International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | Impact Factor: 7.488 |

|| Volume 8, Issue 5, May 2020 ||

Encasement for Walking Assistance using Robotic Technology

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ABSTRACT: Our project represents the design of an exoskeleton robotic technology to assist the paralyzed people to move on their own, by supporting them physically and move their leg independently like a human leg. The working prototype has been designed of two features, one is support and the second one is motion with the help of Arduino based micro-controller support. In support part the robot is holding the whole physique of the paralyzed person and keep the person stand with support. The motion part is taking decision whether to sit down, stand up and walk based on the manual switch that will give command to the microcontroller which assess the command, and move the exoskeleton based on it. The prototype is developed with the intention to help the paralyzed people for helping them walk and remove them from the entitlement of disability.

KEYWORDS: Exoskeleton robotic technology; Arduino based micro-controller; Assess the command ; move the exoskeleton ; entitlement of disability.

I. INTRODUCTION

There are many people with disabilities in today's country's population. Our project is mainly dedicated to them who are paralyzed and can't move their lower body part. Patient of this kind of disease usually uses wheelchair or someone else's help to move or do any kind of mobility-based work. By introducing this device to them they can sit, stand and walk.

This will help them stand up while keeping balance and support their whole body. The revolution of robotic exoskeleton started at the last half of the 20th century. People who could not walk or move started to embrace robotics. In 1965, General Electric (in the US) was in progress with the Hardiman, a large full-body exoskeleton intended to enhance the user's strength to assist in lifting heavy objects. At the end of 1960s and at the start of 1970s, the first gait assistance exoskeletons were developed at the Mihajlo Pupin Institute Serbia and University of Wisconsin-Madison in the US, respectively. The exoskeleton project was recently modified by many other companies such as ReWalk, Ekso GT and Phoenix Medical.

These projects are state of the art which possess more advance technology with better and faster control system for the patient to use. They are primarily made for the rehabilitation of the paralyzed people but can also be used for their day to day like necessities with convenient advance programs and features. And while they are state of the art, they come at prices far beyond reach for normal or poor people to afford. And this is where the assistive exoskeleton shine giving the basic movement at much lower price.

II. PROBLEM STATEMENT

Exoskeletons are dressed external and support the body movement like a power suit. Exoskeletons were developed to support disabled or handicapped people during their rehabilitation process and to support the everyday life, for example, of paralyzed patients. The motivation to use Exoskeletons in industry to assist and help workers to achieve daily tasks, is based on these two different approaches. Exoskeletons will be able to assist disabled workers at work and therefore give them the ability to reintegrate. As a result a reduction of lost work days can be expected.

III. PROPOSED SYSTEM

In the proposed system we developed a metallic exoskeleton which mostly consists of several metallic frame and some electrical parts to run the device in an automated way. The metallic bar holds the overall structure of the exoskeleton. The robust element will support the overall structure of the exoskeleton and give it, its base to work on the whole

exoskeleton. A Relay module is an electrically worked switch of mains voltage. It implies that it can be turned on or off, releasing the current through or not.

The relay module will take command from the Arduino and give signal to the actuators of respective relay part to control their movement. The Arduino Uno control the relay signal which will direct the signal based on their given code, and according to those signals, the actuator will move accordingly moving the exoskeleton. We are using 2 8400 mAh LiPo Battery to ensure the functionality of the actuator and other electronics peripherals with it. This will let the device sustain for a minimum 5 hours of functionality.

