OpenSim open-source software from Stanford accurately models human motion

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There are 640 muscles in the human body, or maybe it is 639. Or maybe it is 850. Or 656. It all depends on whom you ask. In any case, it is a lot. Stanford bioengineer Scott Delp knows; he has programmed almost every one into his latest work, OpenSim, a software application that helps medical professionals and bioengineers study, diagnose and correct abnormalities in how people move.

In the legs alone there are more than 100 muscles, virtually every one necessary to maintain balance and walk properly. Most of us take these for granted; they just work. But for some, they don't. Scott Delp, a professor of bioengineering, mechanical engineering and orthopedic surgery, helps these people.

And now, OpenSim will be on display at The Leonardo, a science and technology museum in Salt Lake City. OpenSim is part of an exhibit exploring human movement.

More than child's play

The idea to unite museum and modeling software was the brainchild of Andy Anderson, a research assistant professor at the University of Utah School of Medicine. He was a visiting scholar working with Delp and Jennifer Hicks over the summer and he put the pieces together to get OpenSim involved with the exhibit in his hometown, Salt Lake City.

The Leonardo exhibit is really two exhibits in one. In the first section, visitors walk across a pressure-sensitive floor and are presented at the other side with color-coded print outs of their weight distribution, identifying even slight imbalances that might be putting undue stress on their limbs and joints. Such stress can lead to pain or arthritis. Over a lifetime, even relatively minor abnormalities can compound until hip and knee replacement surgeries become necessary.

"This one is fun because people can insert various orthotics in their shoes and see how they affect their movement. It's quite telling," said Anderson.

The second exhibit is aimed at kids. To make their research more approachable for a younger audience, the OpenSim development team is creating an interactive soccer game. The real-world player adjusts the strength of two leg muscles on the simulated soccer player to generate the force necessary to kick a virtual ball into a virtual goal.

"This is a simplified version of our software, but by honing things down to just two muscles we can make the science of movement something kids can understand and have fun with," said Hicks, a mechanical engineer and the OpenSim project manager at Stanford. "Most importantly, it is based on real physics and realistic physiology, so it really teaches as it entertains."

"Human movement is incredibly complex," said Hicks. "The kids' first instinct is to crank up the muscles to full strength, but this has unintended consequences, as the kids quickly learn."

Profound implications

Future possibilities for OpenSim are many. It can help determine whether a simple surgery to lengthen a specific muscle might help

victims of cerebral palsy. It can predict how simple changes in gait might reduce the incidence or severity of osteoarthritis. In addition to helping millions delay or avoid costly hip and knee replacements, OpenSim could help in the development of new, more sensitive prosthetics, able to read and interpret electrical impulses to control the devices.

For all its technical wizardry, however, the greatest fact about OpenSim may be that it is open source. Anyone with a computer and an Internet connection can have the software in a matter of minutes. Delp is giving it away.

"OpenSim is out there and hundreds are downloading it every week," said Hicks. "If each copy helps only one person, that's helping a lot of people."

"That's the exciting thing about open source," said Delp. "By putting this powerful software in the hands of as many people as possible, we are setting in motion a self-perpetuating research ecosystem that will build upon itself to push the field forward."

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