An Wireless Module to Detect Human Motion to Mimic Natural Gait in RGO

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***Abstract*— Amputation mainly caused due to trauma or surgery or due to industrial accident which can lead to the removal of their body portion [1]. In India the amputation causes mainly due to motor vehicle trauma, and has 7,455,494 amputations in their total population [2]. This paper describes the Reciprocating gait orthosis that is intended to provide a normal gait cycle for above knee amputees by mimic the movement of functional leg through wireless. The field of exoskeleton and wearable devices for amputation has advanced considerably over the past few years [3]. Our work was mainly focused on the single leg 13cm above knee amputees. The prototype which we have developed could mimic the movement of the functional leg and achieves the normal gait cycle. The system incorporates accelerometer sensor, Wireless transceiver, controller, Dc motor, Rechargeable battery. The x, y, z axis of the functional leg has been detected by the accelerometer sensor and the data sent to the developed leg through wireless transceiver. The received data has further sent to the DC motor which was controlled by driver circuit would achieve the normal gait cycle for the above knee amputee.**

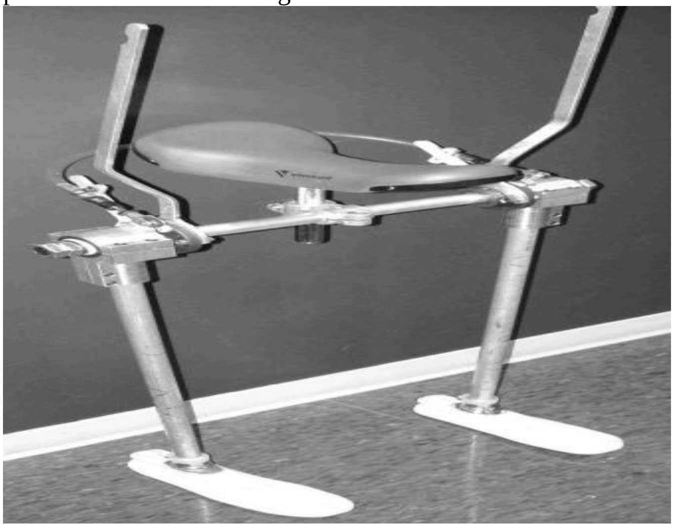
***Keywords*— above knee amputee, RGO, dc motor control, time limit.**

I. INTRODUCTION

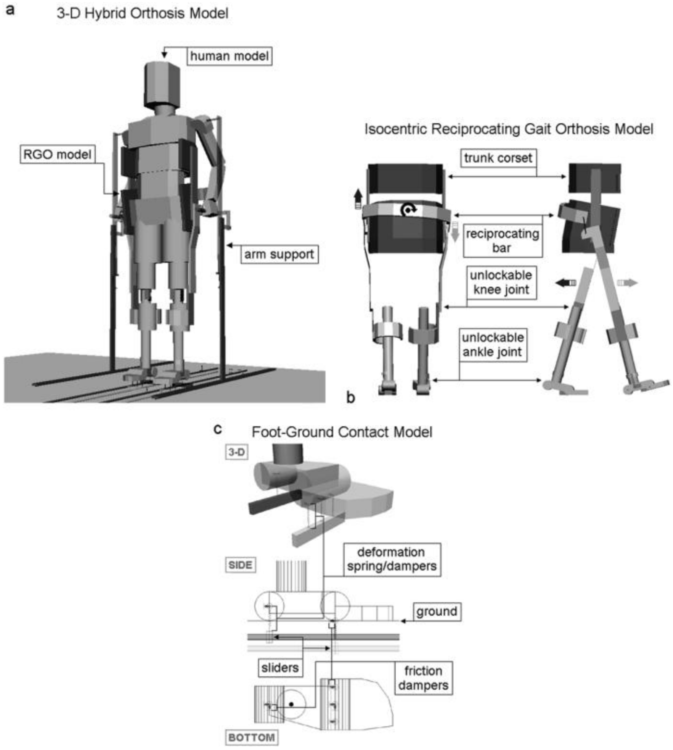
An amputation usually refers to the remove of part of the arm or hand, foot or leg. [1]. It occurs after an injury or during surgery. This type of amputee is caused by loss of blood supply to the body’s tissue. The leg amputees suffers major problems like lack of normal gait cycle, as there is natural sensory loss in the muscle due to amputation they suffer from normal extension/flexion of the knee joint function. According to the population of the countries the US estimates the amputation level in each country all over the world. Amputation in Asia region was divided like northern Asia, Sothern Asia, central Asia, and eastern Asia. Northern Asia country like Mongolia has 19,529 amputees in their total population. Central Asian country like Uzbekistan has 184,872 amputations in their total population. Eastern Asia country like china has more amputation than any other countries in Asia. The amputation count in china comes around 9,091,933 among their total population. Southern Asia country like India has 7,455,494 amputations in their total population. Reciprocating gait orthosis (RGO) [2] is a hip knee ankle foot orthoses (HKAFO) that used for lower limb paralysis patients to walk and stand using crutches or walkers. RGOs are often prescribed so that persons with lower limb paralysis may enjoy the physiological benefits of upright ambulation, such as lower incidence of bone fractures and pressure sores. Studies have reported that the difficulty of ambulating with RGOs is a contributing factor to their limited use and high rates of abandonment. Unfortunately, investigating RGO-assisted gait is complicated by the difficulty of recruiting RGO users for research. The population of RGO users is small, which makes recruiting a sizable, homogenous sample population challenging as implied by the small sample sizes of RGO studies.

