Simulation And Modelling of BCI Based Multi Purpose WheelChair For Paralysed People

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ABSTRACT

According to the survey of Reeve foundation and WHO says, there are nearly 1 in 50 people living with paralysis , every year 5.4 million people affected. Paralysis is caused by spinal injury, stroke, multiple sclerosis, cerebral palsy and other causes like motor accidents and victim of violence. It is also called loss of muscle function in some part of the body. In this paper, we systematically survey a different techniques used for brain computer interface and also review the research on non-invasive, electroencephalography (EEG)-based BCI systems for communication and rehabilitation. Main research focus on previous techniques like deep learning or deep neural network, machine learning , Neuro plasticity, support vector machine, artifact suppression and so on. In this Differing from traditional machine learning algorithms, online sequential machine learning algorithm is empowered to learn distinct high-level representations from raw brain signals without manual feature selection. A certain MATLAB program is designed to use these motions. Our results are to exploit the accuracy rate and to generate the assistive devices for restoration of movement and communication strength for physically disabled patients in order to rehabilitate their lost motor abilities.

Keywords: BCI, Rehabilitate, electroencephalography, paralysis.
1. INTRODUCTION

Paralysis isn't deadly or inherited disorder it is curable however took prolong time. folks with laid low with this sort of latched in syndrome and different kinds of palsy may be a unsolved challenge in these days world. Communication with patients laid low with locked-in syndrome Associate in Nursing different kinds of palsy is an unsolved challenge. Movement restoration for patients with chronic stroke or different brain harm conjointly remains a therapeutic drawback and obtainable treatments don't provide vital enhancements. This review considers recent analysis in brain-computer interfaces (BCIs) as promising solutions to those challenges. The commonest underlying condition that triggers partial or complete palsy in a very patient. In partial palsy, the patient remains in partial management of the affected muscle, incomplete palsy; the patient has no management over the affected muscle tissue. Whereas a number of kinds of palsy let the patient still lead a standard life, there are units a number of that may cause severe complications. The dependence on crutches, regular nursing and loads of different factors will increase considerably. The foremost common complications area unit chest pains, high pressure level, and depression. SPINAL or skeletal structure is that the most significant half in our body wherever the foremost functions area unit to guard the medulla spinal, nerve root and conjointly the inner organs. Medulla spinal injury happens once there's any harm to the medulla spinal that blocks communication between the brain and also the body. Once the medulla spinal battle-scarred, a person’s sensory, motor and reflex messages area unit affected and will not be ready to operate as was common. The upper the amount of injury, the lot of pathology will occur. This could end in partial or complete palsy of the body further as complete palsy of the arms and legs. For persons with a highest level of medulla spinal Injury (SCI), they're solely ready to management a muscle movement from a neck and on top of. Communication with patients laid low with locked-in syndrome Associate in nursing different kinds of palsy is an unsolved challenge. Palsy may be a loss of strength in a very management over a muscle or cluster of muscles in a part of the body. Most of the time, this is often undue to a retardant with the muscles themselves. It’s a lot of probably because of a retardant somewhere on the chain of nerve cells that runs from the part to your brain and back once more. These nerve cells deliver the signals for your muscles to movement restoration for patients with chronic stroke or different brain harm conjointly remains a therapeutic drawback and obtainable treatments don't provide vital enhancements. This review considers recent analysis in brain-computer interfaces (BCIs) as promising solutions to those challenges. The commonest underlying condition that triggers partial or complete palsy in a very patient. In partial palsy, the patient remains in partial management of the affected muscle, incomplete palsy, the patient has no management over the affected muscle tissue. While a number of kinds of palsy let the patient still lead a standard life, there are units a number of that may cause severe complications. The dependence on crutches, regular nursing and loads of different factors will increase considerably. The foremost common complications area unit chest pains, high pressure level, and depression.
1. Facial, wrist, foot, and vocal cord paralysis are typical causes of localised paralysis.

2. Generalized paralysis is categorised according to how much of the body is affected:
   - Monoplegia is a disease in which only one limb, such as an arm or a leg, is affected.
   - Hemiplegia is a condition that affects one side of the body, such as the leg and arm on the same side.
   - Diplegia affects both sides of the body in the same place, such as both arms or both sides of the face.
   - Both legs and occasionally portions of the trunk are affected by paraplegia.
   - Quadriplegia affects all arms and legs, as well as the entire region from the neck down, in some cases. The heart, lungs, and other organs' function can also be impaired.

