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Leg Rehabilitation And Mobility Aid For Paralysis Patients

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ABSTRACT

This project involved designing and manufacturing a cost efficient robot that will retain the leg muscles of paralysis patients. This project group developed a more economic design for paralysis patients to retrain their muscles and feeling of walking in their legs at a lower cost then what is on the market today. The group was able to make the device adjustable and comfortable for the patient to use easily. The group also made the device move in a precise way to simulate the human gait walking motion. Regarding classical rehabilitation techniques, there is insufficient evidence to state that a particular approach is more effective in promoting gait recovery than other. Combination of different rehabilitation strategies seems to be more effective than over- ground gait training alone.

INTRODUCTION

Paralysis, the loss of motor function of a limb or limbs, can be attributed to some of these causes such as stroke, brain trauma, and spinal cord injury. A patient's rehabilitation regimen depends mainly on the severity of their disability. These exercises range from walking on a treadmill to the bending of their fingers. Sometimes however the paralysis is so severe that the patient cannot support their own body weight or lift the weight of their limbs. In the past, these cases were handled by using one or two physical therapists to hold the patients up and assist their motions manually. They also employed a technique that allowed the patients to try their movements in a pool. This was so that it weight of the limbs would seem less due to the support of the water .The major problem with these standard rehabilitation techniques is that the percentage of motor function that is recovered is poor. According to the Journal of Rehabilitation Research & Development the percentage of

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mobility recovered is somewhere between thirty and sixty-six percent.

In New Zealand, more than 82,000 new Claims and 17,200 ongoing claims related to ankle injuries were made to the Accident Compensation Corporation (ACC) in the 2000/01 year, costing an estimated 31.8 million New Zealand dollars and making ankle related claims the fourth biggest cost to ACC Additionally, neurologic injuries like stroke, traumatic brain and spinal cord injuries are also leading causes for ankle disabilities. In the United States, at least 750, 000 incident and recurrent strokes occurred with the prevalence rate being about 200 to 300 patients per 100,000 inhabitants in 1995. However, the biggest effect on patients with ankle disabilities and their family members is usually a result of long-term impairment, limitation of activities and reduced participation.

Traditionally ankle injuries are rehabilitated via physiotherapy and however evidence suggests that without sufficient rehabilitation 44% of people will have future problems ambulation is markedly compromised re-injury prevalence is high; and approximately 38% of people will have recurrent activity limitations affecting their function, Furthermore, during a rehabilitation Treatment, cooperative and intensive efforts of therapists and patients are required over prolonged sessions.

This project focuses on the design of a device to help longtime bedridden patients complete their daily leg rehabilitation training while lying in bed a stationary gait and ankle trainer system was developed to provide neural-rehabilitative treatments aimed at recovering walking abilities in post-stroke patients.

MOTIVATION

A patient's rehabilitation regimen depends mainly on the severity of their disability. These exercises range from walking on a treadmill to the bending of their fingers. Sometimes however the paralysis is so severe that the patient cannot support their own body weight or lift the weight of their limbs. In the past, these cases were handled by using one or two physical therapists to hold the patients up and assist their motions manually. They also employed a technique that allowed the patients to try their movements in a pool. This was so that it weight of the limbs would seem less due to the support of the water. The major problem with these standard rehabilitation techniques is that the percentage of motor function that is recovered is poor. According to the Journal of Rehabilitation Research & Development the percentage of mobility recovered is somewhere between thirty and sixty-six percent.

Experimentation

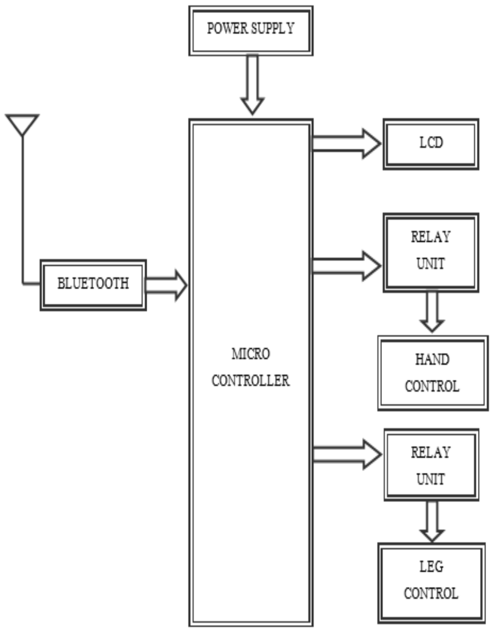

Fig. 3 Conceptual Block Diagram

Electric power source is one of the main block the 230v supply converted to +5 and +12 volts by 7805 and 7812.This 12 volts given to the drive circuit to drive the motors with the help of command received from a single chip. The motor rotates clockwise or anticlockwise when command received.

There are three motors fixed to the leg. one at hip region of 10kg torque and other two at knee and foot region of 3 kg torque which helps the patient to take physiotherapy.

ARDUINO: The Arduino is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller.

MOTORS: Motors are used in this project so as to provide the movement of the mechanical setup, helping the patient to walk autonomously. Due to the motion of the motor it gives physiotherapy to different joints of the leg such as foot, knee and hip region. Here we are using three geared motors for three joints of the leg, one motor at hip region is capable of producing 10kg of torque and other two motors are capable of producing 3kg torque. Each motor runs at 10rpm at 12 volts.

