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# Hand Function Improvement for Hemiplegic Patients Integrated with IOT

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**Abstract**

Hemiplegia is a condition that causes paralysis of one side of the body. It is caused by injury to parts of the brain that control the movements of the limbs thus leading to problems in the way messages pass between the brain and muscles. This work implements the use of Electromyography(EMG) signals to develop an assist device to allow patients facing hand paralysis to regain limited functions of the hands. The proposed system aims at acquiring signals from the muscles and using them to trigger the movements of the patient's hand using motors. The functions involve that of grasp, release, lifting and dropping of the arm. It also includes exercise mechanism which acts as physiotherapy aid. The notification regarding the patient condition will be sent to the user defined number by means of IoT. This mechanism will rehabilitate hemiplegic people to continue with normal life.

**Keywords** *:* EMG, Hemiplegia, IOT ,Physiotherapy, Rehabilitation

## INTRODUCTION

Patient care delivery is being revolutionized with the help of wearable technologies which are connected through the Internet of Things (IoT) platform. Many electrical stimulation systems have been developed in for various applications, which are versatile and efficient due to the advances in computer technology.

Hemiplegia is paralysis of one side of the body due to cerebral damage. It leads to loss of muscle function in that part of the body. The main characteristics noticed in hemiplegic subjects are weakness of specific muscles, abnormal muscle tone, abnormal postural adjustments, and lack of mobility, abnormal movement synergies, loss of joint coordination, and loss of sensitivity.[1]

Electromyography (EMG) is diagnostic technique used to understand the electrical activity of the muscles. These potentials are generated from the muscles when they are stimulated electrically or neurologically.

Studies have proved that repetitive movement training can result in improved recovery. Robotic assisted techniques are being rapidly used for upper and lower limb rehabilitation. These techniques provide high intensity training. It improves grasping and releasing capability of the hemiplegic patients.[2][3][4]

The main aim of this work is to facilitate the arm movement of a hemiplegic patient using an exoskeleton. EMG signals captured from the limbs help in the movement of the exoskeleton. The arm exoskeleton uses a raspberry pi microcontroller that is connected with IoT which serves as a common network. The setup is run by an android app which recognizes voice commands and completes the action accordingly.

## MATERIALS AND METHODOLOGY

### Block Diagram

The designing of the hardware requires components like Raspberry pi 3, DC motor, L293D motor drive, EMG surface electrode, Bluetooth smart, android app, power supply and Python for software implementation. The hardware design is mentioned below. (Figure 1)

The L293D motor driver and DC motor are connected using GPIO pins of the Raspberry Pi 3 microcontroller. The robotic arm is connected to the motor. EMG sensor is also connected with raspberry pi which processes the input EMG signal. This aids in the movement of the arm when the software is run. SD card acts as the storage of Pi. A monitor displays the action being performed by the patient. Android App is connected via Bluetooth. The voice control android app recognises commands which enable the movement of the hand. The inbuilt Wi-Fi in Raspberry Pi 3 enables the Internet of things to send message alert via Way2SMS which is also connected to the system.

### Raspberry pi

Raspberry Pi 3 is a powerful credit-card sized single board computer. It has a wireless LAN and Bluetooth connectivity making it the ideal for many applications. [5][6]The processor is a Broadcom BCM2837 system-on-chip (SoC) multimedia processor.

### DC motor

A DC motor converts electrical energy into mechanical energy. DC motors consists of stator, rotator, commutator and brushes. Applying a voltage to the coils produces a torque in the armature, resulting in motion.

### L293D: Motor Driver IC

The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. The two motor operations of motors can be controlled by input logics at pin 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively. Enable Pins 1 and 9 must be high for motors to start operating. As a result, the outputs become active and work in phase with the inputs.

### EMG Surface Electrodes

Surface electrodes are connected to the arm muscle to record the raw EMG signal from the muscle and a reference electrode is also connected. [7] The muscle activity recorded using EMG sensor is useful as an input signal to the system which can control the device.

**Methodology**

1. The surface electrodes are placed on the hand for detecting EMG signals which acts as the input signal for the device. The EMG sensor is connected in the GPIO port of Raspberry pi.
2. These input EMG signals enables grasping, releasing, lifting and dropping of the robotic arm.
3. The system also includes exercise mechanism as part of the patient's physiotherapy regime.
4. Notifications on the time taken for therapy will be sent to the user defined number of the care taker with help of IOT.
5. The system will help patients with paralyzed hands to regain some movements by means of rehabilitation engineering

## RESULTS AND DISCUSSION

The device is used to improve the hand function in hemiplegic patient. We have collected the raw EMG signal from the bicep muscle and used it for triggering the hand movement. The Grab mode (Figure 2) gets enabled when there is more pulse activation (EMG signals) making the robotic hand in close position.

The free mode (Figure 3) gets enabled when there is little pulse detection (EMG signals) range making the hand in open position.

The Auto mode acts as exercise mechanism where the grab (Figure 4) and free (Figure 5) functions are in continuous movement for certain time.

The message pertaining to the physiotherapy session being carried out (Figure 6) is sent to the given care taker using IoT. This helps to understand the recovery process of patient muscle condition.

