PROCESSING OF EEG SIGNAL THROUGH BCI

Omkar Yadav, Sumit Aher, Wasim Khan, Seemin Inamdar

1. Student, Information Technology, Jayawantrao Sawant College of Engineering, Maharashtra, India
2. Student, Information Technology, Jayawantrao Sawant College of Engineering, Maharashtra, India
3. Student, Information Technology, Jayawantrao Sawant College of Engineering, Maharashtra, India
4. Student, Information Technology, Jayawantrao Sawant College of Engineering, Maharashtra, India

ABSTRACT

Now a days, different technologies are invented for communication between machine and human. A Brain Computer Interface (BCI) gives a correspondence way between human mind and the computer system. With the headway in the territories of data innovation and neurosciences, there has been a surge of enthusiasm for transforming fiction into reality. The real objective of BCI inquire about is to build up a framework that enables crippled individuals to speak with different people and communicates with the outer situations. We show a framework that uses the human capacity to control a cursor on a screen utilizing electroencephalographic (EEG) Mu rhythms". Using BCI communication has occurred between the brain and an external devices.BCI are system that can has conventional channel of communication that provide direct communication and control the human brain and physical devices that translating different patterns of brain activities in real time". The signs were acquired utilizing a uniquely planned terminal top and gear, and sent through a Bluetooth association with a PC that procedures it progressively. The flag was then mapped onto two control signs and this flag is changed over to development of cursor.

Keywords:- *Brain Computing Interface, BCI System, EEG Signals, Electroencephalography, Cursor Control.*

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1.Introduction

As a communication interface to translate brain activities into computer control signals ,Brain Computer Interface (BCI) have received more and more attention in recent years[1]. A standout amongst the most encouraging employments of BCI advances is reestablishing capacity of delibited individuals. BCI innovation can give vision to visually impaired hearing capacity, development to physically tested and so on and in this way give an individual anew life. Research on BCIs began in the 1970s at the University of California, Los Angeles (UCLA) under a grant from the National Science Foundation, followed by a contract from DARPA. The papers published after this research also mark the first appearance of the expression brain–computer interface in scientific literature. The field of BCI research and development has since focused primarily on neuroprosthetics applications that aim at restoring damaged hearing, sight and movement. Thanks to the remarkable cortical plasticity of the brain, signals from implanted prostheses can, after adaptation, be handled by the brain like natural sensor or effectors channels. Following years of animal experimentation, the first neuroprosthetic devices implanted in humans appeared in the mid-1990s.We use EEG ie. Electrophysiological monitoring method to record electric activity of the brain. Our study on BCI provides a communication path between the human brain and the computer system . With the advancement in the areas of information technology and neuroscience, our idea is tofocus on the computer mouse controller that could be controlled by human brain by BCI using EEG. The signals will be obtained using a specially designed EEG headset, and send through a Bluetooth connection to a PC that processes it in real time. The signal will then map to control signals and this signal will be converted to movement of cursor.

2. LITERATURE SURVEY

1.**Sarah N. Abdulkader *, Ayman Atia, Mostafa-Sami M. Mostafa Brain computer interfacing: Applications and challenges HCI-LAB, Department of Computer Science, Faculty of Computers and Information, Helwan University, Cairo, Egypt Egyptian Informatics Journal (2015) 16, 213230**

Brain signals reflect the took care of exercises and controlling conduct of the cerebrum or the impact of the got data from other body parts either detecting or inward organs. Cerebrum Computer Interfacing gives a directing office amongst cerebrum and outside gear. BCI applications have pulled in the examination group. A few examinations have been exhibited in this paper with respect to the developing enthusiasm for BCI application fields, for example, therapeutic,
authoritative, transportation, amusements and stimulation, and security and verification fields.It additionally exhibits the different gadgets utilized for catching mind signals. These chronicle gadgets are separated into two principle classes: obtrusive and non-intrusive. Obtrusive class,which requires embedding surgery, is typically required for basic incapacitated circumstances due to their higher exactness rates accomplished either spatially or transiently. Then again,
the non-obtrusive class, as said beforehand, has been broadly spread in other application fields because of its points of interest over the obtrusive one. Different difficulties and issues acted like a consequence of using cerebrum signals have additionally been examined along with a few arrangements offered by various calculations at different BCI handling segments.

