NARAYANAN KRISHNAMURTHI

Center for Adaptive Neural Systems
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EDUCATION

1999	Ph.D. Indian Institute of Technology, Madras, India Nonlinear dynamics and its applications to biomedical systems, Nonlinear dynamics
1992	M. Sc. Rama Krishna Mission Vivekananda College, Chennai, India Chemistry
1990	B. Sc. Rama Krishna Mission Vivekananda College, Chennai, India Chemistry

PROFESSIONAL INTERESTS

Neuroplasticity
Neurorehabilitation
Bioengineering
Neuromuscular electrical stimulation
Exercise training
Parkinson's disease
Spinal cord injury
Biomedical signal analysis
Nonlinear dynamics

ACADEMIC POSITIONS

02/07 – present	*Assistant Professor, Research,* Center for Adaptive Neural Systems, Fulton School Engineering, Arizona State University, Tempe, Arizona
05/05 – 02/07	*Research Scientist,* Center for Adaptive Neural Systems, Fulton School of Engineering, Arizona State University, Tempe, Arizona
10/01 – 04/05	*Research Scientist*, Brain Dynamics Laboratory, Department of Bioengineering, Arizona State University, Tempe, Arizona
02/00 – 09/01	*Postdoctoral Fellow,* Applied Biodynamics Laboratory, Department of Biomedical Engineering, Arizona State University, Tempe, Arizona
10/99 – 01/00	*Project Assistant*, Department of Physics, Indian Institute of Technology, Madras, India
03/99 – 07/99	*Visiting Postdoctoral Fellow*, Center for Nonlinear Dynamics, Department of Physics, University of Potsdam, Potsdam, Germany.

SPONSORED RESEARCH

Exercise training in Parkinson's disease: Neural and functional benefits
NIH-NICHD-National Center for Medical Rehabilitation Research
1R21HD060315-01A2 09/23/08 – 08/31/10 $495,525
Role: PI

The study will investigate the benefits of a physical exercise program in persons with Parkinson's disease. Specifically, this study will quantify functional benefits and document changes in brain function through the use of ^{18}F-FDG PET imaging techniques. The project is a collaborative effort that includes co-investigators James Abbas and Wayne Willis at Arizona State University as well as several clinical partners - Holly Shill, MD (Sun Health Research Institute), Abraham Lieberman, MD (Barrow Neurological Institute), Kewei Chen, PhD, Padma Mahant, MD, and Johan Samanta, MD (Banner Good Samaritan Medical Center).

Improving orthostatic tolerance after spinal cord injury
Paralyzed Veterans of America Research Foundation
2546 07/01/08 – 06/30/10 $150,000
Role: PI

The major goal of this project is to investigate the use of neuromuscular electrical stimulation to alleviate orthostatic hypotension in people with complete spinal cord injury. This is in collaboration with James Abbas (ASU), Denise Campagnolo, MD, and Candyce Williams, MD (Barrow Neurological Institute).

Adaptive electrical stimulation for locomotor retraining
NIH-NICHD-National Center for Medical Rehabilitation Research
R01-HD049773 07/01/05-04/30/09 $868,573
Role: Research Scientist

The goal of this project is to develop and evaluate an adaptive control system to generate stepping movements using electrical stimulation during treadmill locomotion in individuals with spinal cord injury.

Stimulation-augmented exercise and neuromotor therapy
NIH-NICHD-National Center for Medical Rehabilitation Research
2R44HD050006-02 03/01/05-03/31/2011
Research via subcontract to ASU from customKYnetics, Inc.
Role: Co-Investigator

The goal of this study is to develop a device that will provide a closed-chain, load bearing lower extremity exercise that has the potential to condition muscles and reverse or slow the rate of loss of bone mineral density

Adaptive stimulator for exercise and rehabilitation
NIH-NICHD-National Center for Medical Rehabilitation Research
Research via subcontract to ASU from customKYnetics, Inc.
R44-HD41820 07/01/04-06/30/08
Role: Research Scientist

The goal of this project is to develop and evaluate an electrical stimulation system for exercise after spinal cord injury.

