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Design of Hand Gripper to Stimulate Muscle activity for hemiparetic patients using EMG sensor

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Abstract **Patients with hemiparesis have muscle weakness and are unable to move their arms. Hand control is affected by a variety of neurological diseases such as stroke and spinal cord injury. Regaining hand grasp function is considered as a top priority in improving the quality of life for patients with paralysis, among all the many motor and sensory functions involved in daily tasks.. A measure of electrical activity produced by muscles is defined as an EMG signal. The EMG signal is a valuable source of information for neuromuscular problem diagnosis. Non-invasive surface electrodes are used to detect myoelectric signals at the skin's surface. The major purpose is to build rehabilitative equipment that will improve people's quality of life. Increasing the amount of time you use your hand could help you control it better. Thus, Three biocompatible surface electrodes are put over a skin surface. The Myoelectric signal from muscles will be picked up by the non-invasive surface electrode. The signals which are obtained are amplified with the help of an EMG Module. The microcontroller receives the amplified signal. The flex sensor is used to measures the bending ratio of the fingers. Signals are then processed using a microcontroller. Hand gripper over a finger gets operated. This is intended to aid the patient's performance in daily tasks such as grabbing and releasing objects. As a result of the muscular stimulation, the patient's fingers will engage in order to grab the object.**

Keywords Hemiparesis; EMG Signals; Hand control; surface Electrode; daily task

I. INTRODUCTION

Stroke is the most common cause of Hemiparesis**,** brain damage due to head injuries, trauma and brain tumors. Hemi paresis is the loss of motor skills. It is a severe or complete loss of motor function in one side of the body. Hemi paresis is the muscle weakness or partial paralysis on one side of the body that can affect the arms, legs and facial muscles. The difficulties faced by hemi paretic patients are loss of balance, impaired ability to grab objects, Lack of coordination, Decrease in movement precision. They are unable to do their day to day activities. This hand gripper provide grip for the patients to hold or grab the objects. Their hand function can be recovered through rehabilitation training. The hand plays a vital role in a human's life by offering physical interaction and grasping capabilities. The design of a human hand is indeed a miraculous creation. It comprises a palm with five fingers and is connected to the forearm by a wrist joint. Hand impairment refers to any loss or deviation in hand function, which includes amputation, sensory and motion impairment. Rehabilitative treatments with assistive devices have been effectively used for stroke patients and paralysis with limb disorders. The rehabilitation of the fine motor skills such as finger movements and coordination which usually requires a long time, remains challenging. It's possible to increase or regain your strength and movement on the affected side through rehabilitation. Rehabilitation and its therapy can help you regain movement even years after you are affected by stroke. Post-stroke disability is characterized by a loss of dexterity and strength on the affected side of the body. This weakness is due to a loss of motor function and muscle coordination. Repetitive range of motion exercises help remap the motor function of the brain. The device use tendon driven mechanism [9] as its power transmission mechanism to move the finger which allows the finger to grab. It was powered by an electric motor.

II. METHODOLOGY

Hemiparesis is the loss of motor skills. It is a severe or complete loss of motor function in one side of the body. Hemiparesis is the muscle weakness or partial paralysis on one side of the body that can affect the arms, legs and facial

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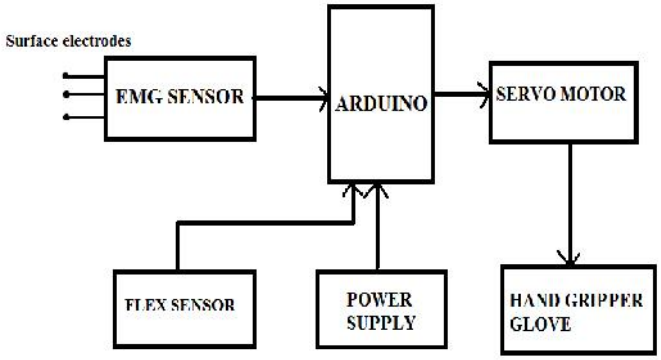