2**. Jan B.F. Van Erp, Fabien Lotte, Michael Tangermann Brain-Computer Interfaces: Beyond Medical Applications https://hal.inria.fr/hal-00688344/document**

Brain-Computer Interfaces (BCIs) convey the guarantee of normal and instinctive human computer interaction. BCI innovation has developed to the degree that it is accessible for home utilize. While most BCI innovation was produced for therapeutic applications, they Distinguish 7 non-medicinal applications including gadget control, client state observing and gaming. They rate these on among others societal effect and time to advertise. Leaps forward are required in the zones of ease of use, equipment and programming, and framework reconciliation, however for fruitful improvement ought to likewise consider client qualities and acknowledgment. They talk about territories of concern like the absence of institutionalization and give 10 proposals to push the field forward.

3. **Pravin M Shende ,Vaishali S Jabade Literature Review of Brain Computer Interface(BCI) UsingElectroencephalogram Signal International Conference on Pervasive Computing (ICPC) - 1-4799-6272-3/15/$31.00(c)2015 IEEE**

In the field of BCI framework designing the principle point is to altering the human computer interaction future with exponentially expanding the results in many number of fields. In this writing audit the talk of novel framework like ECoG and EEG based BCI and the technique with some confinement is done, likewise the procedure isn't limited to the stream of modules of just a single BCI application it is investigate with the these days framework criteria.
There are some framework which talked about depend on the evoked potential, for example,SSVEP based and VCP based which has a few challenges in client preparing and absence of look control issues. As contrast with other module the flag procurement and flag preparing are generally easy to execute with the assistance of classifier which are broadly utilized. There area few wants from the client and BCI framework, for example, long haul preparing of the client
for evaluated EEG flag, framework ought to have the enhance flag preparing unit to deal with 6 low quality flag and advancement of exact EEG flag square to such an extent that it can permit the reenactment based investigation.

3. PROPOSED SYSTEM

When any person touches are body we immediately respond to it because our brain generates response with the help of neurons that are floating here and there in our brain.These neurons collide and generates a pulse that can senseThese electric pulse or waves that are captured by the EEG headset using Electroencephalography ,and Mu Rhythms algorithm using Bluetooth are sent to the computer to convert analog signal to discrete signal by the electric circuit which we created.On this signal further process can be done using different algorithms for mouse cursor control.

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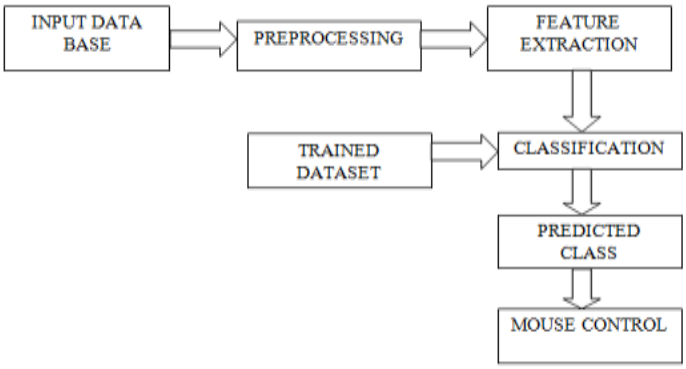

Fig 2: Block Diagram of Proposed System

The real objective of BCI inquire about is to build up a framework that enables crippled individuals to speak with different people and communicates with the outer situations. We show a framework that uses the human capacity to control a cursor on a screen utilizing electroencephalographic (EEG) Mu rhythms. The signs were acquired utilizing a uniquely planned terminal top and gear, and sent through a Bluetooth association with a PC that procedures it progressively. The flag was then mapped onto two control signs and this flag is changed over to development of cursor.

