audio in the VR Environment. Initial pilot testing indicated that the user finds the game easy at an average SM Score of 73% but strenuous at average SM Score of 38%. We observed that users preferred the environmental factors to be directly proportional to the SM Scores, with a higher SM score indicating more pleasant emotional states, FD, FH, and audio are increased to make the experience less pleasant. Whereas if the scores are lower, these environmental variables are decreased. In order to prevent the user from experiencing extremely unpleasant emotions, we applied a distortion effects to the user's view if the SM Score goes below 30% suggesting that they close their eyes and relax. The SanityMeter is displayed to the remote viewers, but is invisible for the player.

4 RESEARCH PLANS

We plan to use this XR demo as a platform to create a large physiological dataset and system evaluation using the diverse demographic audience participating in a massive scale event like SIGGRAPH Asia. In the future, we will contribute to the scientific research community by making this dataset publicly available.

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