

Education

Ph.D. , Computer Science University of California, Los Angeles Advisor: Prof. Michael G. Dyer	2002
M.S. , Computer Science University of California, Los Angeles	1999
B.Tech. , Computer Science and Engineering Indian Institute of Technology, Bombay	1996

Professional Experience

Research Specialist Saban Research Institute Childrens Hospital Los Angeles	2004- present
Post-doctoral Affiliate NASA Jet Propulsion Laboratory California Institute of Technology	2008- present
Post-doctoral Research Scholar Computer Science Department University of Southern California Supervisors: Prof. Maja Mataric and Prof. Gaurav Sukhatme	2003-2004
Post-doctoral Research Scholar Computer Science Department University of California, Los Angeles Supervisor: Prof. Adnan Darwiche	2002-2003

Research Experience

- **Sensor network-based remote health monitoring:** At the Childrens Hospital Los Angeles, I am working on a system for remote health monitoring based on a wireless network of wearable medical sensors. The system transfers sensor measurements to a remote health professional via radio communication, cellular networks, and over the Internet. Thus, subjects can be monitored at home and when they are moving.
- **Cyclone tracking from multiple remote-sensed datasets:** At the Jet Propulsion Laboratory, I am developing a system that can autonomously track cyclones using only images from remote sensing satellites. The datasets have different temporal resolutions and relevance for cyclone eye detection. These are integrated as observations into a state-based filter tracker.
- **Control and coordination in sensor networks:** I am the PI on an NSF grant to explore the use of Markov Decision Processes and Kalman filters for distributed control in low-power sensor networks. The idea is to compute a sophisticated control policy *before* deployment so that the limited processing power on the sensor node will be used only for executing a pre-computed policy.

- **Model Predictive Control for resource management in sensor networks:** I use the Model Predictive Control technique for adapting sensor operation to the available energy and communication resources in the sensor network. The approach involves formulating the control problem as a constrained multi-objective optimization problem. The solution to this optimization problem then provides the control for all the sensors in the network.
- **Remote monitoring of human vital signs:** I developed signal processing algorithms for a microwave-based system for monitoring human vital signs from a distance. This technology will enable heart rate to be measured without requiring the measurement system to make physical contact with the subject.
- **Adaptive sampling in a coastal ocean sensor network:** I applied the Model Predictive Controller approach to a coastal monitoring network in the New York harbor region (NYHOPS). I showed how marine forecasts could be improved by incorporating in-situ sensor measurements. The controller also uses the forecasts to determine the optimal operational parameters of various components in the network. These include the sensor sampling rates, paths of unmanned underwater vehicles, and data transfer routes.
- **Wavelet-based data transmission in lossy networks:** I developed a technique to improve the performance of wavelet based compression when used over lossy wireless links. I developed an algorithm to distribute wavelet coefficients among multiple transmission packets to minimize the error introduced in the reconstruction step due to packet drops. This algorithm is based on a statistical model of the correlation between coefficients.
- **Distributed region detection for sensor networks:** I developed a distributed algorithm for region detection in sensor networks. A region is that area where all the sensors measure similar values. My distributed algorithm enables each sensor node to calculate the extent of the region in which it is located. The algorithm uses communication only between neighboring nodes. The calculated extent is updated as the region changes over time.
- **Tracking and modeling of human interactions:** For my post-doctoral research at USC, I developed probabilistic models of human movement, and especially of their interactions with each other. I tracked movements of people using laser range-finders. The tracks were divided into distinct activities using entropy-based segmentation. The activity segments were then combined to develop a probabilistic model of the observed activities. The models were then used for automatically detecting anomalous behavior.
- **Logical reasoning on embedded systems:** For my post-doctoral research at UCLA, I demonstrated that reasoning algorithms based on propositional logic could be executed even on low-power computing platforms if an efficient representation is used. I demonstrated the approach by programming a Sony Aibo robot to solve the “Wumpus world” problem. The plan to solve the problem was computed offline and stored as an Ordered Binary Decision Diagram in the robot's memory. The project also involved writing vision and robot localization code, and programming for the real-time operating system on the robot.
- **Construction by autonomous agents:** In my PhD dissertation research, I demonstrated how connectionist agents could construct arbitrary structures in a simulated environment. The goal was to build a group of autonomous agents that could rearrange objects in their environment to form arbitrary shapes. I achieved these objectives by coupling a behavior-based architecture with explicit spatial representation. The connectionist approach also facilitated different types of learning in the construction domain.

