The Center for Adaptive Neural Systems presents a symposium on

"Co-Adaptive Learning: Adaptive Technology for the Aging"

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Memorial Union and University Club, Arizona State University, Tempe, Arizona

January 8 and 9, 2009

Speaker Information:

Hermano Igo Krebs, PhD
Principal Research Scientist & Lecturer, Mechanical Engineering
Massachusetts Institute of Technology

TITLE OF TALK: "Neurorehabilitation and Robotics: What have we learned so far"

ABSTRACT: In this presentation, we present a retrospective and chronological review of our efforts to revolutionize the way physical medicine is practiced by developing and deploying therapeutic robots. We present a sample of our clinical results with well over 400 stroke patients, both inpatients and outpatients, proving that mo Lim, Soo-Siangvement therapy has a measurable and significant impact on recovery following brain injury. Bolstered by this result, we embarked on a two-pronged approach: 1) to determine what constitutes best therapy practice and 2) to develop additional therapeutic robots. We review our robots developed over the past 15 years and their unique characteristics. All are configured both to deliver reproducible therapy but also to measure outcomes with minimal encumbrance, thus providing critical measurement tools to help unravel the key question posed under the first prong: what constitutes best practice? We believe that a gym of robots like these will become a central feature of physical medicine and the rehabilitation clinic within the next ten years.

BIO: Hermano Igo Krebs joined MITs Mechanical Engineering Department in 1997 where he is a Principal Research Scientist and Lecturer Newman Laboratory for Biomechanics and Human Rehabilitation after receiving his PhD there. He also holds affiliate positions as an Adjunct Research Professor of Neuroscience at Weill Medical College of Cornell University and Adjunct Professor of Neurology at University of Maryland School of Medicine. He is one of the founders of Interactive Motion Technologies, a start-up company commercializing robot technology for rehabilitation.

Dr. Krebs' goal is to revolutionize the way rehabilitation medicine is practiced today by applying robotics and information technology to assist, enhance, and quantify rehabilitation; particularly neuro-rehabilitation. His PhD studies initiated in 1989 introduced a paradigm-shift in the field of rehabilitation robotics leading to a significant shift away from assistive technology towards robotic therapy. The impact goes far beyond the bench translating into actual patient care of over 400 individuals that were enrolled in his multiple trials. The magnitude of this change goes far beyond the usual ebb-and-flow of activity in technology-related fields with over 100 groups in the world presently investigating this approach.

PUBLICATIONS: ***H. I. Krebs,*** *L. Dipietro, S. Levy-Tzedek, S. E. Fasoli, A. Rykman-Berland, J. Zipse, J. A. Fawcett, J. Stein, H. Poizner, A. C. Lo, B. T. Volpe, and N. Hogan, "A Paradigm Shift for Rehabilitation Robotics", IEEE Engineering in Medicine and Biology Magazine, pp. 61-70, July/August 2008.*

H. I. Krebs *and N. Hogan, "Therapeutic Robotics: A Technology Push", Proceedings of the IEEE, vol. 94, no. 9, pp. 1727-1738, September 9, 2006.*

Randal A. Koene, PhD
Director, Department of Neuroengineering
Fatronik Foundation, San Sebastian, Spain

TITLE OF TALK: "From Wheelchairs to Neural Interfaces in a Virtual Brain Laboratory"

ABSTRACT: Reflecting the maturity of scientific research in chemistry when compared with neuroscience, the discourse in public media about therapies and advances in the treatment of cognitive deficits in our aging population emphasize novel pharmaceutical interventions. By contrast, the emerging field of neuroengineering emphasizes the use of technology and engineered devices in the context of cognitive function. Innovation is concentrated in the three areas: (1) Detection and diagnosis of cognitive impairment, (2) rehabilitation (e.g. after stroke) or extended maintenance (e.g. in Alzheimer's disease) of cognitive function, (3) and support of extended independence and social integration for individuals with cognitive deficits and their caregivers. The technologies being developed range from smarter wheelchairs that simplify but do not take away control from the user, and mobile devices, to implants that operate in a more targeted fashion than pharmaceutical intervention (e.g. deep-brain stimulation, peripheral or surface neural interfaces). All of this is supported by advances in neuroinformatics that are headed toward the development of a virtual brain laboratory.

