Biomechanic Simulation of Human Gait with assistive devices

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Background: Lower limb osteoartritis is a common medical condition which causes jont pain,stiffness, inflammation which hinders patient from basic daily life activities such as walking and running. Osteoartritis can be treated with physical therapy, medication, injection and joint replacement surgery. Which ever medical treatment is used, a rehabiliation device is required to reduce the joint load which is usually achieved by using crutches. Large hip joint contact force during walking is due to abductor muscle force which plays a big role on maintaining the stability during single leg support in human gait. We would like to apply this concept to design an exoskeleton to reduce the hip load during walking.

Problem: Although many rehabiliation exoskeleton has been developed, little of them addresses hip abduction assist and none of them uses the approach of reducing abduction muscle force by weight support which also stabilizes the body. Therefore, we want to develop an exoskeleton that applies this concept.Before the design process, it is essential to investigate the interaction between human body and different external support and actuators with simulation. In this project, we are going to use OpenSim, a biomechanics simulator developed by Standord Unviversity which has been widely used in academia.

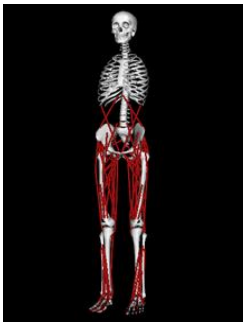

figure: Musculoskeletal model in OpenSim (left). ReWalk, a rehabiliation exoskeleton (right)

Objective

Simulate the muscloskeletal model with external mechanical component, determine the accuracy of result and analysis the physical effect of the extra part.The procedures inculde:

1. Modify the simulation model and simulate human gait with walking assist or body weight support system
2. Compare simulation result with experimental results in order to validate the simulation setup
3. Simulate different assistive devices which has not been simulated and determine the effectiveness of such devices

Requirements

One student in Mechanical, Aerospace, or Mechatronics

Contact

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Development of Concentric Tube Robots

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Background

A continuum concentric tube robot is formed by inserting super-elastic tubes concentrically into each other. The concentric tubes are initially designed as active cannulae for use in minimally invasive surgeries (MIS). As concentric tube robots have compliant structures, the modelling of concentric tubes is difficult. The core equations are differential equations that are derived from equilibrium of force and moment, and are solved through iterative approach. The proposed improvements in concentric tube models must be verified experimentally with a testbed and appropriately designed experimental procedures.

Problem

A testbed (see Fig. 1) that is able to accommodate the tube combinations of up to three super-elastic tubes has been desgined. The assemble of the testbed is to be conducted. The testbed also requries the super-elastic tubes to be fitted through custom-made tube holders, which are to be designed and manufactured. In addition, the experimental approaches to apply the desired external loads precisely on the tube as well as recording the final shape of the concentric tube robot are to be developed.

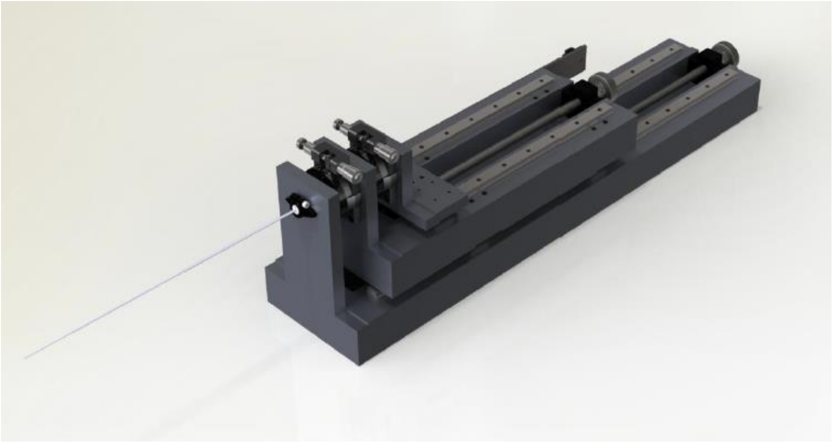

Fig. 1. The CAD model of the testbed.

Objective

To establish the experimental procedures for verifying concentric tube kinematics models:

1. Assembly of testbed.
2. Design and manufacture of super-elastic tube holders.
3. Develope the approach to precisely apply the external loads of the desire kinds, directions and magnitudes onto the concentric tube.
4. Develope the approach to precisely measure the shape of concentric tube robot, the tip position and orientation, as well as relative twist angles between super-elastic tubes.

Requirements

One student in Mechanical, Aerospace, or Mechatronics

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