

Survey of Brainwave analysis and its retrieving techniques for BCI

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Abstract— Electric and Magnetic brain waves are created from each and every word we think. These waves have different frequencies and amplitudes. These brain waves carry substantial information about the activity or word being processed and then recognize them. Different methods of imaging brain activity such as positron emission tomography, functional magnetic research imaging and magnetoencephalography tomography have emerged as valuable source of knowledge, especially about where in brain different kinds of activity occur. This paper identifies the user's adeptness on brain control systems and ability to control brain generated waves in a closed neurofeedback loop. Brain computer interfaces are communication devices which allows user to transmit commands to a logic processing circuit on the basis of brain activities or waves.

Keywords—EEG, MEG, brainwaves, neurofeedback, FFT, DFT, IFFT

I. INTRODUCTION

Neurofeedback is immediate preparing of mind capacity, by which the brain figures out how to work more efficiently. It is an approach to measure and train brain action so it is a type of brain wave biofeedback. Neurofeedback is preparing in regulation towards oneself. It is basically biofeedback connected to the mind straightforwardly. Regulation towards oneself is an essential piece of great mind function. Self-regulation preparing permits the framework (the focal sensory system) to improve the storage capacity in a better way.

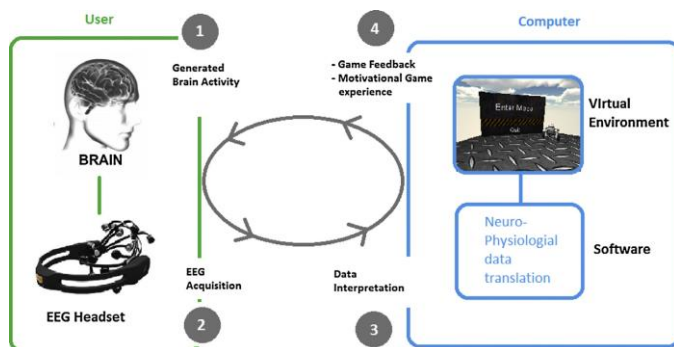


Fig.1. Feedback Loop^[1]

II. THEORY OF BACKGROUND

At the foundation of all our considerations, feelings and practices is the correspondence between neurons inside our brains. Brainwaves are delivered by synchronized electrical beats from masses of neurons speaking with one another. Brainwaves are located utilizing sensors put on the scalp. They are partitioned into transmission capacities to portray their capacities (beneath), however they are best considered a constant range of awareness.

A. Detailed description of brainwaves

Delta waves (.5 to 3 Hz) are the slowest however loudest brainwaves (low recurrence and profoundly infiltrating, in the same way as a drum thump). They are produced in deepest contemplation and dreamless slumber. Delta waves suspend outside mindfulness and are the wellspring of sympathy.

Theta waves (3 to 8 Hz) happen frequently in slumber but on the other hand are predominant in the profound thought. It goes about as our passage to learning and memory. In theta, our faculties are withdrawn from the outer world and concentrated on signs beginning from inside. It is that nightfall state which we regularly just experience briefly as we wake or float off to rest.

Alpha waves (8 to 12 Hz) are available amid quietly streaming musings, however not exactly reflection. Alpha is 'the force of now', being here, in the present. Alpha is the resting state for the mind. Alpha waves help general mental coordination, tranquility, sharpness, brain/body joining and learning.

Beta waves (12 to 38 Hz) overwhelm our typical waking condition of cognizance when consideration is regulated towards cognitive undertakings and the outside world. Beta is a "quick" action, present when we are alarm, mindful, occupied with critical thinking, judgment, choice making, and occupied with centered mental movement. Beta brainwaves are further partitioned into three groups; Low Beta (Beta1, 12-15hz) can be considered a 'quick sit still, or pondering. Beta is also known as Beta2(15-22hz) is considered as high engagement.

