IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 8, Issue 8, August 2020

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.488

9940 572 462 | 6381 907 438 | ijircce@gmail.com | www.ijircce.com

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | Impact Factor: 7.488 |

|| Volume 8, Issue 8, August 2020 ||

Classifying Action Based on Features of Higher Order Statistics from EEG Signal in BCI Using Support Vector Machine

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ABSTRACT: In the field of bio-medical, the brain interface is to make and adapt methods of human-computer Interaction. This is Brain–Computer Interfaces (BCI). An assortment of use spaces to think about and approve BCI collaboration, including correspondence, natural control, neural prosthetics and innovative articulation. Electroencephalograph (EEG) signals acts as a communication between men and machines. The BCI-based control framework for robots utilizing the EEG has been recommended for versatile robots and humanoids, and some different machines to control. In this undertaking we do the control interface to decipher. Human goals into proper movement directions for mechanical frameworks. The experimental procedures consist of extraction of EEG signals, optimizing the exact signal and machine control

KEYWORDS: Brain-Computer Interfaces (BCI), Electroencephalograph (EEG), Support Vector Machine (SVM)

I. INTRODUCTION

Brain-computer interface (BCI) is a fast-growing emergent technology, in which researchers aim to build a direct channel between the human brain and the computer.Many of the people suffer from neuromuscular disorders such as amyotrophic lateral sclerosis (ALS), spinal cord injury, brainstem stroke and many other disorders responsible for causing the loss of voluntary muscle control. Such people are often locked in a wheelchair or on a bed unable to move their limbs or go anywhere they would like to go by themselves.

They have to face great barriers in the modern society due to their disabilities and deprivation of common activities like interacting or playing games with other people, activities that are crucial for personal development and have a significant impact on the quality of life. Those with a lack of motor skills would benefit enormously from devices that can augment their mobility. Over the last few years, the state of the art technology known as the -Computer Interface (BCI) has become more and more accessible to the wider public and it is our moral responsibility to use such technologies in order to lift these barriers and give disabled people a chance to regain a normal life.

There has been a lot of work in this direction during the past few years where researchers have tried innovative solutions for developing a user-friendly and easy to use assistive systems for controlling a system. In 2012, Yipeng et al designed a BCI system that was using motor imagery (MI) signals acquired from thinking left, thinking right and thinking push combined with the artefact signals from eye blinking and tooth clenching in order to control an AR system. A different setup was suggested by Byung et al, where a hybrid interface was used.

In their study, the system was controlled by using a low-cost electroencephalogram (EEG) headset together with an eye- tracking device. Although the BCI systems presented by previous authors come as affordable solutions for those who want to control a system with their minds, the same studies have confirmed that BCI systems based on motor imagery commands are susceptible to artefacts like inappropriate eye blinking or muscle activity.

II. RELATED WORK

In this section, we have discussed different papers referred, based on ECG Signals using various techniques.

In this paper [1] has studied grouping calculations used to configuration Brain-Computer Interfaces (BCI). These calculations were separated into five classifications: direct classifiers, neural systems, nonlinear Bayesian classifiers, closest neighbor classifiers and bl ends of classifiers. The outcomes they acquired, in a BCI setting, have been broke down and contrasted all together with give the perusers rules to pick or structure a classifier for a BCI framework. More or less, it appears that SVM are especially proficient for synchronous BCI. This presumably is because of their regularization property and their insusceptibility to the scourge of-dimensionality.

S.-A. Chen, C.-H. Chen, J.-W. Lin et al. proposed a wireless EEG and EOG BCI system for detecting eye movements in 9 directions. This system is capable of transmitting EEG and EOG signals wirelessly to a computer, where the signals will be processed and classified. Compared with other eye movement detection methods, no more electrodes are needed in our system to extract EEG signals. For testing the performance of the proposed system, a baseball game was designed. The results demonstrated good classification accuracy with 9 directions. Also, the users can easily play the BCI game and have fun with high accuracy [3].