DRIVER CIRCUIT: Any hardware for its working would require the use of driver circuit for its proper functioning. In this project, driver circuit has been used to drive the motors. We are using relay driver circuit in order to drive the motors. It acts as a bridge between the microcontroller and motors.

POWER SUPPLY: Power supply is needed for any electronic device to work. Power supply supplies voltage to various parts of the circuit and hence the need for it.

LCD DISPLAY: A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

FLOWCHART

X,Y→ INPUTS

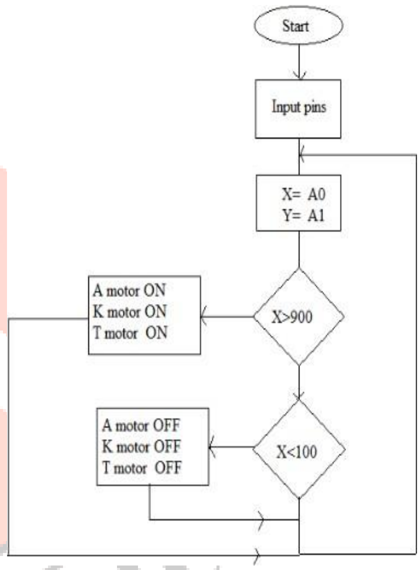

Fig 4.1 Flowchart for motor control

In order to represent the operation of motors we have used two input X and Y, where X is for motor control and Y is for Physiotherapy. For all the three joints of leg three motors are fixed, the motor at ankle is represented by A the motor at knee is represented by K and the motor at the thigh is represented by T.

In this flowchart we are going to discuss about the motor control only We have set some Threshold value of steps in Joystick for both the operation.

When X is greater than 900 steps all the three motors A,K,T are in on condition which helps for the patients to move forward. When X is less than 100 all the motors will be in off condition

Y → INPUT

Fig 4.2 Flowchart for physiotherapy

As discussed earlier the input pin Y is used for physiotherapy. When Y is greater than 900 steps only ankle motor A is turned on and off for its rehabilitation exercise similarly when Y is lesthan 100 steps both knee and thigh motors will be on for its rehabilitation exercise. The process will be repeated.

RESULT AND OUTPUT

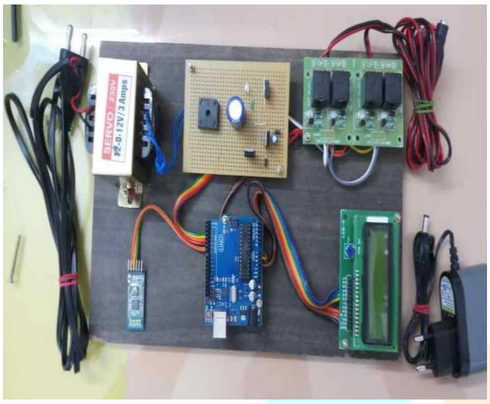

FIG 5.1 ELECTRONIC KIT

The Electronic kit consists of the transformer, power supply, relay board, LCD display, Ardiuno and a Bluetooth. The transformer used here is step down transformer which is used to convert the 230v to 12v. This transformer's output is given to the power supply board from which the power is distributed to the relay board, ardiuno and relay board. The relay board is used to control the motor which are in the mechanical kit to control the hand and leg mobility respectively.

The following Fig shows the mechanical set up. The motor which is fixed at the top of the kit is used to control the mobility of the hand of the patient. The motor which is fixed at the top of the kit is used to control the mobility of the leg of the patient.

Fig 5.2 Mechanical Kit

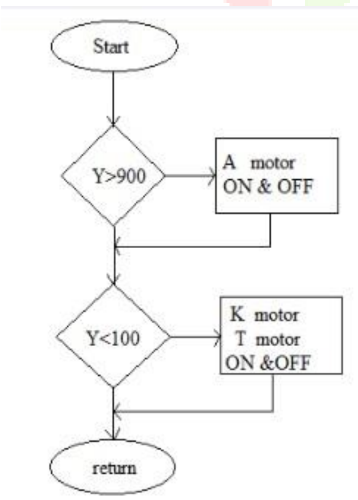

Fig 5.3 Hand Motor At Lower Position

The plate that holds the hand of the patient is in the lower side.

Fig 5.4 Hand Motor At Upper Position

The plate that holds the hand of the patient is in the upper side.

Fig 5.5 Leg Motor At Lower Position

The plate that holds the leg of the patient is in the lower side.

Fig 5.6 Leg Motor At Upper Position

The plate that holds the leg of the patient is in the upper side.

CONCLUSION

Due to the high cost of existing rehabilitation options, 85% of the paralysis patients in China are not able to get treatment for their conditions. The project group was faced with an important task to give these patients a relatively inexpensive, yet affective, alternative to help them with their recoveries.

By designing a four-bar linkage system that allowed the thigh to follow a precisely calculated knee trajectory curve, the authors were able to match the motion of a human thigh while walking. This coupled with a knee mechanism that incorporated a compound gear train and a step motor that was run by a computer program that allowed the shin to move in a precise curve that represented the actual lower leg motion of a human, allowed the authors to create a very precise mechanism that will help a patient regain their leg motion.

The work can be further extended wherein more advanced technology can be incorporated like smart phones, eye contacts and remotes instead of joystick to move clockwise or anti-clockwise and can be used for other parts of body parts like hands and so on.

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