

Narayanan Krishnamurthy

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SKILLS

Software (ADSP assembly, C/C++, Java, Matlab, LabVIEW and Python) and Hardware development (breadboard, PCB, VHDL) experience. AutoCAD and Solidworks. Design, analysis, modeling and simulation of a variety of biological and engineering problems, detail oriented, enthusiastic researcher and individual contributor, with great interpersonal skills for teamwork. See web page for project details.

FELLOWSHIP

- 1) **Computational Training** - Summer 2008. Was awarded short term funding from Center for Neural Basis of Cognition for Summer research as part of Computational Neuroscience Training.
- 2) **Electrical and Computer engineering teaching fellowship**: 2004-2006. Was awarded Teaching Fellowship by the Electrical and Computer engineering department of the University of Pittsburgh. Responsibility of the fellow included weekly office hours and recitations to help students with homework, solved review tests and graded homework. Assisted the professor in undergraduate and graduate classes in Circuits Design, Signals and Systems, Digital and Analog Communication and Filter Design, Stochastic Processes, and DSP. See web page for teaching sample.

EXPERIENCE

Graduate student researcher, Sensory Motor Integration Laboratory - Dr. Batista; Pittsburgh, PA 2007-2009

- A) **Hardware projects**: Researched electronic components, ordered and tested circuits on bread board and made the following for the SMILE lab: Manual pushbutton, and DAQ operated liquid reward system. Accelerometer and Photodetector systems to provide motor spin up feedback and graphics rendering timing for accurate psychophysical measurements.
- B) **Interfacing experience using National Instruments LabVIEW**: 1) Behavioral control Rig 2 using Nintendo Wiimote: Researched, ordered, and assembled the real-time computer running Pharlap OS. The real-time computer has National Instruments Data Acquisition (DAQ) card, and communicates with a host and GPU systems running LabVIEW standalone application. Instrumental for the development and testing of the LabVIEW client with the open source wiimote library. The system performance was validated for acquisition rate (100hz), latency (50ms), accuracy (1+5mm), and max nRMS error (3%) and found to be on par with commercial motion tracking systems. The system is being used everyday since June 2009, without any issues. 2) Interfaced the Phasespace motion tracking system by creating a demo LabVIEW client. 3) Implemented population vector decoding algorithm in LabVIEW, verified Matlab and LabVIEW implementations produce identical results.
- C) **Neural data analysis using Matlab**: 1) Determined onset latency of eye and hand cells, using spike density function. The eye and hand cells had mixed onset latencies. 2) Implemented a time invariant Kalman filter decoder, using kernel smoothed PMd neural activity. The decoder is stable and was used to decode hand movement trajectory after training, on hundreds of test trials different from the training set. D) **Training of Macaque**: I have trained four macaque monkeys in the lab to perform, reaching, tracing tasks, one of them was trained to reach in a virtual reality display, while another was trained to perform switching reaches to visual and tactile cues.
- D) **Preliminary and proposal meeting presentations**: 1) For my preliminary exam, I looked at switching tasks, and how oculomotor and reaching commands can be modified online, especially interested in interactions between the oculomotor and reaching systems, to see effects in online correction capacity in the eyes fixated versus free conditions. 2) For my proposal meeting, I was interested in the influence of gaze on M1 hand area activity. There is strong evidence suggesting there is integration of gaze direction signals in pre-frontal and parietal areas of the cortex which in turn project to primary motor cortex (M1). Experiments were developed to record from hand area of M1 while a macaque performed a visuomotor intensive task like drawing/tracing shapes. The neural recordings would then be analyzed for gaze dependent modulatory effects. Presence of any gaze dependent modulation in hand area of M1 could be used to improve the performance of decode of hand movement kinematics from neural activity by 1) either monitoring eye movements or 2) calibrating and modeling for gaze dependent modulation in the estimation algorithms to obtain better reaching estimates. Though the performance of the second option is less than the first, its more flexible and practical in terms of usage and implementation of a cortical prosthesis.

CAN Software Intern, BOSCH; Pittsburgh PA spring 2006

Designed and implemented a higher layer protocol viz. the driver and daemon on top of a Control Area Network (CAN). The daemon takes care of addressing, fragmentation and reassembly. The implementation was a multithreaded applica-

tion in C++, using link-list, circular queue data structures and mutual exclusion and semaphore constructs of OS and waitForSingle event handlers. The application was integrated with the PRISM architectural middleware developed by BOSCH. See webpage for report.

