Investigation on Different Filters and Different Frequency Bands for Brain Computer Interface with Right Hand and Left Hand Imaginations

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Abstract - For severely paralyzed people, Brain Computer Interface (BCI) is the only option to communicate. For BCI at least left hand and right hand imagination have to be identified. This paper investigates the region of frequency band and the filter type that provide significant separation between left hand and right hand imagination. For this analysis C3 and C4 channels of 59 channel system Electroencephalogram (EEG) are used. It is found that 5-10Hz band of C3 and C4 provides significant separation. Further, Chebychev type II filter emphasise the separation between left hand and right hand imagination and C4 have shown higher separation than C3.

Index terms - Brain Computer Interface (BCI), Electro-encephalogram (EEG), Event-Related Desynchronization (ERD), Event-Related Synchronization (ERS), Infinite Impulse Response (IIR), Discrete Fourier Transform (DFT), Amyotrophic lateral sclerosis (ALS)

I. Introduction

Some disease can really cause severely paralyzed condition called the locked-in syndrome[1], where the patient loses all voluntary muscle control. An example of such kind of disease is Amyotrophic Lateral Sclerosis (ALS)[1]. The ALS only affects the integral part of the motor pathways contain special neurons, the large alpha motor neurons[1]. In the beginning stage of ALS it only cause muscle weakness and atrophy. When it is developing further, the patient may lose the ability of voluntary actions, such as speaking, eating, moving and breathing, progressively. Despite, the patient can still see, hear, and understand what is occurring around them, because the disease does not attack cognitive and sensory functions[1].

Those who lost the motor pathway, any natural way of interaction (since they can understand what is happening around them) with the environment are lost as well. The only option for communication in such cases is BCI. BCI is a communication channel which does not rely on the brain's normal output pathways of peripheral nerves and muscles. So it gives an opportunity to supply paralyzed patients with a new approach to interact with the environment[1].

In order to do that, first the brain signals of a healthy subject are used to train and analyse, then to implement the system on paralyzed subjects. This will avoid delays related to train the paralysed subject.

There are three main brain monitoring methods namely invasive, partially invasive and non-invasive. In non-invasive method, there are different neuron signal imagings or reading techniques such as Magneto encephalography, Magnetic resonance imaging, functional magnetic resonance imaging and electroencephalogram (EEG). Among those EEG is the main interest due to its advantages such as low cost, convenient operation and non-invasiveness.

Further monitoring the effects on the signal is related to what was attempted or what was thought by the subject. One possibility to open a communication channel for these patients is to use EEG signals to control an assistive device that allows, for example, the selection of letters on a screen of brain–computer interface (BCI) devise[2]. Towards the direction of using BCI to interact with the subject at least left hand and right hand imagination (motor imagery) have to be used in order to find what the subject is thinking. As shown in Fig .I the imagination of a limb (arm or leg of a person) movement can modify brain electrical activity similar to actual limb motion [3]. Depending on the type of motor imagery, different EEG patterns can be obtained. Activation of hand area neurons either by preparation for a real movement or by imagination of the movement is accompanied by a circumscribed event-related