DESIGN AND FABRICATION OF EXOSKELETON ARM USING BLUETOOTH MODULE

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Abstract

An exoskeleton is the external skeletal structure that supports or protects the body, in contrast to the internal skeleton (endoskeleton) of a human. Many people in the world are confined to a wheelchair due to injuries or illnesses which cause muscle weakness. One such illness is a genetic condition known as muscular dystrophy; patients suffering from this have limited muscle movement which can result in muscle waist, muscle hypertrophy and muscle pain. The exoskeleton is getting important to humans in many aspects such as power assist, muscle training, motor functioning and rehabilitation. This project aims to develop a voice operated exoskeleton arm. The appropriate words to be recognized are first trained by the user using the speech recognition module. The output of the speech recognition kit is sent to the Arduino microcontroller. According to the inputs received by the Arduino, appropriate signals are now sent to the motor driver to rotate the required motor in the specific direction. Pulse width modulation is used to set the required speed with which the motor has to rotate. Thus, each part of the robotic arm can be controlled by controlling the direction of that particular motor. The motor continues to rotate until the user says a second command or a stop command. When the stop command is said all the motors remain ideal. The advantage of using this exoskeleton arm is disabled people can regain the use of their limbs using the exoskeleton arm. Parkinsons people can gain the rehabilitation. Hence an attempt has been made to build a blue tooth operated exoskeleton arm for disabled people.

Keywords: online shopping, convenience, web site quality, awareness

Introduction

An exoskeleton is the external skeletal structure that supports or protects the body, in contrast to the internal skeleton (endoskeleton) of a human. It consists of structure and joints that are very much similar to the human anatomy. Many people in the world are confined to a wheelchair due to injuries or illnesses which cause muscle weakness. One such illness is a genetic condition known as muscular dystrophy; patients suffering from this have limited muscle movement which can result in muscle waist, muscle hypertrophy and muscle pain.

Statement of the Problem

The recent examinations by the World Health Organization (WHO) says that about 15% of the total population experiences a type of inability , in that more than half cannot bear the cost of health care systems. Due to different reasons, the general and appendage brokenness patients are expanding. There are more than 10 million disabled all over, out of which 30% are arm disabled persons. Many of the people as been diagnosed with different types of injuries and new cases have been diagnosing still. Almost 50% of these cases bring about some loss of sensation or movement to the arms and hands. The growth and use of exoskeleton arm is considered as the major remedy for this situation where the muscles do not receive any signals from the central nervous system.

Keeping above points in mind an attempt has been made to design and fabricate blue tooth operated exoskecton for disabled people, further utilized paralyzed people can make movement of their arm using the device and In industries to lift any weights and also In military to lift heavier objects and relieve strain on the body during physical operations.

Objectives of the study

- To develop a prototype project of voice operated exoskeleton arm by using Bluetooth module.
- To reduce the size and weight of the device to prevent the fatigue of the user.

- Development of portable exoskeleton arm

Review of Literature

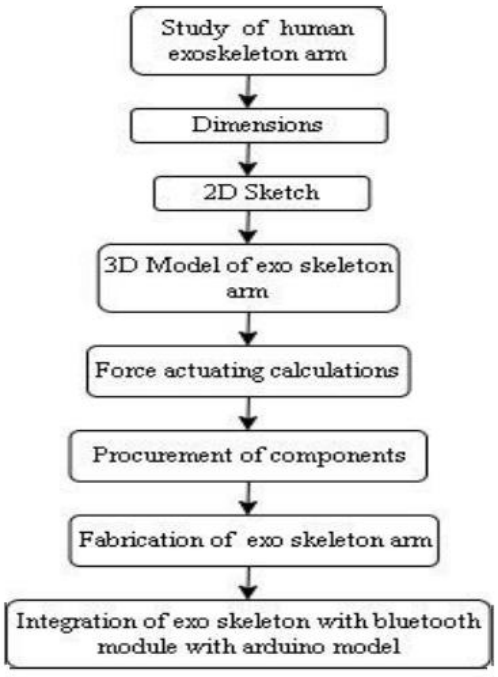
Manns PJ, Hurd C, Yang JF. Manns PJ, et al. J Neuroeng Rehabil.(2019), Studied perspective of people with spinal card injury learning to walk a powered exoskeleton, by developing the Powered exoskeletons for over ground walking to help people with neurological impairments to walk again and found Extended training in powered exoskeletons has led to changes in walking and physiological functions