Gamma waves (38 to 42 Hz) are the speediest of cerebrum waves (high recurrence, in the same way as a woodwind), and identify with concurrent preparing of data from diverse mind territories. It passes data quickly, and as the most unobtrusive of the brainwave frequencies, the brain must be tranquil to get to it. Gamma was customarily rejected as 'extra mind clamor' until analysts found it was very dynamic when in conditions of all inclusive adoration, charitableness, and the 'higher ideals'. Gamma rhythms regulate recognition and cognizance, vanishing under anesthesia. Gamma is likewise over the recurrence of neuronal terminating, so how it is produced remains a riddle. The vicinity of Gamma identifies with stretched cognizance and profound development.^{[7][9][10]}

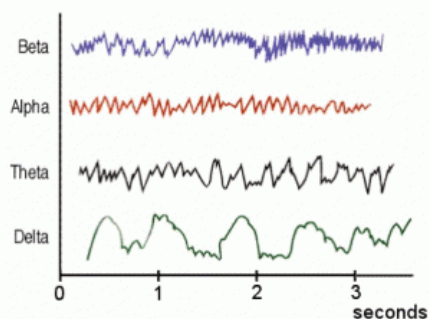


Fig.2. Brain wave patterns^[7]

B. Working of Brainwaves

The human brain is comprised of billions of interconnected neurons about the span of a pinhead. As neurons communicate, examples show as solitary musings, for example, a math count, and expansive passionate states, for example, consideration and contemplation. The normal human thinks roughly 70,000 contemplations every day. Therefore, every communication between neurons makes a minuscule electrical release, measurable by EEG (electroencephalogram) machines. These charges are difficult to gauge from outside the skull. Nonetheless, a predominant mental state, determined by aggregate neuron action made by several thousand simultaneous releases, can be measured. EEG measures the mind movement from the scalp with EEG sensors joined to the head on a terminal top or headset without being surgically embedded and it is most generally utilized. From an evolutionary perspective, these essential capacities are available in many creatures. As people advanced into more clever animals, the prefrontal cortex in the front of the mind is the place higher intuition happens. Feelings, mental states, focus, and so on are all predominant here. This is the real explanation behind Neurosky's principle sensor arrangement on a position known as Fp1. Distinctive brain states are the aftereffect of diverse examples of neural association. These examples lead to waves described by diverse amplitudes and frequencies. As illustrations, brainwaves somewhere around 12 and 30 hertz are called Beta Waves they are connected with fixation, while waves somewhere around 8 and 12 hertz are called Alpha Waves they are connected with quiet unwinding. Dominating brainwaves, the compression of muscles is likewise connected with novel wave examples, called EMG

waves. Disconnecting these EMG designs Mindwave gadgets distinguish eye squint.^[11]

C. NeuroSky Working

The single sensor on Fp1 gives a high level of freedom; neurosky gadgets can gauge various mental states at the same time.



Fig3. NeuroSky MindWave 0001^[11]

All electrical gadgets, including machines, lights, divider attachments, and so on, release some level of surrounding "commotion". This commotion is frequently sufficiently noisy to jumble brainwaves. Accordingly, research center EEG gadgets will get arbitrary readings when both the reference terminal and the essential anode are associated with a protest that is not transmitting brainwaves. Sensing mental movement through electrical commotion is similar to attempting to spy on a discussion at a boisterous ballgame - from outside the stadium. Previously, customary EEG gadgets have bypassed this issue by measuring brainwaves in entirely controlled situations where no lights, gadgets, and so forth meddle with the EEG signal. To build the EEG brainwave flag, a thick therapeutic gel is utilized for conductivity. As EEG gadgets relocate from the research center to homes, a great many people don't have rooms without electronic obstruction, nor would they like to apply a conductive fluid to their head each time they utilize an EEG gadget. Neurosky's methodologies to without gel sensors and loud situations relieve these difficulties.

Part of Neurosky's IP includes commotion scratch-off.

- Signal enhancement makes the raw brainwave sign stronger.
- Filtering conventions wipe out referred to commotion frequencies, for example, muscle, beat and electrical devices.
- Notch channels dispense with electrical clamor from the framework, which differs from 50hz to 60hz, contingent upon overall geography.
- Filter innovation stays at the fore front of Neurosky R&d, and future items will refine this flawed capacity.

Extra IP includes electrical building.