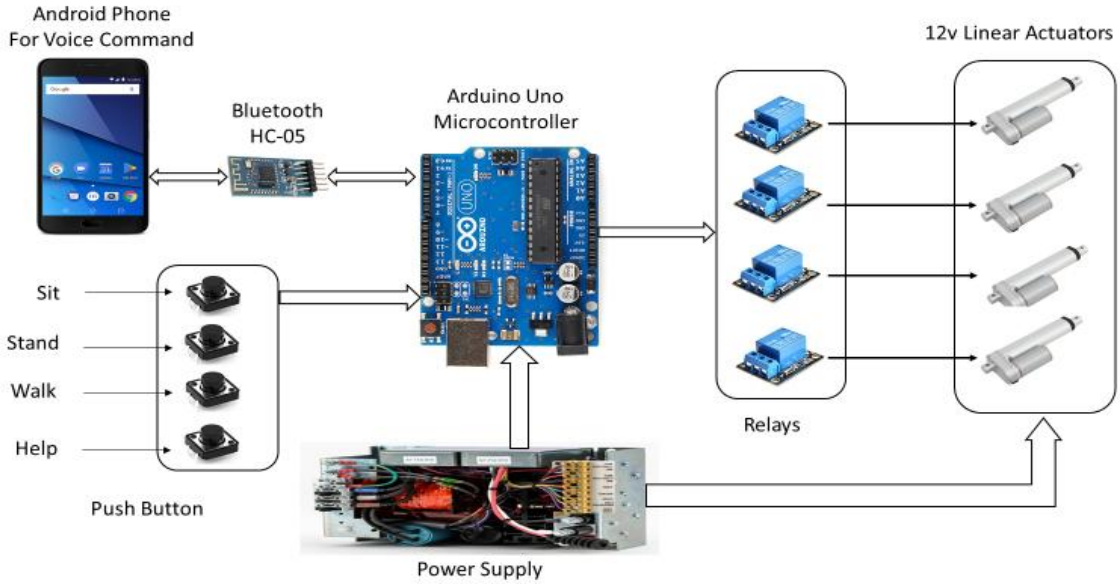

Fig 1: Working Method of the System

The step by step process of the device running with a command signal is given below.

1. Firstly, when the switching command is pressed, the relay sends signal to the microcontroller. There are 8 relay which gives different set of signals to the microcontroller based on the movement to be made.
2. The device when given the walk signal starts moving forward.
3. First, the left leg is lifted up and moved forward when relay 1 and 2 are high. The leg will start coming down to the ground when relay 3 and 4 are on. Half cycle complete.
4. Next, the right leg is lifted up and moved forward when relay 5 and 6 are high. The leg will start coming down to the ground when relay 7 and 8 are on. In this way, full cycle of 1 step is complete. After pressing the switch of the walk button, the whole function will start with a delay of 1 second, and will fully complete the full cycle within a time of 18 second.
5. By the combination of the movement of the left leg and the right leg using 8 relay signal, it can be seen that the exoskeleton achieved its goal by moving a paralyzed patient based on the command given to them.
6. During the movement of standing and sitting up , all the relay works together at the same time. The function of the stand and sit is reciprocal to one another. While the device is in stand position , when pressing the stand button , the device will not do anything. But if the sit button is pressed, all the relay will signal all the 4 actuator at both the leg to go down at the same time.

IV. SIMULATION &SOFTWARE

A. Simulation

To avoid theoretical error and unexpected circumstancesin this project, some simulation of the designed circuit and hardware are done before implementing the physical parts. By this way, better understanding of the work by the system is achieved and the validity of the project isensured.

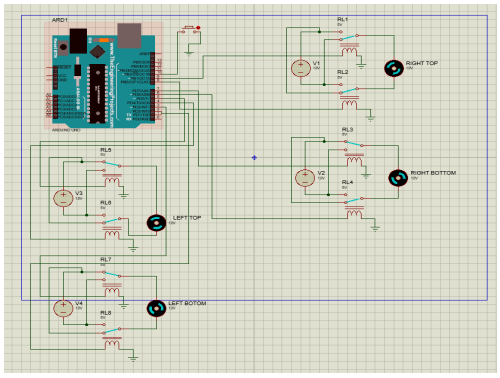

Fig 2: Schematic Design of the Arduino and Relay Module.

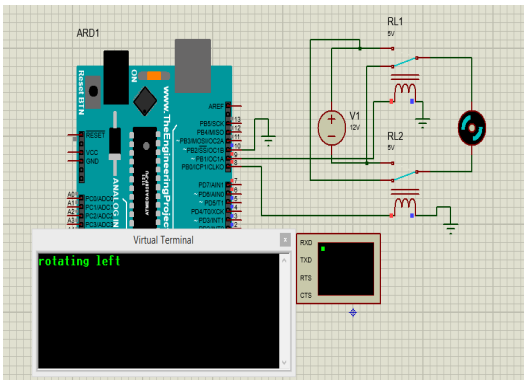

Fig. 3: Relay signal for motor to turn left.