1.1 BRAIN COMPUTER INTERFACE

Brain-computer interfaces (BCIs) acquire brain signals, analyze them, and translate them into commands that area unit relayed to output devices that do desired actions. BCIs don't use traditional contractile organ output pathways. The most goal of BCI is to exchange or restore helpful operate to folks disabled by contractile organ disorders like amyotrophic lateral pathology, brain disorder, stroke, or neural structure injury researchers have gone on to use medical instrument, intracortical, electrocorticographic, and alternative brain signals for more and more complicated management of cursors, robotic arms, prostheses, wheelchairs, and alternative devices. The sphere of brain–computer interfaces (BCIs) has adult apace within the previous few decades, permitting the event of ever quicker and additional reliable helpful technologies for changing brain activity into management signals for external devices for folks with severe disabilities. once humans watch the encompassing surroundings, visual information is processed by the brain, and it's attainable to reconstruct an equivalent on the screen with some considerable accuracy by analyzing the physiological information. BCIs area unit typically directed at researching, mapping, assisting, augmenting, or repairing human psychological feature or sensory-motor functions. Figure 1, shows grouping brain signal through electroencephalogram and to amass data transmission. The brain wave signals captures the brain signals and interrupting them through proprietary as Attention and Meditation rule during which get ranges of Attention and Meditation level. These level acts as an input to the pc (computers, laptops)

According to Daly and Wolpaw, a BCI system “enables a new real-time interaction between the user and the outside world” specifying that the signals extracted from brain activity “are translated into an output” from which the user receives feedback that affects his brain activity.
II. LITERATURE REVIEW

Ansari et al. (2019) This study aimed to control an electrical wheelchair with a BCI receiver for people who are unable to move their hands or legs and are essentially paralysed due to cerebromedullospinal disconnection. The signal from the EEG is preprocessed to remove objects, and then options are extracted mistreatment the methodology. We used a progressive machine learning technique for classification on-line ordered Extreme Learning Machine is a minor modification of the utmost Learning Machine. BCI receiver parameters include an EEG cap with sixteen electrodes connected out of fourteen for deed details, resulting in an overall accuracy of 97.62 percent using 10-fold cross validation.

Mudgal et al. (2020) In Neuroscience, one such emerging technology is the Brain Computer Interface (BCI). It enables direct contact between the brain and an external computer, bypassing the normal contractor networks. It is used not only in the medical sector and in health care, but also in a variety of other aspects of human life such as entertainment, gaming, education, self-control, and promotion. This paper principally centered on applications of BCI in neurosciences.

Dutt-Mazumder et al. (2020) To see if a non-invasive P300-based BCI and mouse emulation system could be created. Users of head mice with cervical medulla spinal injury (SCI) And this configuration is to seek out the time interval The P300-BCI Master of Education with an accuracy of 82 percent, response-time of 149 seconds, and lower response-time variability than head-mouse. The head-mouse outperformed the P300-BCI Master of Education on all outcome metrics, including precision, time period, and error distance.

Chamola et al. (2020) A brain-computer interface (BCI) is a communication system that uses brain impulses to manipulate external computers. To monitor a humanoid robot, multisensor data fusion and machine learning-based translation algorithms are used. This paper addresses a variety of BCI uses, including tale appearance and object grasping navigation. Parameters - EEG-recorded brain impulses used to produce control commands.

Riquelme-Ros et al. (2020) Many wearable devices for capturing (EEG) signal in standard of living have been created, according to. This approach is intended to determine the right conductor configurations.
for wearable graphical record systems in order to obtain the best results for Pbi applications alleged. Wearable graphical record devices should be designed with well-known graphical record datasets in mind.

Park, Seonghun et al. (2020) During acting action imagination tasks, motor mental imaging (MI)-based (BCI) systems monitor electrical brain function patterns through (EEG) signals to forecast user intention. The encephalogram signals were subjected to feature extraction and classification using the machine learning algorithms Common spatial Patterns (CSP) and Linear Discriminate Analysis (LDA). The management of BCI advised.