Teaching Experience

Teaching Assistant Coordinator Computer Science Department, UCLA	2001
Teaching Assistant/Associate/Fellow Computer Science Department, UCLA	
• <i>Logic Design of Digital Systems</i>	1997-2001
• <i>Computer Systems Architecture</i>	1997, 2000
• <i>Digital Design Project Lab</i>	2000
Instructor Center for Talented Youth (CTY), Johns Hopkins University	
• <i>Theoretical Foundations of Computer Science</i>	1997

Academic Service

Program Committee member: Twentieth National Conference on Artificial Intelligence (AAAI 05), Workshop on Sensor Networks for Earth and Space Science Applications (ESSA) at IPSN 2009

Local Arrangements Committee member: International Joint Conferences on Artificial Intelligence (IJCAI 2009)

Judge: California State Science Fair 2004, 2007

Reviewer

IEEE Sensors Journal
IEEE Communications Magazine
International Journal of Computational Intelligence and Healthcare Informatics
IEEE Transactions on Image Processing
Journal of Applied Optics
International Journal of Social Robotics
International Conference on Data Mining
IEEE Aerospace Conference

Students Advised

Shuping Liu
PhD student, Department of Electrical Engineering, USC

Refereed Publications

A. Panangadan, M. Mataric and G. Sukhatme. Tracking and Modeling of Human Activity using Laser Rangefinders. To appear in *International Journal of Social Robotics*, 2010.

A. Panangadan, S. Ho, and A. Talukder, Cyclone tracking using multiple satellite image sources, *17th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems*, Seattle, 4-6 November, 2009.

S. Liu and **A. Panangadan**, Evaluation of a Markov Decision Process-based coordinated sampling method, Workshop on Sensor Networks for Earth and Space Science Applications, *8th ACM/IEEE International Conference on Information Processing in Sensor Networks*

(IPSN), San Francisco, 16 April, 2009.

S. Liu, **A. Panangadan**, C. Raghavendra, and A. Talukder, Poster abstract: MDP framework for sensor network coordination, *8th ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN)*, San Francisco, 13-16 April, 2009.

A. Talukder and **A. Panangadan**, Online visualization of adaptive distributed sensor webs, *IEEE Aerospace Conference*, Big Sky, Montana, 7-14 March, 2009.

A. Panangadan and M.G. Dyer, Construction in a simulated environment using temporal goal sequencing and reinforcement learning, *Adaptive Behavior*, 17(1), pages 81-104, 2009.

A. Talukder, **A. Panangadan**, A.F. Blumberg, T. Herrington, and N. Georgas, Improving the forecast accuracy of an ocean observation and prediction system by adaptive control of the sensor network, *Eos Trans. AGU*, 89(53), Fall Meeting Supplement, Abstract IN31A-1120, 2008.

A. Talukder, **A. Panangadan**, A. Blumberg, T. Herrington, and N. Georgas, Improving the science return from coastal sensor webs using autonomous predictive control and resource management. Eighth Annual Earth Science Technology Conference, University of Maryland, June 24-26, 2008.

A. Talukder, **A. Panangadan**, T. Herrington, A. Blumberg, and N. Georgas. Autonomous adaptive resource management in sensor network systems for environmental monitoring. In *IEEE Aerospace Conference*, Big Sky, Montana, 1-8 March, 2008.

