ABSTRACT: Robots designed for physical rehabilitation are usually ground-mounted devices with heavy motors. Yet motors are overkill for an application in which energetically passive robot behaviors have been found to produce the best patient outcomes. A robot that behaves passively discourages “slacking” and induces recovery by requiring effortful participation from the patient. Recognizing an opportunity to address rehabilitation with a lightweight wearable exoskeleton, my students and I have ditched motors in favor of transmissions—in particular fluid power transmissions. I will describe how a fluid circuit creates passive motion constraints while valves select transmission ratios and thereby place virtual guiding surfaces in the jointspace of the patient. We are designing feedback controllers for this very interesting hybrid nonholonomic system using differential geometric methods and a set of Jacobians that map between taskspace, jointspace, fluidic actuator space, and “valvespace” to guide the wearer’s motion. I will also present results from experiments in which stroke patients produce motions without slacking using passive guidance from our prototype wearable robots.

BIO: I am a professor at the University of Michigan Department of Mechanical Engineering. My research is in the area of haptic interface, where I apply techniques from multibody dynamics, nonlinear controls, and robotics. Humans acquire a great deal of information from their environment through the sense of touch. I believe that the elements of interaction that support the kind of relationship one enjoys with a musical instrument or tennis racquet, say, also belong in one’s relationship with a computer. There is much to learn about the mechanical contact between human and computer and much to exploit for information transfer. A computer fully outfitted for mechanical interaction can even go beyond providing for human expression and entertainment, it can function as a teaching aide or provide performance enhancement.

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