4. WORKING OF PROPOSED SYSTEM

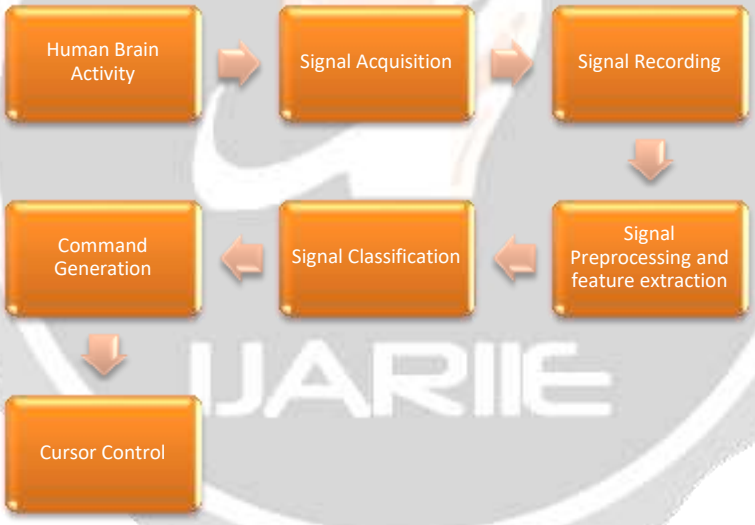

Fig 3: Architecture of Proposed System

Following steps are carried out for obtaining the desired output:

Training: In this we take sample of 2-3 persons and check the cursor movement in each direction top, left right, bottom. Each sample taken in all are 20 in each direction. This training data is recorded.

Preprocessing: Out of the 2-3 person the sample of one person will be selected to obtain the training data .After the recording of signal a graph will be generated in any manner depending on the thinking of the person to remove the baseline to make perfect graph that is easily understandable. For preprocessing of signal we are using Zero Phase Low Pass Filter Algorithm.

Feature Extraction: We extract the feature from this graph based on time and frequency .For this we are using Discrete Wavelet Transform Algorithm and to determine the movement of the cursor we are using Mean, Standard, Kurtosis, Skewness.

Classification: Here we are classifying the outputs that are obtained .For this we are using Minimum Distance Classifier Algorithm and K-nearest Neighbor Algorithm.

Predict Class: The class can be predicted on the basis of the values that are obtained using calculation. There are set limit of these values. If the values are between this limit then the movement of cursor is done in the following direction right ,left, bottom ,up respectively.

Mouse Control: According to the predict class the following result is obtained ie. up, bottom, right, left.

5. ALGORITHMS

A. Matlab Software Tools Use:

Signals are ubiquitous across many research and development domains. Engineers and scientists need to process analyze and extract information from time domain date as part of their day to day responsibilities.

In range of predictive analytics applications, signals are the raw data machine learning system must be able to leverage for the purpose of creating understanding and for informing decision making.

We use consolidated signal processing methods to extract fairly small number of highly-description features and we finally train a small neural network to map the feature vector in to six different activity algorithm on a prerecorded dataset. This is how the matlab and library functions can help for deliver functions can help for deliver high performance results.

B Zero Phase Low Pass Filter

A zero phase filter is a special case of a linear phase filter in which the phase slope is $\alpha = 0$. The real impulse response $h(n)$ of a zero-phase filter is *even*. That is, it satisfies

$$h(n) = h(-n), \quad n \in \mathbf{Z}$$

Note that every even signal symmetric, but not every symmetric signal is even. To be even, it must be symmetric about time 0. A *zero-phase filter cannot be casual(*except in the trivial case when the filter is a constant scale factor $h(n) = g\delta(n)$). However, in many ``off-line" applications, such as when filtering a sound file on a computer disk, causality is not a requirement, and zero-phase filters are often preferred.

It is a well known Fourier symmetry that *real, even signals have real, even Fourier Transform*. Therefore,

a real, even impulse response corresponds to a real, even frequency response.

This follows immediately from writing the DTFT of h in terms of a cosine and sine transform:

$$H(e^{j\omega T}) = \omega_T(h) = \sum_{n=-\infty}^{\infty} h(n)\cos(\omega nT) - j\sum_{n=-\infty}^{\infty} h(n)\sin(\omega nT)$$

DTFT

Since h is even, cosine is even, and sine is odd; and since even times even is even, and even times odd is odd; and since the sum over An odd function is zero, we have that

$$H(e^{j\omega T}) = \sum_{n=-\infty}^{\infty} h(n)\cos(\omega nT)$$

for any real, even impulse-response h. Thus, the frequency response $H(e^{j\omega T})$ is a real,even fumction of ω.

