Design of Active Lower Limb Exoskeleton Model to Aid Biomechanical Activities

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Abstract- **We present an electromechanical lower limb exoskeleton model that can be used to rehabilitate the lower limb disabled patients or paraplegic patients assisted with caliper. However other types of calipers like fixed leg caliper and ankle or knee caliper may impose a complication in providing normal and complex flexion and extension to the disabled lower limb . Its an electromechanical lower limb exoskeleton model that can be adopted With respect to kinematics and actuation to a wide range of patients. The introduced design allow to compose lower limb exoskeleton with motorized actuation, which will helps in flexion and extension of hip, knee & ankle ventures, The joints can be flexed by synchronization with the motorized actuation .Three different modules are used in this project , An actuator for active support and a controlling unit for controlling the actuation of the whole system and external supporting module to hold the design intact .The external controller is placed on the Hand crutch which indeed provide better stability for the patients using the exoskeleton system .This concept of electromechanical exoskeleton is a feasible low cost design module over the existing fixed knee caliper.**

I.INTRODUCTION

Here we introduce an active exoskeleton model to aid biomechanical activities. The realization of exoskeleton for rehabilitation of lower extremity disabled patients has seen in 21st century. Because a lower limb disability leads, the patients in pathetic condition due to the causes of mobility impairments and depending on the affection level, gait may be affected drastically making it even impossible. In 1969s the first active exoskeleton is introduced in the industrial workplace , that have developed at an incredible rate and now encompass almost every aspect of modern world. Exoskeletons are defined as an electromechanical system that is designed around the shape and function of the human body, with segments and joints corresponding to those of the person it is externally coupled with .The lower exoskeleton was implemented for rehabilitation of an individual who have lost their motor functions in their lower limbs. In the following sections, we begin with a description of an exoskeleton based on the electromechanical modules.

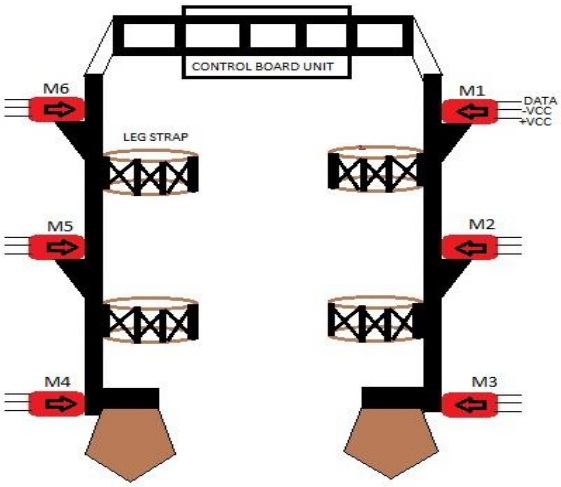

Fig 1: Design of proposed Exoskeleton Model

II.HARDWARE DESCRIPTION AND WORKING

Arduino uno

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to- DC adapter or battery to get started.You can tinker with your UNO without worring too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.Uno means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards. Arduino is an open-source electronics platform based on easy-to- use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by

sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers -students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Servo motor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor although the term *servomotor* is often used to refer to a motor suitable for use in a control system. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

Servos are self-contained electric devices that rotate or push parts of a machine with great precision. Servos are found in many places: from toys to home electronics to cars and airplanes. If you have a radio-controlled model car, airplane, or helicopter, you are using at least a few servos. In a model car or aircraft, servos move levers back and forth to control steering or adjust wing surfaces. By rotating a shaft connected to the engine throttle, a servo regulates the speed of a fuel-powered car or aircraft. Servos also appear behind the scenes in devices we use every day. Electronic devices such as DVD players use servos to extend or retract the disc trays. In 21st-century automobiles, servos manage the car's speed: The gas pedal, similar to the volume control on a radio, sends an electrical signal that tells the car's computer how far down it is pressed. The car's computer calculates that information and other data from other sensors and sends a signal to the servo attached to the throttle to adjust the engine speed. Commercial aircraft use servos and a related hydraulic technology to push and pull just about everything in the plane. Two common servo sizes. The standard servo on the left can range in power or speed to move something quickly, or it can accommodate a heavier load, such as steering a big radio-controlled monster truck or lifting the blade on a radio-controlled earthmover toy. The miniature servo is about the size of a U.S. quarter and is intended for applications where smallness is a critical factor but a lot of power is not.