Mathematical RGO model developed by assumptions of kinematics or kinetics of gait is helps predict how changes in RGO design will affect gait cycle. Controlled RGO mechanism is not effective as the mathematical model if the system is analogous to RGO users then the behavior of that system could be identified for RGO users.

A mechanical Lower Limb Paralysis Simulator (LLPS) was designed to provide able-bodied persons with a set of paralyzed legs. The purpose of this study was to determine if able-bodied LLPS users exhibit some of the distinguishing patterns of RGO-assisted gait.

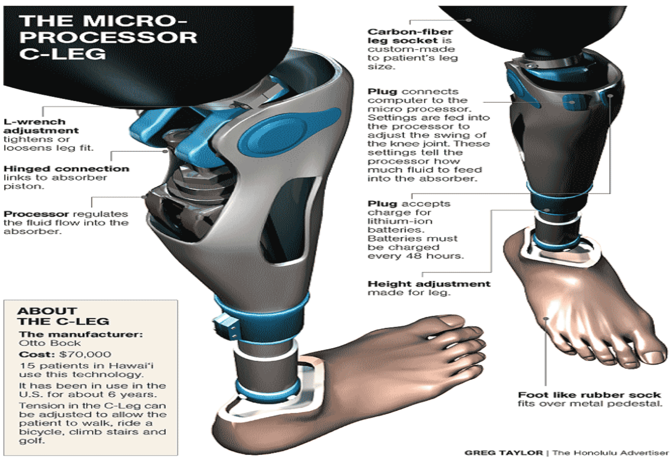


The functional neuromuscular based mechanical RGO [2] has been also developed by stimulating the nerve in the muscles. It has a temporal relationship between necessary muscle activation and dynamic state of the joint.



This system was developed to examine the walking pattern after the spinal cord injury occurs which coordinates the knee and ankle joints of a RGO, while giving propulsive forces and controlling unlocked joints with functional neuromuscular stimulation.

The existing system was the Otto-Bock Cl-leg which mimic the knee's functionality during gait, microprocessor controlled knee joints have been developed which controls the flexion and extension of the knee. The otto bock's C-leg was introduced in 1997,ossur's Rheo knee was released in 2005, whereas the power knee by ossur, introduced in 2006. The idea was originally developed by Kelly james, a Canadian engineer, at the university of Alberta.



The microprocessor receives the signals from the sensors which analyses the knee angle and moment of the leg. and to determine the type of motion being employed by the amputee. Most microprocessor controlled knee joints are powered by a battery housed inside the prosthesis. The sensory signals are computed by the microprocessor are used to control the resistance generated by hydraulic cylinders in the knee joint.