A real frequency response has phase zero when it is positive, and phase π when it is negative. Therefore, we define a *zero-phase filter* as follows:

A filter is said to be *zero phase* when its frequency response $H(e^{j\omega T})$ is a real and even function of radian frequency ω, and when $H(e^{j\omega T}) > 0$ in the filter passband(s).

Recall from that a passband is defined as a frequency band that is ``passed" by the filter, *i.e.*, the filter is not designed to minimize signal amplitude in the band. For example, in a low pass filter with cut-off frequency ω_c rad/s, the passband is $\omega \in [-\omega_c, \omega_c]$.

π -Phase Filters

Under our definition, a zero phase filter always has a real, even impulse response [$h(n) = h(-n)$], but not every real, even, impulse response is a zero phase filter. For example, if $h(n)$ is zero phase, then $-h(n)$ is not; however, we could call $-h(n)$ a ``π-phase filter" if we like (a zero-phase filter in series with a sign inversion).

C Discrete Wavelet Transform

Steps of Discrete Wavelet Transform

Wavelets are frequently used to de commotion two dimensional signs, for example, pictures. The accompanying illustration gives three stages to expel undesirable white Gaussian clamor from the loud picture appeared. Matlab was utilized to import and channel the picture.

The initial step is to pick a wavelet sort, and a level N of deterioration. For this situation biorthogonal 3.5 wavelets were picked with a level N of 10. Biorthogonal wavelets are regularly utilized as a part of picture handling to distinguish and channel white Gaussian noise, due to their high complexity of neighboring pixel power esteems. Utilizing this wavelets a wavelet change is performed on the two dimensional picture.

Following the decay of the picture document, the subsequent stage is to decide edge esteems for each level from 1 to N. Birgé-Massart methodology is a genuinely regular technique for choosing these limits. Utilizing this procedure singular edges are made for N = 10 levels. Applying these edges are most of the genuine separating of the flag.

The last advance is to remake the picture from the changed levels. This is proficient utilizing an opposite wavelet change. The subsequent picture, with white Gaussian commotion expelled is appeared beneath the first picture. While separating any type of information it is essential to evaluate the flag to-clamor proportion of the outcome. For this situation, the SNR of the uproarious picture in contrast with the first was 30.4958%, and the SNR of the denoised picture is 32.5525%. The subsequent change of the wavelet separating is a SNR pick up of 2.0567%. It is vital to take note of that picking different wavelets, levels, and thresholding procedures can bring about various sorts of sifting. In this case, white Gaussian clamor was been evacuated. In spite of the fact that, with various thresholding, it could simply have been opened up.

The main purpose of the DWT is to decomposes the recorded EEG signal into multi-resoltion subsets of coefficents: a detailed coefficient subset (cDi) and an approximation coefficient subset(cAi) at the level i.so,at the first decomposition level we obtain cD1 and cA1 then the first approximation cA1 can be transformed into cD2 and cA2 at the second level and so on.

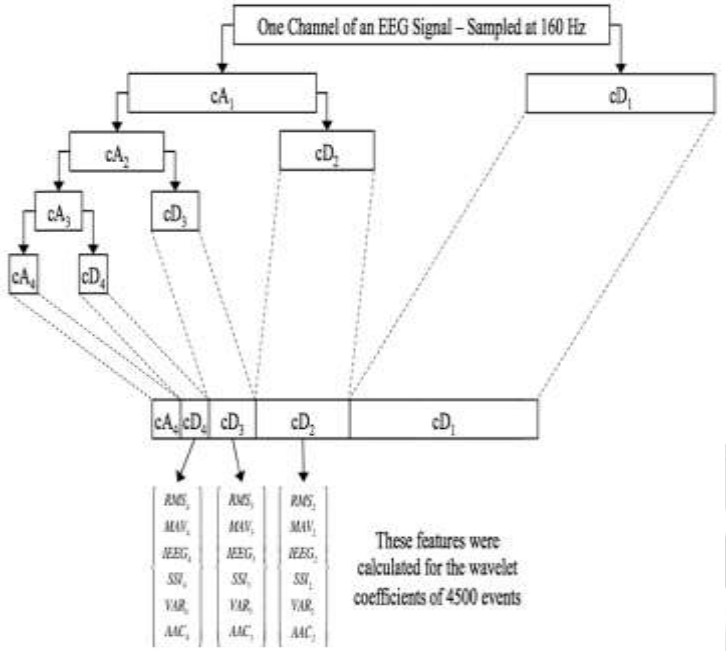

Figure 3. Feature Extraction by the multi-resolution decomposition of EEG signals

The wavelet transformation of any EEG record at four levels results in four details and one approximation with the frequency ranges listed in table.there are many electrophysiological features that are associated with the brain normal motor output channel.some of the important features are the mu(8-1hz) and beta(13-30hz) rhythms.

