

# FABRICATION OF ROBOTIC PROSTHETIC HAND FOR THE PARALYSED USING RF SIGNALS

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**Abstract**—To develop a robotic prosthetic hand for helping people who have partially lost their ability to control their hand by mimicking the motion of the unparalysed hand. The system is intended for people who have partially lost the ability to control correctly the hand muscles, for example after a stroke or a spinal cord injury. The device is used to achieve full flexion/extension motion of the four fingers and thumb of the right hand based on the motion of the identical digits of the left hand.

**Index Terms**- Extension, metacarpophalangeal (MCP), proximal Interphalangeal (PIP), Distal Interphalangeal (DIP), interphalangeal (IP), Radio Frequency (RF)

## I. INTRODUCTION

Hand is one of the most important organs of the human body. Its normal motor capability is crucial for people's daily activities. However, hand injuries are common problems, especially due to stroke and occupational accidents. These injuries can lead to a loss of motor functions of the hand. It is essential to perform rehabilitation for the hand to regain previous dexterity. Stroke can cause deficiency in various neurological areas. Mainly it causes disability in the motor system. This causes paralysis of one side of the body of the stroke survivor. To be able to understand and repair the hand motor function after a person undergoes stroke has been the major focus of rehabilitation research. Currently most rehabilitation activities are performed manually by physiotherapists. However, it causes high personnel costs. For rehabilitation the stroke patients who have to undergone harsh, moderate or mild motor deteriorations, an optional therapy known as bilateral movement training has demonstrated positive results. In comparison to unilateral training patients obtaining bilateral training indicated better improvement of the upper extremity functions and decrease in movement time of the damaged limb.

The main aim of this work is to fabricate a robotic prosthetic hand for paralyzed hand. The system is intended for people who have partially lost the ability to control correctly the hand muscles, for example after a stroke or a spinal cord injury. The device is used to achieve full flexion/extension motion of the four fingers and thumb of the left hand based on the motion of the identical digits of the right hand. The robotic hand follows the same motion traced by the controller hand by the help of radio frequency signals. The movement is acquired from the unparalysed hand using flex sensor and motion is given by the help of servomotor which is wirelessly controlled using RF signals. By this way the hand motor function of the impaired hand of the stroke

survivor can be enhanced due to plasticity of the human brain.

## II. LITERATURE REVIEW

The research conducted by one group had developed the design of a grip mechanism assistant device that can be employed for finger rehabilitation. [1]The device consisted of the index and the thumb finger. Since the index and the thumb have a different extension and flexion movement, and different number of bones, different mechanism was developed for each finger. In other works a robotics based rehabilitation device have been developed that can perform the hand grasping and releasing based on the finger extension and flexion movement. [2]The device used the wire-driven mechanism to perform the finger extension and flexion movement. The device can be use provide assistance for repetitive finger extension and flexion movement during the rehabilitation. The actuating system of the device enables the patient to control the movement of hand by using the self-motion control concept. While in other research, a hand exoskeleton device has been developed for people who have partially lost the ability to control correctly the hand musculature. [3]Based on EMG (Electromyography) signals the system can understand the subject volition to move the hand. Actuators can help the finger movements in order to perform the task. [4]In another study a hand exoskeleton design has been developed where each finger has four degrees of freedom. The flexion and extension in MCP joint, PIP joint, and DIP joint, and also the abduction/adduction in MCP joint can be done by this device.

These are the different types of rehabilitation hand available. Each of these hands uses a different technique for motion. Each has its own advantages and disadvantages. The robotic prosthetic hand selected for this paper is based on simple design and logic. This device is able to give full flexion and

extension motion of the four fingers and thumb of the right hand by mimicking the motions of the fingers of the left hand. Although the device can perform the extension and flexion movement the device cannot perform abduction and adduction movement.

### III. MODELING

The modelling was done in the solidworks software. The solidworks was a better alternative when compared to the catia and other software's due to its simplicity and flexibility. The design of the human hand model imitates an actual human hand. It had four fingers and a thumb. Each of the four fingers of the human hand has MCP, PIP and a DIP joint. These joints were imitated in the modelled hand using ball joints. This provides free motion of the fingers about the joints. The thumb only has the MCP and IP joints. All these fingers are then connected to a base with forms the palm of the human hand. This modelled human hand is used for mimicking the actions of the prosthetic hand. The modelled hand and the device can be combined together in solidworks such that the motion of the human hand is mimicked by the device. Even though each ball joint provides a degree of freedom for the hand, the DIP and PIP joints are constrained by the device. So bending takes place only at the MCP joints.

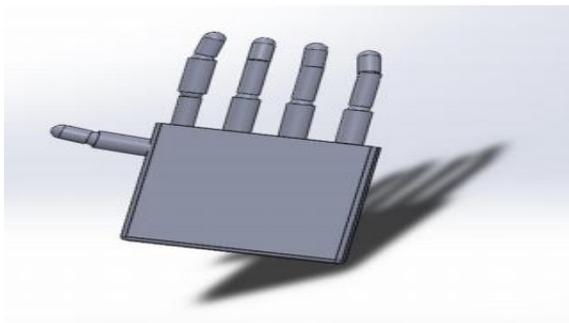


Fig 1. Human hand modeled in Solidworks

The device is modeled in such a way that it can be worn on the human hand. It has two rods which are connected at a joint about which it can be rotated. One of the rods has three loops like structure where the four fingers can be inserted. The loops are placed apart from each other in such a way that it avoids the joints. So when the rod moves the four fingers simultaneously moves along with it. The other rod is especially made for the thumb. It has two loops.