ACADEMIC SERVICE

Reviewer for IEEE Transactions on Biomedical Engineering, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Journal of Neurology, Neurosurgery & Psychiatry, Medical & Biological Engineering & Computing, and American Institute of Biological Sciences.

Program committee member for Program Committee Member - First International Joint Conference on Biomedical Engineering Systems and Technologies (BIOSTEC-2008), and the International Conference on Bio-inspired Systems and Signal Processing (BIOSIGNALS 2009)

INVITED TALKS

"*Deep brain stimulation as a treatment for Parkinson's disease"*, at Arizona School of Health Sciences, Mesa, AZ, 2nd November, 2006

"*Computational Analysis of Neurological Disorders"*, at State University of New York, Binghamton, 11th August, 2005

"*Parkinson's disease: Effects of DBS settings on posture control"*, Brown Bag Seminar at Biodesign Institute representing the Center for Adaptive Neural Systems, 19th September, 2004.

"*Investigation of Motor and Sensory Cortical Interactions during Learning and Adaptation"*, at National Brain Research Institute, Gurgaon, India, June, 2003

"*Analysis of Neuronal Interactions during Adaptation and Learning in Motor Control of Primates: A Model Independent Approach using Information Theory"*, at the 2nd Joint EMBS/BMES Conference, Houston, TX, USA, Oct 23-26, 2002

"*Nonlinear and linear dynamical analyses of human ECG, EEG, and cerebral blood flow"* at the Department of Bioengineering, Arizona State University, 1st June, 2001

WORKSHOPS

Mentoring Strategies - funded by Howard Hughes Medical Institute to Arizona State University, October 19, 2007, Arizona State University, Tempe, AZ, USA.

Proposal Budgets, April 12, 2007, Arizona State University, Tempe, AZ, USA

Locating Funding, March 14, 2007, Arizona State University, Tempe, AZ, USA

The Fundamentals of Research Administration for the Investigator, January 2007, Arizona State University, Tempe, AZ, USA

Successful Grant writing and Collaborative Projects, February 24, 2005, Arizona State University, Tempe, AZ, USA

International IEEE EMBS Summer School on *Biocomplexity, Bioscaling and Biosignal Interpretation*, June 24 – July 1, 2001, Dartmouth College, Hanover, NH, USA

Montreal 2000 Summer school on *Nonlinear Dynamics in Biology and Medicine*, May 22 – June2, 2000, Montreal, Quebec, Canada

AWARDS AND SCHOLARSHIPS

2008: Exploratory Research Grant Award from National Institutes of Health
2008: Clinical Study Research Grant Award from Paralyzed Veterans of America
2006: First World Parkinson Congress – Junior Scholarship Award
2001: Neural Control and Autonomic Regulation (NCAR) Young Investigator Award Finalist

2000: Integrated Rehabilitation and Engineering Program Fellowship from Center for Applied Bio Dynamics, Boston University
1999: Max-Planck Institute Visiting Post Doctoral Fellowship, Germany
1996: Awarded 'Excellent' performance in Honours Diploma in software Technology and systems Management from NIIT, Madras, India
1995: Senior Research Fellowship from the University Grants commission, India
1993: Qualified in the Graduate Aptitude Test in Engineering
1993: Junior Research Fellowship from the University Grants commission, India

PUBLICATIONS (My first name 'Narayanan' has been used in all of my publications)

Peer-Reviewed Journal Publications:

Narayanan, K., M. Stefani, P. Mahant, J. Samanta and J.J. Abbas, "*Deep brain stimulation settings alter posture shift velocity in Parkinson's disease*" (to be submitted to Gait & Posture)

L.D. Iasemidis, P.M. Pardalos, D-S Shiau, W.Chaovalitwongse, ***Narayanan, K***., A. Prasad, K. Tsakalis P. Carney and J.C. Sackellares, "*Long-term prospective on-line real-time seizure prediction*", Clin Neurophysiol., 116, 532-544 (2005)