Over the past 25 years, and especially in the recent 15 years, many productive BCI research programs have arisen. Because of its relatively low cost, high temporal resolution, and low clinic risk, EEG based BCIs are probably the best choice for a practical BCI. So far, many EEG-based prototypes have been demonstrated in laboratories such as: cursor control, visual keyboards, and mind controlled wheelchairs and prosthetics. These new innovations in neuroscience will be a milestone in human history. While we have only made a baby step into the world of bio-mechatronics, through this field we can slowly enter a world where there are no longer physically handicapped other than the most severely brain damaged. At the same time, the possibilities for use for augmentation of our abilities are also endless, as the barrier between our minds and our computers is weakened and finally broken.

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In another work Bell CJ1, Shenoy P, Chalodhorn R et al. [5] Controlling a cursor and spelling a word, however it has been viewed as a far-fetched possibility for increasingly complex types of control attributable to its low motion toward clamor proportion. Here they show that by utilizing progresses in apply autonomy, an interface dependent on EEG can be utilized to order an in part self-ruling humanoid robot to perform complex errands, for example, strolling to explicit areas and getting wanted articles. Visual criticism from the robot's cameras permits the client to choose subjective articles in the earth forget and transport to picked areas. Results from an examination including nine clients show that a direction for the robot can be chosen from four potential decisions in 5 s with 95% precision.

In [6] Brain-computer interface combining eye saccade two electrode EEG signals and voice cues to improve the ability of wheelchair. A two electrode EEG system combining eye movement classification and a voice-menu. Eye movements are used to access a voice menu giving voice cues, which is proposed used in a system to control several things such as wheelchairs, TV, smart lights and smart doors. There are in total four classes: Looking straight, looking to the right, looking to the left and blinking. Feature extraction is done with a method called Independent Component Analysis (ICA), while classification is performed with two machine learning algorithms: Support Vector Machine (SVM) and K-Nearest Neighbours (KNN).

In this paper [7] author presents a low-complexity eye-classification scheme using a self-made algorithm instead of machine learning. The directions classified are right-glancing, left-glancing, up-glancing and down-glancing. The electrode placements used are F7 and F8 for right and left glances, while AF3 and AF4 are used for up and down glances. A low complexity Extended Moving Difference filter is used as edge detection, with Pulse Width Modulation (PWM) and demodulation used to differentiate between the movements and blinks.

Here [8] author presents a way to classify the up, left, right and down by using 19 channels. Normalization is performed to remove the DC offset present in the electrodes, and Fast Fourier Transform (FFT) is used on the normalized signal to exclude frequencies outside the $0 - 42$ Hz range. A total of 78 features are presented based on four different properties.

In this[9] author presents a system using an Auto Regression (AR) model with a neural network to distinguish looking straight ahead, blinking, looking to the left and right. Data was recorded through 3 channels (Fp1, F7, F8) and an AR model of second order was used where two coefficients were calculated for each channel resulting in a total of 6 features.

This paper [10] created a GUI solution with a moving ball to instruct the test subjects. Electrode placements are F7 and F8 and the recorded signal is then filtered with a band pass filter from 0.5 to 100 Hz using an 8th order Butterworth filter and a 4th order notch filter with stop band from 48 to 52 Hz. Feature extraction is performed by wavelet transform and classification is done with a self-designed algorithm with six classes. The classes were up, down, left, right, straight, and blink. They achieved an online average accuracy of 85percent.

III. PROPOSED ALGORITHM

A. *Design Considerations:*

- Step 1:- Plotting the Point in N Dimensional Space
- Step 2:- Point Segregation
- Step 3:- Hyperplane Possibility
- Step 4:- Hyperplane with maximum margin
- Step 5:- Multi Dimensional Space in SVM
- Step 6:- Prediction

B. *Description of the Proposed Algorithm:*

The objective of this work is to control a system using EEG signal. The task includes creating a dataset of EEG recordings while test subjects performs a set of movements, and to use machine learning classification to differentiate between the movements. Through proof of concept, the classification should be implemented in real-time allowing the classifier to be used as part of a real-world control application

IV. METHODOLOGY

Stage 1: EEG signals contain increasingly significant data about mind issue and various kinds of relics. Signals as dataset are as ofnow stacked to the apparatus so we will utilize that signs to plot the information and representation of the time-recurrence space plots which can be shown all together.

