

# Namrata Vaswani

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## Contact Information

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## Education

**University of Maryland, College Park**

GPA: 3.72/4

**Ph.D Candidate**, Electrical and Computer Engineering (Expected Summer 2004)

*Major:* Communications and Signal Processing, *Minor:* Control

*Dissertation:* Abnormality and Change Detection in Shape Dynamical Models for Activity

**Indian Institute of Technology (IIT), Delhi**

GPA: 8.42/10

**B.Tech.**, Electrical Engineering (May 1999)

*B.Tech Project:* Recognition of Dynamic Hand Gestures for Robot Control

## Research Interests

- Statistical Signal/Image Processing, Computer Vision, Machine Learning, Pattern Recognition
- Information Theory for Image/Video Compression and Hypothesis Testing
- Sequential Monte Carlo Methods (Particle Filtering): Convergence Issues and Applications in Tracking, Approximate Nonlinear Filtering and Change Detection
- Shape Analysis and Deformation Models for Medical Image Processing/Vision/Robotics
- Decision Theory: Image Retrieval, Classification, Change Detection in Time Series

## Publications (<http://www.cfar.umd.edu/~namrata/publications.html>)

### Change Detection in HMMs Using Particle Filters

- N. Vaswani, “*Statistics for Slow and Drastic Change Detection Using Particle Filters with Unknown Change Parameters*”, In preparation for IEEE Trans. on Signal Processing.
- N. Vaswani, “*Bound on Errors in Particle Filtering with Incorrect Model Assumptions and its Implication for Change Detection*”, IEEE Intl. Conference on Acoustics, Speech and Signal Processing (ICASSP), 2004.
- N. Vaswani, “*Change Detection in Partially Observed Nonlinear Dynamic Systems With Unknown Change Parameters*”, American Control Conference (ACC), 2004.
- N. Vaswani, R. Chellappa, “*A Particle Filtering Approach to Abnormality Detection in Non-linear Systems and its Application to Abnormal Activity Detection*”, 3rd Intl. Workshop on Statistical and Computational Theories of Vision, 2003, held along with IEEE ICCV 2003.

### “Shape Activities”: Shape Deformation Models for Groups of Moving Objects

- N. Vaswani, A. RoyChowdhury, R. Chellappa, “*“Shape Activities”: Stochastic Models for Moving/Deforming Shapes with Application to Abnormal Activity Detection*”, Accepted for publication in IEEE Transactions on Image Processing.
- N. Vaswani, A. RoyChowdhury, R. Chellappa, “*Activity Recognition Using the Dynamics of the Configuration of Interacting Objects*”, IEEE Conf. on Computer Vision and Pattern Recognition (CVPR), 2003.
- N. Vaswani, A. RoyChowdhury, R. Chellappa, “*Statistical Shape Theory for Activity Modeling*”, IEEE ICASSP, 2003.
- R. Chellappa, N. Vaswani, A. RoyChowdhury, “*Activity Modeling and Recognition Using Shape Theory*”, Behavior Representation in Modeling and Simulation (BRIMS), 2003.

### Image Classification Using Linear Subspaces

- N. Vaswani, R. Chellappa, “*Principal Component Null Space Analysis for Image/Video Classification*”, submitted to IEEE Transactions on Image Processing.
- N. Vaswani, R. Chellappa, “*Classification Probability Analysis of Principal Component Null Space Analysis*”, Intl. Conf. on Pattern Recognition (ICPR), 2004.
- N. Vaswani, “*A Linear Classifier for Gaussian Class Conditional Distributions with Unequal Covariance Matrices*”, ICPR, 2002.

### Infra-Red Image Compression

- N. Vaswani, A. K. Agrawal, Q. Zheng, R. Chellappa, “*Moving Object Detection and Compression in IR Sequences*”, book chapter in Computer Vision beyond the Visible Spectrum, Eds B. Bhanu and I. Pavlidis, Springer, 2003.
- N. Vaswani, R. Chellappa, “*Best View Selection and Compression of Moving Objects in IR Sequences*”, IEEE ICASSP, 2001.

