ASU, Walter Reed Researchers Create Prosthesis Of The Future

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Researchers at Arizona State University's Polytechnic campus and the Military Amputee Research Program at Walter Reed Army Medical Center are teaming up to create the next generation of powered prosthetic devices based on lightweight energy storing springs.

The device, nicknamed SPARKy, short for Spring Ankle with Regenerative Kinetics, will be the first-of-its-kind smart, active and energy-storing transtibial or below-the-knee prosthesis.

Existing technology in prosthetic devices is largely passive and requires the amputee to use 20 to 30 percent more energy to propel themselves forward when walking compared to an able-bodied person, according to Thomas Sugar, ASU assistant professor of engineering at the Polytechnic campus.

Once complete, SPARKy is expected to provide functionality with enhanced ankle motion and push-off power comparable to the gait of an able-bodied individual.

"A gait cycle describes the natural motion of walking starting with the heel strike of one foot and ending with the heel strike of the same foot," says Sugar. "The cycle can be split into two phases - stance and swing. We are concerned with storing energy and releasing energy (regenerative kinetics) in the stance phase."

When you look at the mechanics of walking, it can be described as catching a series of falls, explains Sugar. In the team's device, a tuned spring brakes falls and stores energy as the leg rolls over the ankle during the stance phase, similar to the Achilles tendon.

Sugar's team, made up of doctoral students Joseph Hitt and Matthew Holgate, and Barrett Honors College student Ryan Bellman, have coined SPARKy a robotic tendon because of its bionic properties.

"What we hope to create is a robotic tendon that actively stretches springs when the ankle rolls over the foot, thus allowing the springs to thrust or propel the artificial foot forward for the next step," says Sugar

"Because energy is stored, a lightweight motor can be used to adjust the position of a uniquely tuned spring that provides most of the power required for gait. Thus less energy is required from the individual."

The team is the first to apply regenerative kinetics to design a lightweight prosthetic device. Others are using large motors combined with harmonic drives, a monopropellant or extremely high pressure oil.

Sugar's team already has proof that SPARKy is working. In recent experiments with able-bodied subjects outfitted with a robotic ankle orthosis, or a powered assist device, the researchers found that the spring and motor combination was able to amplify the motor power by three-fold. This significant finding allows SPARKy to be downsized from a 6-7 kg motor system to a 1 kg (2 lb) system which is significant weight savings for those who wear a prosthetic.

"We expect this device to revolutionize prosthetics and will be especially helpful for military personnel wounded in active duty," says Hitt.

The project is a multi-phased effort led by ASU's Human Machine Integration Lab, Arise Prosthetics and Robotics Group, Inc. Arise Prosthetics is helping in the fitting of the device and Robotics Group, Inc. is designing embedded processors and motor amplifiers.

The first phase of SPARKy featuring the robotic tendon is expected to be ready for demonstration in December 2007. "I will know it is successful when a wounded solider is able to walk using the device on a treadmill," says Sugar about this phase.

The project will culminate with the functionality to support walking in a daily environment, which is expected in 2009.

About Dr. Thomas Sugar

Dr. Thomas Sugar has built a large research program in medical robotics, as a co-investigator on a National Institutes of Health (NIH) contract for stroke rehabilitation, the principal investigator on an NIH grant on robotic spring ankles for gait assistance, and principal investigator on the three-year Department of Defense grant to build SPARKy.

ASU's Polytechnic campus, located in southeast Mesa, offers bachelor and graduate degree programs, unparalleled by other Arizona state universities, through the Morrison School of Management and Agribusiness, East College, the College of Science and Technology, and the School of Educational Innovation and Teacher Preparation.

http://www.poly.asu.edu.