Hand Gesture Controlled Robotic Leg for Handicapped

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Abstract - *According to the World Health Organization (WHO), every year there are over 1.2 million deaths due to road accidents around the world, 20 to 50 million persons sustain injuries, and more than 5 million remain disabled for life. About 15% of the world's population lives with some form of disability, of whom 2-4% experience significant difficulties in functioning of legs. There are many people who are handicapped by the legs who are not able to walk without any support. These may be aged people, accidental case or patient who lost legs.*

Our project is a great help to these people. Nowadays wheelchairs and prosthetic legs help these people, but only to some extent. When prosthetic leg doesn't help the person to sit like a normal person, wheelchair doesn't enable to climb the staircase. For that we design ROBOTIC LEG which possess all the basic properties a normal human can do for example walking, sitting, climbing stairs etc.

The motion of the leg is done with the help of hand. When the hand is being moved in a specific direction, the motion of the leg is made. Also a specific gesture is predefined and programmed for initiating the climbing up motions. The two servomotors are used to provide external torque for joints of legs. The flex sensor depicts the gesture and is send from hand to leg wirelessly using wifi. The accelerometer-gyroscope sensor is used to calibrate and estimate the position of the body. The power supply is given by using 3.7V battery in hand & 8V Lipo battery in leg.

Keywords: Robotic Leg, gesture, servo motors, flex sensors, gyroscope sensor.

1. INTRODUCTION

During the past few years, there has been a large research attempt in improving the design of humanoid robotic legs and produce setups with motion capabilities inspired by the smoothness, accuracy and compliance that characterize the human lower-limb motion. A robotic leg is a mechanical leg that can perform the same functions of a human leg. The robotic leg is typically designed and programmed to execute similar functions of a human leg. A robotic leg is similar to a prosthetic leg. However, a robotic leg can be controlled electrically or mechanically.

A robotic leg attaches to an individual who has had a lower extremity amputation of a portion of a leg or foot. Doctors and technicians measure the remaining limb structure and of the person's prosthesis to ideally fit the robotic leg. After they attach the robotic leg, they embed the sensors in the robotic leg that measure the electrical activity created by re-innervated muscle contraction, and existing thigh muscle.

A legged vehicle allows locomotion in environments cluttered with obstacles where wheeled or tracked vehicles cannot be used. It is inherently bi-directional, provides superior mobility in difficult terrain or soil conditions (sand, clay, gravel, rocks etc.) and provides an active suspension. The legs also give the versatility and allow it to be re-configured.

2. OBJECTIVE

The objective of our project is to provide a great support for physically challenged persons who are not able to walk without any support such as polio patients, accidental cases who lost their legs etc. Our main aim is to overcome the disadvantages provided by a wheelchair which is the only option available for such people to travel.

The main objective behind this project work is:

- To give power at joints of leg to perform naturally.
- To give supplementary torque at joints of handicapped and aged person.
- To provide independency while exercising the affected leg for recovery after any mishaps.
- To make handicapped person independent in the sense of walk and stable stand.

3. RELATED WORKS

There have been a few attempts on building on the unique functionality of the genuine leg prosthesis for smoother, more intuitive walking, improved safety, and better support in everyday situations. That is simple to control using the Cockpit app on your iPhone or Android

Smartphone. This advanced feature will be difficult for an elderly person who has lost the eyesight or doesn't know to handle the technology. However, there has been no significant product that helps an amputated person in easily using the prosthetic leg.

4. BLOCK DIAGRAM

In the block diagram, there are two sections. The hardware at the hand is given on the right side and hardware at the limb is given on the left side. The microcontrollers used in our projects are ESP8266 and ESP32. ESP8266 is placed at the leg and ESP32 is placed at the hand. The glove section consists of 3 sensors, 2 flex sensors and one accelerometer gyroscope sensor. The limb section consists of 2 high torque servo motors that is knee servo and hip servo. Since we are having a WiFi module in built in the microcontroller we are making one as WiFi and other as hotspot. When gestures are made using the glove, flex sensors depicts them and sends from glove to limb wirelessly.

