

# Design of Smart Therapy Device for Leg Fracture with Cramp Detection

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**ABSTRACT:** A bionic leg for paralysis and bone fractured patients is developed to re-train their muscles and revive the feeling of exercise their legs. The system is fully integrated and with the exception of charging it needs no special approach during application by the patient by using remote to adjust their positions. This project has two modules first module is transmitter and second is receiving module, the transmitter side has remote controlling given to the patient. The Receiver module interfaced to angle based gear DC motors. Chain drive system is employed. Gear box are used to control the direction of rotation of motors in manual mode through remote signals. To train the muscles, to initiate and stop the automated movement of the mechanical limbs. The user can fix the angle position from 0degree angle to 180degree angle using remote control. Limited rpm is used to control the movement of motors both mechanically and electrically. Cramp detection can be done by ultrasound module to indicate the patients.

**KEYWORDS:** Infrared, AVR microcontroller, chain drive system, gear DC motor, ultrasonic sensor

## I. INTRODUCTION

In recent times, the rate of accidents and the risk of major or minor fractures have increased. People are also getting affected by paralysis. Many of them become bedbound due to the fractures and paralysis. The patients become reliant on others. A therapist is needed for doing the daily exercises to re-train the bones and muscles. Muscle cramps and swellings occur due to several factors. It may be due to fast walking, strenuous exercises or lack of muscle use. These cramps can be detected using ultrasonic sensor. The above listed problems can be diminished by the proposed system. The gear motors have been used to control the angle and the position of the leg. The ultrasonic sensor is used to detect the cramp and swelling of the leg. The infrared remote can be used to control the position of the leg holder. This device starts working only when the leg is sensed by the infrared sensor placed on the leg holder.

## II. RELATED WORK

The prosthesis<sup>[1]</sup> which is commercially available, comprises of carbon fibre springs is able to store and release the elastic strain energy when in contact when it is in contact with the walking surface. Less than one-half of the mechanical energy is released by the passive-elastic prosthesis. Calf muscles are responsible for propulsion and ankle extension during walking. These generate one eighth of the mechanical energy.

The main problem<sup>[2]</sup> everyone is facing now a days is bone fractures due to accidents. While walking, leg muscles get contracted and relaxed which gives severe pain to the patients. The push off force by the trailing leg has been an efficient method to replace the huge amount of energy losses which occurs during the step-to-step transition. The passive-elastic prosthesis is used to provide the net positive work which are performed by the calf muscles during the push-off phase or walking.

Restoring the fractured bone<sup>[3]</sup> that has occurred during accidents has become a very big challenge in recent times because a constant physiotherapy is required for the patients. Using this device, the external help can be reduced as the exercise is performed by the device itself. An alarm is used to alert the patients regarding the timings. This device uses quasi-passive ankle-foot prosthesis for active damping mechanism.

The patients who are suffering from the paralysis<sup>[4]</sup> will be expecting someone to perform the daily exercises as they cannot move their leg. A high peak ankle power is provided for the prosthesis for facilitating the forward propulsion. The prosthetic leg is used to reduce the man effort from performing exercises. The motor can be used to facilitate the forward and reverse direction to do the exercises. The speed is also controlled.

### III. PROPOSED SYSTEM

A person suffering from bone fracture or paralysis will be depending upon others for help. This device is designed to perform some basic exercises to the patients. The fractured leg or paralysed leg is placed on the leg holder. The infrared sensor is placed on the bionic leg to sense whether the leg is placed at the right position or not. The ultrasonic sensor is used to detect the cramps and swelling by calculating the distance of the leg from the sensor. The power supply can be either 230V AC or 12V DC. An infrared remote is used to adjust the movement of the bionic leg holder which is given to the patient. Infrared converter is used to convert the infrared signals to digital signal to recognize the microcontroller. Gear motor is used in this device to lift the bionic leg. H-bridge circuit and the motor driver IC L298 are used to drive the 12V gear motor by 5V output from the microcontroller. The current status of the leg, swelling condition, comments are displayed using LCD. This device can reduce the work of physiotherapist and others.

#### A. BLOCK DIAGRAM

The output of the infrared converter and the ultrasonic sensor are given to the AVR- 16bit microcontroller to manage the position of the bionic leg and to detect the swelling or cramps in the leg respectively. The Power supply can be either AC or DC. The output of the microcontroller is given to the H-bridge driver board and L298 IC which in turn controls the movement of the Gear motors. The block diagram of the device is shown in Figure.1.

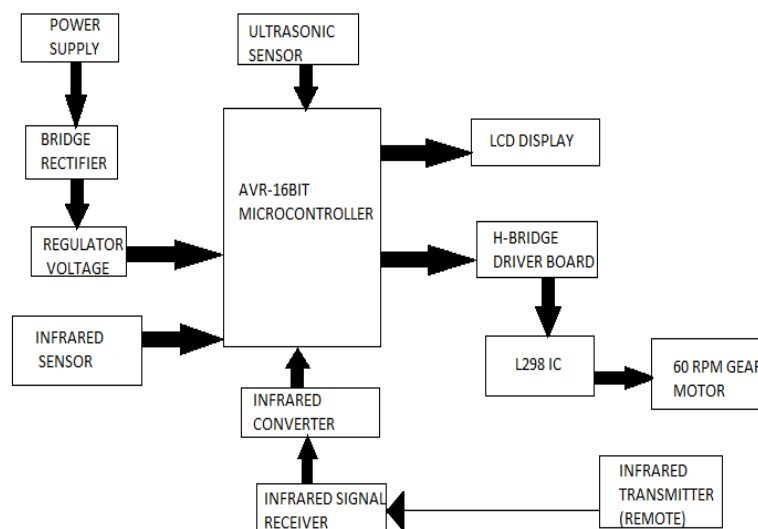


Fig. 1 Block Diagram

### *B. INFRARED SENSOR*

An infrared sensor is used to indicate the presence of the leg on the leg holder. It emits infrared radiations and when the leg is detected, the radiations are reflected back to the sensor.