Table 1. Frequency range for the decomposed details and approximation

Signal Component	Frequency Range
cD_1	40 – 80 Hz
cD_2	20 – 40 Hz
cD_3	10 – 20 Hz
cD_4	5 – 10 Hz
cA_4	0 – 5 Hz

Phinyomark et al. (2013) provided the mathematical definitions of many amplitude estimators for neurological activities. If we assume that the n^{th} sample of a wavelet decomposed detail at level i is $D_i(n)$, then we can define the following features:

- Root Mean Square (RMS)

$$RMS_i = \sqrt{\frac{1}{N}\sum_{n=1}^{N} D_i^2(n)} \quad (1)$$

- Mean Absolute Value (MAV)

$$MAV_i = \frac{1}{N}\sum_{n=1}^{N} |D_i(n)| \quad (2)$$

- Integrated EEG (IEEG)

$$IEEG_i = \sum_{n=1}^{N} |D_i(n)| \quad (3)$$

- Simple Square Integral (SSI)

$$SSI_i = \sum_{n=1}^{N} |D_i(n)|^2 \quad (4)$$

- Variance of EEG (VAR)

$$VAR_i = \frac{1}{N-1}\sum_{n=1}^{N} D_i^2(n) \quad (5)$$

- Average Amplitude Change (AAC)

$$AAC_i = \frac{1}{N}\sum_{n=1}^{N} |D_i(n+1) - D_i(n)| \quad (6)$$

D Minimum Distance Classifier

Universal MDM BCI Classifier

- Given a number of training trials Xz for each class z
$\in\{1,\ldots,Z\}$ do appropriate preprocessing,
estimate an appropriate form of covariance matrix Cz and estimate their Z class means M1 ,…, MZ.
- For unknown trial X do the same preprocessing, estimate the same form of covariance matrix C and assign to class k as per
argmin
$\delta\leftrightarrow$CM,
that is, to the class which mean is the closest to the covariance matrix, according to distance
Rδ.

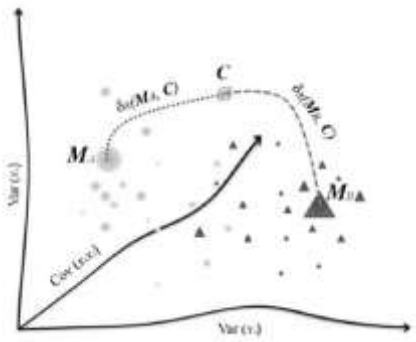

Figure: The Minimum Distance to Mean (MDM) Classifier. We illustrate the MDM algorithm with the example of 2x2 covariance matrices and two classes, labeled A and B. 2x2 covariance matrices have three non-redundant elements, which are the variance of the two process x1(t) and x2(t) and their

covariance. We may then represent each covariance matrix as a point in 3D-space. The training (labeled) trials for class A are represented as spheres and for class B as pyramids. Given two geometric means MA and MB and un unlabeled trial with covariance matrix C (represented as a cube in the figure), the algorithm assigns the trial to the class which mean is the closest, according to an appropriate distance measure δR. The distance measure is not linear, as can be appreciated in Appendix A. This is represented figuratively by curved lines in the figure. The MDM algorithm acts exactly in the same way for whatever dimension of the covariance matrices and whatever number of classes.

This is the simplest classification method one can think of and known as minimum distance classifier (MDM). The classification algorithm is illustrated in fig. 2 for the case of a two-class BCI (Z=2). It works exactly in the same way for whatever number of classes. As it is well known, defining the mean as the arithmetic mean and the distance as the Euclidean distance yields are better classification accuracy.

6. CONCLUSION

The BCI is used to provide the communication between the computer systems i.e. smart system and the human brain . Here we are proposing a system using which the mouse of the computer will be operated on the EEG signals. The system is very efficient than the others system.

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