Figure 1.Block diagram

In Our proposed model, EMG electrodes is placed over the forearm. The acquired signal is processed and data were extracted. The EMG signal from our body is picked up by the EMG sensors and the analog bio signal is converted to digital values by Microcontroller.The flex sensor is used to measures the bending ratio of the finger and sends the signal to the microcontroller. The servomotor which is connected to Microcontroller used for finger movements and coordination. Arduino software is used for programming in the opening and closing movements with certain interval and angle with the respective values of servomotor . By using EMG(Electro Myo Graph) sensors with external electrical power supply the body signal (Myoelectrical) is used to stimulate the wrist function .The power supply for the model is given through battery (9v). Based on the final output ,the contraction and relaxation of the muscle is calculated in a numerical value. With the threshold value which been set on the arduino The servo motor gets actuated .The servo motor is connected to the hand gripper via a cable line. The motor rotates in 2 directions, clockwise and anticlockwise. When the fingers are needed to be closed the motor rotates in clockwise direction and when the fingers are needed to open the motor rotates in anticlockwise direction which are utilized to contract and relax the fingers in order to grab the object. The hand Gripper is attached to the motor to provide a grip for the fingers to hold the object. The finger gets pulled or pushed towards the desired position. The Connections are shown in figure 1.

A.*Hardware Design*

1.EMG SENSOR MODULE

*T*he EMG Sensor is placed on the patient's arm's skin. EMG sensors to recognize the movement of arm and hand gestures. It is used to detect the EMG signals from muscle. EMG Muscle Sensor Module V3.0 With Cable And Electrodes will measure the filtered and rectified electrical activity of a muscle; outputting 0-Vs Volts depending the amount of activity in the selected muscle, where Vs signifies the voltage of the power source. Power supply voltage: min. +-3.5V. EMG was collected from the forearm, specifically the extensor digitorum communis and the flexor digitorum profundus. This was done by placing a bipolar surface electrode-amplifier on the skin above each muscle and a reference electrode on the bony part of the elbow. This Muscle Sensor v3 measures, filters, rectifies, and amplifies the electrical activity of a muscle and produces an analogue output signal that can easily be read by a microcontroller.The obtained EMG signals can be viewed in Arduino In figure 2.

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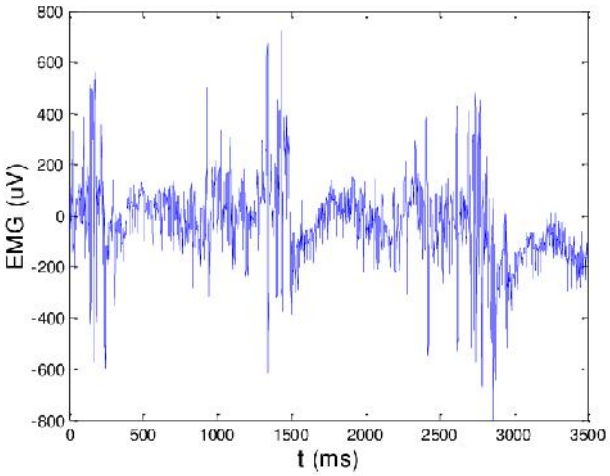

Figure 2.Typical raw EMG data

2.SERVOMOTOR

The Servo Motor Micro SG90 is a very common and inexpensive servo in a compact micro size package. A servomotor is a linear actuator or rotary actuator that allows for precise control of linear or angular position, acceleration, and velocity. It consists of a motor coupled to a sensor for position feedback. Attached to the output shaft out the top of the box is a servo wheel or Arm. These wheels or arms are usually a plastic part with holes in it for attaching push / pull rods, ball joints or other mechanical linkage devices to the servo. The three electrical connection wires out of the side are V- (Ground), V+ (Plus voltage) and S Control (Signal). The control S (Signal) wire receives Pulse 13 Width Modulation (PWM) signals sent from an external controller and is converted by the servo on board circuitry to operate the servo The power applied to the motor is proportional to the distance it needs to travel. So, if the shaft needs to turn a large distance, the motor will run at full speed. .

3. ARDUINO MICROCONTROLLER

The Atmega328P is a high performance and low powered 8-bit microcontroller, which is based on AVR RISC Architecture. The Atmel 8-bit AVR RISC-based microcontroller combines 32 KB ISP flash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general-purpose I/O lines, 32 general-purpose working registers, 3 flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8 channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and 5 software-selectable power-saving modes.The board has 14 digital I/O pins and 6analog input pins. There is a USB connector for talking to the host computer and a DC power jack for connecting an external 6-20 V power source.