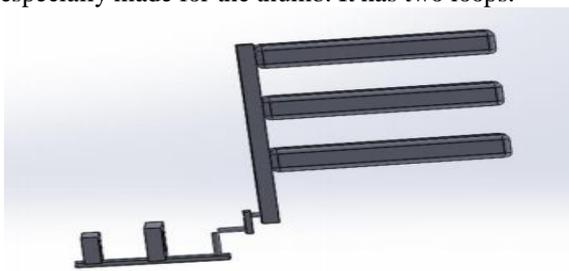


Fig 2. Rehabilitation device modeled in Solidworks

The thumb can be inserted into this loop. So as the rod moves so will the thumb along with it. In practical application the joint where the two rods meet are given to two motors which provide the necessary rotational motion to the rods. During fabrication changes have been made on the model of the hand depending on the necessity.

### IV. TRANSMITTER

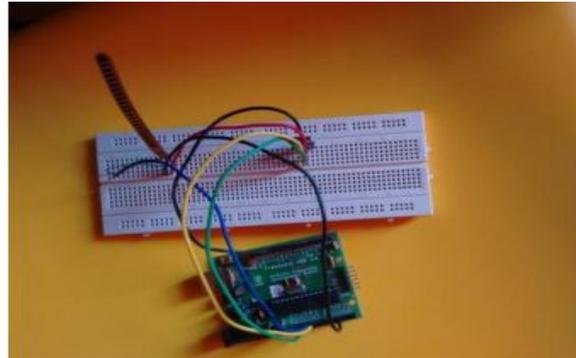


Fig 3. The transmitter

The entire prosthetic hand comprises of a transmitter and a receiver section. The Fig.3 shows the transmitter section. The transmitter section comprises of a flex sensor, RF transmitter, arduino and power supply. The transmitter is responsible for analyzing the motion of the unparalysed hand and then sending the data wirelessly to the receiver section. The flex sensor is a type of sensitive resistive sensor whose values changes when it bends. This sensor is placed on the working hand. When the hand bends the flex sensor also bends. This sensed value is send to the arduino. The sensed flex sensor value is then given to the arduino which in turn gives it to the RF transmitter for sending the data to the receiver section wirelessly. The arduino has an Atmega 328microcontroller in it. Necessary program has been given to the arduino for reading this sensed value and for operating the RF transmitter. The arduino is powered by an external power supply.

### V. RECEIVER

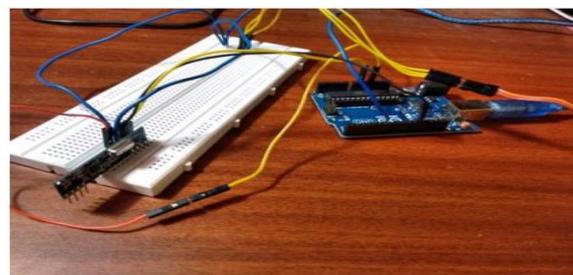
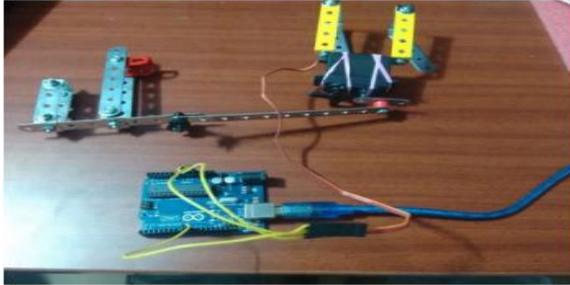


Fig 4.The receiver

The receiver can be considered as a two part system. It consists of the controller of the prosthetic hand and also the prosthetic hand. The controller of the hand has RF receiver and the arduino board. The fig.4

shows the controller part of the robotic hand. The sensed value that is transmitted from the transmitter section is received using the RF receiver of the receiver section. This sensor value is taken by the arduino and then mapped to the range of the servo motor. The servo motor is the main actuating part of the prosthetic hand.



**Fig 5.The prosthetic hand (receiver section)**

The Fig.5 shows the robotic prosthetic hand. It has a long link to which other hollow bands are connected. The bands are given so that the paralyzed hand can be easily placed into the robotic hand. So when the link moves the entire hand will also move. For the actuation of this link a crank-crank rocker mechanism is used. One of the cranks is the servo motor itself. The servo motor is given a rotational motion from 0-180 degrees. The mechanism is connected in such a way that when motor is at 0 degree the hand will be fully extended. The Fig 6 shows the fully extended robotic hand worn on a human hand.



**Fig 6.The prosthetic hand on a human hand**

When the motor rotates to the 180 degree position the hand will fully flexed (bend). The thumb is also connected to the moving link in such a way that when the entire hand moves so does the thumb along with it. So by this robotic prosthetic hand full flexion/extension of the hand can be achieved. Since the servo motor moves by the sensed value of the flex

sensor its motion will be corresponding to the motion of the unparalyzed. So the mimicking action is implemented here. The power supply for the arduino and servo are externally given.

## CONCLUSION

Modeling and fabrication of robotic prosthetic hand for motor function rehabilitation is based on simple design and easy attachment, has been presented in this paper. The device was able to achieve full flexion/extension motion of the four fingers and thumb of the right hand based on the motion of the identical digits of the left hand. Here wireless capability and mimicking features are implemented using the robotic arm. The robotic hand is semi-autonomous. So it provides more safety and controllability to the user. Although the device can perform the extension and flexion movement it cannot perform abduction/adduction movement as a consequence more work needs to be done.

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