The Concept of Telekinesis and Traditional Computer Controllers in Action: A 3D Shooter Game Enhanced with Unicorn-BCI and cVEP - Presented by EEGamers

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Abstract: This project represents an advancement in the field of gaming technology by introducing a novel application of a Brain-Computer Interface (BCI) using the code-modulated visual evoked potentials (cVEP) paradigm within a 3D shooter gaming environment. The concept of telekinesis is integrated as an additional gameplay mechanic, by blending BCI technology with traditional gaming controls. Our game allowed players to temporarily immobilize enemies by maintaining focus, effectively simulating telekinesis in the game. The project, developed during the BR41N.IO Hackathon April 2023 by g.tec neurotechnology GmbH, underscores the potential of BCI as an effective and engine real-time system with applications extending to various interactive in-game scenarios. Although our project is no longer in active development, it has opened doors for exploring BCIs potential in gaming, offering users superhuman abilities and enhancing the overall gaming experience. Our code and models are available on GitHub.

Keywords: Telekinesis, Brain-Computer Interface (BCI), code-modulated visual evoked potential (cVEP), 3D Game, Electroencephalography (EEG), Unicorn, Unity, Hackathon

1. INTRODUCTION, DESCRIPTION AND CURRENT STATUS

The EEGamers team comprises five members with diverse academic backgrounds, including cognitive science, AI, and game development. Our project, developed during the BR41N.IO Hackathon April 2023, aimed to introduce a successful integration of a BCI system utilising Electroencephalography (EEG) technology and the cVEP paradigm in a 3D gaming environment. We emphasized the synerge of BCI as an additional controller, enabling unique in-game abilities not attainable through traditional controllers or current BCI implementations in a 3D game. While our project is no longer in active development, we have made our work accessible on GitHub, contributing significantly to the ongoing exploration of BCIs potential in the gaming sphere by other teams and developers.

2. METHODOLOGY

Our research methodology revolves around the utilisation of pseudo-random sequences within the cVEP paradigm. In our experimental configuration, we integrated the cVEP paradigm by implementing flashing sequences on the headgear of an adversary drone within our 3D shooter gaming environment (refer to Figure 1).

BCI systems utilising cVEP demonstrate the potential for achieving exceptionally high online accuracy, making them well-suited for real-time control applications (Riechmann, et. al, 2016). These systems can detect the cVEP signal when a user focuses on the pseudo-random sequences. This detection process is initiated following an initialization or setup phase, during which the BCI calibrates and establishes a baseline for interpreting the user’s brain signals. Once this initial setup is complete, the BCI becomes attuned to the user's specific neural responses, enhancing the ability to identify the cVEP pattern. The concept here is that users can harness their focusing ability in the game. When they concentrate on the enemy, indicated by the flashing headgear, the BCI can recognize the cVEP pattern, which is reflected in the user's brain data when they focus on a cVEP object. In essence, this allows the system to seamlessly translate the user's mental intention of focusing onto the object into actionable commands within the game, such as triggering game events or interactions.

Building on this foundation, in our game, when the BCI successfully detects the cVEP signal from the user, it triggers a temporary immobilization of the enemy. This immobilization is visually represented to the user by the appearance of a cage around the enemy of the character (refer to Figure 2). This innovative interaction effectively translates the user's mental intention of focusing onto the object into actionable commands within the game, recreating the illusion of telekinesis and illustrating the augmentation of cognitive capabilities beyond the boundaries of conventional human capacities.

3. NOVELTY AND INNOVATION

Our project represents a significant advancement in the field of gaming technology. The hallmark of our project lies in the application of cVEP within a 3D gaming environment, introducing the concept of telekinesis as an additional gameplay mechanic. By seamlessly blending BCI with traditional gaming controls, we have established a method that mirrors the feeling of wielding superhuman abilities within the game world. Our project doesn't merely substitute an already well-designed game mechanic; instead, it introduces an independent additional mechanic that operates separately from the keyboard and mouse. This innovation enhances both the speed and accuracy of in-game actions, thereby augmenting the overall gaming experience.

4. USER BENEFITS

One of the most significant advantages of our BCI project is the array of new benefits it offers to potential gamers. By integrating BCI as an auxiliary controller alongside traditional inputs, we offer users a level of realism and superhuman abilities that were once beyond the reach of conventional gaming methods.

5. REAL-WORLD APPLICATIONS

The integration of BCI can be extended to a wide variety of gaming applications, especially in the context of science fiction gaming, where the idea of superhuman abilities, such as telekinesis, aligns seamlessly. The success of our project highlights its viability as an effective and engaging real-time BCI system with potential applications spanning numerous gaming scenarios.

While much of BCI-research primarily focuses on assisting individuals with disabilities, it's important to note that many cutting-edge BCI systems remain scarce and expensive. The motivation behind our project's development stems from our desire to popularize BCI technology in the gaming sphere, extending its utility beyond medical applications. By fostering increased demand for BCIs within the gaming community, we anticipate that more companies may invest in BCI technology. This, in turn, could lead to cost reductions and advancements in BCIs through economies of scale, ultimately benefiting not only gamers but also individuals with disabilities.

6. ACKNOWLEDGMENTS

We express our sincere gratitude to g.tec neurotechnology GmbH for providing us with the opportunity to innovate at the intersection of BCI technology and gaming during the BR41N.IO Hackathon 2023. Our appreciation goes out to the experts whose guidance enriched our project's quality during the event.

Furthermore, our gratitude extends to Tilburg University and the Department of Cognitive Science & Artificial Intelligence. Their support and organization enabled us students to partake in the BR41N.IO Hackathon 2023.

7. REFERENCES

H. Riechmann, A. Finke and H. Ritter, "Using a cVEP-Based Brain-Computer Interface to Control a Virtual Agent," in IEEE Transactions on Neural Systems and Rehabilitation Engineering, vol. 24, no. 6, pp. 692-699, June 2016, doi: 10.1109/TNSRE.2015.2490621.

APPENDIX

Figure 1: Design of the Enemy.

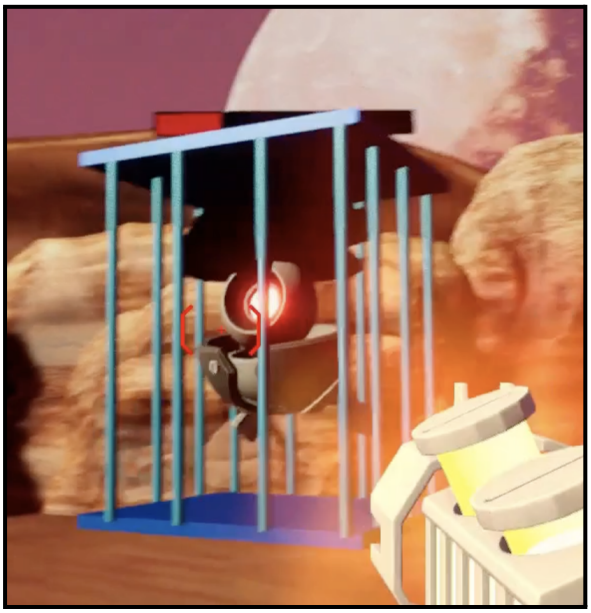

Figure 2. Enemy Immobilized through Telekinesis. Visualization of enemy incapacitation using a cage.