Bluetooth Module

Bluetooth wireless technology is becoming a popular standard in the communication arena, and it is one of the fastest growing fields in the wireless technologies. It is convenient, easy to use and has the bandwidth to meet most of today's demands for mobile and personal communications. The figure below show a bluetooth module.Bluetooth technology handles the wireless part of the communication channel; it transmits and receives data wirelessly between these devices. It delivers the received data and receives the data to be transmitted to and from a host system through a host controller interface (HCI). The most popular host controller interface today is either a UART or a USB Here only focus on the UART interface, it can be easily show how a Bluetooth module can be integrated on to a host system through a UART connection and provide the designer an optimal solution for Bluetooth enabled systems. Supply voltage at VCC pin can vary between 1.8 V and3.3 V. VCC and BTEN combined to a single 3.3 V supply voltage.

HC-06 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The HC-06 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless communication. This serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate)3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).

HC-06 PIN DESCRIPTION

The HC-06 Bluetooth Module has 6pins. They are as follows:

ENABLE:

When enable is pulled LOW, the module is disabled which means the module will not turn on and it fails to communicate. When enable is left open or connected to 3.3V, the module is enabled i.e. the module remains on and communication also takes place.

Vcc:

Supply Voltage 3.3V to 5V

GND:

Ground pin

TXD & RXD:

These two pins acts as an UART interface for communication

STATE:

It acts as a status indicator.When the module is not connected to / paired with any other bluetooth device,signal goes Low.At this low state,the led flashes continuously which denotes that the module is not paired with other device.When this module is connected to/paired with any other bluetooth device,the signal goes High.At this high state,the led blinks with a constant delay say for example 2s delay which indicates that the module is paired.

BUTTON SWITCH:

This is used to switch the module into AT command mode.To enable AT command mode,press the button switch for a second.With the help of AT commands,the user can change the parameters of this module but only when the module is not paired with any other BT device.If the module is connected to any other bluetooth