Stage 2: Basically we will screen the EEG signals as indicated by the arrangement of anodes which is called montages. After thatwe will watch the EEG signs to perceive and dispense with various illness related antiquities. At that point undesirable signwill be subtracted by differential enhancer.

Stage 3: Finally we will continue for the sign separating dependent on the various sorts of brainwave frequencies tofinding and mimic assortment of mind issue by utilizing Python

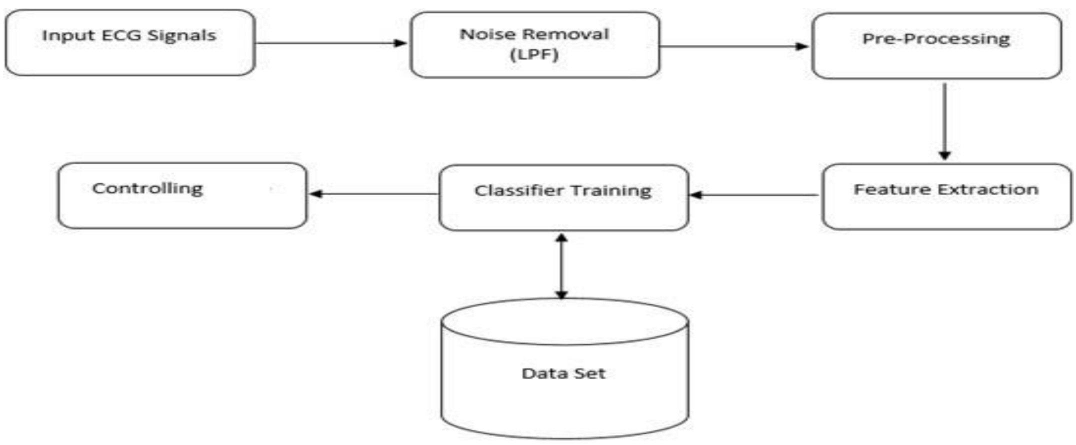


Fig 1: System Architecture

V. PSEUDO CODE

Step 1: Generate all the possible routes.
Step 2: Calculate the TE_{node} for each node of each route using eq. (1).
Step 3: Check the below condition for each route till no route is available to transmit the packet.

```
    if (RBE < = TEnode)
        Make the node into sleep mode.
    else
        Select all the routes which have active nodes
    end
```

Step 4: Calculate the total transmission energy for all the selected routes using eq. (2).
Step 5: Select the energy efficient route on the basis of minimum total transmission energy of the route.
Step 6: Calculate the RBE for each node of the selected route using eq. (3).
Step 7: go to step 3.
Step 8: End.

VI. SIMULATION RESULTS

The simulation involves to evaluate the performance of the BCI framework proposed in this paper, a situation was made where each subject needed to control the drone on a predefined way. The order succession was utilized during the test trials. The subjects were told to look at one boost at a time. The subject needed to change their look to the following boost in the grouping. As indicated by the input got from the BCI framework the orders were classified as Correct (C), Incorrect (I) or Not Recognized (ND). In this investigation, the BCI framework accomplished accuracy of 94 percent across ten subjects. The outcomes obtained from the subjects used in the assessment phase of the BCI framework is outlined in Table below. The table presents the time elapsed, the number of command and output sent by the BCI framework to the drone. The current work presents a review of the application areas that may use of EEG based BCI technology to assist in achieving their tasks and purpose. The scope of work emphasizes medical and biomedical engineering application areas, with a focus on researches in the field of brain controlled robotic systems; classification, techniques, and tasks.

