MTKE (Motorized, Therapeutic Knee Exoskeleton)

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Background

In 1960, GE (General Electric) produced what is noted as the first modern day exoskeleton named the Hardiman. The Hardiman weighed 1,500 lbs and reducing the reaction weight by a factor of 25. It was never successfully controlled so the project was scrapped. At the commencement of the 21st century, with the resurgence and evolution of motors, many exoskeletons both enhancatory and assistive have emerged. As our product is intended for therapeutic use, some of the currently marketed products that resemble ours are the Ekso from Ekso Bionics and the Indego developed at Vanderbilt University.

Abstract

The M-TKE is a gait-mimicking, motorized brace intended for leg motion stimulation. It is the first phase of the NJIT BME project to produce a full, lower limb exoskeleton, the M-TEL (Motorized Therapeutic, Exoskeletal Legs). The central idea behind the M-TEL is to produce a gait training exoskeleton to be used in a rehabilitative setting for paraplegic, CP and simply patients diagnosed with any disease that impairs lower body motor function. This paper however will centralize on the M-TKE, its development and the research that is being done in coalition with the production of it. The concept behind the M-TKE is that when motion is induced in a leg that has lost mobility, blood flow to the leg will increase, some muscle will be regenerated, and ultimately some functionality of the leg will be restored.

Design Concept

The device, as it currently stands, is an exoskeleton that makes use of a child-sized, custom, hip-knee-ankle orthosis upon which two Dynamixel MX-106 motors are mounted via 3-D printed, nylon attachments and gears at each of the two joints. The ankle is locked for simplicity. The knee joint’s gears are at a ratio of 4:1 whereas the hip joint gears apply a ratio of 4.5:1 since it calls for the greatest torque requirements. According to the motion capture data recorded and analyzed for normal versus locked ankle gait, these gear ratios are sufficient for producing necessary torque values from our 8 N*m motors.We simplified the system to run on prerecorded motion captured gaits. The coding does however allow for easy implementation of real time gait analysis as an open source product.