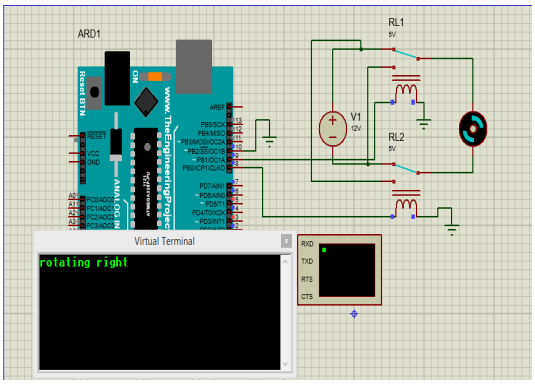

Fig. 4: Relay Signal for motor to turn right

In the above picture 8-relay module is connected to the Arduino Uno. The 8-relay signal worked when the command of the relay was transferred to the microcontroller where the code was set of 8 different relay signals. The code was completed and executed in the Arduino software and the circuit design was accomplished in the Proteus 8 Professional Software.Thefunctionthatwereexecutedbythecodeofthe8 relays in the Arduino software is given below. In the figure 3, the relay signal has been given for the motor to turn left representing the pull of the actuator. In the figure 4, the opposite can beseen.

B. Software

For software purpose, we used 3 different software for different purpose in our project.

1. Solidworks computer aided designsoftware
2. Arduino IDE for Arduinoprogramming
3. Arduino Embedded C.
4. Android Program

Solid Works Modelling

Fig. 5: Solid works modeling back movement

Fig. 6: Solid works modeling forward movement

The main design of the exoskeleton was done by using Solidworks, which is a computer-aided design and computer- aided engineering computer program. By using this software, a virtual product was made to understand the functionality and the sustainability of the project device. In figure 5, we can see the actuator moving down moving the leg frame towards the ground. In figure 6, the actuator fully lifts the leg up to move the leg forward.

Android App

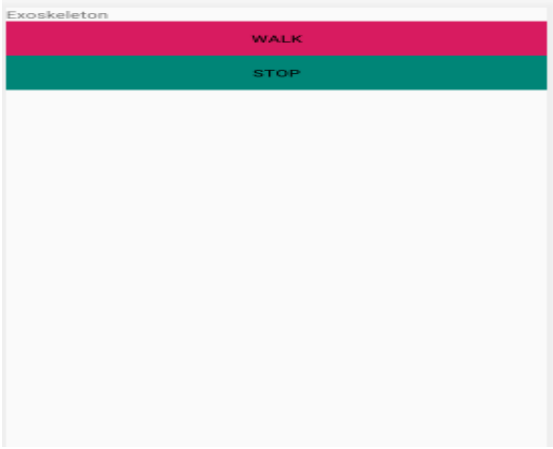

Fig. 7: Android App to control device

In figure 7 ,the Android app is been created which has two button ,one to Walk and another to Stop where the paralysed person can access the exoskeleton model through phone by using this app.

V. HARDWARE

The Assistive Exoskeleton is a metallic exoskeleton which mostly consists of several metallic frame and some electrical parts to run the device in an automated way.

A.1 Metallic Frame

Made of Steel, this metallic bar holds the overall structure of the exoskeleton. Compare to carbon fiber they maybe heavier, but the robust element will support the overall structure of the exoskeleton and give it, its base to work on the whole exoskeleton and help keep the integrity of the device in the long run. Also, it is very much cheaper than carbon fiber and available in the local market since low cost is one of the novelty of this project.

A.2 Actuators

4 Linear actuator
Brand:Louie
Model: XTL100
Stroke: 100mm or 4inch
Push Load: 1000N
Voltage: 12V DC
Speed: 12mm/s

In this project, 2 of them are used, 1 on the upper thigh, and 1 on the back calf of the leg. These actuators will be used to control the overall movement of the exoskeleton by moving them according to the command they are given in a synchronizedmotion.

Fig. 8: Linear Actuator

B.1 Relay Module as MotorDriver

A Relay module is an electrically worked switch of mains voltage. It implies that it can be turned on or off, releasing the current through or not. The relay module will take command from the Arduino and give signal to the actuators of respective relay part to control their movement.

B.2 Arduino UNO

Arduino Uno is used to control the relay signal which will direct the signal based on their given code, and according to those signals, the actuator will move accordingly moving the exoskeleton [8].

