Basis of mobility disorders to be studied using 3-D simulations of patients' movements

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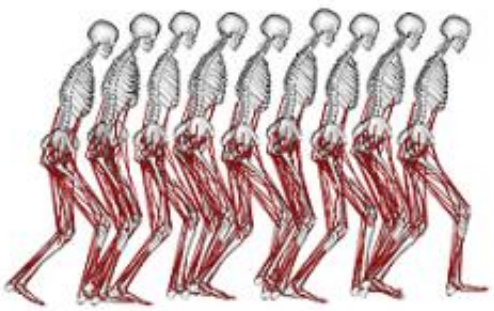

With software known as OpenSim, a researcher created a 3-D musculoskeletal model of a cerebral palsy patient who walks in a crouch posture. A new Stanford center aims to advance the use of OpenSim. Credit: Katherine Steele/Delp laboratory

A stroll around the block, a quick hand-written note to your neighbor, a giggling game of tag -- it's easy for many of us to take activities like these for granted. But for children and adults with movement disorders, the motions of everyday life can be challenging.

A new research center at Stanford aims to improve the lives of people affected by reduced mobility by using computer-generated simulations to better understand the mechanical basis of human movement.

A movement disorder can have many origins, such as a birth defect,

spinal cord injury or stroke. Rehabilitation scientists facilitate treatment of mobility disorders by studying the bodily cause of physical impairments and providing a scientific basis for therapies that can improve function.

The source of physical impairment is often hidden among the complex interactions of the nervous, muscle and skeletal systems of the human body. Simulating a patient's movement in three-dimensional computer models can help uncover the source of the problem, whether it's the size of a particular muscle or bone or the way these components perform.

Computer models also provide a visual platform on which to test whether surgery would improve mobility for a specific patient.

Scott Delp, a professor of bioengineering (the department is jointly supported by the School of Medicine and the School of Engineering) is the director of a new research center on campus that will support the rehabilitation science community with state-of-the-art simulation tools. The National Center for Simulation in Rehabilitation Research, funded by a $4.5 million grant from the National Institutes of Health, will be part of a national network of research centers to support and advance medical rehabilitation research.

"People think about cancer and cardiovascular disease as the major problems associated with aging, but mobility is also very important. When people lose mobility, it can be devastating to their mental and physical health," said Delp, who is the James H. Clark Professor I in the School of Engineering. "It's a big challenge to figure out ways to maintain mobility as people age and restore mobility when people have physical disabilities."

Two years ago, Delp and his team introduced a free software program called OpenSim, a biomechanical research platform that simulates

biological movement. OpenSim combines data on muscle size and strength, joint motion and recorded movements of a subject to produce a highly realistic simulation of a specific person's maneuvering. The new research center will now focus OpenSim toward the purpose of understanding and treating movement disorders.

One of the center's early targets is cerebral palsy. Many children with cerebral palsy walk in a crouch-like pose, with their knees excessively bent. The cause of the crouch gait, which can be exhausting, painful and even debilitating, varies from patient to patient.

In some patients, the hamstring muscles are very tight and short and pull the knees bent. If the hamstrings are surgically lengthened, these patients may be able to straighten their legs and walk more easily. However, if that surgery is used on a patient who walks in a crouch gait for a different reason, the procedure could be ineffective or, worse, harmful.

By creating a computer model of a patient's movements, researchers can non-invasively explore whether the surgery would be appropriate for a specific patient.

"If you make a simulation of a subject walking, we can tell you how long the hamstring muscles are during the motion and compare that to normal muscle," said Katherine Steele, a graduate student in the Delp lab studying cerebral palsy movements.

Whether modeling cerebral palsy, stroke or prosthetics, the simulations created in OpenSim allow researchers to explore potential causes of mobility problems and run virtual tests of treatment options. The new center also will encourage researchers to share their models and build upon each other's work.

The lack of a standard method for modeling movement had been an

impediment to the rehabilitation science community. “One of the biggest drawbacks of previous studies using simulations is that people cannot reproduce those results,” said Ayman Habib, who designed the graphical interface of OpenSim. “OpenSim solves that problem by providing a standard tool used by the entire field,” said Habib, who will provide technical support to the center.

A common platform that allows researchers to share their models, which can take years to build, will also propel rehabilitation research forward. The center will be responsible for curating a collection of movement models, ensuring scientists all over the world can share them. If scientists develop a biomechanical model of the hand, for example, they can add it to the center’s database, making it available to anyone who might want to build on the work — by adding it to a model of a wrist or arm, for instance.

“Sharing models accelerates research because it’s so much effort to build and test each one of these biomechanical models,” said Delp.

Another goal of the center is to strengthen the worldwide rehabilitation science community by training international scholars to use the OpenSim software over several intensive months at Stanford. The scholars will then return to their home institutions as OpenSim ambassadors and teach their colleagues how to use the software in their own studies.

The benefits of the center and OpenSim are already obvious to many members of the rehabilitation science community. When he requested letters of support for the center from early users of OpenSim software, Delp received a flood of glowing responses.

“Once we started getting those letters we knew we were on the right track because we had the seed of something that could make a real difference for the entire field of rehabilitation,” said Delp.

More information: simtk.org/home/opensim