

Biomedical applications in central nerve systems

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Abstract

Key Words:

1 INTRODUCTION

Fundamentally human beings need communications it involves listening and speaking, conversely cruel neurological disorders; brain stem stroke, amyotrophic lateral sclerosis, etc. Limit a persons potential to communicate thoughts, emotions, and fundamental needs. That kind of patients typically vigorous brain with brain activities is normal (Gandhi et al., 2011), relyon alternative ways of communications. Several efforts from 1960 onwards machine learning methods for analyzing bio signals effort physician with fast and exact diagnosis. Researchers are emphasized symbiotic relationship potential between human and computer (Licklider, 1960). Based on symbiotic relationship brain computer interface (BCI) developed for the purpose of neuronal activity interprets, direct communications.

The neuronal activities in brain electrical signals are generated for communication purposes BCI used. Due to low measurement cost, EEG signals are widely used for brain status analysis, its high resolution and non invasive nature (Wolpaw and Wolpaw, 2012). Dissimilar brain regions are conscientious for diverse tasks of the body. As diverse brain regions are responsible for different tasks of the body, neurological in turn can be utilized to determine the relevant brain region(s) for a given task. For example, C3 and C4 electrodes are well known for brain locations for the discovery of the supply motor imagery. Nevertheless, significant brain region(s) may vary depending on the specified tasks (Dornhege, 2007). Hence, in attendance is require to mechanically discover relevancy of brain region(s) for a given motor images task.

2 Brain and machine interface (BMI)

Brain-machine interfaces provides innovative approaches, BMI detects motor intent from the user brain activities, due to external device translates into executable action performance, such as robotic arm and computer cursor (Thakor, 2013). It works based on neural activities principle; associated with intended trajectories movements. BMI works on the principle that neural activities in the brain are associated with intended movement trakectories, even actual movement of absence. Through advanced computer algorithms the multichannel neural indication recorded and it interpret

these neuronal actions into executable cruise information (Wessberg, 2000), based on neural information accuracy and resolution transfer. Neural activity detection different range of techniques used it includes magnetic, optical, electrical recordings.

Electroencephalogram (EEG) neural signals records noninvasively, in human subjects electrodes can record μ (8-12 Hz), β (12-30 Hz) and γ (30-100 Hz), correlate frequency bands (Nicolas-Alonso and Gomez-Gil, 2012), through P300 signals evoked through event stimuli (Yuan and He, 2014). Due to its placement of scalp EEG recordings can capture ambient artifacts and noise, signals in neural system travels cranium and skin recording electrode (Buzsaki et al., 2012). Penetrating electrodes records single as well as multi unit action potentials from an ensemble or individual neurons. Microelectrodes are implanted different cortical as well as sub cortical areas it includes primary, pre motors, thalamic and supplementary motors, movements and movement intention signals are recorded (Patil et al., 2004). Presently, there are major strategies two captures to restore function behind the stroke with BMIs. The first aims of strategy on nonfunctional cortico-spinal pathways bypassing allowed for permanent and continuous control in the robotic devices (Collinger et al., 2013) otherwise in paralyzed muscles of functional electric stimulation (FES) (Ethier et al., 2012). In the daily life activities through substituting for motor functions lost, such assistive BMIs revival of adaptable motor control was demonstrated (Collinger et al., 2013). The strategy seconds aims at neuroplasticity facilitation and motor learning to improve motor recuperation (rehabilitative BMIs) (Dobkin, 2007).