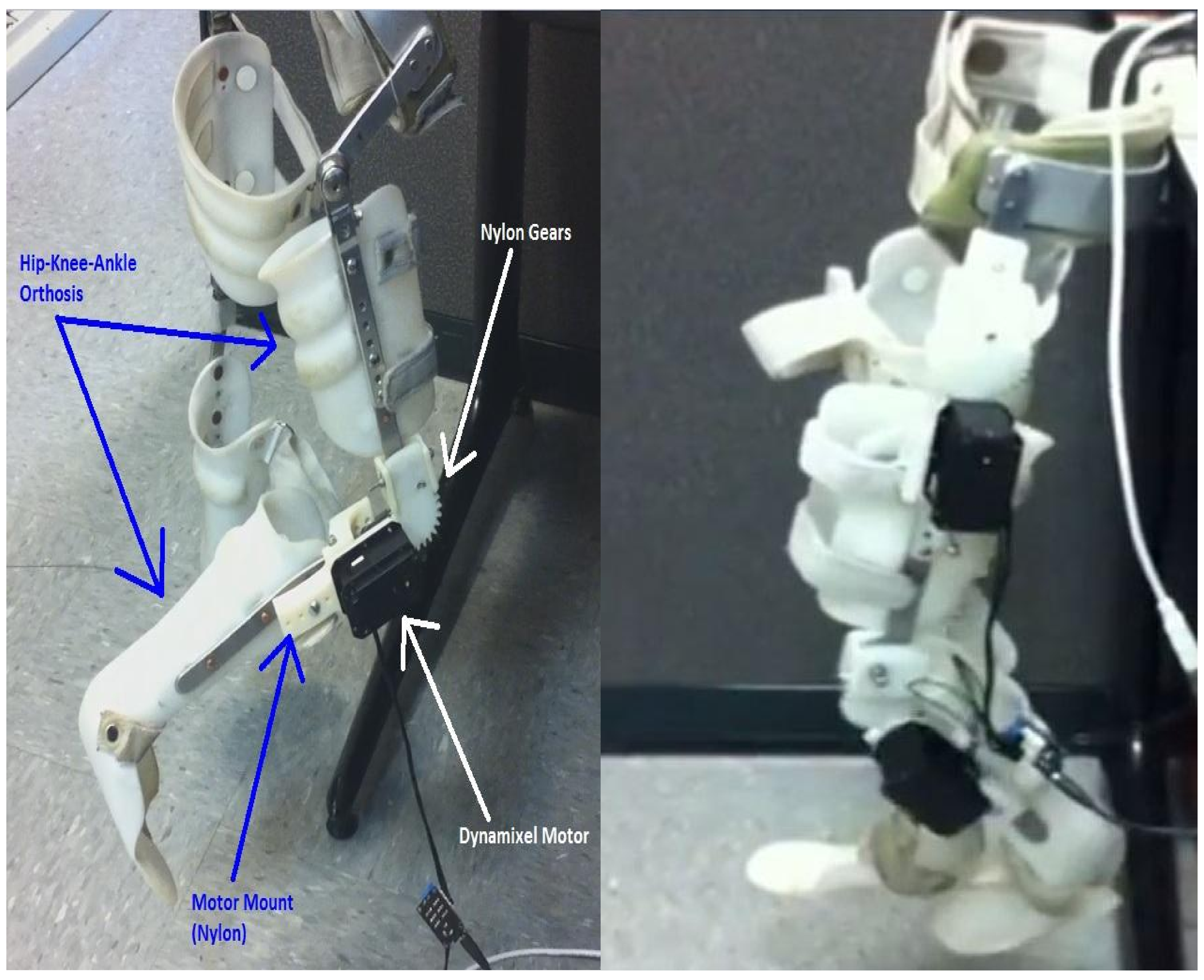

Figure1 - MTKE (pictured left) and MTEL (pictured right).

Test Results

The exoskeleton was shown to successfully function while loaded. It accepted and replicate joint angles from prerecorded gaits. The exoskeleton was shown to have a variable gate based on user specifications along with several safeties and redundancies to prevent operator injury in the event of failure.

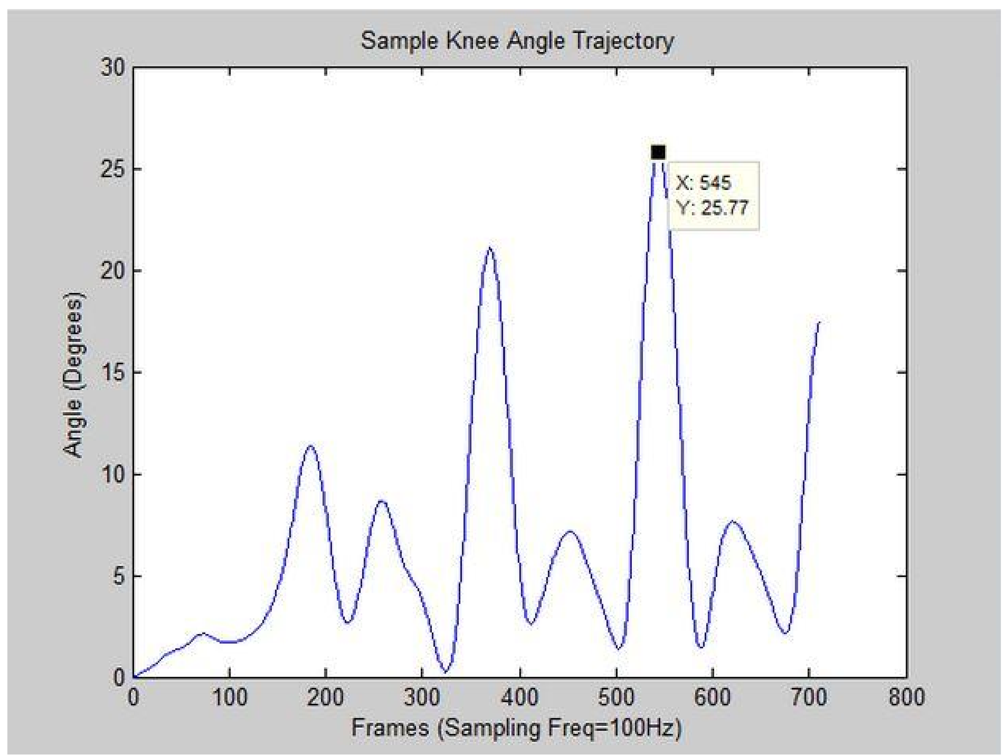

Figure 2 - Knee angle trajectories for a locked ankle trial of one of our subjects. These angles are then converted into motor units for the motor to follow for gait mimicking.

Figure 3 - Full system test was run using footed pajamas filled with 10 lbs of rice to simulate a weighted leg. This was done to confirm the design could perform the necessary motions while subjected to an expected load.

References

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