Neurological Rehabilitation of Movement Disorder Based on Non-Invasive DBS

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Abstract— Non-invasive Deep Brain stimulation (DBS) is an effective method for treating the movement disorders such as Parkinson’s disease, essential tremor, dystonia, etc. Currently there are many treatments available for treating movement disorders but it may cause many side effects such as memory loss, occurrence of stroke and nerve problems. To overcome those side effects and minimizing the neurosurgical intervention of human, a non-invasive method is proposed for stimulating the deep brain. In this technique, minimum number of nerves which are co-related with hands and legs has been identified for stimulating the deep brain by using dual tree complex wavelet transform (DTCWT). By performing this segmentation process, the region affected by movement disorders are identified and the stimulation process is done by providing a force feed-back signal according to patient health in the form of non-invasive type with the help of physician.

Key words: Dual Tree Complex Wavelet Transforms, Non-Invasive DBS, Stimulation

I. INTRODUCTION

Movement disorders are neurological conditions that affect the speed, fluency, quality and easy of movements. Abnormal fluency or speed of movement may involve excessive or involuntary movement (hypertobesia) or slowed or absent voluntary movement (hypokinesia). Every body movement, from raising a hand to moving the hand in any of the directions, and also there is a complex involves central nervous system, muscles and nerves of the body.

Currently the treatments involved for recovering the movement disorders are meditations, Botulinum toxin injections, physical rehabilitation, etc. but it may cause some side effects such as memory loss, blurred vision, and depression. Another treatment involved for treating movement disorders is an invasive deep brain stimulation which is of surgical process may also cause some side effects such as spinal cord infection, occurrence of stroke and also its highly economical. To overcome those side effects and reduce the economic cost of the treatment new non-invasive deep brain stimulation is proposed to identify minimum number of nerves by dual tree complex wavelet transform.

In this paper, the section denoising removes the noise present in the image for obtaining clear output and the section image edge detection detects the edges of the outer part exactly for identifying the external parts and then the segmentation process and nerve identification is carried for identifying the affected area and the nerve for rectifying the patients respectively.

II. RELATED WORK

Invasive Deep Brain Stimulation (DBS) mechanism is performed through surgical in many ways for recovering the patients who are affected by movement disorders. Adaptive deep brain stimulation mechanism as in [1] is done with the help of bipolar local field potential. By performing this surgical process the patients get recovered but it is highly economical. Brain Machine Interface (BMI) as in [2] is another technique which uses decoder algorithm to convert neural activity of the patients into control signals for an external actuators to attain a feedback signal created by the closed loop feedback system. To overcome the disadvantages in BMI, a closed loop decoder adaptation algorithm is proposed for surgical process in which the neural activity are recorded and it is converted into control signal and then it is fed into prosthesis device. In this algorithm Bayesian regression to self-train the decoder and it’s again fed to actuator for stimulation process. The Bayesian regression uses two statistical formulations; fast and exact interference are allowed with the help of a joint formulation and a factorized formulation that, allows the addition and temporary omission of neurons as in [3]. By using nth order unscented Kalman filter, the decoder and parameter update system simultaneously predicts the BMI user’s desired movements and tracks tuning changes in the user’s neuronal modulation. The adaptive decoding accuracy is improved with the number of tuned neurons including any recently changed neurons. The larger ratio of unchanged neurons to the changed neurons results the more accurate decoder output.

The adaptive closed-loop deep brain stimulation based on local field potential (LFP) as in [4] describes a system for treating movement disorder by means of adaptive electro-stimulation able to detect bio potentials from stimulating electrode. The LFP connected with the electrode are measured with a standard electrode with one or two contacts on the implanted DBS electrode for measuring bipolar signal and monopolar signal. As compared with the open-loop adaptive deep brain stimulation the closed-loop adaptive deep brain stimulation automatically adjust the stimulation parameter as in [5] to achieve the motor symptoms reduction based on the feedback signal recorded from the brain with the help of DBS electrodes as implanted for stimulation. At both low (20 Hz) and high frequency (130 Hz), the performance of the closed-loop stimulation was better than that of open-loop stimulation since the open-loop stimulation cannot restores the neural activity of the patients.