- Extrapolating EEG brainwave signals from clamor requires both a reference point and electrical circuit establishing.
- The establishing makes the body voltage the same as the headset.
- The reference is utilized to subtract the normal encompassing clamor through a procedure known as regular mode dismissal.
- The ear cartilage is an area that encounters the same encompassing clamor as the Neurosky temple sensor however with negligible neural action.
- Consequently, it is significant that the ear association be safely fit.^[11]

III. ABOUT BCIS

According to Athanasios Vourvopoulos and Fotis Liarokapis, client's adjustment on mind controlled frameworks and the capacity to control mind created occasions in a shut neuro-input circle. The client experience is evaluated for the further understanding of brain-computer interfacing. A working framework has been created focused around off-the-rack parts for controlling a robot in both the genuine and virtual world. Utilizing business brain-computer interfaces (BCIs) the general expense, set up time and intricacy can be diminished. The framework is isolated in two models based on the headset sort utilized. The main model is focused around the Neurosky headset and it has been tried with 54 members in a field study. The second model is focused around the Emotiv headset including more sensors and exactness, tried with 31 members in a lab environment. Assessment results show that robot route through business BCIs can be powerful and common both in the genuine and the virtual environment.

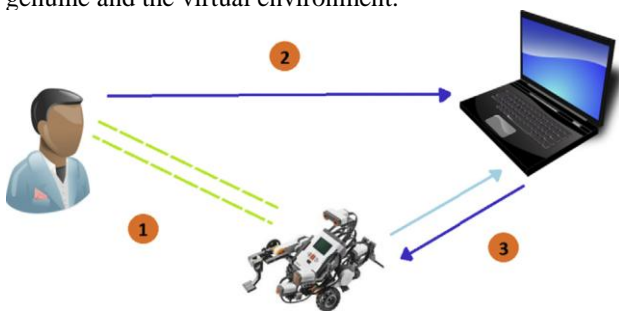


Fig.5. Overview of the System^[11]

A human-robot communication framework with business and non-obtrusive BCI headsets utilizing off-the shelf segments for mechanical tele-operation is also displayed. Two models have been tentatively tried to find that it is so natural to control brain created occasions in a shut neuro-criticism circle. In general, results are guaranteeing and imperative for the improvement of future neuro-criticism based frameworks going from genuine recreations to restoration and clinical examination. It has been examined through the client testing

the effect that these sort of engineering needs to "sound" clients with no past encounter on BCI controlled diversions. Specifically, results demonstrate that execution and spryness of the clients was decreased over time both on the preparation process and the general communication in both interfaces. This is vital for surveying future BCI diversions and help further in outlining better situations for BCI, Hybrid BCI and other Natural User Interface frameworks with high cognitive requests.^[11]

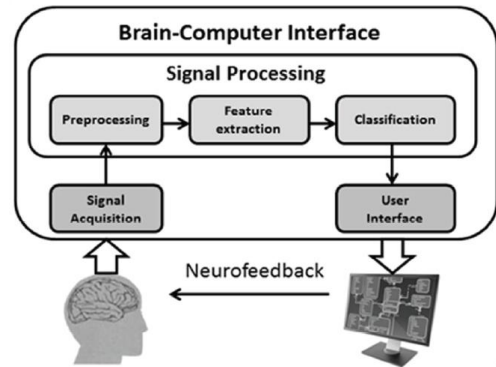


Fig.4. Scheme of BCI^[41]

A. Analyzing EEG waves using Mind Wave reader

Electroencephalography (EEG) is ordinarily utilized as a part of mixture experimental fields. Shockingly, business gadgets are for the most part exceptionally costly, costing a large number of dollars. Lately, gadgets costing under \$200 have been made accessible. The Mindwave Mw001, created by Neurosky Inc., is presently the minimum extravagant business EEG gadget, costing short of what \$100. The paper exhibits how to record and methodology the crude EEG signals from the Mindwave Mw001 in the MATLAB environment. This paper then indicates how Fast Fourier Transform (FFT) is utilized to find the recurrence segments in a period area signal.

Wojciech shows how to record the crude EEG signals from the Mindwave Mw001 in the MATLAB environment. For this reason, the Fourier investigation has been utilized as an effective approach to make the phantom examination. The initial three segments portray the hypothetical suppositions. It is all used to perform the straightforward test. Two distinctive mental states have been utilized to record and methodology the two examples of the crude EEG signal. On the premise of the phantom investigation the five sort of waves were recognized. Thereafter, the specimens were thought about in admiration of these waves. The watched contrasts are affirmed with hypothesis information.^[21]

B. Human Emotional Response using Mind Wave reader

To analyze the response of humans using the device Katie Crowley performed two tests and their results are examined. The Stroop test, which is regularly used to impel stress, we had the capacity evaluate the suitability of the Neurosky headset for measuring the contemplation and consideration level of a single person. A fruitful result in this study permitted us to apply the same standards to another strategy for testing, The Towers of Hanoi. While this test has insisted

the suitability of the Stroop test to fluctuate a subject's anxiety level we want to run a further study utilizing a test outline that will expand push in the dominant part of subjects. The headset can now be utilized as a screen for enthusiastic reaction (consideration/intercession) in a test environment.^[3]