Student Researcher (lab rotation 2) Dr. Mosse, Computer Science, University of Pittsburgh; PA fall 2006

UNIX network programming of wireless ARM based Sharp PDA's. I had tested the implementation of the (α, t) clustering algorithm, on wireless PDA 's; and wrote a simple clientserver application in Linux (sockets) that utilized the underlying adhoc-routing infrastructure, to transmit messages between the PDA's. Came up with a chat like pub-sub architecture to communicate emergency evacuation messages for clients subscribed to the service. See webpage for report.

Student Researcher (lab rotation 1) Dr. McCloud, Electrical Engg, University of Pittsburgh; PA summer 2005

Worked on a Multi-sensor distributed detection problem, building on the statistical detection theory and geometrical invariance work by Friedlander et.al. Performed Monte-Carlo simulations in Matlab to plot ROC of different receivers used in communication. See webpage for report.

Senior Development Engineer, Midas Communications; Chennai, India 1998-2001

I have worked across layers (physical, data link, MAC and network layers) in the commercialization of Voice and Data subscribers of the DECT wireless units developed jointly with IIT Madras. Some of the projects that I had completed from inception through release, programming in assembly and C for ADSP based subscriber units are: 1) Implemented Auto-Ranging procedure in subscriber terminal equipment, a procedure used to adjust clock timing to compensate propagation delays 2) Modified AMD Flash programming procedure for the terminal equipments on-air application code upgrade 3) Restructured the application code for the use of overlay memory in ADSP2187 processor, for implementation of multiple service subscriber as per DECT standard. 4) Expanded the Link Layer entity in WSIP to support multiple connections, involved in the re-design of the inter-working of WSIP 5) Implemented caller line identification presentation (CLIP) in WSIP, using DTMF tones for Brazil, China, India

Management Trainee Engineer, ITC Bhadrachalam Paperboards; Sarapakka, Andhra, India 1996-1997

One of the two selected through a competitive on-campus recruitment by ITC for the commissioning of their 25MW coal powered generator for the new paperboards machine in Sarapakka.

EDUCATION

Institution	Degree/Diploma	date
University of Pittsburgh, PA, Pittsburgh	Bioengineering PhD student and Center for Neural Basis of Cognition Trainee, GPA 3.4/4.0	2007-till date
The George Washington University, Washington DC	MS Computer Engineering, GPA 3.7/4.0	2001-2003
Silverline Institute of Center for Development of Advanced Computing, Chennai India	Diploma in advanced computing	1997-1998
Kakatiya University, Regional Engineering College Warangal, Andhra India	BS Mechanical Engineering, Graduated with Honors Distinction and Deans List for 1993	1992-1996

ABSTRACTS & POSTERS

- Wiimocap- a low-cost motion capture system using the nintendo wiimote;** Society For Neuroscience (SFN) 2009; N. Krishnamurthy^{1,2}, D. Bacher¹, J. F. McFerron³, A. P. Batista^{1,2}; 1-Univ. Pittsburgh, Pittsburgh, PA; 2-Center for the Neural Basis of Cognition, Pittsburgh, PA; 3-Crossroads Consulting LLC, Johnstown, PA
- Paucity of fast-timescale correlations in monkey cortex -** Bio Medical Engineering Society 2009; C. Lehocky¹, N. Krishnamurthy¹, B. M. Yu^{2,3}, G. Santhanam², S. I. Ryu², A. Afshar², J. Cunningham², V. Gilja², R. Kalmar², Z. Rivera-Alvidrez², K. Shenoy², N. Hatsopoulos⁴, M. T. Harrison⁵, and A. P. Batista¹; 1University of Pittsburgh, Pittsburgh, PA, 2Stanford University, Stanford, CA, 3University College London, London, UK, United Kingdom, 4University of Chicago, Chicago, IL, 5Carnegie Mellon University, Pittsburgh, PA
- A cross-modal reach redirection task in Rhesus monkeys reveals speeded processing for vibrotactile stimuli -**SFN 2009; J. M. Godlove^{1,2}, N. Krishnamurthy^{1,2}, M. A. Faulkner¹, A. P. Batista^{1,2}; 1Univ. Pittsburgh, Pittsburgh, PA; 2Ctr. for the Neural Basis of Cognition, Pittsburgh, PA
- An experimental rig for closed-loop neural prosthetics -** SFN 2008; D. Bacher¹, J. F. McFerron³, N. Krishnamurthy^{1,2}, A. P. Batista^{1,2}; 1Univ. Pittsburgh, Pittsburgh, PA; 2Ctr. for the Neural Basis of Cognition, Pittsburgh, PA; 3Crossroads Consulting LLC, Johnstown, PA