Son, Ji Eun, et al. (2020) It is based on the creation of a higher limb curriculum. A flicker action video was used in a gradual state visual potential (SSVEP) activated brain pc interface (BCI)-functional electrical stimulation (FES) based action observation game. The BCI-FES method was compared in two scenarios: The findings show that by comparing a flicker action video to a flicker noise video, the T3 and P3 channels in the action video had more letter suppression in 8–13 cps than the noise video. Furthermore, in comparison to the noise video, the T4, C4, and P4 channels showed improved high beta (21–30 Hz) for the action. Finally, for the action video in dist, T4 showed suppressed low beta (14–20 Hz).

Ghorbel, Agnès, Et al.(202)The systems has created new opportunities for human-machine interaction researchers to expand the capabilities of standard wheelchairs by introducing specialized interfaces to alter the user to emit a command perceptible and comprehend by a machine. during this paper, we tend to gift a survey on totally different human-machine interactions used for dominant an electrical chair and that we demonstrate the effectiveness of our interface supported human facial expressions.

3. MACHINE LEARNING AND ONLINE SEQUENTIAL EXTREME LEARNING APPROACHES ON WHEELCHAIR

3.1 OSELM

Online consecutive extreme learning machine (OS-ELM) will learn the information one-by-one or chunk-by-chunk with the fastened or varied chunk size. It had been planned by Liang et al. may be a quicker and additional correct algorithmic rule as compared to different on-line learning algorithms. first, the improved OS-ELM algorithms ought to be network structure adjustment to boost learning prominence; second, OS-ELM algorithmic rule learning with stability can have an effect on its generalization ability. For such reasons, during this paper we have a tendency to propose a survey of OS-ELM algorithmic rule with the event of history and therefore the latest results of researching which might hopefully support researchers within the future.
3.2 Machine Learning - is the field of study that provides computers the aptitude to be told while not being expressly programmed. Metric capacity unit is one in every of the foremost exciting technologies that one would have ever bump into. The ability to be told. Machine learning is actively being employed nowadays, maybe in more places than one would expect. However 3 main strategies area unit used nowadays.

3.2.1 Supervised Learning - Supervised learning is one amongst the foremost basic forms of machine learning during this kind, the machine learning algorithmic rule is trained on labeled knowledge. Despite the fact that the info must be labeled accurately for this methodology to figure, supervised learning is extraordinarily powerful once employed in the proper circumstances algorithmic rule with the labeled parameters needed for the matter.

3.2.2 Unsupervised Learning - Unsupervised machine learning holds the advantage of having the ability to figure with untagged knowledge. This suggests that human labor isn't needed to form the dataset machine-readable, permitting abundant larger datasets to be worked on by the program. In supervised learning, the labels enable the algorithmic rule to search out the precise nature of the connection between any knowledge points.

3.2.3 Reinforcement Learning - It directly takes inspiration from however kith and kin learn from information in their lives. It options associate formula that improves upon itself and learns from new things employing a trial-and-error methodology. Favorable outputs area unit inspired or ‘reinforced’, and non-favorable outputs

4. METHODOLOGY OF PROJECT

4.1 Signal acquisition - EEG signals acquisition is especially done by putting graph electrodes on the scalp exploitation bio signal process platform for Bio signal acquisition

![Figure 4.1 Work flow of project](image)

4.2 Signal pre processing

The preprocessing starts with sampling of the input. Because the knowledge is collected in a very continuous encephalogram signal and it has to be discretized for computation. Sampling frequency was
set to 256Hz. (frequency vary is zero.3Hz to 30Hz) below zero.3Hz was feeble signal higher than thirty cycle was noise or gamma signals therefore it's neglected. After sampling, we have a tendency to mete out noise reduction employing a band pass filter. Victimization EEGLAB tool cabinet, we have a tendency to divide the continual encephalogram knowledge into epoch end datasets, Then, the ocular artifacts in every set were removed by the computer code. Collecting {input knowledge input file computer file} from encephalogram and split data into windows having a pair of sec interval. Normalize Every window and applying FFT to the window knowledge. mix all channels to cut back the amount of options.

