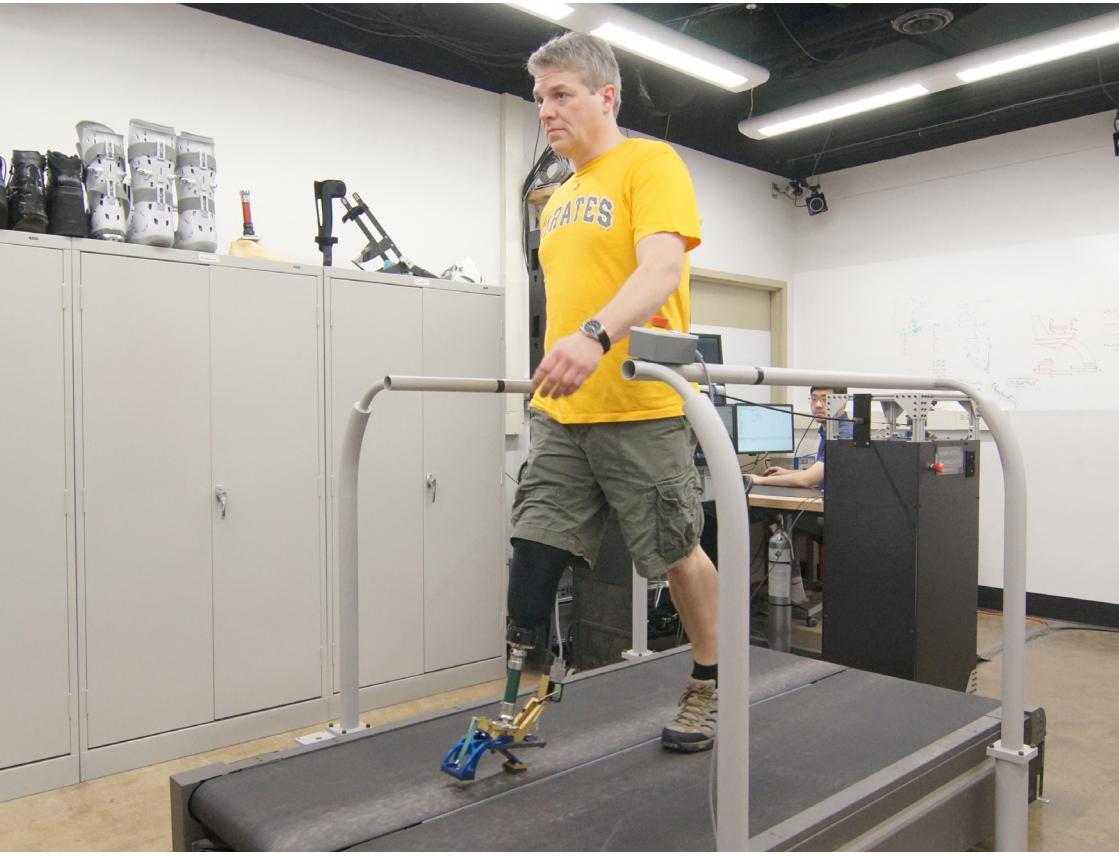
HuMoTech

Increasing mobility for people with below-knee amputation using a robotic ankle-foot prosthesis



speedgoat
real-time simulation and testing

HUMOTECH

Spin-off from Carnegie Mellon University uses MATLAB & Simulink with Speedgoat hardware to develop a robotic ankle-foot prosthesis to aid research into improving mobility and quality of life for individuals with below-knee amputation

Human Motion Technologies, LLC (HuMoTech) is a spin-off from Carnegie Mellon University's Experimental Biomechatronics Laboratory, based on the PhD thesis work of HuMoTech founder and president, Josh Caputo. The company was founded in summer 2015 and is located in Pittsburgh, PA. They are currently a small but passionate team with a big vision and are growing rapidly.

Below-knee amputation

Amputation below the knee is an increasingly common disability that reduces mobility and adversely affects quality of life. Individuals with amputation expend more energy to walk, and the intact limb experiences increased loading and even injury.

A normal functioning ankle joint produces a large burst of mechanical work during the "terminal stance": the phase of walking when the body moves forward on the supporting foot. This burst is known as push-off, and is much reduced in passive ankle prostheses.

In order to enable more research to be done in this area, the team at HuMoTech created an ankle-foot prosthesis that can accurately reproduce a large variety of prosthetic ankle behaviors, including increased push-off.

