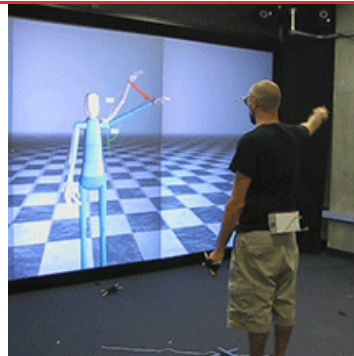


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PT Phone Home

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by Gordy Slack

Bob, an elderly rancher, injured his rotator cuff digging a fence-post hole on his property in San Andreas, California. His neighbor drove him to the UC Davis Medical Center, where a doctor prescribed a pain medication and one month of thrice-a-week physical therapy. Unable to drive due to his injury and unwilling to further burden his neighbor, making the three-hour round-trip to the clinic so often was out of the question. So, instead of working with a therapist directly, Bob agreed to do exercises they taught him. The exercises hurt, and after the first couple of tries Bob quit. Consequently, the injury got worse. A month later, Bob was in too much pain, and the motion of his arm was too limited for him to clean up, let alone work his ranch. When his daughter visited, the house was a mess, the chickens untended, and the fence in shambles. Bob's daughter decided it was not safe for him to live alone anymore. A simple, treatable accident had transformed Bob from a productive, self-sufficient, social person to a resentful and disabled nursing-home patient.

Bob is hypothetical but the scenario is real enough to [Dr. Jay Han](#), Associate Professor of Medicine at UC Davis Medical Center (UCDMC). As Director of the Neuromuscular Disease Clinic, he prescribes physical therapy to many patients who—because they live in remote parts of California, or because they do not drive, or cannot take time off from work—are unable (or disinclined) to comply. The resulting costs—in health, dollars, time, and quality of life—are huge, Han says.

"It is a big problem, and it is growing bigger," says Han. Already, about half of the ailments that primary care physicians treat are musculoskeletal (neck, back, and shoulder pain), and the most frequently prescribed treatment is occupational therapy or physical therapy. As Baby Boomers continue to age, there will not be enough physical therapists to give them the clinical attention they will need.

[Marcelo Kallmann](#), Associate Professor of Computer Science at UC Merced, is aware of the impending demographic and epidemiological crises, and thinks that commercial platforms for exercise games might be able to help. "With the explosion of Wii and Kinect-type games, I wondered if we could use those same technologies to create therapeutic medical tools," he says. That is when he got in touch with CITRIS medical director Han and the team at UCDMC.

In 2011, Han and Kallmann received a \$75,000 CITRIS seed grant to collaborate on a project that uses



Professor Marcelo Kallmann at UC Merced leads the visualization efforts to enable the virtual physical therapist tool.

sensors and virtual characters in a tool that will amplify the reach and influence of actual physical therapists.

The virtual therapist tool will allow clinicians and patients to meet in virtual three-dimensional environments and work together, or individually, on therapy. Patients can have therapy sessions at home, saving money and time and improving outcomes, says Han. By boosting patient compliance and data collection, and by allowing doctors to work with multiple patients at once, the tool will also empower doctors to give better, more efficient treatment. The tool will automatically track patients' progress, flag potential problems, and generate data that will shed light on the effectiveness of different PT methods.

Because the visualization is in 3D, the tool will allow participants to shift their perspectives during sessions. If a patient wants to examine her therapist's movements during an exercise, she can shift her vantage to view him from above, behind, or the side. She can zoom in or out as well. Her own avatar can be placed next to the therapist's or transposed on top of his like a transparency to more closely compare movements.

The patient and therapist would have an audio connection as well as a visual one. "The therapist would say, 'Follow me. Can you do this motion? Do you feel pain here or there?' while pointing with his avatar's hand," says Kallmann.

Han suspects that many patients would be motivated by group therapy, but getting a group with the same condition all together in one place and time just isn't plausible in a typical clinical setting. With remote access, though, Bob and several other patients could attend virtual group sessions focused just on rotator cuff exercises.

"In addition to the engineering challenges," says Kallmann, "we are also looking at what patients need and what they will accept. We still do not know how patients, doctors, and physical therapists will view a tool like this, but are progressing step by step. We want the application to be as simple as possible while covering the important functions."

Two platforms are being considered for the project. The first is based on precise inertial or optical motion capture sensors like the ones used by the gaming and movie industry. These sensors could be adopted in clinics and provide reliable tracking; however, users would have to wear the sensors. The second approach only relies on a depth camera sensor like the Kinect, which visually locks on to certain body parts and tracks their motion through three-dimensional space. Although not as accurate, the Kinect is inexpensive, does not require wearing devices, and is easy to set-up at homes.



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The system will allow physical therapists to compile a library of commonly performed exercises from which she could draw the most appropriate ones for a particular patient's needs. While some sessions might be "live," with both therapist and patient online at the same time, others would be pulled from the library. In the later case, the virtual therapist would guide the patient through the exercises autonomously, without being driven by an actual therapist on the other end. The patient could conduct these exercises any time. These sessions could be logged and data collected and/or transmitted, so the therapist can track the patient's compliance and progress.

"Compliance is also big issue," says Han. "Sometimes I see a patient four weeks after I assigned exercises and they have not improved much. So I ask them, 'Did you do your exercise?' They say, 'Yes, I've been doing them religiously. But I am still not better!' I just have to take them at their word. With the new system, we will be able to log and monitor a patient's compliance and adherence to therapy. That way, I can tell what is working and what is not. Better still, when I see they are not doing the exercises properly, I can call them and get them back on board."

If that patient is Bob, and if he pushes through the pain and exercises properly, he could fix his fence post and get back to work and to his full, productive life. That would be a victory for Han and Kallmann, for Bob (and the tens of thousands of real Californian patients like him), and for society at large.

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