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# A Prototype of the Humanoid Model for Rehabilitation of Patients with Severe Motor Disorders

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***Abstract:*** ***The purpose of this project is to develop a prototype device for the Rehabilitation of Patients with Severe Motor Disorder (paralytic patients). There has been a constant need for the development of non-invasive electrical stimulation of the spinal cord using brain impulse. As of now, physiotherapy is the only method of treatment where the patients can regain their movement to some extent along with some intake of medicines or drugs to strengthen their nerves. In some cases brain implants and surgery are also used. Physiotherapy requires a lot of effort from the patients and it is very painful. In this project, I have developed a non-invasive electrical stimulator prototype that could make the limbs to move by collecting the impulses from the brain. This could be done in two ways. One is by Human Thinking and the other is with the help of Bluetooth. In the first method, EEG sensor has been used to detect the impulse of brain. This sensor collects the impulse from the brain and converts into electrical stimulation making the corresponding limb motor move as per the instruction given by the brain. In the second method, a third person can also operate this device using Bluetooth of his/her mobile to make the limb motor move. Thereby, limb movements of the humanoid model can be activated.***

***Keywords: Rehabilitation, Motor Disorder, Non-Invasive, EEG sensors.***

## I. INTRODUCTION

Paralysis is a result of Spinal Cord Injury (SCI) where our spinal cord gets damaged that results in functional loss such as moveables or feeling [1][2][5]. This should not be taken into account as muscle weakness. It has many symptoms such as speaking or writing problem, vision loss, headaches, etc [3]. If anyone of the symptom is noted along with muscle weakness, the person should consult a Doctor. As per the survey, 1 out of 50 persons will undergo some kind of paralysis[4]. Often this damage occurs due to unexpected accidents or diseases like polio, spinal tumors, etc [5]. Paralysis affects the central nervous system of our human body. Spinal Cord Injury can happen due to various reasons and the disability that results have various forms [2].Tetraplegia or Quadriplegia is one such type where paralysis is caused by illness or injury. This results in the partial or complete loss of the use of function all four limbs and trunk [6]. The other type is Paraplegia which is similar but does not affect the arms. Here, both sensation and control are lost [7]. Paralysis can only be controlled, there is no complete cure for this. Medicines along with physiotherapy can cure to some extent [8][9]. Functional Electrical Stimulation(FES) can be used for patients having lower leg and foot paralysis and Brain Implants can also be used in some cases [10][11]. Nowadays, electrical stimulation is considered to be one of the effective methods. The principle used here is direct exposure of the spinal cord to the electrical current through the electrodes kept on the patient's skin. The main advantage of this method is that it is non-invasive when compared to epidural electrical stimulation. The electric current moves into the spinal cord through the skin and initiate movements [12]. The main disadvantage is that the electrodes should be properly placed with respect to the spinal cord.

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## II. PROPOSED METHOD

### A. Hardware required

The proposed system contains the following hardware components.

- PIC 16F877A Microcontroller
- EEG Sensor
- DC motors
- Bluetooth Module
- LCD

### B. Software Used

- The software used here was Embedded C to process PIC 16F877A Microcontroller.

### C. Design and Functions

The developed electrical stimulator has five identical stimulation channels. Each channel includes the following elements connected in series: a voltage converter, a current supply providing the required load current within a wide range of load resistance, and an output driver. Each channel is connected via PIC microcontroller to an indicating unit implemented as a quantized display with a membrane keyboard and a radio module. The electrical stimulator includes a power supply with an accumulator battery. The stimulator can be connected to a PC via a USB port or wireless radio channel. The electrical stimulator provides the generation of single or repeated rectangular pulses with or without modulation.

The pulse duration is 0.1-2ms; repetition frequency; 1-99 Hz; current amplitude, 0-250mA; modulation frequency, 4-10 kHz. The PIC microcontroller software allows the triggering mode and other parameters to be selected independently for each channel. The pulse characteristics listed above were selected on the basis of the available data on the efficiency of transcutaneous stimulation of muscles at different pulse duration times.