Subject	Time (s)	Commands		
		C	I	ND
1	62	8	0	24
2	60	8	2	22
3	124	7	0	51
4	118	7	0	45
5	100	8	1	32
6	78	7	0	70
7	156	8	1	34
8	140	6	0	62
9	84	8	2	38
10	92	7	1	38
Mean	101.4	7.4	0.72	41.6
Std. dev.	30.7	0.66	0.74	14.8

Table 1 : Results obtained by the subjects during the evaluation Process of the BCI system.

Fig 2 : Performance Comparison of Proposed System and Existing System

PERFORMANCE RESULT AND ANALYSIS

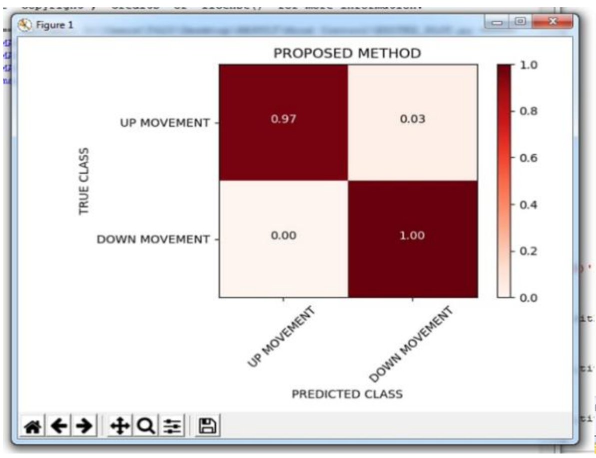


Fig 3 : Proposed Method

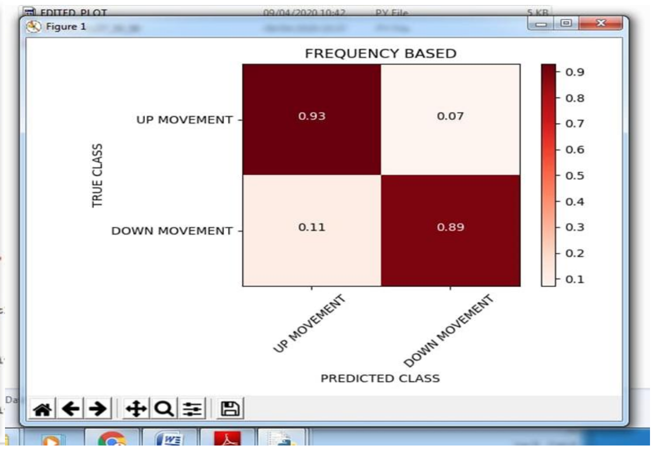


Fig 4 : Frequency Based

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | Impact Factor: 7.488 |

|| Volume 8, Issue 8, August 2020 ||

DETAIL COEFF , APPROX. COEFF AND SIGNAL AMPLITUDE

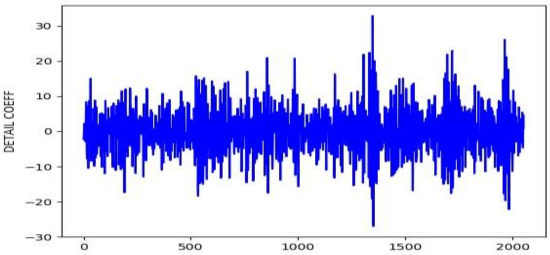


Fig 5 : Detail Coeff.

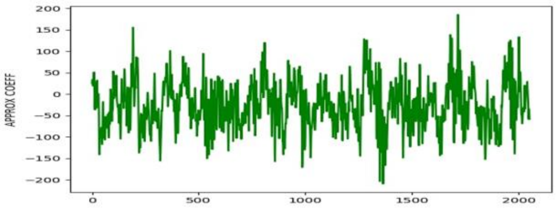


Fig 6 : Approx. Coeff.