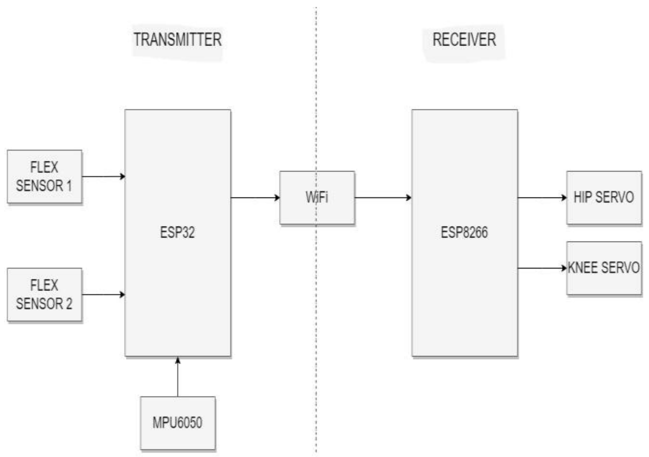

Fig 1: Block Diagram

The accelerometer used is MPU6050 gyroscope sensor which calibrate and estimate the position of the body so that it can differentiate through which pane the person is now moving. Two high torque servo motors are placed in the leg which give power at the joints which is connected to microcontroller. The glove portion is powered by a 9V battery and the limb part by a 8V Lithium Ion battery. In the transmitter section, there are three sensors, two flex sensors and one accelerometer gyroscope sensor. These are together connected to a ESP8266 microcontroller. The sensor will read from it and will transmit it to the next section using wifi. In the receiver, the main controller is ESP8266 and two devices are connected to it which are hip servo and knee servo. The data from wifi is converted to readable data and then drive the servo.

5. CIRCUIT DIAGRAM

In the circuit diagram, there are two sections. The first section shown is transmitter section. The main controller in the transmitter section is ESP32-WROOM-32D.In it two flex sensors are connected which acts like a voltage divider. The voltage in its centre point will vary according to the resistance in the flex sensor. The variation in the resistance of the flex sensor takes place in accordance with the bending of the flex sensor. The resistance will increase when the flex sensor bends downwards and hence the voltage decreases. The flex sensors F1 and F2 is connected to the pins 4 and 5 of ESP32 microcontroller respectively. The controller will read this using analog to digital convertor (ADC). The MPU6050 used is an accelerometer gyroscope sensor which communicates with microcontroller using ITC which is represented as SDA and SCL lines which is powered using 3.7V lithium ion battery. The SDA, SCL pins of gyroscope sensor is connected to the pins 33 and 36 of ESP32 microcontroller respectively.

The second section shown is receiver section. The main controller in the receiver section is Adafruit_HUZZAH_ESP8266_breakout. The power supply section consists of 8V battery which is connected to three regulators, first one is 5V 7805, other two are 317 which are adjustable regulator where 6V is already made set for servo motors. Two servo motors are connected using separate power supplies for getting sufficient power. ESP8266 is connected to servo using data lines, from this using pw signals servo motors are controlled. ESP8266 microcontroller has a wifi in built so the data from transmitter is transmitted through wifi to receiver which will collect the data and drive the servo motors.

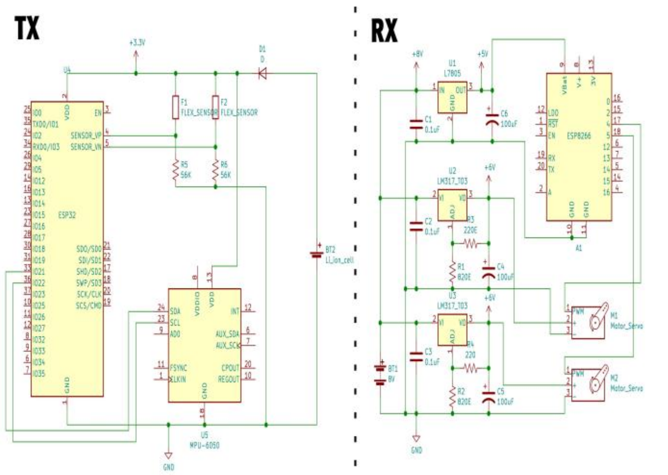

Fig 1: Circuit Diagram

6. WORKING

Our project consists of two sections: Hand glove section & Leg section. Hand glove section serves as a transmitter & leg section acts as a receiver.

Hand gloves section consists of two flex sensors, accelerometer, WiFi microcontroller and power supply battery. Leg section consists of two servos, WiFi microcontroller and power supply battery. We have 3 modes of operation. Walk mode, step mode and sit mode. As name indicates, walk mode is for walking assistance, step mode for climbing steps and sit mode for sitting.

Switching between modes is achieved by finger gestures captured by flex sensors attached to thumb & index finger.

When all fingers are released, walk mode is activated. When thumb alone is released, step mode is activated. When index finger alone is released, sit mode is activated.

Flex sensor values are captured periodically and transferred to the receiver section. Driving servos is achieved with accelerometer by capturing the angle of hand position. Accelerometer value is sampled and averaged periodically and transferred to the receiver.