The results of the research into the alternating current stimulation in the kHz range were also taken into account. Electric currents below 40 mA can be used to determine the involvement thresholds for the muscles responding to stimulation of the spinal cord. Use of currents with amplitudes exceeding 200 mA provides excitation of spinal cord structures and conduction tracts with reduced excitability caused by disease or injury. Such structures do not respond to pulses below 200 mA. 3 pulse shapes can be used: non-modulated rectangular, modulated rectangular unipolar & modulated rectangular bipolar. Pulses with different shapes are used for different purposes, for testing the conduction parts in the patients or healthy subjects, for treatment and rehabilitation of patients with spinal cord disorders of different degrees of severity. The mean current (a direct component of current) in each channel of the stimulator is zero. At each time moment, only a single channel of the stimulator is active. This allows the summation of pulses and the risk of unpredictable current growth that could be dangerous to the patients to be avoidable.

### D. Circuit Diagram

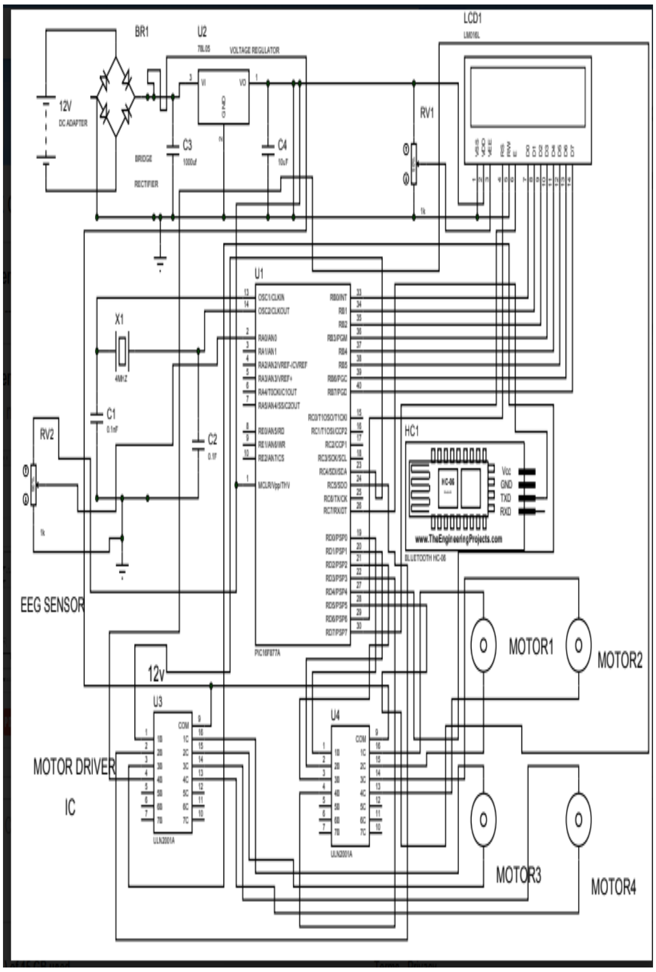


**Fig. 1. Circuit Diagram of Prototype**

### E. Circuit Diagram description

The entire circuit is connected with power supply. The electrodes in the EEG sensor record the brain impulses from the subject regarding which arm or leg to move. The brain signals produced for these words/instructions were converted into voltage using PIC Microcontroller. The microcontroller then triggers the motor driver IC. Depends on the voltage produced, the driver IC makes either of the arm or leg motor to move which is attached to it. The voltage produced will be displayed in LCD. This device is also enabled with Bluetooth. The helper/relative of the patient who is assisting him can control the patient's movement with the help of Bluetooth as per the commands stored.