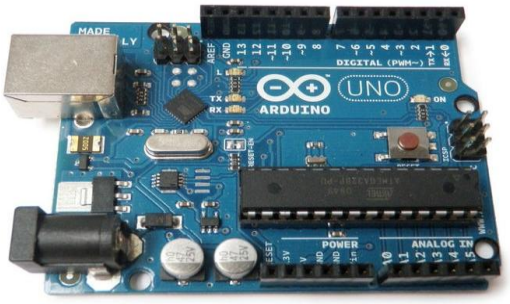

Fig.9. Arduino UNO

C.1 Power Supply

Control supply is a reference to a wellspring of electrical compel. A contraption or system that provisions electrical or diverse sorts of essentialness to a yield load or assembling of weights is known as constrain supply unit or PSU. The term is most generally associated with electrical essentialness supplies, less much of the time to mechanical ones, and once in a while to others

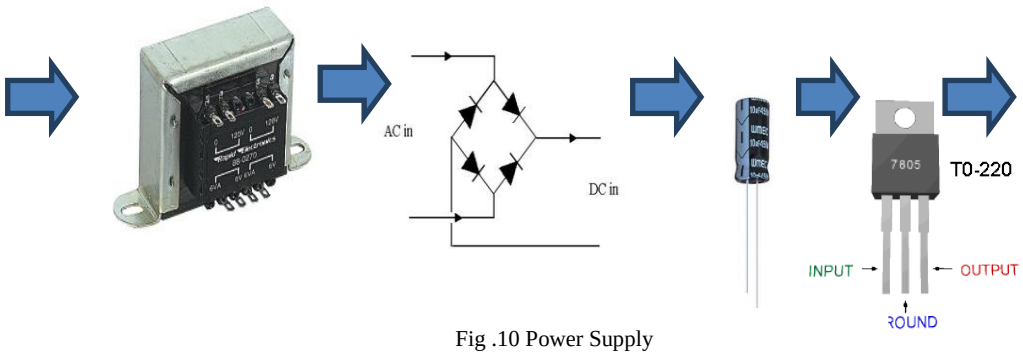

Fig .10 Power Supply

VI. RESULTS ANALYSIS

The result of the project mainly focuses on two part. The hardware result which will focus on how the device is running with a patient, if the goal is being achieved properly. And the software result which will focus on the simulation of the electrical part of the device if the different control signals are properly delivered with each command.

It is to be mentioned again the design of the whole frame with the accurate placement position of the actuators will allow the movement of the frame in the desired position which has been alreadysimulatedintheSolidworkssoftware.Whilethedevice can fully support the patient physically, the stability of the patient is maintained using two elbow crutch which are to be held at both hand of the patient to keep the balance of the device and the body of thepatient.

Also, thedeviceismademimickingthemovementofthesimulation, so the patient should be able to walk or stand still comfortably bothwhentheswitchisturnedonoroffrespectively

The step by step process of the device running with a command signal is given below

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Fig .11 Lower Limb Exoskeleton with LinearActuator

VII. FUTURE SCOPE OF THIS STUDY

The assistive exoskeleton that was developed in this project can be used in other purpose like robotics research, medical research etc. The sustainability of the project is directly proportional to the importance of the project. The importance of the project is determined by the usage of the project. In India, hundreds and thousands of people are paralyzed in some way or another. Most of them are poor.

The Assistive Exoskeleton is targeted specifically for this kind of people. With high demand, this project under proper observation can flourish on a large scale and mass manufacture of the device can be started with proper sponsor. After further development of the project in future, the device can be exported on global scale to different other countries of the world. There are many points and spaces for future development which will improvise the usability of the device and make it more user friendly.

Differential Gear will be used instead of actuator which will give us faster operation and better mobility. IOT (Internet of things) technology can be used to monitor the patients' health status and also keep it informed to the family member and the physician of the patient. Wireless input system for information gathering and command system can be added which will let the exoskeleton to be controlled in a wireless manner. Furthermore, it can mainly target to control the system by simply thinking or by using brain wave. This can open up vast scope of study for this project

VIII. CONCLUSION

The Assistive Exoskeleton will be extremely useful for the physically paralyzed individuals in terms of movement. Paralyzedindividuals will be able to move from one place to another independently. The Exoskeleton will act as a base of more improved design from generation to generation of development in the upcoming future as more research will be done towards it. The developed prototype gives us better result at moving a paralyzed person from one position to another, thus giving us an accurate estimate of the real deal to come. This project can change the world of paralyzed

people who are poor and cannot afford to spend millions of moneys to walk and can take us to the betterment of mankind.

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