A prototype for Immersive Agent based Brain-Computer Interface

Author Keywords

ABSTRACT

AUTHOR KEYWORDS

ACM CLASSIFICATION KEYWORDS

H.5.1. Multimedia Information Systems: Artificial, augmented, and virtual realities

INTRODUCTION

The EEG parametric

We modify OpenBCI- with Oculus CV1

Selected from a standard 10–20 system

Early researchers propose that EEG alpha (8-13Hz) band power and its variance, include upper-alpha wave [11] and individual alpha frequency (Klimesch, 1999), could be used as the indicator for p

Previous study proposes that Alpha (8-13 Hz) is dominant during flowing thought and meditation.

Higher alpha EEG activity is more associated with relaxed conditions than with states of stress

Investigations of human EEG response to viewing fractal patterns

International 10-20 system (Investigations of human EEG), different areas: frontal, parietal, temporal, sensory info is precepted and modified by parietal and temporal regions. While frontal area is more significant to visual stimuli

RELATED WORKS

**-EEG Based Mediation**

EEG is commonly used as a

benchmark

**-BCI-based Virtual Reality**

In recent decades research groups have been bridging Brain-Computer Interface and Virtual Reality [5]. The purposes of these systems are (1) using BCI as an input in virtual world and (2) using virtual reality to provide safe experiment environment [2].

The using of BCI as input in VR generally involves motor imagery(MI) [5]. This means people could control or move objects in an immersive 3D graphic environment [6]. Because of that, VR community deems BCI as an assistive and intuitive input device for virtual environment. To connect mental state and command, the active-input BCI requires a training session for each individual. The application of these systems often related to balancing avatars (1 dimension) [4], car driving (2 dimension) [9] or moving characters (3 dimension) [7]. Several experiments reveal that the success rate of these control is decent [10].

DESIGN CONSIDERATION

**-System Structure**

The system is composed of 4 parts: Unity platform, Oculus VR device, OpenBCI EEG device and Tensorflow agent.

The Unity platform runs as the server, rendering the frames directly to Oculus VR headset and to monitor. The OpenBCI EEG processing software and Tensorflow agent run as the client. The data is streamed using UDP with OpenBCI and TCP with Tensorflow. since the former one requires less delay and the later one needs precision.

The Tensorflow agent record the EEG state, evaluate

and send action [] to the unity server. And the server updates the environment in Oculus VR.

The render frame is controlled by the Tensorflow agent

**-Electrodes Selection**

Due to the size of Oculus device, the Fp, O and AF areas of the 10-20 Electrodes system is occluded by VR Glass. Some study [3] [8] suggest that the Fp and AF Electrodes are more relevant to facial muscle movement instead of neural activities. And More detailed research also revealed the correlation of specific emotion with the band power of a specific Electrodes. [3] These evidences suggest that

Statistic are collected

Minimal requirement is proposed by

In this way, the accuracy could be promised with minimal electrodes selected

**-Low-cost and opensource**

The complicated headset with 54 or 64 Electrodes used to be widely adopted in EEG-related research [?]. These devices are more expensive than VR device itself. While research show that device with 5-6 channels could produce decent accuracy in emotion related brain activity (SSVEP) [1]. And more complicated devices fit event-related signals (such as P300).

To shirk the cost, 8-Channel OpenBCI Board is chosen. OpenBCI is an opensource hardware with substantial modifying space. The accelerometers and SD card are removed. The 3D-printed headset is lightened to a half for Oculus CV while xx of xx Electrodes is kept. Except the free-to-use unity3D Engine, all the software required to run and develop is opensource.

Suitable for VR; Channels; Availability; price = X Oculus CV 1

Our Device (Forked from OpenBCI) Yes; 8 of 23 Locations; price = 0.625 \* Oculus

Neurable Yes; 7 Channels; Not available Yet; No price info

Emotiv insight No; 5 Channels; Price = 0.75 \* Oculus

Original OpenBCI No; 8 of 35 Locations; Price = 1.25 \* Oculus

Emotiv Epoch+ No; 14 Channels; Price = 1.99 \* Oculus

Biosemi Yes; 16 Channels; Yes; Price = 40.5 \* Oculus

NeuroScan Yes; 64; Price = 231 \* Oculus

Table X. the cost of popular EEG devices

Compared with other device, the price of our device is reasonable for every Oculus VR users. It promises the freedom for community development and flexibility for researchers.

IMPLEMENTATION

- System Specification

Due to the rendering and calculation load, the Unity server is deployed on a data station with 2 NVIDIA TITAN X Graphics Card. The Oculus CV device and EEG headset is calibrated for each person before the session start.

EEG raw data is acquired @250Hz. The data is filtered to 1-50Hz and Fast Fourier transformed into EEG band power: Delta wave (0.5–3 Hz), Theta wave (4–7 Hz), Alpha wave (8–13 Hz), Beta wave (16–31 Hz) and Gamma wave (32–50 Hz). The band power data is send to UDP server in Unity and streamed in hard drive for future analysis.

Run at different pace

-Example 1

-Example 2

EVALUATION

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