PUBLICATIONS: ***R. A. Koene*** *and M. E. Hasselmo, "Consequences of parameter differences in a model of short-term persistent spiking buffers provided by pyramidal cells in entorhinal cortex", Brain Research, vol. 1202, pp. 54-67, 2008.*

R. A. Koene *and M. E. Hasselmo, "Reversed and forward buffering of behavioral spike sequences enables retrospective and prospective retrieval in hippocampal regions CA3 and CA1", Neural Networks, vol. 21, pp. 276-288, 2008.*

Richard Neptune, PhD

Associate Professor, Mechanical Engineering
University of Texas at Austin

TITLE OF TALK: "Experimental and simulation analyses of human gait: insight into neuromotor control."

ABSTRACT: An integrated understanding of normal and pathological locomotion has been difficult to achieve because of the extremely difficult, if not impossible, task of measuring the governing elements of muscle coordination, including the neural signals initiating muscle contraction, the forces produced from these contractions, and the effects of individual muscle forces on the resulting movement. Thus, little quantitative data exists describing how muscle forces produce an observed locomotor task. Detailed musculoskeletal models and forward dynamic computer simulations integrated with experimental data provide a powerful framework to identify the complex dynamic interactions within the neuromusculoskeletal system and causally relate muscle force to a corresponding movement. Such analyses can help establish a scientific basis to diagnose impaired movement, predict clinical intervention outcomes, develop more effective rehabilitation strategies and design more effective prosthetic/orthotic devices for those with lower limb disabilities. In this talk, I will show how computer simulations combined with experimental data can provide insight into the neuromotor control of human locomotion by identifying how individual muscles are modulated to meet changes in mechanical demand during normal walking.

BIO: Dr. Rick Neptune earned his Ph.D. in Mechanical Engineering from the University of California, Davis in 1996 and is an Associate Professor in the Department of Mechanical Engineering at The University of Texas at Austin. His research interests are in the areas of musculoskeletal biomechanics, neuromotor control of human movement, and design optimization of prosthetic and orthotic components. His research integrates musculoskeletal modeling, computer simulation and experimental analysis techniques to analyze various patient populations including lower-limb amputees and those with post-stroke hemiparesis. His research is supported by the VA, NSF and NIH.

PUBLICATIONS: *C.P. McGowan,* ***R.R. Neptune,*** *and R. Kram, "Independent effects of weight and mass on plantar flexor muscle activity during walking: implications for their contributions to body support and forward propulsion", Journal of Applied Physiology, vol. 105, no. 2, pp. 486-94, 2008.*

R.R. Neptune, *K. Sasaki, and S. A. Kautz, "The effect of walking speed on muscle function and mechanical energetics. Gait & Posture, vol. 28, no.1, pp. 135-143, 2008.*

Mindy Fain, MD
Chief, Section of Geriatrics and Gerontology, Department of Medicine and
Director, Arizona Geriatric Education Center, University of Arizona State University
Medical Director, Home TeleHealth Implementation Project,
Southern Arizona VA Health Care System, Tucson, Arizona State University

TITLE OF TALK: "'There's No Place Like Home': The Promise of Co-Adaptive Learning for Aging in Place"

BIO: Mindy Fain is pointed and passionate about health care: "Health care is a right for everyone," she declares. Since joining the University of Arizona medical faculty in 1985, she has made a remarkable difference in the availability and quality of health care in Arizona, especially among the state's burgeoning population of elderly.

Among her achievements, she expanded one of the first geriatric home care programs in Arizona, bringing social services, pharmacy support, physical therapy and sophisticated medical management of individuals who were bound to the home due to chronic illness. For its outstanding clinical programs and customer service, innovative education models and continuous improvement efforts, in 2002 Fain's program received the Under Secretary for Health's Award as a Clinical program of Excellence in Home-based Primary Care.

As medical director of Southern Arizona Veterans Administration Health Care System Home-based Primary Care (SAVAHCS) since 1988, Fain has guided this remarkable effort to provide care in their own homes for aging veterans with complex medical problems to national prominence for combining the best of geriatric medicine with the best of palliative care.