B. Veeramani, ***Narayanan, K***., A. Prasad, L.D. Iasemidis, A. Spanias and K. Tsakalis, "*Measuring the direction and the strength of coupling in nonlinear systems - A modeling approach in the state space*", IEEE Signal Processing Letters, 11 (7), 617-620 (2004)

S. Sabesan, ***Narayanan, K***., A. Prasad, A. Spanias, J.C. Sackellares, and L.D. Iasemidis, "*Predictability of Epileptic Seizures: A comparative study using Lyapunov exponent and entropy based measures*", Biomed Sci Instrum., 39, 129-35 (2003)

B. Veeramani, A. Prasad, ***Narayanan, K***., A. Spanias, and L.D. Iasemidis, "*Measuring information flow in nonlinear systems - A modeling approach in the state space*", Biomed Sci Instrum., 39, 65-70 (2003)

R. Venugopal, ***Narayanan, K***., A. Prasad, A. Spanias, J.C. Sackellares, and L.D. Iasemidis, "*A new approach towards predictability of Epileptic Seizures: KLT Dimension*", Biomed Sci Instrum., 39, 123-128 (2003)

L.D. Iasemidis, P.M. Pardalos, D-S. Shiau, W. Chaovalitwongse, ***Narayanan, K***., Shiv Kumar, P.R. Carney and J.C. Sackellares, "*Prediction of Human Epileptic Seizures based on Optimization and Phase changes of brain electrical activity*", J. Optimization Methods and Software, 18 (1), 81-104 (2003)

Narayanan, K., J.J. Collins, J. Hamner, S. Mukai, and L.A. Lipsitz, "*Predicting Cerebral Blood Flow Response to Orthostatic Stress from Resting Dynamics: Effects of healthy aging*", The American Journal of Physiology, 281: R716-R722 (2001)

Narayanan, K., R.B. Govindan and M.S. Gopinathan (2000) "*Evidence for low dimension chaos in electrically coupled chemical oscillator in batch condition*", Indian J. Chem. A 39: (1-3) 345-355

Narayanan, K., R.B. Govindan and M.S. Gopinathan, "*Unstable Periodic orbits in Human Cardiac Rhythms*", Phys. Rev E 57, 4594-4603 (1998)

Govindan, R.B., ***Narayanan, K***., and M.S. Gopinathan, "*On the evidence of Deterministic Chaos in ECG: Surrogate and Predictability Analysis*", Chaos 8, 495-502 (1998)

Peer-Reviewed Book Chapters:

S. Sabesan, ***Narayanan, K***., A. Prasad, L.D. Iasemidis, A. Spanias and K. Tsakalis, "*Information flow in coupled nonlinear systems: Application to the epileptic human brain*", In: Data Mining in Biomedicine, Eds: P. Pardalos, V. Boginski, A. Vazacopoulos, Springer Optimization and its Applications Series, Springer, pp. 483-504 (2007).

R.B. Govindan, ***Narayanan, K***., M.S. Gopinathan and N. Pradhan, "*Unstable periodic orbit spectra of theoretical and experimental dynamical Systems*", In: Nonlinear Phenomena In Physical And Biological Sciences edited by S. K. Malik, M. K. Chandrashekharan and N. Pradhan (2000), pp. 153-194.

R.B. Govindan, ***Narayanan, K***., and M.S. Gopinathan, N. Pradhan, R. Sreenivasan, and P. Dwivedi , "*The Spectrum of Unstable Periodic Orbits Of The Human Brain*", In: Nonlinear Dynamics and Brain Functioning edited by R. Sreenivasan, N. Pradhan and Paul E. Rapp, Nova Science Publishers, Inc, 1999, pp. 345-377

Peer-Reviewed Conference Proceedings and Abstracts:

Narayanan, K., A. Sitek, P. Mahant, J. Samanta and J.J. Abbas, "*Effects of Deep Brain Stimulation Amplitude on Gait in Parkinson's Disease*", 37th Annual Meeting of Society for Neuroscience, November, November 3-7, 2007, San Diego, CA.

