FUNCTIONAL MUSCULAR STIMULATION THROUGH GESTURE RECOGNITION FOR PLEGIC PATIENTS

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INTRODUCTION:

The number of neurological disorder cases is recorded to be increasing every year. A neurological disorder is any disorder of the body's nervous system. Structural, biochemical or electrical abnormalities in the brain, spinal cord or other nerves can result in a range of symptoms. Examples of symptoms include muscle weakness, poor coordination, loss of sensation, seizures, confusion, pain and altered levels of consciousness. There are many recognized neurological disorders, some relatively common, but many rare. They may be assessed by neurological examination, and studied and treated within the specialties of neurology and clinical neuropsychology. Interventions for neurological disorders include preventative measures, lifestyle changes, physiotherapy or medication.

Stroke is a major health problem in India. The average annual incidence rate of strokes in a recent study from Kolkata was 145 per 100,000 population which compares well with the developed countries. Stroke burden has been rising in India, as compared to the developed countries, where it has reached a plateau or decreased. To recover from this major health problem in India, stroke and other neurological disorders, physiotherapy is proven to help shorten the recovery period. Physical therapy, or physiotherapy, is a physical medicine and rehabilitation speciality that remediates impairments and promotes mobility, function, and quality of life through examination, diagnosis, prognosis, and physical intervention. It is carried out by physical therapists.

While physical therapy can be aiding, rehabilitation, customarily besides being a long and arduous process, is also an expensive deal which makes it beyond reach for the majority. The motive is to design an economical device that is compact and easy to use, that decreases the tedious and long duration of the recovery period.

ELECTROMYOGRAPHY (EMG)

Surface EMG is a method which deals with the detection of electrical signals emanating from skeletal muscles. The EMG activity of voluntary muscle contractions is related to tension. The functional unit of the muscle contraction is a motor unit, which is comprised of a single alpha motor neuron and all the fibers it enervates. This muscle fiber contracts when the action potentials (impulse) of the motor nerve which supplies it, reaches a depolarization threshold.

The depolarization generates an electromagnetic field and the potential is measured as a voltage. The depolarization, which spreads along the membrane of the muscle, is a muscle action potential. The motor unit action potential is the spatio and temporal summation of the individual muscle action potentials for all the fibers of a single motor unit. Therefore, the EMG signal is the algebraic summation of the motor unit action potentials within the pick-up area of the electrode being used. The pick-up area of an electrode will almost always include more than one motor unit because muscle fibers of different motor units are intermingled throughout the entire muscle. For quite some time now EMG has been applied in many useful applications such as biomechanics, rehabilitation medicine, neurology, gait analysis and exercise physiology.

There are two types of EMG techniques, namely, surface EMG and needle EMG. Surface EMG is preferred over needle EMG in this mechanism for the following primary reason. Needles cause discomfort and increase the tightness or spasticity in the muscles, and cramping may occur occasionally due to repeated use. On the other hand, surface electrodes are easy to use, cause no discomfort and are reusable.

FUNCTIONAL ELECTRICAL STIMULATION (FES)

FES is a form of orthotic/therapeutic treatment that applies transcutaneous electrical current to initiate contractions in muscles and is commonly used for individuals with spinal-cord injuries (SCIs) and stroke. FES has proven to facilitate upper and lower body mobility. As the human nervous system is mediated by electrical events in the form of ionic currents, artificial application of electricity to the body can be used for many applications. For example, electrical stimulation is used for therapeutic purposes such as pain suppression, muscle conditioning or wound healing. FES is used when the application of low level electrical excitation causes restoration or aiding of a function that is normally under central nervous system (CNS) control, but is missing or impaired due to disease, trauma, or developmental complications.

The main objectives for the use of electrical stimulation in stroke are:

1. Increases force and decreases atrophy of paretic muscles.
2. Stretches spastic muscles that are subject to fatigue.
3. Maintains muscle and connective tissue trophism, avoiding accumulation of waste products, deficiency of water, oxygen and nutrients, and minimizing adhesions that restrict gliding planes of tissues, which can lead to shortening of the tissues.

Using the above two methods, hand gestures are observed and recorded using EMG technique and are then replicated on another hand using FES. The interconnection between the two has been established using a switch circuit. The switch is responsible for enabling the FES circuit, which provides electrical pulses to the desired muscle, only when an activity is recorded in the reference hand.

OBJECTIVE:

The objective of the project is to dwindle the recovery period for paralysed patients. This can be done by making the patient exercise at regular intervals. The project helps in providing speedy recovery as the device can be used by the patient himself or by any of the family members for routine physiotherapy sessions. This can be done by detecting the EMG signals of the reference hand and replicating this motion on the patient's hand. The pulses provided to the muscles for the motor units to show movement, vary from person to person.

They are proportional to the weight of the person and also vary in accordance with the fat content of the body. The device can also be used by athletes and the elderly to recover from muscle fatigue.

METHODOLOGY:

Figure A: Gesture Recognition

Figure B: Functional Muscular Stimulator

The mechanism has been divided into two sections, namely, Gesture Recognition and Functional Muscular Stimulation. The first section is concerned with the acquisition and processing of the EMG signals from the reference hand when muscle activity is recorded. The second section deals with reception of the peak voltage recorded from the reference hand and replicating that movement through Functional Electrical Stimulator circuit on the imitation hand.

CONCLUSION:

We have constructed a set-up that has the potential to detect the EMG signal of the muscle movement in a normal/reference hand and replicate that motion (with degree of freedom, intensity and direction) to another set of hand muscles which are incapable of moving themselves, for reasons such as paralysis. Series of experiments on numb and virile and hands have shown that muscle stimulation is accurately reproduced from reference hand to experimented hand. This method is highly advantageous and can be practically applied in medical areas and hospitals. Further research is recommended to identify methods for optimum use of the project for more accurate finger and joint replication.

FUTURE WORK:

The scope of the project can be further extended to replicate multiple muscle movements with more accurate finger and joint replication. Moreover, the set-up uses radio frequency communication between the references set to the receiver set which can also be extended to multiple receiver sets, thus stimulating muscles of different patients at once.