Table 1: Properties of cement

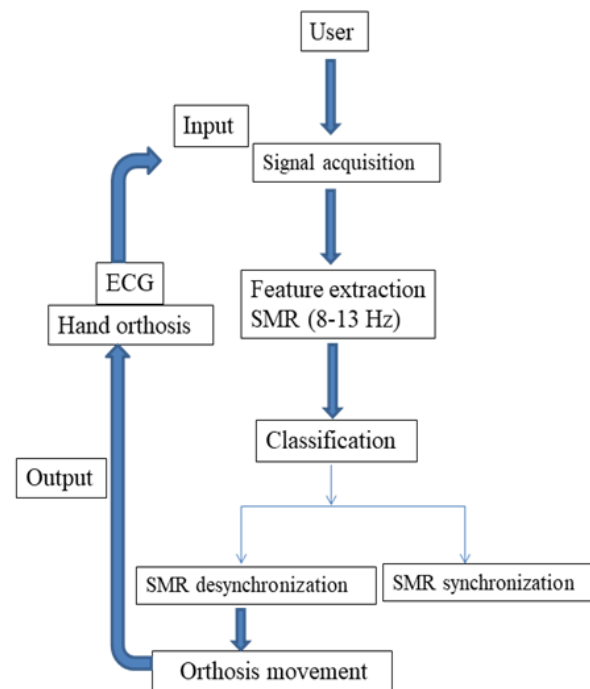


Fig. 1. EEG-BMI system for motor rehabilitation

3 Upper limb Neuroprostheses for quadriplegics

SCI can lead to quadriplegia, lower, upper and trunk affects, it affects digestion, respiration, walking, standing, sexual functions, bladder control and other automatic functions. Losses decreases significantly patients life quality. Well defined micro stimulation mapping brain regions are BMI electrodes usually placed; parietal, frontal regions, modulation, intention and execution (Fafrowicz et al., 2012). Neurons are direction dependent; patient can move arm in one direction, firing more other tuned in different directions. BMI interpret from the brain neural signal recordings convert into commands are in digital forms that controls robotics arm individually with the motor impairments, demonstrated in rats, monkeys and currently in human subjects (Chew et al., 2013). BMI canister transduce motor commends into electrical stimulation directly of

muscle groups or upper limb peripheral nerves to reanimate arm movements (Bouton et al., 2016). Functional electric stimulation (FES) used to prevent muscle atrophy through neuromuscular circuit stimulation for rearrange rehabilitation of muscles (Martin et al., 2012), currently FES method observed paralyzed monkeys upper limb, arm movements can reanimate. Intraspinal microstimulation (ISMS) in monkeys induces grasping and reaching function (Zimmermann et al., 2011), through this method in rats cervical spinal cord injured area improvement in forelimb functions, grip strengths by stimulation of epidural (Alam et al., 2015).

4 Lower limb neuroprostheses for paraplegics

Paraplegia lead by SCI, lower or lesion at thoracic level showed result sensation loss, lower limbs movements, sexual function and bladder control also disrupted depending on the brutality and injury locations. In current research focusing restore these functions for improving the life quality (Fong et al., 2009). For regaining lower limb functions different approaches physical body weight and rehabilitation treadmill training supported are applied for the paraplegic patients. The locomotor training of physical rehabilitation strategies combined with electrical stimulation in the spinal cord (Morawietz and Moffat, 2013). Movement dependent plasticity (flexibility) may engage in recreation a responsibility in the mechanism that mediates this improvement (Edgerton and Roy, 2012). Mammalians neural networks are specialized in the lumbosacral spinal cord, which is called as central pattern generator (CPG) that can produce the patterns, in rhythmic motor forms (Kuo, 2002). Without any sensory input in the animal experiments; cats, dogs, rats spinal-cord has neuronal pools abilities produce the rhythmic movements (Kiehn and Butt, 2003). Stimulation through electrical can trigger dormant CPG for sustaining coordinated rhythmic motors outputs (Ichiyama et al., 2005). Electrical stimulation combined with treadmill training improves spinal cord rhythmic functions, through different electrochemical produce synergistic motor outputs (Gerasimenko et al., 2015a). Mainly BMI demonstrated to restore function of upper limb in cervical SCI individuals, lower

limb motor functions standing and walking required leg control and trunk muscles and maintenance of balance, reflex mechanism for preventing falls (Pons et al., 2013).