For walking, only hip motion is required. Thus hip servo alone is activated. In walk mode, hip servo locomotes the leg synchronised with hand motion. For climbing steps, hip motion and synchronous knee motion is required. Thus both servos need to be activated. In step mode, knee servo rotates in same ratio of hip servo for synchronous motion. For sitting, knee need to be bend to 90 degrees. Thus knee servo rotates faster than hip servo for quick knee bend.

7. EXPERIMENTAL RESULTS

7.1 Walk Mode

. **Fig 3:** Hand gestures for walk mode

First mode of our project is walk mode. Walking is an important function of human leg. Our project supports such actions using to and fro movement of open palm faced down. When the hand is moved 30° forward, the leg provides forward leap. When the hand moves 120° backwards from the rest position, the leg pushes the body forward co-ordinating with the other leg. This is the main feature of our project. Figure 3 shows the hand gesture for walk mode.

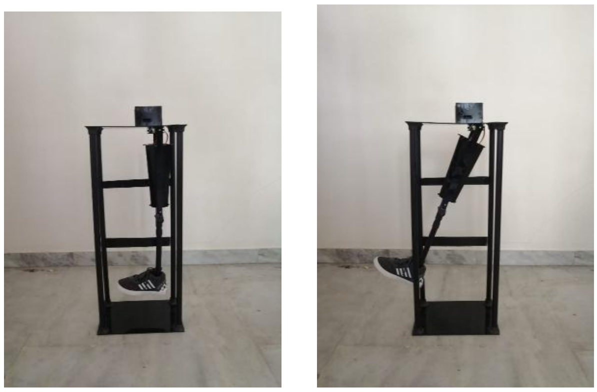

Fig 4: Output obtained in walk mode

The first figure in the output shows the initial rest position of the leg. As the hand moves forward and backward with the walk mode gesture, the leg movement obtained is the second figure of the output which is shown in figure 4.

7.2 Step Mode

Fig 5: Hand gesture for step mode

Second mode of our project is step mode.This mode helps the person to climb stairs. This is one of the unique features of our project. Normally prosthetic legs are not designed to climb stairs. The user should use folded palm with thumb pointed outwards gesture. On providing this gesture, the knee bends 60°. On releasing the gesture the leg attains normal state. Alternatively using and releasing the gesture will provide coordinated motion for climbing stairs. The hand gesture for step mode is shown in figure 5.

Fig 6: Output obtained in step mode

The first figure in the output shows the initial rest position of the leg. As the hand gesture is provided the knee is raised to 60° as shown in the second figure of the output in figure 6.

7.3 Sit Mode

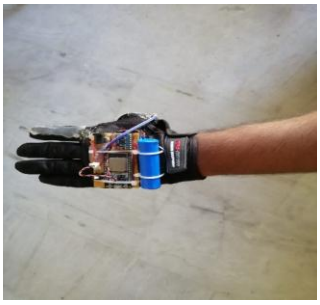

Fig 7: Hand gesture for sit mode

The third mode of our project is sit mode. Sitting is also an important function of a human body. Normal prosthetics restrict users from bending knee making it uncomfortable. Our project provides a gesture for users which when executed provides 90° bend to the knee making it easier to sit comfortably. The gesture for sit mode is folded thumb. The hand gesture for sit mode is shown in figure 7.

Fig 8: Output obtained in sit mode

The first figure in the output shows the initial rest position of the leg. The second figure of the output in the figure 8 shows the leg is greater than step mode for ease of sitting.

8. ADVANTAGES

1 The cost of structure is less as compared to other supporting structures, so it is affordable to ordinary persons.

2. No effect of corrosion since corrosion resistant material is used.

3. Material is water proof so no leakage or shortage problems.

4. Structure is light in weight.

5. All the structure can separate and assemble, so any part can be changed as per the requirement.

6. As per the requirement of the user the programming can be changed.

9. FUTURE SCOPE

1. By changing the material which is lighter in weight having same or more strength the cost can be saved.

2. The change in design of structure can be possible or the desired change can be done to enhance its aesthetic and ergonomic features.

3. Using optimum motor speed and torque cost can be saved.

4. The programming can be done in the point of view to give more ease to that person.

5. More switching can give the range of operation.

6. Adjustable length will give more proper movement and can be universal.

10. CONCLUSION

In this project, a new robotic supporting leg was developed for the elderly and handicapped people .Robotic systems are believed to be used as standard rehabilitation tools in the near future. Our project is available at high clinical improvement evidence and low costs so that it is affordable for a common man. When the usual prosthetic legs are bulkier, heavier and do not have join movements, our model is not bulky and there is no need for having a long duration power supply solutions. The usage of robotic systems allows precise measurement of movement kinematics and dynamics, which should be used for assessing patient recovery ability and progress.

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