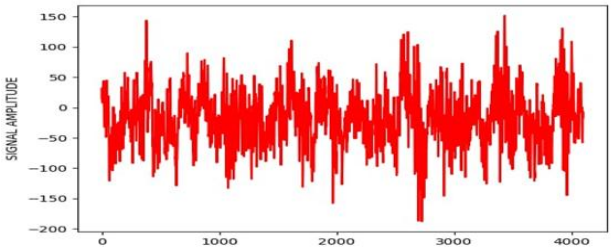
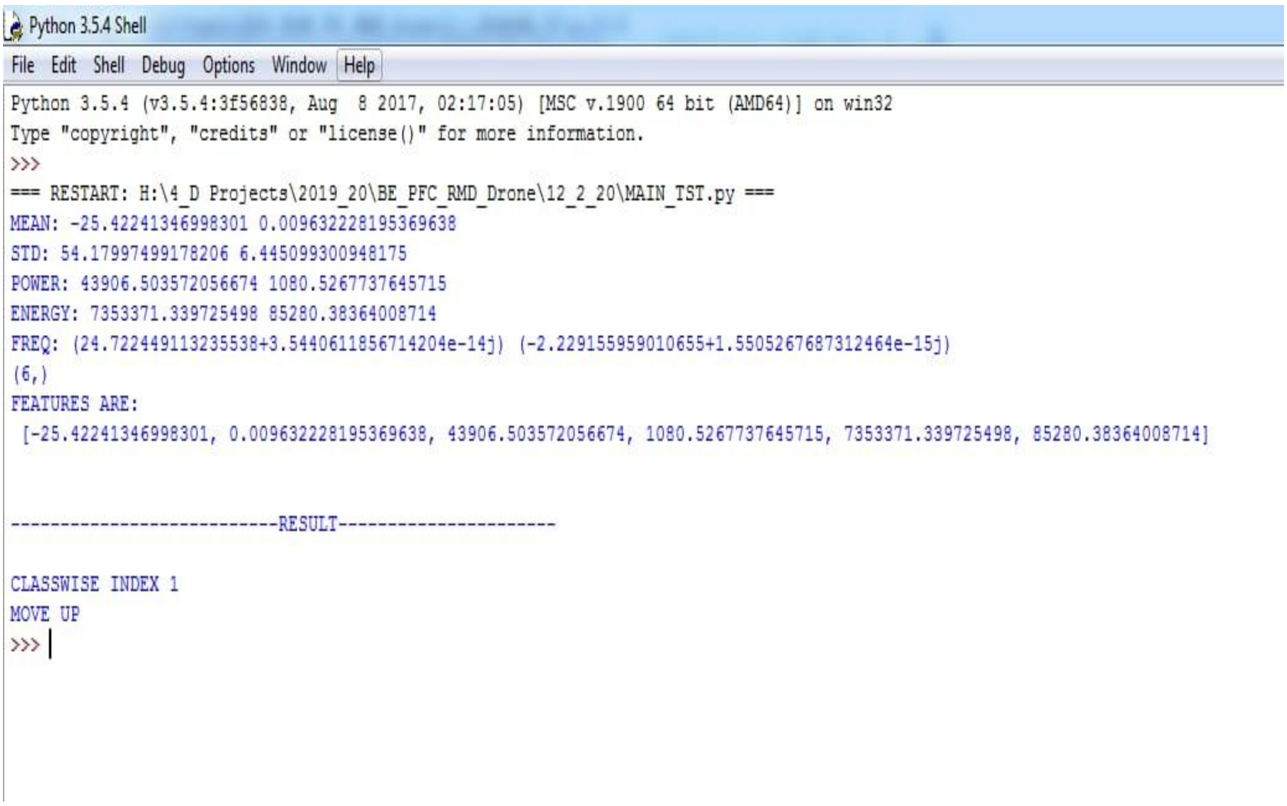