It has some significant drawbacks that impair its use. They can be susceptible to water damage and thus great care must be taken to ensure that the prosthesis remains dry. Another drawback was the time delay between the functional leg and the developed leg.

II. METHODOLOGY

DESIGN

To design the reciprocating gait orthosis for the above knee amputees the average Asian height and weight is considered. The average Asian height is 165cms and the average Asian weight is 70kgs.

In lower limb the joints are the most important as it bears and provides support to the body weight. There are three types of joints in leg; they are 1) Hip joint 2) Knee joint 3) Ankle joint. But in our project the case is that we are going to design and develop orthosis for above knee amputee, so we have to consider only knee joint and ankle joint. Pressure sensor is placed on the foot in order to overcome the possibilities of falling down.

In knee joint there are two degrees of freedom can be performed that is extension and flexion. The range of motion for the knee joint is from 0° to 130°. During flexion, healthy range of motion for knee joint is 0° to 90°. During extension, healthy range 90° to 130°. The range of motion for this work can be controlled by threshold which can be performed by the microcontroller and analog to digital converter.

Proximal sensors are used to detect the metal targets approaching the orthosis, without physical contact with the orthosis. DC motor is placed in the developed leg is controlled by the drive circuit L239D. Microcontroller MSP 403G2452 is used to create an algorithm to give data to the amputee limb for the normal gait cycle.

We have used one motor at the knee joint and we have fixed the ankle joint, because it's just to support and bear weight , there would not be more rotation or major movement done by ankle joint.

For controlling the range of motion, the springs can be used which prevents the unwanted knee extension/flexion.

Knee Joint	Normal standard leg	Our RGO protocol
Flexion	110-130 degrees	100-140 degrees
Extension	15 degrees	10-20 degrees

Block diagram of the designed system is shown in Figure 1, which represents the working model of a reciprocating gait orthosis for the above knee amputees

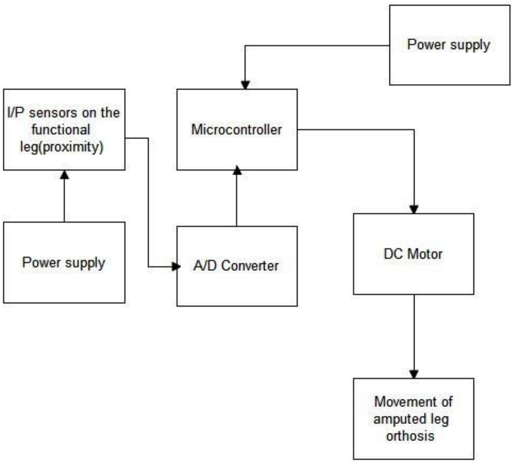


Fig1. Working model of RGO for above knee amputees

The proximal sensor is placed on the functional leg which detects the metal element or obstacles. The 12V power supply is used as an input power for the sensor. The proximal sensor senses the movements of the functional leg, the signal would be in analog signal which can be converted into digital signal by the ADC and the digital signal is sent to the microcontroller (MSP430G2452) where the angle and speed of the leg is calibrated using a function programmed in it. Another 5V power supply is provided to the microcontroller. The driver is interfaced with the port of the controller. The measured angle and speed from the functional leg by the proximal sensor is given opposite direction to the driver of the DC motor. And the DC motor rotates according to the given control. So that the normal gait cycle can be achieved by the above knee amputee patients.

III. CONTROL STRATEGY

For the height 165cms and weight 70 kgs the mass of the body segment such as thigh, calf, and foot will be 9.85kgs, 2.94kgs and 0.91kgs. In this work the level of injury in the knee was 13cms above the knee. Stature estimation for 40 individuals according to their sex, height, the average femur length and average shank length is estimated. Mass of the body segment for each part is calculated using regressions equations.

Torque of the motor is given by the equation,

Torque (T) =Force (F) x perpendicular distance (D)

Fig1. Shows the Reciprocating gait orthosis (RGO) for above knee amputees prototype which has one functional leg connects with the proximal (IR) sensor and developed amputee leg connects with the DC motor in the knee joint.