## III. PROCEDURE

- There are two methods to use this device. One is by Human thought and the other method by Bluetooth
- Before using this device, Switch on the power supply.
- In the first method, EEG electrodes are placed on the temple region of the head of a person. Here, I have kept a humanoid model for demonstration purpose.
- Next, the Person is asked to think about which region to move. If he thinks the right arm to move, the corresponding right arm motor of prototype moves.
- Similarly, the person can move the left arm also.
- In addition to this, a third person (relative who is assisting the patient) will have a Bluetooth connection to control the movement. This is the second method.
- If he wants to move the motor placed in the left arm of the prototype, he chooses the appropriate command and then the left arm will move.
- Similarly, the person can move motor placed in the right arm, right leg & left leg of the prototype by choosing the appropriate command.

## IV. IMPLEMETATION

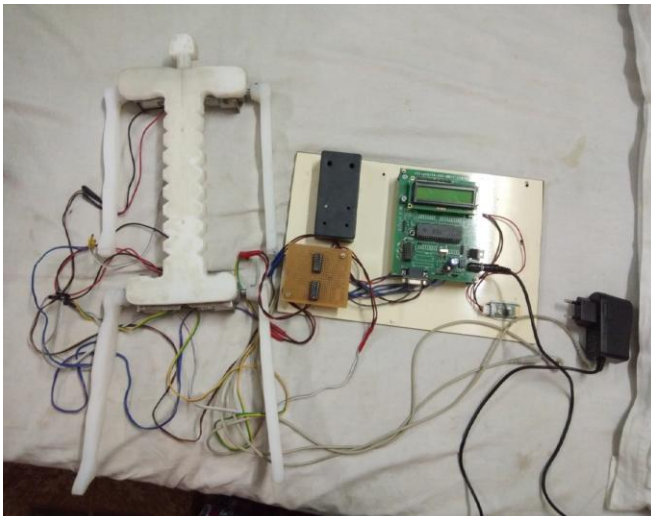

**Fig. 2. Prototype Model**

## V. RESULTS AND DISCUSSION.

### Case 1

In case 1, I have placed the electrodes on different persons. When they thought to move the right arm, the motor placed on the right side of the prototype moved.

Similarly, when they thought to move left arm, the motor placed on the left side of the prototype moved. . This is because the voltage produced when we think “Move Left Arm” will be less than 400V and “Move Right Arm” will be greater than 400V. So, only the appropriate motor is running making the appropriate limb to move.

**Case 2**

In case 2, I have the Bluetooth connection for the device to control the movement of the prototype. When I want to move the left arm of the patient, the appropriate commands were chosen then the motor placed in the left arm of the prototype moved. Similarly, the left leg, right arm & right leg of the prototype can be moved by choosing the appropriate commands. These commands were predefined and connected with Blutooth of the mobile and motor driven IC.

**Table- I: Case 1 – Result Analysis**

| S.No | Patient is asked to think | Voltage Produced | Action/Movement of Motor |
|---|---|---|---|
| 1 | Move Left Arm | < 400 | Motor placed on left arm of the prototype moved. |
| 2 | Move Right Arm | >400 | Motor placed on right arm side of the prototype moved. |

**Table- II: Case 2 – Result Analysis**

| S.No | Command | Movement of Motor |
|---|---|---|
| 1 | a b c d | Motor placed on left arm of the prototype moved. |
| 2 | e f g h | Motor placed on right arm of the prototype moved. |
| 3 | i j k l | Motor placed on left leg of the prototype moved. |
| 4 | m n o p | Motor placed on right leg of the prototype moved. |

## VI. CONCLUSION

In this project, I have reported a prototype device that could the make the humanoid limbs to move. Here, our brain impulses are used to move the limbs. As this is just a model, this project can be extended to humans for the treatment of paralysis (caused as a result of spinal cord injury) using brain impulse. By using this device, the patient slowly regains the motor nerve actions within a few months. There won’t be any pain in using this device. This project is electrically safe and non-invasive.

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