Bhatnagar T, Ben Mortensen W, Mattie J, Wolff J, Parker C, Borisoff J. Bhatnagar T, et al. IEEE Int. Conference Rehabil Robot. (2017). this project aims to develop the Exoskeleton technology has potential benefits for wheelchair users' health and mobility. However, there are practical barriers to their everyday use as a mobility device. In particular, challenges related to travelling longer distances and transitioning between using a wheelchair and exoskeleton walking may present significant deterrents to regular exoskeleton use. In an effort to remove these barriers, a combined exoskeleton-wheelchair concept ('COMBO') has been proposed, which aims to achieve the benefits of both these mobility technologies. Given the inherent importance of including user-stakeholder opinions when designing an assistive technology solution, a study was undertaken to explore the perspectives of wheelchair users and healthcare professionals on the proposed conceptual design of the COMBO.

Baltrusch SJ, Houdijk H, van Dieën JH, Kruif JTCM. Baltrusch SJ, et al. J Occup Rehabil. 2021 Mar;31(1):129-141.doi:10.1007/s10926-020-09891-1.(2021). Studied Passive Trunk Exoskeleton Acceptability and Effects on Self-efficacy in Employees with Low-Back Pain: A Mixed Method Approach..This project aims to develop the Purpose Determinants of successfully introducing passive exoskeletons in the working environment to decrease mechanical loading on the back, are acceptability of the device to management and employees, including self-efficacy of employees when using the device. Therefore, the aim of this study was to assess self-efficacy of employees with low-back pain when using an exoskeleton and the acceptability of such a device to these employees and their managers and used a mixed method approach.

Experimental work:

Construction of exoskeleton arm:



Work Flow chart

Table 1. Details of components used

SL.No	Items	Parameters	Quantity
1	Dc Geared motor	Speed-100rpm	1nos
2	Aluminium sheet	Thickness-3/4 inch (19mm)	1nos
3	Gear [40 teeth] Gear [20 teeth]	40 teeth 20 teeth	1nos
4	Battery	12v rechargeable	1nos
5	Screw Screw	M8 M4	6nos 6nos
6	Light weight belt	Easy removable	1nos
7	Micro controller	ATmega328P	1nos
8	Hbridge (DC Motor Driver)	-	1nos
9	BLUETOOTH MODULE	-	1nos