III. BLOCK DIAGRAM DESCRIPTION

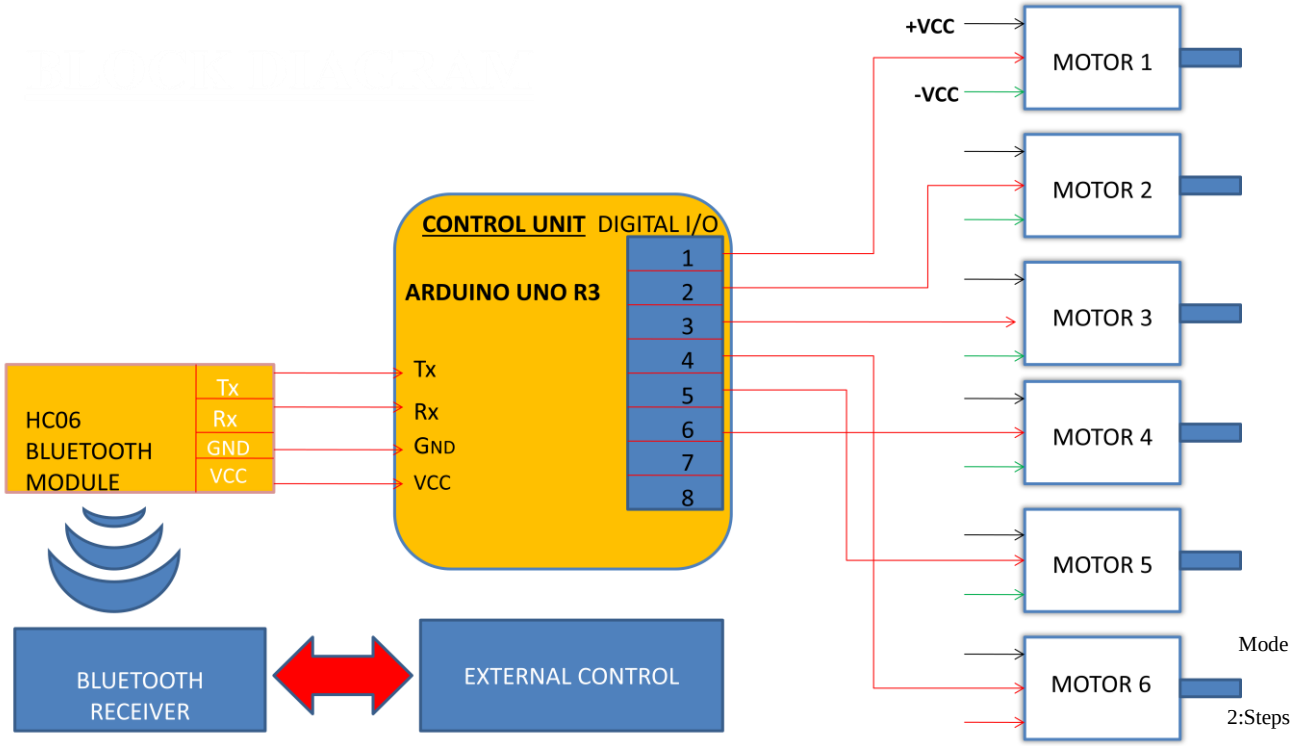

Fig 2: control and actuator system

Mode 1: Walking

- External controller gives the steps command to the Bluetooth module and which gives its output to aurdino development board through the communication channel (Tx&Rx) pins
- The program uploaded in the aurdino will run sequentially according to the command given to the aurdino
- Thus the aurdino gives the PWM(pulse width modulation) output to the servomotors digital pin through the aurdino digital output and it rotates the motor present on each leg joint.Each motor will run according to the preset angle and it performs the functions
- External controller gives the walking command to the Bluetooth module and which gives its output to aurdino development board through the communication channel (Tx&Rx) pins
- The program uploaded in the aurdino will run sequentially according to the command given to the aurdino
- Thus the aurdino gives the PWM(pulse width modulation) output to the servomotors(6.nos) digital pin through the aurdino digital output and rotates the motor present on each leg joint
- Each motor will run according to the preset angle and it performs the function called walking

IV.CIRCUIT DIAGRAM

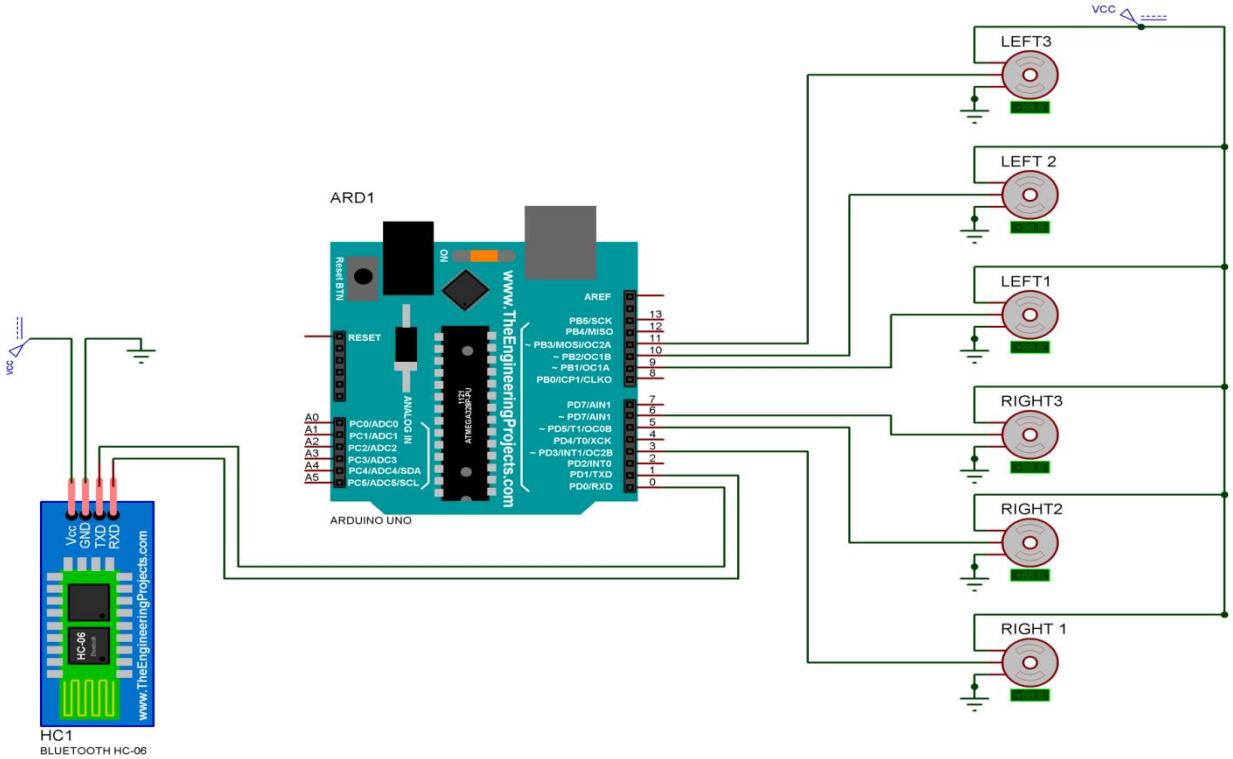

Fig 3: circuit diagram of exoskeleton system

V.HARDWARE MODULE

VI. CONCLUSION

In this project, we proposed a prototype design of the lower limb active exoskeleton model to aid biomechanical movements. We used standard type servo actuators, that is three servo motors for the each limb. By effective combination, we can take advantages of the three actuations on each joint . The hip and knee joint actuator provides transalatory progression while the ankle actuator assists the other two joints . The experiments and analysis show that this exoskeleton is ideal for the rehabilitation of the paraplegic patients, and the dimensions of the system is relatively small. Further research work is to study the lower limb exoskeleton together with person**.**

VII. REFERENCE

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