Kwang-Eun Ko characterized human brainwaves as indicated by feelings and thought about the results. We utilized sound and visual pictures to prompt feelings, and the brainwaves were changed into force range qualities utilizing a FFT. We evacuated flags in the low recurrence extent to kill antiques of brainwaves and the remaining signs which are chosen recurrence extents were ascertained with relative force values.^[5]

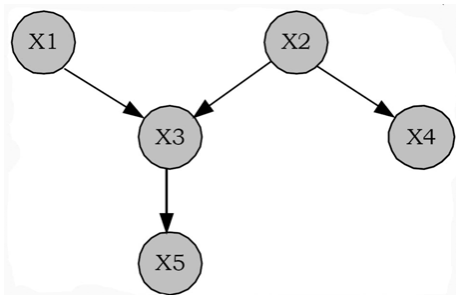


Fig.6. Simple Bayesian System^[5]

Since human feelings can't be measured precisely, author utilized likelihood deduction and a Bayesian system. In looking at results, numerous feelings indicated diverse likelihood values, yet "outrage" and "misery" show comparative likelihood values.^[5]

C. EEG Feature Reduction Technique

The ERD/ERS (Event related (De)Synchronization) name starting points from the wonder of EEG sign force climb or fall in the recurrence groups 8-12 Hz and 18-26 Hz, when a subject spontaneously envisions a development. In our analysis we attempted to characterize EEG signals for a solitary no concurrent trial of envisioning development. In analyses creators utilized just 8 EEG channels. Discrete Fourier change coefficients were utilized as characteristics. For peculiarity diminishment a straight discriminant examination was actualized. The investigations demonstrated that it is conceivable to order effectively the "mental undertakings" with the utilization of just 8 terminals. Direct discriminant examination is a great apparatus for gimmick decrease. Just two segments of LDA were utilized. Creators tried 10-NN, LDA and QDA classifiers. All arrangement routines gave little arrangement mistakes. For these systems and for the first client, arrangement mistake was just 4%. For the second and third client arrangement mistake was around 9%. Such a little mistake is a decent result. It is important that EEG signal contained antiques, for example, EOG and ECG. The principle weakness of executing LDA for peculiarity decrease is the need of utilizing all FFT coefficients (characteristics) as the info signals. The new set of gimmicks is ascertained focused around all perceptions. Such a

circumstance won't happen in genuine BCI usage. So the results for genuine BCI framework can be more awful.^[4]

D. Person Authentication using brain waves

Sebastien Marcel explored the utilization of mind movement for individual confirmation. It has been indicated in past studies that the brain wave example of each individual is special and that the electroencephalogram (EEG) can be utilized for biometric ID. EEG-based biometry is a rising research subject and we accept that it may open new research bearings and applications later on. Individual validation expects to acknowledge or to reject an individual asserting a personality, i.e., contrasting biometric information with one format, while the objective of individual ID is to match the biometric information against all the records in a database. We propose the utilization of a measurable skeleton focused around Gaussian Mixture Models and Maximum A Posteriori model adjustment, effectively connected to speaker and face verification, which can manage stand out preparing session. We perform serious test recreations utilizing a few strict train/test conventions to demonstrate the capability of our strategy. It is demonstrated that there are some mental assignments that are more fitting for individual verification than others.^[6]

IV. CONCLUSION

Thus we can conclude with that of the devices available for BCIs, Neurosky's MindWave reader is comparatively cheaper and user friendly. It uses brain training functions with the device to operate and gives accurate results for attention and meditation levels. If we grab alpha, beta, gamma, theta waves from those wonders can be created. Automation will be reaching its heights when controlling everything using brainwaves becomes possible.

More and more functionalities can be discovered that can be helpful to make the technologies more flexible and bring ease of use in various environments.

Common in all devices is that mostly they use FFT, IFFT, DFT and sampling techniques to distinguish the brainwaves into alpha, beta, gamma, and theta. Biometrics and Identification are the applications that will be served with the brainwaves. Various systems will become better secure.

Acknowledgment (HEADING 5)

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