SPARKy device helps amputees return to normal lives

Arizona State University researchers have developed a prosthetic device that literally puts the spring back into an amputee's step. They have developed and refined SPARKy (for spring ankle with regenerative kinetics) into a smart, active and energy-storing below-the-knee (transbitial) prosthesis.

SPARKy is the first prosthetic device to apply regenerative kinetics to its design, which resulted in a lightweight (4-pound) device that allows the wearer to walk on grass, cement and rocks, as well as ascend and descend stairs and inclines.

The device operates by employing a spring to store energy as the wearer walks during normal gait, said Thomas Sugar, an ASU associate professor of engineering at the Polytechnic campus who led the research. Sugar and his colleagues – ASU doctoral students Joseph Hitt and Matthew Holgate, as well as Barrett Honors College student Ryan Bellman – have been developing and refining SPARKy for three years as part of a U.S. Army grant.

SPARKy uses a robotic tendon to actively stretch springs when the ankle rolls over the foot, thus allowing the springs to thrust or propel the artificial foot forward for the next step. Because energy is stored, a lightweight motor is used to adjust the position of a finely tuned spring that provides most of the power required for gait.

"SPARKY basically removes the old passive devices and makes it an active device the wearer uses to attain normal gait, which for an amputee is a significant return to normal function," Sugar said. It's not only an active prosthetic device, but also allows a wider range of movement than previous devices, and weighs less and causes less fatigue for the wearer.

The device is featured in the January 2010 issue of *National Geographic*, in an article titled "Merging Man with Machine, the Bionic Age."

SPARKy provides functionality with enhanced ankle motion and push-off power comparable to the gait of an able bodied individual. Sugar said the device reached its primary goal of returning the functionality of the amputee to his/her status prior to losing a limb.

The device is built to take advantage of the functional mechanics of gait. A gait cycle is the natural motion of walking, starting with the heel strike of one foot and ending with the heel strike of the same foot.

"The cycle can be split into two phases, stance and swing," Sugar said. "We are concerned with storing energy and releasing energy (regenerative kinetics) in the stance phase."

The mechanics of walking can be described as catching a series of falls, Sugar added. In SPARKy, a tuned spring (acting like the Achilles tendon) breaks the fall and stores energy as the leg rolls over the ankle during the stance phase.

While the project is nearing completion of its three year grant, there still is much more work to do to refine the device.

To date, SPARKy has allowed users to walk on inclines, steps and to walk backwards, which are not trivial tasks for people who have only had access to passive, and sometimes cumbersome, prosthetics. In the future, the team plans to make additional improvements to lower the weight of SPARKy by integrating very fast microprocessors and using the smallest lithium ion batteries.

"We want our finished device to allow soldiers to return to active duty," Sugar said.

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ASU Polytechnic engineering professor Tom Sugar and ASU students have been working on a below the knee prosthetic device called SPARKy since 2007.
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