Even though the closed loop stimulation mechanism process provides a tremendous change in the treatment of movement disorder it may causes some effects...
such as occurrences of stokes, spinal cord infection, memory loss, nerves problem. To overcome these side effects, a new technique which is entirely different from the above mentioned mechanism is proposed and to reduce the economic cost of the treatment.

III. PROPOSED SYSTEM

In this paper, non-invasive deep brain stimulation is proposed for rehabilitating the movement disorders patient’s without any surgical process. The process involved in this mechanism is segmenting the nerve area which is co-related with affected hands and legs using dual tree complex wavelet transform (DTCWT). With the help of physician, feed-back signal obtained according to the patient’s health is stimulated to the segmented area in the form of non-invasive type.

A. Non-Invasive DBS:

Normally invasive deep brain stimulation is the process of surgical mechanism for stimulating the particular area co-related with affected part. Whereas in non-invasive DBS is the process of treating the movement disorder patients without breaking the skin or organ for diagnosis purpose. Here, the feedback signal is applied directly to segmented area of the brain which is obtained from the patient’s body with the help of physicians through multi input multi output module.

B. Image Acquisition:

The image related to the movement disorders patient are obtained from the scan center. With the help of the obtained image the rehabilitating mechanism are carried out for identifying the affected area in brain. The acquired images are in the form of SPECT image which is shown in Fig.1

![Fig. 1: SPECT Brain Image](image)

C. Preprocessing:

Normally the images obtained from scan center or hospital is in the form of JPEG, PNG, SPECT types may contain noise, low-frequency, reflections, background noise etc. Before involving image segmentation process the should be preprocessed for removing lower frequencies present in the images, background noises and removal of reflections and also normalizing the intensity present in the image particles. The preprocessing stage involves image denoising, image edge detection and then image enhancement.

1) Image Denoising:

In Gaussian noise, each pixel in the image will be changed from its original value by a small amount of pixel value. In histogram, a plot of the amount of distortion of a pixel value against the frequency with which it occurs, shows a normal distribution of noise. While other distributions are possible, the Gaussian (normal) distribution is usually a good model, due to the central limit theorem that says that the sum of different noises tends to approach a Gaussian distribution.

![Fig. 2: Gaussian Noise](image)

2) Image Edge Detection:

Various edge detection algorithms are used for detecting the wide edges, accurate edge detection at the borders.

![Fig. 3: Wiener Output](image)

![Fig. 3: Image Edge Detection](image)

Mainly by using Sobel operator, Prewitt operator, Roberts operator, Canny edge detector detects the edges of the images accurately. The sobel operator emphasizes edges and transitions it is a discrete differentiation operator and prewitt operator is based on convolving process for detecting outer edges of the images. The Roberts operator works in the principle of discrete differentiation and canny edge detector is based on multi stage algorithm for finding wide edge of the image.

3) Image Enhancement:

The image enhancement process involves image histogram which acts as a graphical representation of tonal distribution process for plotting the number of pixels in the tonal value. By considering the histogram of the image there is a possible of judging the total distribution of that particular image. The frequent intensity value are spread all over with the help of histogram equalization. The histogram image of our result is shown in Fig.4

![Fig. 4: Image Enhancement](image)
4) **Image Segmentation:**

Image segmentation process is done with the help of Dual-Tree Complex Wavelet Transform (DTCWT) for calculating the complex transform with the help of two separate decompositions. The DTCWT uses filters in the lower and upper DWT which calculates the real and imaginary values with the help of two separate sub band signals. The segmented output image of the movement disorders patient for identifying the area of the affected region is shown in Fig.5.

5) **Nerve Identification:**

With the help of morphological extraction algorithm the nerve identification process is done for identifying the shape features in the image. This algorithm is used to extract the imperfections of the morphological operation. The dilation and erosion process of the morphological extraction are the basic elementary of many algorithms which deals with binary image for representing the extracted image and the description of the shape. This nerve identification process clearly identifies the affected nerve of the patients which causes movement disorders. The morphological extraction of the patient image is shown in Fig.6.

IV. **RESULT AND CONCLUSION**

From the result of the morphological extraction and the segmented output of the patient’s brain image the affected area of the brain is easily determined and affected nerve which is co-related with the legs and hands of the patients are identified clearly. After this identification, the nerves are treated by applying force-feedback signal with the help of physicians using multi input multi output devices. In future, the signal is applied to the brain directly by obtaining the signal from inside the body of the patients.

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**REFERENCE**