### *C. ULTRASONIC SENSOR*

The ultrasonic sensors are used to determine the cramps and swellings by measuring the width of the leg. This is done by a transducer to emit and receive the ultrasonic pulses that contains the information about the proximity. The ultrasonic sensor is shown in Figure.2.



Fig.2. Ultrasonic sensor

### *D. H-BRIDGE MOTOR DRIVER*

An electronic circuit which is used to redirect the polarity of the voltages. This driver board allows the motor to rotate in forward and reverse directions. Thus, the movement of the motor is controlled. The H-bridge motor driver is shown in the Figure.3.



Fig.3. H-Bridge Motor Driver

### *E. GEAR MOTOR*

The gear motors are generally used for rotation. The infrared remote is used to control the rotation of the motor either as forward or reverse. The gear motors are used because it can increase torque and reduce the speed. The gear motor is shown in Figure.4.

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Fig.4.Gear motor

#### *F. WORKING PRINCIPLE*

The device starts working only when both power supply and the output of the infrared sensor are high. The IR sensor is used to determine whether the leg is placed on to the bionic leg. The ultrasonic sensor is used to detect the swellings or cramps by measuring the distance. The movement of the leg is controlled by the gear motors via motor drivers. The angle of the bionic leg is controlled by the infrared remote by the patient. The movement of the bionic leg is shown in Figure.5.

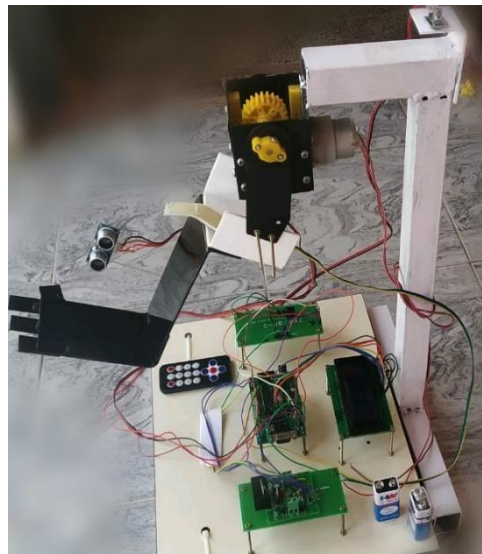


Fig.5.Movement of Bionic leg controlled by the remote

#### **IV. RESULT**

As a result, the therapy can be self-reliant without depending on the physiotherapist or someone. The speed of the bionic leg can be controlled according to the convenience of the patient. The power can be saved because the device starts working only when the leg is placed on the leg holder. The additional feature in the device is cramp detection. The working model, top view, LCD outputs of the device are shown in Fig.6,7,8 respectively.

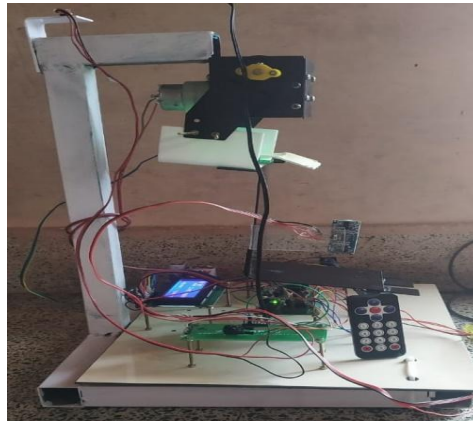


Fig.6. Working Model

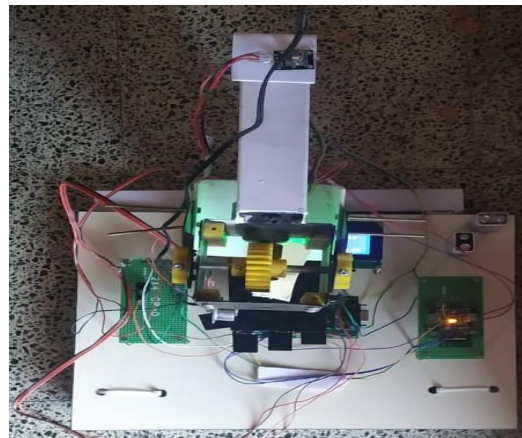


Fig.7.Top view



Fig.8. LCD displaying the position of leg.

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## V. CONCLUSION

The proposed system will help the patients to re-train the bones and muscles to normal state. It can also be used for paralysed patients to perform the therapy in home. The device can be further enhanced by using voice control and can be made automated. This mechanism can be used for other parts of the body.

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