4.*HAND GRIPPER*

The Hand Gripper is designed based on cable system.The glove is elasticized wrist for fit . It will be super comfortable. Nylon wire is connected above the gloves along with hand gripper. The Gripper is made up of 3D plastic pieces which is attached to the glove on the flexion crease. This Gripper help the Hemiparetic patients to grab the object in the desired position.It is connected with Servomotor after the signal acquired ,the gripper gets activated.External power supply is given to the microcontroller at 9v.

5. FLEX SENSOR

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A flex sensor is a kind of sensor which is used to measure the amount of defection otherwise bending. The designing of this sensor can be done by using materials like plastic and carbon. The carbon surface is arranged on a plastic strip as this strip is turned aside then the sensor's resistance will be changed. Thus, it is also named a bend sensor. As its varying resistance can be directly proportional to the quantity of turn thus it can also be employed like a goniometer. It is a two-terminal device.

Pin P1: This pin is generally connected to the +ve terminal of the power source.

Pin P2: This pin is generally connected to GND pin of the power source

B.Software used

1.Arduino IDE

The Arduino Integrated Development Environment (IDE) is a cross platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards. In our model, Arduino Programming language is being used. The Arduino runs a simplified version of the C programming language, with some extensions for accessing the hardware. The Arduino software is free and open source. The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems. Arduino is an open-source electronics platform based on easy-to-use hardware and software. The threshold value and servo are defined in a program.on the result of emg signals,the arduino decides the movement of servomotor and hand gripper.

III. RESULT AND DISCUSSION

The Output of the model is received from the arduino board as an analog EMG value which process the finger to open and close. We Use cable system which functions to pull up or push up the sleeve placed over the finger on the glove. As per the EMG value Received from the patient which extends and close finger accordingly with delay time. The hand gripper glove is fitted to the person recovered from stroke,he has slight shivering while grabbing the glass,after wearing EMG glove ,it gives support to his finger and strong grip to grab the object. The EMG signals are acquired, the motor gets activated when the person tries to grab the object. By using a hand gripper glove the subject grabs the object and holds it for a few minutes. This hand gripper glove helps the post stroke patients to do their daily activities.

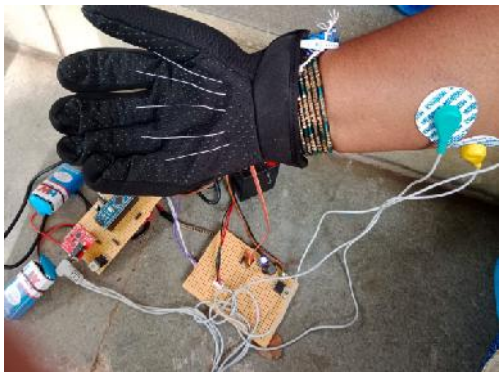

Figure 3.Our prototype model.

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IV. CONCLUSIONS

The modeling and EMG based control of an exoskeleton hand to provide excellent assistance to the stroke survivors in accomplishing simple daily hand functions. Being able to accomplish these basic tasks, which are often less appreciated by healthy individuals, can significantly improve their quality of life.The hand grip assistive device is a device that is expected to support the hemiparetic people in their gripping activities. The device is in the form of wearable use to improve gripping power . The new developed control system, implementing sensors which electromyography. The main parts that are threshold calculation program, . The modes is for user to select which mode suitable for them. This new control program allow user to not over depended on the device and try to active the device by moving their own finger. It is hope that the new control system for the hand grip assist device able to improve user experience in using this device. Stroke is most often caused by damage in the brain and nervous system. So, in order to recover the hand actions, various physical exercises need to be performed. This hand glove works as an assistive device. The proposal of the hand glove is lightweight. The servo motor as actuators give the hand lightweight structure and low cost hand glove. This glove enables it to do activities of daily living. It works just like a human hand simulation, but with a lesser precision. The future of this device will continue to aim for a universal design that persons recovering from stroke, or people with other needs, may use for rehabilitation or assistance. Glove, as a tool is efficient in recreating the Hand Movement and performs Motor Skill exercises that help improve muscle strength and coordination.

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