Extremely active in the Arizona medical community, Fain is a member of the board and editor of the Journal of the Arizona Geriatric Society. She also contributes to the continuing education of medical colleagues and other health professionals through numerous presentations on geriatrics. A number of the state Attorney General's Task Force on Elder Abuse and Neglect, she is tireless in her efforts to raise community awareness about this growing problem and what can be done to combat it.

A Phi Beta Kappa graduate of the New York University School of Arts and Sciences, Fain received the American Medical Women's Association "Citation for Scholarship" upon her graduation from NYU medical school. In 2000, she was named Geriatrician of the Year by Arizona Geriatrics Society and in 2004 was named the John A. Harford Geriatrics Leadership Scholar.

PUBLICATIONS: *N. Ahmed, R. Mandel, and **M. J. Fain**, " Frailty: An Emerging Geriatric Syndrome", The American Journal of Medicine, vol. 120, pp. 748-753, 2007*

***M. J. Fain,** "Should Older Drivers Have to Prove That They Are Able to Drive?", Archives of Internal Medicine, vol. 163, pp. 2126-2128, 2003.*

Misha Pavel, PhD
Professor, Department of Biomedical Engineering and Department of Computer Science and Electrical Engineering
Co-Director of Orcatech, Oregon Health and Science University

TITLE OF TALK: "Statistical Pattern Recognition and Machine Learning in Elder Care"

ABSTRACT: Changes in lifestyle and improvements in healthcare are rapidly increasing life expectancy and changing our aging population demographics. The increasing proportion of elders in the global population relative to the younger adults has resulted in rapidly escalating demands on healthcare and elder care, posing unprecedented economic and social challenges. Technology-based approaches appear to offer promising solutions that may alleviate these problems by enabling proactive and economically feasible care. These approaches are based on multidisciplinary research and development of technologies ranging from early detection and diagnosis of subtle changes to context-based physical and cognitive aids. The general framework consists of minimally obtrusive, continuous sensing combined with statistical pattern recognition and machine learning algorithms. The results of the computational approaches may enable (1) continuous assessment of changes in the physical, physiological and cognitive state of the elders, (2) rehabilitation and maintenance of the elders' abilities and (3) implementation of context-based assistive devices. In this presentation I will review a number of ongoing projects at the Oregon Center for Aging and Technology that range from small pilot experiments to large longitudinal studies.

BIO: http://www.bme.ogi.edu/~pavel/

Holly Shill, MD
Director, Thomas H. Christopher for Parkinson's Research
Sun Health Research Institute

TITLE OF TALK: "Adaptive technology in Parkinson's disease: where do we go from here?"

ABSTRACT: Using Parkinson's disease as an example, this presentation will review key areas that are most appropriate for technological intervention. We will review studies done to date specifically focusing on issues related to gait, speech, cognition, basic self care and remote clinical assessment. Current areas of active study will be reviewed and ideas for further exploration will be proposed. At the end, generalization of these ideas into mechanisms for healthy aging will be provided.

BIO: Holly Shill MD grew up in Tempe, Arizona. She did her undergraduate work in electrical engineering at University of Arizona in Tucson, followed by four years of medical school there. She completed a neurology residency at Barrow Neurological Institute (BNI) in Phoenix, AZ. Following that, she spent three years as a clinical fellow in the Human Motor Control Section at the National Institutes of Health in Bethesda, MD. Currently, she directs the Christopher Center for Parkinson's Research at Sun Health Research Institute in Sun City, AZ. She spends approximately 60% of her time in the clinic, managing patients with movement disorders, and 40% of her time in research. Her research interests include risk factors for the development and progression of Parkinson's disease and innovative treatments for Parkinson's. She also studies pathogenesis of Essential Tremor. She has received multiple honors over the years for her academic pursuits, including National Merit Scholar, Alpha Omega Alpha Medical Honors Society and the Fellows Award for Research Excellence at the NIH. She has published many scholarly articles and book chapters on movement disorders, and speaks to the medical community about movement disorders on a regular basis. She is active in patient support groups for Essential Tremor, Parkinson's disease, Dystonia, Huntington's disease and Restless Leg Syndrome.