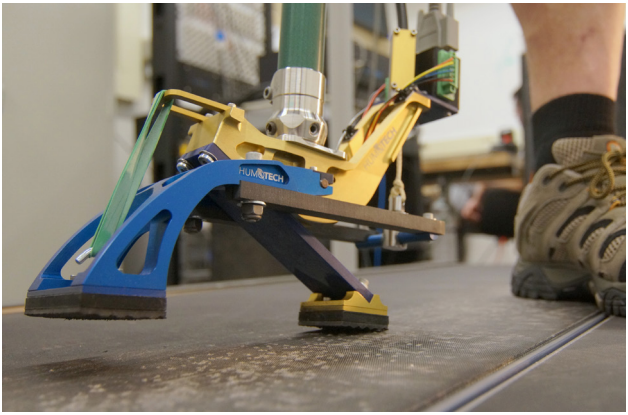
Ankle-foot prosthesis with off-board actuation

The prosthesis provides controllable torque about the ankle axis. The keel portion of the device is controlled by an external actuator unit, while a passive heel spring provides compliance in the early stance phase of the walking cycle. The amount of applied torque is measured with a load cell, and the joint angle is measured with an optical encoder.

The external actuator unit was also designed by HuMoTech and consists of a servo-motor, a servo-drive and a drive pulley. Torque is transmitted to the prosthesis via a Bowden cable: a cable guided inside a flexible sheath.

The control signals for the high-performance torque control are determined using the actual torque applied at the ankle prosthesis together with the prosthesis joint angle. The Speedgoat Performance real-time target machine measures such torque and angle using real-time measurements from a load cell and an encoder, respectively, and computes motor commands to regulate ankle joint impedance.

The interface and control code was developed in MATLAB & Simulink. Simulink Coder was used to automatically generate the code to run on the target machine.



The HuMoTech ankle-foot prosthesis in use

Experiments

Researchers at Carnegie Mellon University have already used the robotic ankle-foot prosthesis for several experiments. Such results have led to a better understanding of the push-off burst effect on walking effort, hip work, metabolic energy expenditure among other interactions.

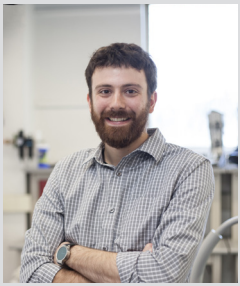
Other universities and government labs across the USA are now using the device for further research projects.

The Future

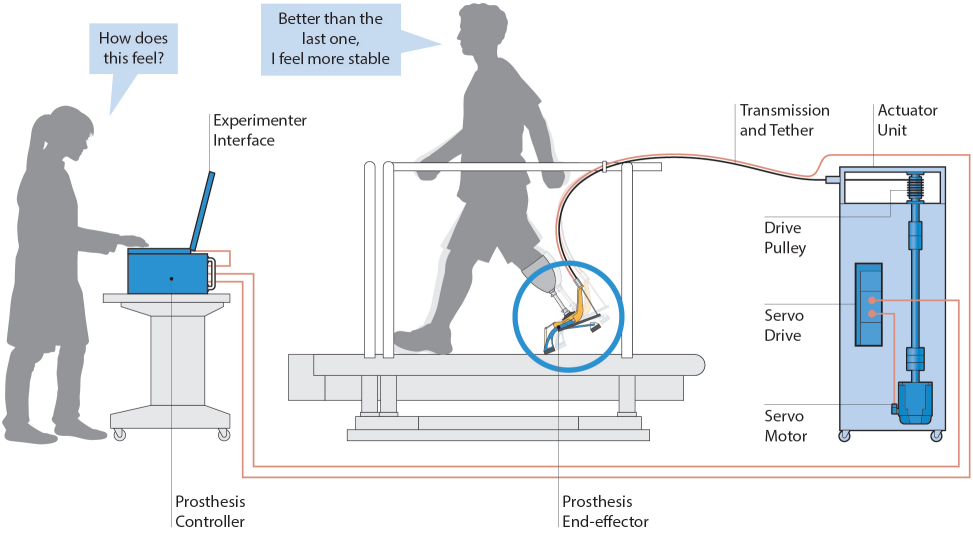
HuMoTech plans to continue to refine their products and expand their offerings. They are considering integrating the openframe configuration of the compact Speedgoat Baseline real-time target machine into the actuator unit, and are working on developing a clinical product that helps patients test-drive assistive devices prior to prescription, which they believe will greatly expand their market.

Speedgoat's value contribution

"For us Speedgoat offers a perfect combination of performance, customizability, modularity, a reasonable price point, integration with MATLAB & Simulink, and excellent support." - Josh Caputo



Josh Caputo, PhD
President & CEO, HuMoTech



A typical set-up for an experiment using the ankle-foot prosthesis and actuator

HuMoTech
Pittsburgh, PA, USA

www.humotech.com

Speedgoat products used
- Performance real-time target machine
- IO101: 16-bit Analog I/O module
- IO317: Configurable FPGA I/O module

MathWorks software used
- MATLAB®
- Simulink®
- MATLAB Coder™
- Simulink Coder™
- Simulink Real-Time™

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