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IOT Brain – Computer Interface

I. INTRODUCTION

THIS survey paper explores the applications of IOT Brain – Computer interface devices that can be used for medical purposes. Today, the use of the IOT is growing rapidly across different areas. This adoption of IOT devices is expected to improve efficiency in all aspects of life. The healthcare and medical sector stands at the forefront of IOT device adoption, integrating a diverse range of technologies to enhance patient care and quality of life. Some these devices include patient monitoring systems, smart implants, biomechanical aids, prosthetics, and health trackers [1]

Despite the significant advancements in various applications within the medical industry, there remains one area that has received less attention and progress. The brain is highly complicated organ and till this day is not fully understood. Within our modern society, mental health issues cause significant challenges. In our fast-paced world, where the demands of development, learning, earning, and survival are constant, these mental health struggles can hinder progress and even lead to other health problems.[4]

Given these challenges, more people are interested in using IOT technology to create brain-computer interface devices for mental health problems. These devices could change how we treat mental health issues by keeping track of people's mental states in real-time, offering early help, and personalized treatments. In this survey paper, we'll look at the latest improvements in IOT based brain computer interface technology for mental health care, to see how they could help and what problems they might bring. [1]

What Is Brain Computer Interface

A Brain-Computer Interface is a high-tech system that acts as a middleman between your brain and a computer or other devices. It takes the signals your brain sends out and translates them into commands that a computer or device can understand. [3]

The main process of a Brain-Computer Interface includes signal acquisition, feature extraction, feature translation and device output.

Signal acquisition.

Signal acquisition involves measuring brain signals using specific sensors, like scalp or intracranial electrodes for electrical activity. These signals get boosted to proper levels for electronic processing and might undergo filtering to eliminate noise or unwanted characteristics, Afterward, the signals are turned into digital data and sent to a computer. [3]

Feature Extraction

The process of feature extraction involves analysing digital signals to identify key characteristics associated with the user's intention while filtering out any unwanted signals. These features are then put into a simpler format that is more suitable for translation into output commands. The main purpose of this process is to extract all the features that are correlated with what the user is needing or looking for. [3]

Feature Translation

The next step in the process is the feature translation. After the signal features have been identified, they will proceed to into a feature translation algorithm. This algorithm is responsible for changing those features into the right commands for the device. For example, suppose we have a prosthetic arm that is being worn by someone. The feature translation algorithm interprets the signal features extracted from the user's brain activity and translates them into commands for the prosthetic arm. If the algorithm detects a specific activity associated with holding an object, it will trigger the prosthetic arm to close its grip, likewise, if it detects another activity that's associated with releasing an object, it will then proceed to send a command to the prosthetic arm to release its grip. [3]

Device Output

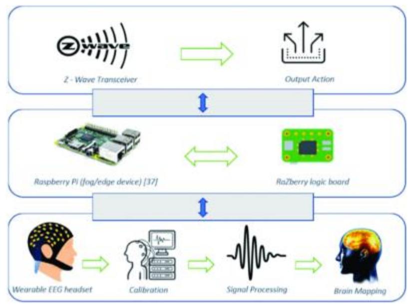
The commands from the feature translation algorithm ultimately end up controlling the device through various outputs and functions that are based on the signals received, extracted, and translated. [3]

Process Summary

The process of interacting between the brain and devices involves several stages. Initially, signal acquisition uses specific sensors to measure brain signals, which are then amplified and filtered to eliminate any noise before being converted into data for a computer to process. Feature extraction is the next step which includes analysing the signals to identify any relevant characteristics that's associated with the user's intention and are simplified for translation into output commands. The feature translation algorithm then proceeds to convert these identified features into commands for the device.

Current methods

IOT devices are equipped with fundamental capabilities which described previously and includes sensing, communication, and processing. The current methods used to control this process are things like keyboard and speech recognition, which is not a viable option in this application. A new approach aims to remotely manage IOT devices using brain signals. [2]



The utilization of EEG signals to govern IOT devices approach proposes a direct interface between the brain and control mechanisms. It aims to explore the current technologies of EEG as a starting point to solve the problem of implementing the interaction between IOT devices and the brain.[2][3]

Central to this concept, is the EEG headset, that has been engineered to capture and interpret brainwave patterns with precision. Acting as the middleman between the brain and the interface. It converts these signals into commands for IOT devices. [2][3]

With that being said, the headset could have various implementations. Rather than using EEG implemented devices, another method is to use ECOG implemented device which is another approach to record brain signals and requires a different implementation. For this paper, we will continue to discuss the methods used in an EEG device to capture brain signals. [2][3]

Following the first step of the EEG headset capturing brain waves and interpret the brainwave patterns, the captured EEG signals are transmitted to an edge layer which uses a cost-effective computing device such as Raspberry Pi where initial processing occurs.[2][3]

Within the edge layer, a control mechanism is implemented that uses wireless communication technologies to connect the IOT device.[2][3]

Commands originating from EEG signals are sent from the control layer to the IOT devices, prompting them to take specific action. [2][3]

Key challenges of the approach

The method described previously results in a few challenges that need to be addressed. The main challenges in this method are associated with signal quality and reliability, having the devices adapt to different brains as they produce different patterns and requires robust algorithms and clinical validation and compliance with regulation. [2][3]

Signal Quality and reliability.

The most significant challenge in this method is ensuring the accuracy and reliability of the EEG signals captured by the headset. Achieving this goal demands a highly effective signal processing, including the implementation of robust algorithms to filter out any unwanted noise. Additionality, the proper placement of electrode also impacts the quality of the signal. [2][3]

Variability and Adaptation

Each individual's brain varies, and each user has different brain patterns of brain signals. This variability poses challenges in developing such algorithms for feature extraction and translation as the system needs to adapt to diverse user and their respective brain activity. [2][3]

Clinical Validation and compliance with regulation

Ensuring that IOT brain-computer devices are safe, effective, and follow the rules for medical use is important. This means going thorough tests in real medical situations to make sure the devices work well and don't harm patients. It also involves getting approval from government agencies, which sets strict standards for medical devices. Researchers and doctors need to work closely together and provide lots of evidence that the devices are safe and effective. While this process takes time and effort, it's crucial for making sure patients are protected and the devices can be used safely in healthcare. [2][3]

Your opinion: Based on a comparison between the different articles you are reviewing, please comment on how the work presented (in terms of methods used and results) can be improved further.

Based on the challenges described in the previous section, we can examine these challenges further and by improving these challenges we can improve the overall method. [2][3]

To refine this method, focus should be placed on advancements in signal processing algorithms to enhance the accuracy and reliability of EEG signals, while tailoring algorithms for individual variations in brain signals through machine learning and artificial intelligence. [2][3]

In conclusion, addressing these challenges can improve the method. By refining signal processing algorithms and tailoring them to individual brain signals using machine learning, we can enhance the accuracy and effectiveness of brain-computer interface technology. These improvements will make interactions with IOT devices smoother and more intuitive. [2][3]

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