M. Venugopal, K.E. Feuvrel, D. Mongin, S. Bambot, M. Faupel, **A. Panangadan**, A. Talukder, and R. Pidva. Clinical evaluation of a novel interstitial fluid sensor system for remote continuous alcohol monitoring, *IEEE Sensors Journal*, 8(1), pages 71-80, 2008.

A. Talukder, S. M. Ali, **A. Panangadan**, and L. Chandramouli. Predictive controller for heterogeneous sensor network operation in dynamic environments. In *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, IEEE Press, pp. 1133-1139, 2005.

A. Panangadan, S. M. Ali and A. Talukder. Markov decision processes for control of a sensor network-based health monitoring system. In *Proceedings of the Seventeenth Innovative Applications of Artificial Intelligence Conference (IAAI)*, AAAI Press, Menlo Park, Calif., pp. 1529-1534, 2005.

A. Talukder, S. M. Ali, **A. Panangadan**, C. Jadhav, R. Pidva, R. Bhatt, L. Chandramouli, and S. Monacos. Optimal server scheduling and power management in sensor networks. In *Optical Pattern Recognition XVI, Proceedings of SPIE*, vol. 5816, pp. 221-232, 2005.

A. Panangadan, M. Mataric and G. Sukhatme. Identifying human interactions in indoor environments. In *Proceedings of the Third International Joint Conference on Autonomous Agents and Multi-Agent Systems (AAMAS)*, IEEE Computer Society, pp. 1308-1309, 2004.

A. Panangadan, M. Mataric and G. Sukhatme. Detecting anomalous human interactions using laser range-finders. In *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, IEEE Press, pp. 2136-2141, 2004.

A. Panangadan and M.G. Dyer. Learning spatial and temporal correlation for navigation in a 2-dimensional continuous world. In *Proceedings of the 19th International Conference on*

Machine Learning (ICML), Morgan Kaufmann, pp. 474-481, 2002.

A. Panangadan and M.G. Dyer. Goal sequencing for construction agents in a simulated environment. In *Proceedings of the International Conference on Artificial Neural Networks (ICANN)*, Springer, pp. 969-974, 2002.

A. Panangadan and M.G. Dyer. Learning social behaviors without sensing. In *From Animals to Animats 7: Proceedings of the 7th International Conference on Simulation of Adaptive Behavior (SAB)*, Bradford Book/MIT Press, 2002.

A. Panangadan and M.G. Dyer. Construction by autonomous agents in a simulated environment. In *Proceedings of the International Conference On Artificial Neural Networks (ICANN)*, Springer, pp. 963-970, 2001.

G. Chao, **A. Panangadan** and M.G. Dyer. Learning to integrate reactive and planning behaviors for construction. In *From Animals to Animats 6: Proceedings of the 6th International Conference on Simulation of Adaptive Behavior (SAB)*, Bradford Book/MIT Press, pp. 167-176, 2000.

Non-refereed Publications

A. Panangadan and G. Sukhatme. Data segmentation for region detection in a sensor network. CRES Technical Report 05-005, University of Southern California, 2005.

A. Panangadan. Construction using autonomous agents in a simulated environment. PhD Thesis, Computer Science Department, University of California, Los Angeles, 2002.

Awards

Co-Principal Investigator <i>CSR-EHS: DEFT Distributed Embedded Fault-Tolerant Control of Resource Constrained Sensor Networks</i> National Science Foundation (Award #0615132) \$100,000	2006
Conference Travel Grant 19th International Conference on Machine Learning	2002
Best Teaching Assistant Award (both student and faculty nominated categories) Computer Science Department, UCLA	2001-2002
Conference Travel Grant European Neural Network Society	2001
Departmental Fellowship Computer Science Department, UCLA	1996-1997
Certificate of Merit for Outstanding Academic Performance Central Board of Secondary Education, Government of India	1992
Certificate of Honour, 7 th rank in the Physics Talent Test The Physics Society, Madras (Chennai), India	1991