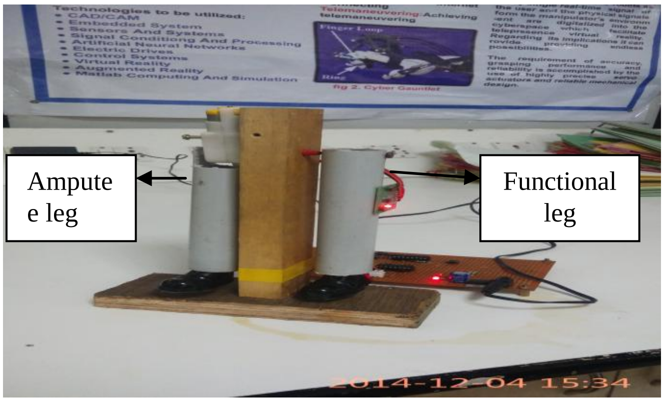


Fig2. Prototype of RGO in above knee amputees

When the power supply was given to the sensor in the functional leg, the movement and the speed of the functional leg was recognized by the sensor and given to the amputee leg through microcontroller. In Fig3 it shows that when the functional leg moves backward the amputee leg does the extension up to 20 degrees.

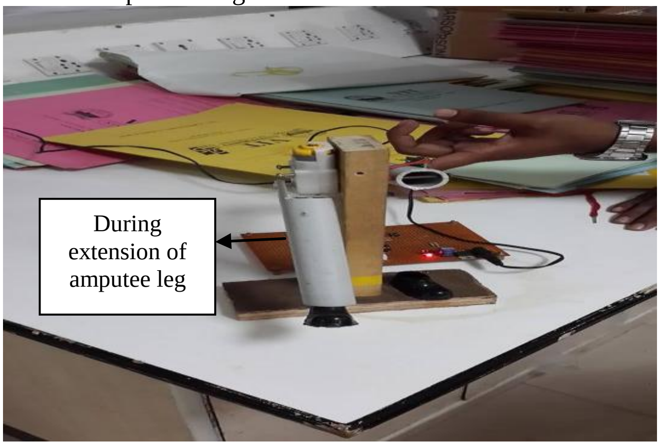


Fig3. Prototype During knee extension

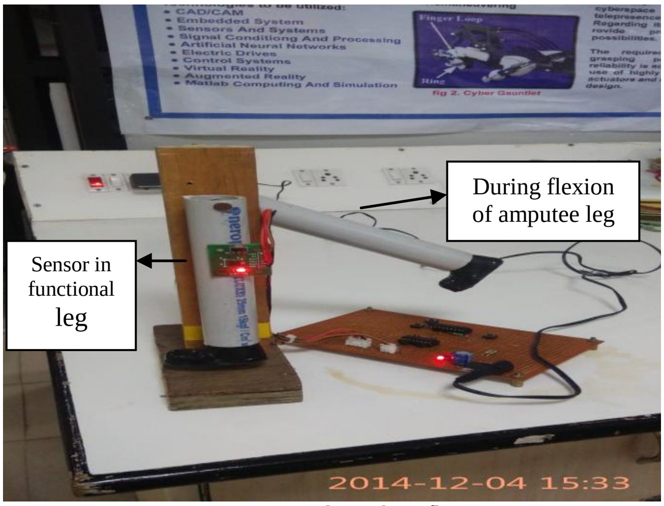


Fig4. Prototype during knee flexion

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Fig 4. It shows that when the fnctional leg moves forward the amputee leg does the flexion upto 140 degrees.

IV. RESULT

The reciprocating gait orthosis for above knee amputees has been designed and the protocol was made. The testing of the knee joint and their range of motion have done with the prototype

V. CONCLUSION AND FUTURE WORK

In this paper we have designed and made prototype of reciprocating gait orthosis for the above knee amputees. The next stage of this work would be to develop it for the commercial purposes. Using G-sensors the response of the sensor can be improved. The design would be implemented using Medical Standards and using FDA approved materials. The so deigned orthosis would then be studied by using it for clinical trials. The data acquired would be analyzed using statistical analysis and required modifications in the design would be made so that it mimics the standard normal gait.

VI. REFERENCES

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