A. Downing, ***Narayanan, K***., and J.J. Abbas, "*Postural control of self-initiated weight shifts in able-bodied children and adults*", Annual Conference of American Society for Biomechanics, 2007 (submitted)

Narayanan, K., S. Mulligan, P. Mahant, J. Samanta and J.J. Abbas, "*Deep brain stimulation alters postural control in Parkinson's Disease*", abstract presented at 36th Annual Meeting of Society for Neuroscience, October, October 14-18, 2006, Atlanta, GA

Narayanan, K., S. Mulligan, P. Mahant, J. Samanta and J.J. Abbas, "*Deep Brain Stimulation Effects on Posture Control in Parkinson's Disease*", World Parkinson Congress, February 22-26, 2006, Washington D.C (published in Movement Disorders, Vol. 21, Supp. 13, P209, page S115, 2006)

S. Mulligan, ***Narayanan, K***., P. Mahant, J. Samanta and J.J. Abbas, "*Effect of deep brain stimulation on posture control in Parkinson's disease*", 9th International Congress of Parkinson's disease and Movement Disorders, March 5-8, 2005, New Orleans, LA (published in Movement Disorders, Vol. 20, Supp. 10, P478, page S141, 2005)

E.T. Hsiao-Wecksler, ***Narayanan, K***., B.S. Lee, C.A. Laughton, and L.A. Lipsitz, "*Does Tai Chi affect postural sway & muscle activity in older adults?*" 27th Annual Meeting of the American Society of Biomechanics, Toledo, OH, September 25-27, 2003

S. Sabesan, ***Narayanan, K***., A. Prasad, and L.D. Iasemidis, "*Improved Measure of Information Flow in Coupled Non-Linear Systems*", The Proceedings of IASTED International Conference on Modeling and Simulation, Palm Springs, USA, 2003, pp. 329-333

B. Veeramani, ***Narayanan, K***., A. Prasad, and L.D. Iasemidis, "*On the use of Directed Transfer Function for Nonlinear systems*", The Proceedings of IASTED International Conference on Modeling and Simulation, Palm Springs, USA, 2003, pp. 270-274

R. Venugopal, A. Prasad, ***Narayanan, K***., and L.D. Iasemidis, "*Nonlinear Noise Reduction and Predictability of Epileptic Seizures*", The Proceedings of IASTED International Conference on Modeling and Simulation, Palm Springs, USA, 2003, pp. 240-245

L.D. Iasemidis, A. Prasad, ***Narayanan, K***., J.C. Sackellares, P.M. Pardalos, D.S. Shiau and W. Chaovalitwongse, "*Prediction of epileptic seizures by linear and nonlinear methods*", International

Nonlinear Sciences Conference on Research and applications in the Life Sciences, Vienna, Austria, February 7-9, 2003

A. Prasad, ***Narayanan, K***., K. Tsakalis and L.D. Iasemidis, "*Hysteresis in coupled chaotic oscillators and application to epileptic seizures*", International Nonlinear Sciences Conference on Research and applications in the Life Sciences, Vienna, Austria, February 7-9, 2003

Narayanan, K., D.J. Weber, J. He, A. Prasad, and L.D. Iasemidis, "*Analysis of Neuronal Interactions during Adaptation and Learning in Motor Control of Primates: A Model Independent Approach using Information Theory*", Proceedings of the Second Joint EMBS/BMES Conference, Houston, TX, USA, Oct. 23- 26, 2002, pp 2552-2553

Narayanan, K., and L.A. Lipsitz, "*Do resting Cerebral Pressure - Flow dynamics predict Cerebral blood flow responses to Orthostatic Stress? Effects of healthy Aging"*, presented in Experimental Biology 2001, 31 March - 4 April, 2001, Orlando, FL, USA

Narayanan, K., R.B. Govindan, M. Ramasubba Reddy and M.S. Gopinathan, "*Dynamics of cardiac system through unstable periodic orbits*", Proceedings of 19th International Conference - IEEE/EMBS Oct.30 - Nov. 2 1997, pp 2019-2021

REFERENCES

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