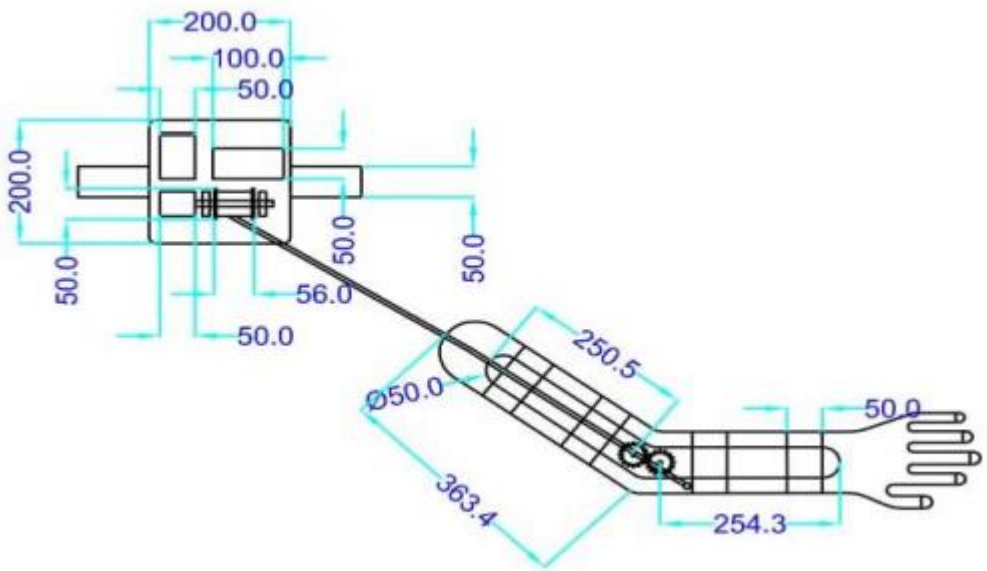


Fig 1. 2D Model

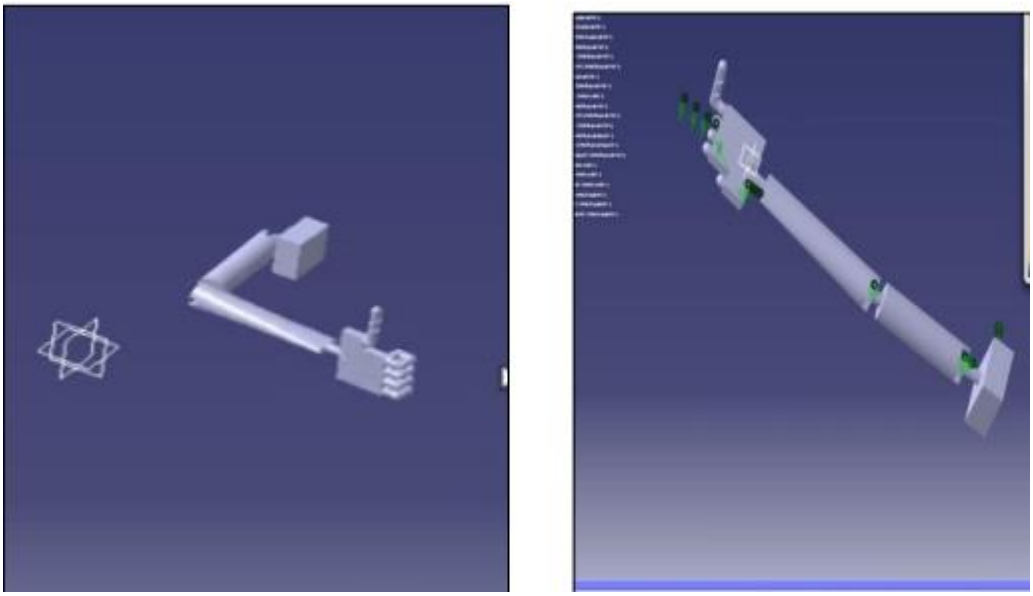
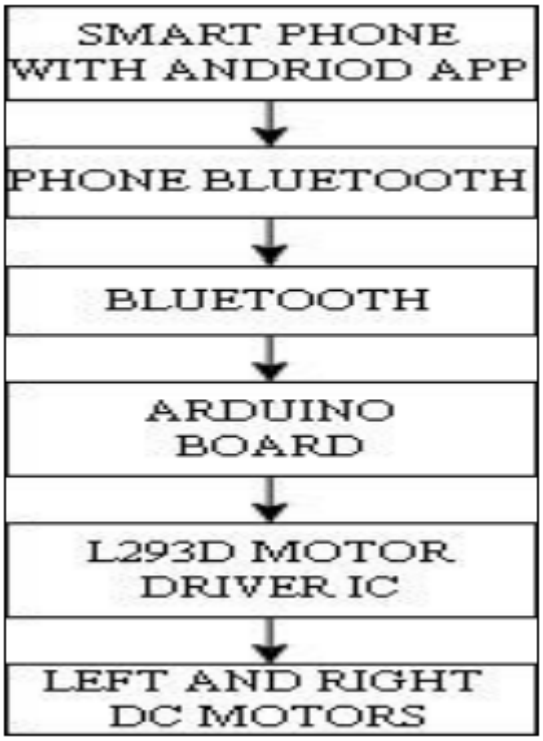


Fig 2. 3D models

Table2. Flow chart and Programming of Exoskeleton arm for Bluetooth voice control module



