Controlling Player Avatars and Influencing Game Worlds Using Multi-Modal Input Systems

Final Year Project: Research

# Useful

## Demonstration of a Semi-Autonomous Hybrid Brain–Machine Interface Using Human Intracranial EEG, Eye Tracking, and Computer Vision to Control a Robotic Upper Limb Prosthetic

<https://ieeexplore.ieee.org/abstract/document/6683036?casa_token=8eFYNtMeT2gAAAAA:ptQ8BBvUlh8lAUUPHZ6g9HQx5w1zm7Rb593ojrATAKlB7ZmLef5Sxiz4bjS2aou0V0wJ7hGu_A>

Using a multi-modal input of Human Intercranial EEG (invasive), eye-tracking and a computer vision AI, the authors of the study set out to control a semi-autonomous robotic limb using these inputs allowing for the picking up and dropping of objects from a table.

They concluded this is indeed possible, and the trail was successful with a 100% accuracy for a singular object in vision, and a 70% accuracy when 3 objects where in vision.

## Games, Gameplay, and BCI: The State of the Art

<https://ieeexplore.ieee.org/abstract/document/6518141?casa_token=CBwmRxx15oEAAAAA:21ka6qQ-juyj0y5dilq4UKtnVgSjOg9SgGcn2nOn2QA33uSppAPDDVBi1vuGfgmfSq-OGQPzSw>

The study examines the relationship between the games and BCI, how games have been used for BCI in the past, and how modern studies are looking into using BCI as an input modality for games.

## DESIGN OF EMG BIOFEEDBACK SYSTEM FOR LOWER-LIMB EXERCISES OF THE ELDERLY USING VIDEO GAMES

<https://www.researchgate.net/profile/Angkoon-Phinyomark-2/publication/273121826_Design_of_EMG_Biofeedback_System_for_Lower-Limb_Exercises_of_the_Elderly_Using_Video_Game/links/54f74adc0cf210398e92796c/Design-of-EMG-Biofeedback-System-for-Lower-Limb-Exercises-of-the-Elderly-Using-Video-Game.pdf>

The study uses EMG based games to build confidence in elderly patients who might avoid going out in fear of falling, they also mention the system and use of EMG controlled games would work as a good rehabilitate source.

## Effects of Gamification in BCI Functional Rehabilitation

<https://www.frontiersin.org/articles/10.3389/fnins.2020.00882/full>

The studies analysis whether the act of playing a game negatively or positively effects rehabilitation of patients that have suffered a stroke. The results concluded that there was neither a positive nor negative effect on performance of the study. However, boredom was decreased, and satisfaction was increased in the trails including the games.

## Comparing interaction techniques for serious games through brain–computer interfaces: A user perception evaluation study

<https://www.sciencedirect.com/science/article/pii/S1875952114000391?casa_token=W2lyMls9lCsAAAAA:zcWmZ_ulPpbRAKBdfDqXdQXmMAysnSlLBUpzAbAk9Ej3r_mt4AlTqcxF9heThRjNzubg83HY6A>

The study compares the use of two different EEG systems, a single dry electrode and 14 wet electrodes. Then asks users to take control over a player avatar to walk around a game world by changing there state of mind.

## User training for machine learning controlled upper limb prostheses: a serious game approach

<https://link.springer.com/article/10.1186/s12984-021-00831-5>

Using the intent of training participants to control a prosthetic arm, a serous game was made to take in the inputs of the EMG system and map them to multiple different games. One was used to roll a ball around a maze, and the other was used to grab things using a virtual hand (gripper).

# Potentially Useful

## Driving Persuasive Games with Personal EEG Devices: Strengths and Weaknesses

<https://dl.acm.org/doi/epdf/10.1145/3314183.3325008>

The study attempts to build a playable game for stroke patients to train with at home, a ship moves side to side to avoid falling rocks. This is controlled by using motor imagery to move your left and right hand, moving the ship in their respective directions. The study found it wasn’t as successful as they hoped, and the infancy of consumer EEG headgear is one of the major issues.

## Examining User Experiences through a Multimodal BCI Puzzle Game

<https://ieeexplore.ieee.org/abstract/document/7272646?casa_token=UI5adguQDAYAAAAA:5qc1uPNKQSkBhnIeVNp5qtpDTnOs3zhrhGFSv67qXbxpF9mjV6gApuxfVp_KoZcrRu5Yi1HX7g>

The paper describes an experiment involving the control of a games difficulty using a single sensor non-invasive EEG device, the results came back to increase user enjoyment and allowed for users who could control their meditation level to enjoy the game more. However, it also notes that such a high strain mentally inflicted fatigue on the users over long periods of play, which lead to problems with valid signals.

## Gaming control using a wearable and wireless EEG-based brain-computer interface device with novel dry foam-based sensors

<https://link.springer.com/article/10.1186/1743-0003-9-5>

The Authors of the paper put forward the idea using a dry electrode-based EEG device to act as an input for an archery game, the device calculated the players focus and translated it to an accuracy modifier within the game.

## The Development of Body-Powered Prosthetic Hand Controlled by EMG Signals Using DSP Processor with Virtual Prosthesis Implementation

<https://www.hindawi.com/journals/cpis/2013/598945/>

Using surface Electromyography and a micro-controller, the authors of the paper developed a prototype design for amputees to control a simple prosthetic. They concluded the prototype gave a satisfying result.

## EEG-based brain controlled prosthetic arm

<https://ieeexplore.ieee.org/abstract/document/7746219>

The authors of the paper attempted to develop an EEG based prosthetic using the Neurosky Mindwave headset, unfortunately they did not get the desired results they were after. They concluded that the lack of data from only a single sensor was not enough for complex tasks like opening and closing a hand.

## Prosthetic Control by an EEG-based Brain-Computer Interface (BCI)

<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.467.9453&rep=rep1&type=pdf>

The authors conducted an experiment to allow for the control of a prosthesis by imaging left and right-hand movements. They concluded that it is entirely possible to control a prosthetic in this way when an 82.5% to 90% success rate was found.

## EEG Mind controlled Smart Prosthetic Arm

<https://ieeexplore.ieee.org/abstract/document/7737375>

The authors put forward the idea of using a 3D printed prosthetic to allow for a cheaper alternative to modern prosthesis using EEG. Using 14 sensors and the training of thinking about moving a cube left and right, the authors stated that the hand would open and close when thinking about either left or right.

# Not Very Useful