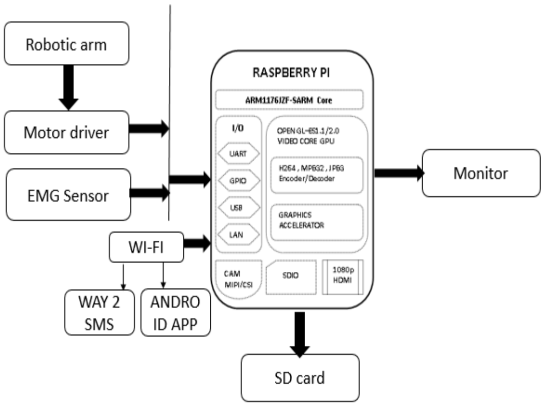


*Figure:1: Block diagram of work*

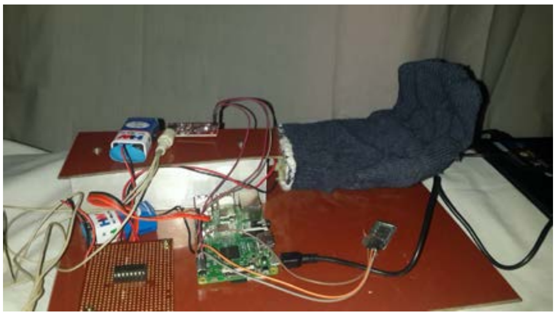

*Figure 2: Grab Position of hand prototype in lateral view*

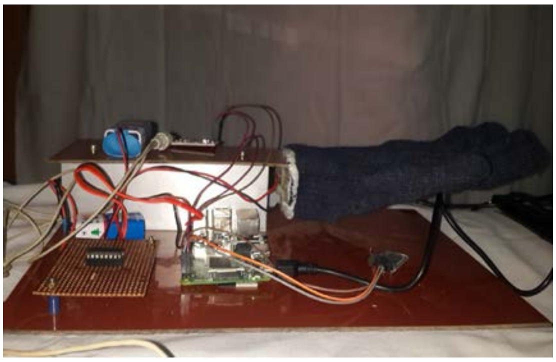

*Figure 3: Free position of hand prototype in Lateral view*

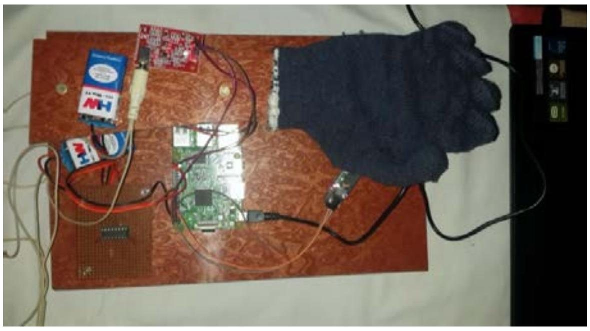

*Figure: 4: Grab position of hand prototype in Top view*

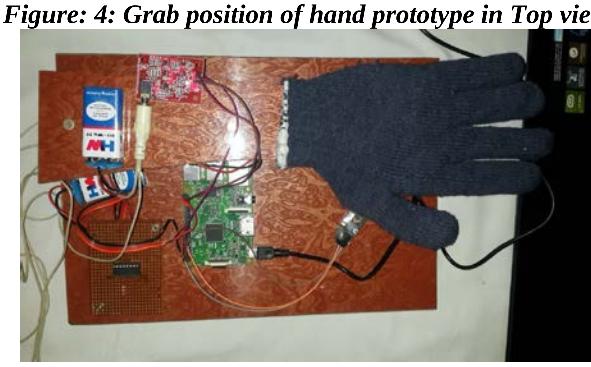

*Figure 5: Free position of hand prototype in Top view*

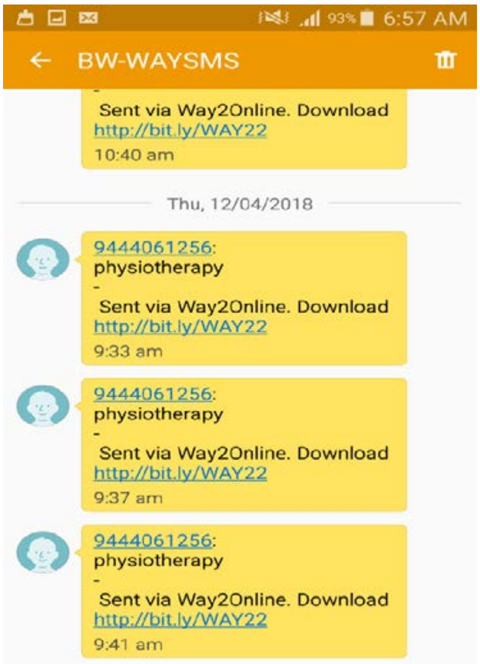


*Figure 6: Message Notification of Physiotherapy Session*

## CONCLUSION

The work allows the hemiplegic patient in improving the muscle condition of the arm. The non-invasive technique of the proposed system is very beneficial to the patient as the errors wouldn't be fatal to the patient unlike the existing invasive techniques. The notification is important feature of the proposed system as it informs about the patient condition. By the control strategy proposed in this project, we deeply hope that the patients will benefit greatly and regain their self-confidence.

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