Cortical areas are responsible for initialization of movement, fine control, postural adjustments, and motion perception and illustration information incorporation during walking (Drew et al., 2004). These cortex regions include; vestibular area, sensory-motor, parietal area 5 and cerebellum (Morton and Bastian, 2004). During treadmill walking rats showed cortical involvement in movement of proximal muscle; limb joints, and trunk muscles (Alam and He, 2013). Based on neuronal firing patterns can change for transition movement, can track these changes, in monkey cortical neuronal spike, conversion from position to squatting. From the cordial recording of neuronal spikes in associated with locomotive movements. Lower-limb association, intentions are translated in to actual moment electrical stimulations in peripheral nerves and muscles (Alam and He, 2014).

5 Current challenges and future developments

BMIs are used therapy for stroke that's non-invasive, provides extraordinary results, small generators use in brain signals high frequencies, based on the sensors and electrode distances from the signal sources. In frequency, rhythms such as SMR, low showed correlation very limited, emergency with proposed movements, high gamma band decoding, action potentials, and lofty degree of autonomy prosthetic limbs control. The neural plasticity basis BMIs hypothesized pre and postsynaptic neurons simultaneous activation involved by Hebbian plasticity. Driving functional connectivity optimally it may be critical. So for that brain signals, high gamma broad band (70 to 300 Hz) power may uniformly prove, even more successful than inferior frequency signals because SMR. Currently showed that signals of gamma band used decode highly fractionated movements, signals obtained most effectively using invasive records of subdural, intracranial electrodes require implantation, cortical, and epidural electrodes, instead of a craniotomy burr hole reduce peri-operative risk and cost. In a rat model after brain

injury effective use of implantable neural interface to bridge damaged neural pathways for the restoring the functions. In rate the primary motor cortical area injured leads disruption of communications between somatosensory areas and motors. Implanted neural prosthesis translated action in the pre-motor cortex in to the electrical stimulation contingent in somatosensory cortex.

Table1. Available spinal cord stimulation techniques

S. No	Types of stimulation	Country	Discovery and important findings	Tested against	References
1	Localization	USA, Canada	Localization of stimulation; targeted areas resolution highest possible. Stimulation delivers ventral or dorsal structures	Rats, cats	Saigal et al., 2004; Bamford et al., 2010
2	Localization	USA	Stimulation targeted ares ; resolution depends on the size and number of electrodes, no cellular resolution	Rats, cats	Lavrov et al., 2015
3	Advanced Medtronic	USA	Advanced Medtronic restore stimulator; electrodes 16, 65X49 mm area.	Rats, cats	Angeli et al., 2014
4	Intraspinal, epidural, transcutaneous	Canada	Invasive, electrodes surgically placed, it penetrates spinal cord and top of dura mater. Non-invasive electrode place in skin	Rats, cats, monkeys and humans	Bamford et al., 2010
5	Plasticity induced	WA	Due to individual neuron accessibility the plasticity is spike time dependent	Rats, cats	McPherson et al., 2015
6	Plasticity induced	USA	Activity dependent plasticity; weight supported step and voluntary stand and passive step training	Rats, cats	Angeli et al., 2014; Minassian et al., 2015
7	Function recovery	WA	Fore-limb motor function improved in monkeys and spinally confused rats	Rats, Monkeys	McPherson et al., 2015
8	Function recovery	USA	Body weight supported in treadmill belt stepping with moving	Rats, Cats	Lavrov et al., 2015
9	Function recovery	California	SCI patients 5/5 motor complete, regained hip and knees movements	Rats, cats	Gerasimenko et al., 2015b

6 Conclusion

The brain, machine and neuroprostheses powerful tool and greatly advanced, many challenges need to overcome, recover neural circuit functionality, in paralyzed patients limb functions restored, the clinical larger need to understand BMIs treatment response, recovery mechanisms, implantable system safety, reliability. Neuroprostheses potential treat patients SCI depends on levels enhanced understanding, network level underlying mechanisms and physiology mediated improvements functionally. In BMI larger clinical studies need for understanding predictors treatment response, mechanisms in the stroke recovery, in brain mechanisms showed better recovery combination of BMIs non-invasive and invasive brain stimulation promises. References

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