4.3 Feature extraction

Fast Fourier rework is to extract options from delta, alpha, theta and beta waves. The classification and modification full concentrate on the ELM algorithmic program. we've used 2 phases within the classification victimization OSELM. Feature extraction in BCI application is that the method of extracting feature which will be accustomed distinguish the graph signal into totally different categories. The options extracted from the graph signals area unit used for

4.3.1 Hardware Specifications

The project's hardware specifications are as follows: DB9 Cable, 7805 Regulator IC, Neurosky Headset, A C Adapter, Robot case, Robotic Wheels, General Purpose Board, Male to Male Jumper Wires, and Voltage Regulator

4.3.2 Software Specifications Operating system: Windows 10

Coding Language: C

Tool: MATLAB Version R2018b

4.4 Data collection

Matlab software. Database: Physionet EEG database and Russian database

4.4.1 Control devices

After feature extraction the result obtained is provided as an input to OS-ELM for feature classification. In our work, we had partitioned the dataset into 85% and 15%. 85% of the dataset was utilized for training while rest 15% was utilized for testing. Several iterations were performed and method of cross validation was used to find out the final accuracy. An accuracy of 97.62% was obtained. Precision
obtained was 97.84%, sensitivity was 97.55% and specificity obtained was 99.00%. The above parameters were computed using below mentioned equation.

The dataset was trained and tested on various classifiers and a comparison has been made using the performance measures such as accuracy, sensitivity, and specificity. It has been observed that OS-ELM performed better than the rest of the classifiers.

\[
\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}
\]
\[
\text{Precision} = \frac{TP}{TP + FP}
\]
\[
\text{Sensitivity} = \frac{TP}{TP + FN}
\]
\[
\text{Specificity} = \frac{TN}{TN + FP}
\]

The first part used was the boosting part wherever some batch knowledge of knowledge of information classification and crucial management action there's a definite quantity of discrepancy in classifying the waves, since the signals area unit endlessly being captured by the numerous electrodes gift on the scalp. Was accustomed train the neural network within the initialization stage these data were discarded once the boosting part was completed? The most part was the second part that was the serial learning part. During this part, RLS algorithmic rule was accustomed update the output weight victimization the idea of rule. The algorithmic rule was accustomed classify the data set into four totally different categories for four different facial expressions.
5. RESULTS AND DISCUSSION

The dataset was trained and tested on various classifiers and a comparison has been made using the performance measures such as accuracy, sensitivity, and specificity. It has been observed that OS-ELM performed better than the rest of the classifiers.

| Classifier          | Sensitivity | Accuracy |
|---------------------|-------------|----------|
| K.Nearest Neighbour | 92.61       | 88.24    |
| Support vector machine | 85.68      | 90.69    |
| Random forest       | 83.85       | 79.85    |
| ELM                 | 95.28       | 94.32    |
| OS-ELM              | 97.55       | 97.62    |
| Decision tree       | 88.46       | 86.15    |
Figure 5.1 Acquired EEG Signal

| Facial expressions | Wheelchair movement | accuracy |
|--------------------|---------------------|----------|
| Blink | Front movement | 100% |
| Eyebrow raise | Right movement | 96.8% |
| Headshake | Left movement | 99% |
| smile | Reverse movement | 100% |

Table 5.2 Table of Inference

Brain wave with frequency range

- Alpha waves give an accuracy of 100% and precede the output of blink motion. The blink motion gives the forward movement. Alpha wave frequency up to 8-12Hz.

- Beta waves give an accuracy of 96.8% and proceed the output of eyebrow raise. This motion gives the right side movement with the frequency of 12-30Hz.

- Theta waves give an accuracy of 99% and proceed the output of headshake. This motion gives the left movement with the frequency of 4-7Hz.

- The ideal scenario of a zero training BCI is possible using healthy EEG but the classification accuracy is extremely lower.
6. CONCLUSION

From this research says brain controlled wheel chair can be completely needful and regain the disabled people mobility to improve their quality of life. In this project focused purely on patient comfortness and their functions for normal life. Huge number people affected neuromuscular disorders and lost their whole life. Advances are made on the technology of smart wheelchairs with sensors and driven by intelligent control algorithms to minimize the level of human intervention. The effectiveness of our interface is proved by comparing it in term of success rate, safety, cost, etc..., with other techniques used in literature.

7. FUTURE SCOPE

Future studies will focus on integrating the Internet of Things (IoT) concept to remotely assist impaired people. In fact, digital health field is all the more important as it is a key sector of the IoT.

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