Fig 7 : Signal Amplitude

RESULT



```
Python 3.5.4 Shell
File Edit Shell Debug Options Window Help
Python 3.5.4 (v3.5.4:3f56838, Aug  8 2017, 02:17:05) [MSC v.1900 64 bit (AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
=== RESTART: H:\4_D Projects\2019_20\BE_PFC_RMD_Drone\12_2_20\MAIN_TST.py ===
MEAN: -25.42241346998301 0.009632228195369638
STD: 54.17997499178206 6.445099300948175
POWER: 43906.503572056674 1080.5267737645715
ENERGY: 7353371.339725498 85280.38364008714
FREQ: (24.722449113235538+3.5440611856714204e-14j) (-2.229155959010655+1.5505267687312464e-15j)
(6,)
FEATURES ARE:
 [-25.42241346998301, 0.009632228195369638, 43906.503572056674, 1080.5267737645715, 7353371.339725498, 85280.38364008714]


---------------------------RESULT----------------------

CLASSWISE INDEX 1
MOVE UP
>>>
```

VII. CONCLUSION AND FUTURE WORK

Brain actuated System control system which can serve as a platform to investigate a relationship between complex unmanned robot behaviors and human mental activities. This is the novel idea of controlling robots by mapping asynchronously high-level mental commands into a finite state automaton. This automaton is a key feature for the efficient control of the mobile robot. This type of new research lines are very promising in order to resolve the different open problems which are not satisfactorily solved with current techniques.This represents an attempt to control machines via brain signals. In this research, the goal is to control the direction (left or right) of the electric drone by EEG signals

In future system will be applicable in it industry. The data analysis and classification procedure is performed offline on the data collected through the user study. Future works will be aimed to address alternative procedures in order to allow online evaluation of the data

REFERENCES

[1] F. Lotte, M. Congedo, A. Lécuyer, F. Lamarche, and B. Arnaldi, "A review ofclassification algorithms for EEG-based brain–computer interfaces," Journal ofneural engineering, vol. 4, no. 2, p. R1, 2007

[2] S.-A. Chen, C.-H. Chen, J.-W. Lin, L.-W. Ko, and C.-T. Lin, "Gaming controlling via brain-computer interface using multiple physiological signals" in Systems, Man and Cybernetics (SMC), 2014 IEEE International Conference on. IEEE, 2014, pp. 3156–3159.

[3] S. Xing, R. McCardle, and S. Xie, "Reading the mind: the potential of electroencephalogram y in brain computer interfaces," in Mechatronics and Machine Vision in Practice (M2VIP), 2012 19th International Conference. IEEE, 2012, pp. 275–280.

[4] A. Mani Maran and S. Saravanan,"Artificial Neural Networks (Anns) For EEG Purging Using Wavelet Analysis", International Journal Of Electronics And Communication Engineering, pp. 563-570 ISSN 0974-2166 Volume 4, Number 5 (2011)

[5] Bell CJ1, Shenoy P, Chalodhorn R, Rao RP, "Control Of A Humanoid Robot By A Noninvasive Brain–Computer Interface In Humans", Journal Of Neural Engineering, 2008.

[6] Ker-Jiun Wang, Lan Zhang, Bo Luan, Hsiao-Wei Tung, Quanfeng Liu, Jiacheng Wei, Mingui Sun and Zhi-Hong Mao (2017).

[7] Chi-Hsuan Hsieh and Yuan-Hao Huang, "Low-Complexity EEG-Based Eye Movement Classification Using Extended Moving Difference Filter and Pulse Width Demodulation", International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), DOI: 10.1109/EMBC.2015.7320062, 2015

[8] Sherif M. Abdelfattah, Kathryn E. Merrick and Hussein A. Abbass, "Eye movements as information markers in EEG data", IEEE Symposium Series on Computational Intelligence (SSCI), 2016.

[9] Hai Thanh Nguyen, Nguyen Trung, Vo Toi and Van-Su Tran," An autoregressive Neural Network for Recognition of Eye Commands in an EEG- Controlled Wheelchair ", International Conference on Advanced Technologies for Communications , 2013

[10] Abdelkader Nasreddine Belkacem, Duk Shin, Hiroyuki Kambara, Natsue Yoshimura and Yasuharu Koike, "Online Classification Algorithm For Eye- Movement-Based Communication Systems Using Two Temporal EEG Sensors", Biomedical Signal Processing and Control , Volume 16, February 2015, Pages 40- 47.

BIOGRAPHY

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