PROGRAMMING

```
#include <SoftwareSerial.h>.
#include< LiquidCrystal.h>
#include <String.h>

const int rs = 13, en = 12, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
 LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
SoftwareSerial bluetoothSerial(8, 9);/* (Rx, Tx) */
int IN1=6;
int IN2=7;
char ch; String readvoice;
char Serial_read(void);
```

```
void setup()
 {
 pinMode(IN1,OUTPUT);
pinMode(IN2,OUTPUT);
digitalWrite(IN1,LOW);
 digitalWrite(IN2,LOW);
lcd.begin(16,2);
Serial.begin(9600);
bluetoothSerial.begin(9600);
Serial.println("VOICE CONTROLLED HAND MOVEMENT");
 lcd.print("VOICE CONTROLLED");
lcd.setCursor(0, 1);
lcd.print("AUTOMATION");
delay(2000);

}
void loop()
 {

VOICE_MODE();
}
 char Serial_read(void)
 {
 char ch;
 while(Serial.available() == 0);
ch = Serial.read();
return ch;
}
void FORWARD()
 {
digitalWrite(IN1,HIGH);
 digitalWrite(IN2,LOW);
 }
void REVERSE()
 {
digitalWrite(IN1,LOW);
 digitalWrite(IN2,HIGH);
}
void STOP()
{
 digitalWrite(IN1,LOW);
digitalWrite(IN2,LOW);
}
void VOICE_MODE()
{
 Serial.println("VOICE MODE ");
lcd.clear();
 lcd.print("GIVE VOICE..");
 while(1)
{
bluetoothSerial.begin(9600);
 while (bluetoothSerial.available())
{
//Check if there is an available byte to read delay(10);
```

```
//Delay added to make thing stable char c = bluetoothSerial.read();
//Conduct a serial read readvoice += c; //build the string- "forward", "reverse", "left" and "right"

}
Serial.println(readvoice);
delay(1000); if (readvoice.length() > 0)
 {
Serial.begin(9600);

if(readvoice == "forward")
 {
Serial.begin(9600);
Serial.println("forward");
cd.clear(); lcd.print("LED1 ON...");
 FORWARD ();
}
else if((readvoice == "reverse")||(readvoice == "riverse"))
 {
 Serial.println("reverse");
 lcd.clear();
lcd.print("LED2 ON...");
 REVERSE();
}
else if (("stop")||("top"))

Serial.println("stop");
 lcd.clear();
 lcd.print("Fan ON...");
 STOP();
}

readvoice="";
}
}
}
```

Calculations of motor torque and arm actuating force .

Torque Calculations

DC GEARED
Motor Speed (N) = 30rpm
Voltage (V) = 12 volt
Power (P) = 12 W
Torque of the motor Torque (T) = (P X 60) / (2 X 3.14 x N)
= (12x 60) / (2 x 3.14 x 30) = 3.821N-m

Arm Actuating force

L1 = 50 mm
 L2 = 254 mm
F1 = 68 Kg
 F2 = ? F1 x L1 = F2 x L2
68 x 50 = F2 x 254
F2 = 3400/254 F2 = 13.38 Kg

By changing L1 we can increase or decrease the speed of arm going up and down. Also weight carrying capacity can change

Results and Discussion

The integration of human and robot into a single system offers remarkable opportunities for a new generation of assistive technology. Despite the recent prominence of upper limb exoskeletons in assistive applications, the human arm kinematics and dynamics are usually described in single or multiple arm movements that are not associated with any concrete activity of daily living . Moreover, the design of an exoskeleton, which is physically linked to the human body, must have a workspace that matches as close as possible with the workspace of the human body, while at the same time avoid singular configurations of the exoskeleton within the human workspace. Moreover, results of a manipulability analysis of the exoskeleton system indicate that the singular configuration of the exoskeleton system may be moved out of the human arm physiological workspace while maximizing the overlap between the human arm and the exoskeleton workspaces. The collected database along with kinematic and dynamic analyses may provide a fundamental basis towards the development of assistive technologies for the human arm. With the help of our project we are finally able to give the user extra strength which will allow him or her to pick and move objects which are beyond his capable limit.

Table No.3: Weight lifted and Time

SL NO	VOICE COMMANDS	WEIGHT IN KG	OPERATION	TIME REQUIRED
1	UP	AFTER LIFTING WEIGHT - 500g -1kg -1.5kg	ELBOW MOVES UPWARDS	 3.5 sec 4.5sec 5.5sec
2	DOWN	REALISING THE WEIGHT -500g -1kg -1.5kg	ELBOW MOVES DOWNWARDS	 6sec 5sec 4sec

Discussion

Rehabilitation robots have become important tools in stroke rehabilitation. Compared to manual arm training, robot-supported training can be more intensive, of longer duration and more repetitive. Therefore, robots have the potential to improve the rehabilitation process in stroke patients.. However, the implementation of an exoskeleton device introduces the challenge of reproducing the motion of the human shoulder, which is one of the most complex joints of the body. Thus, this project starts with describing a simplified model of the human shoulder. On the basis of that model, a new ergonomic shoulder actuation principle that provides motion of the humorous head is proposed, and its implementation in the exoskeleton arm therapy.

Conclusion

The conclusions of the project work are as follows:

A systematic approach has been made to design and implement Voice operated exoskeleton arm.

Factory workers who involved in heavy load lifting can utilize this device which helps them to relive from lift related health issues. And also and they are able to be more physically active both on the clock and off. Exoskeletons can transfer the weight of a user's arms from the shoulders, elbow by reducing physical stresses. The advantage of using this exoskeleton arm is disabled people can regain

the use of their limbs using the exoskeleton arm.Parkinson's disease people can gain the rehabilitation.

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