Alvaro Fernandez, MBA/MA
SharpBrains.com, Chief Executive Officer

TITLE OF TALK: "The Emerging Cognitive Fitness Market: Status, Trends and Challenges"

ABSTRACT: Scientific, technological and demographic trends have converged to create a new $225m market in the US alone: software and online applications that can help assess and train cognitive abilities, both sharpening minds and contributing to healthier aging. We will summarize the science, key market segments, players and future trends, with special emphasis on the need for public-private partnerships in the following areas:

1) Best practices: to share best practices in preventive brain health education, seniors housing, hospital-based programs, insurance-led initiatives, public policy efforts.
2) Standards: to define standards for neurocognitive assessments and training tools,
3) Taxonomy: to establish a common taxonomy and language,
4) Education: to engage professionals and the public at large in well-informed "brain maintenance",
5) Policy readiness: to anticipate policy implications and improve readiness,
6) Research path: to propose a research and applications path.

BIO: Alvaro Fernandez, co-founder and Chief Executive Officer of SharpBrains, is an internationally recognized expert and thought leader in the emerging cognitive fitness field. He is regularly sought after by reporters to comment on the industry, by industry associations to translate the scientific advancements into practical applications for their members, and by organizations to interpret research and market trends.

Alvaro is a member of the Global Agenda Councils initiative run by the World Economic Forum, and co-author of The State of the Brain Fitness Software Market 2008 report. He started his career at McKinsey & Company and led the launch and turnaround of several publishing and education companies in the US and Europe, including Bertelsmann On Line, Docent, Inc, and Edusoft, a unit of Houghton Mifflin. Alvaro has an MBA and MA in Education from Stanford University, and enjoys teaching The Science of Brain Health and Brain Fitness at SFSU and UC-Berkeley Osher Lifelong Learning Institute.

Skip Rizzo, PhD
Rehabilitation Engineering Research Center for Technologies
for Successful Aging with Disability
University of Southern California

TITLE OF TALK: "Virtual reality motor training strategies to optimize participation in persons aging with and into disability"

ABSTRACT: Continuing advances in Virtual Reality (VR) technology, along with concomitant system cost reductions have supported the development of more usable, useful, and accessible VR systems that can uniquely target a wide range of clinical targets and research questions. Much like an aircraft simulator serves to test and train piloting ability, VR simulations can be used to assess and rehabilitate human cognitive and motor performance under a range of stimulus conditions that are not easily deliverable and controllable in the real world. This presentation will detail the rationale for the clinical application of this technology, provide some examples from our work developing VR game-based motor training systems, and describe some of the projects within our recently awarded NIDRR RERC to create low cost home-based VR training systems designed to optimize participation in persons aging with and into disability.

BIO: Dr. Rizzo graduated from SUNY-Binghamton with his doctorate in clinical psychology. He now conducts research on the design, development and evaluation of Virtual Reality systems targeting the areas of clinical assessment, treatment and rehabilitation. This work spans the domains of cognitive, motor and psychological functioning in both healthy and clinical populations. His cognitive work has addressed the use of VR applications to test and train attention, memory, visuospatial abilities and executive function. In the motor domain, he has developed VR Game systems to address physical rehabilitation post stroke and following Traumatic Brain Injury. In the psychological domain, his latest project has focused on the translation of the graphic assets from the Xbox game, Full Spectrum Warrior, into an exposure therapy application for combat-related PTSD with Iraq War veterans. Some of his latest work involves designing artificially intelligent virtual human patients for training novice clinicians on effective diagnostic interviewing.

PUBLICATIONS: *B. Lange, S. Flynn, and **A. A. Rizzo**, "Game-based Telerehabilitation", (European Journal of Physical and Rehabilitation Medicine- In Press)*

***A. A. Rizzo,** and G. Kim, "A SWOT analysis of the field of Virtual Rehabilitation and Therapy", Presence: Teleoperators and Virtual Environments, vol. 14, no. 2, pp.1-28, 2005.*