### Undergraduate Research

- A. Ramamoorthy, N. Vaswani, S. Chaudhury, S. Bannerjee, “*Recognition of Dynamic Hand Gestures*”, Pattern Recognition, Vol. 36, No. 9, pp. 2069-2081, Sept 2003.
- M. Sharma, N. Vaswani, S. Tuli, “*Novel Techniques for Time and Frequency Domain Characterization of Surface Acoustic Wave Devices*”, VIII National Symposium on Ultrasonics in 1997, at Amritsar, India.

### Course Work

Random Processes for Communications and Control, Estimation and Detection Theory, Information Theory, Digital Image Processing, Image Understanding, Statistical Signal Processing, Advanced Digital Signal Processing, Digital Communications, Linear System Theory, Optimal Control, Real Analysis-I & II, Mathematical Statistics-II, Seminar classes on Optimization, Particle Filtering, Signal Processing for Communications

### Seminars/Talks

- Convergence Results for Particle Filters
- Sequential Quadratic Programming Approach to Nonlinear Programming
- Markov Random Fields for Image Texture Segmentation
- Wavelet Based Statistical Signal Processing Using HMMs
- The CONDENSATION Algorithm for Object Tracking

### Computer Skills

**Operating Systems:** Unix, Linux, Windows, DOS

**Languages/Software:** MATLAB, C, C++, VC++, LaTeX

### Experience

- **Graduate Research Assistant, Center for Automation Research, University of Maryland, College Park, Jan 2000 - Present**  
- See Summary of Research Projects
- **Research Intern, HRL Labs LLC, Malibu, CA, June-Oct 2001**  
- Vision Based Object Detection for Collision Warning  
- Overcomplete Blind Source Separation Using Convolutional Independent Component Analysis
- **Graduate Research Assistant, UMIACS, University of Maryland, Aug-Dec 1999**  
- Gesture-Driven Control of Spaces and Objects in Collaborative Augmented Reality

- **Intern, Synergy Systems and Solutions, Delhi, India, May-Aug 1999**  
- Prepared a report on Theory/Algorithms for Developing a Pipeline Leak Detection Software
- **Intern, Philips Semiconductors, Bangalore, India, May-July 1998**  
- Design and Synthesis of a Peripheral Interface Bus Controller
- **Summer Undergraduate Research Award (SURA), Center for Applied Research in Electronics, IIT-Delhi, India, May-July 1997**  
- Awarded a research grant and stipend for the project “Time & Frequency Domain Characterization of Surface Acoustic Wave Devices and Cancellation of Triple Transit Interference”

#### Honors/Awards/Professional Activities

- Nominated for Best B.Tech Project in Electrical Engineering at IIT-Delhi, 1999
- Summer Undergraduate Research Award (SURA) at IIT-Delhi, 1997
- Gold Medal in Delhi Regional Mathematics Olympiad, 1995
- National Talent Search Exam (NTSE) Scholarship, 1993-99
- Junior Science Talent Search (JSTS) Scholarship, 1992-93
- Reviewer, IEEE Trans. on Pattern Analysis and Machine Intelligence(PAMI), IEEE Conf. on Decision and Control(CDC)

#### Summary of Research Projects

- **Change Detection in Hidden Markov Models (HMMs) Using Particle Filters**  
We study the problem of change detection in continuous state HMMs using particle filters when the changed system parameters are unknown and the change can be slow or drastic. Drastic changes can be detected easily using the increase in tracking error (TE) or negative logarithm of the observation likelihood (OL). For slow changes which get missed by OL or TE we propose a statistic called ELL and show its connection to Kerridge Inaccuracy. We show the asymptotic convergence (with time, number of particles) of the modeling and particle filtering errors in approximating the ELL, analyze their behavior with increasing rate of change, and also discuss complementariness of ELL and OL for slow and drastic changes. We show simulation results for simulated examples and for the abnormal activity detection application discussed below.
- **“Shape Activity” Models for Tracking, Abnormality Detection and Segmentation**  
The aim is to model “activity” performed by a group of moving and interacting objects (which can be people or cars or different rigid components of the human body) and use the models for tracking and abnormal activity detection. We treat the objects as point objects (referred to as ‘landmarks’) and model their changing configuration as a moving and deforming “shape” using ideas from Kendall’s shape theory for discrete landmarks. A continuous state HMM which takes the objects’ configuration as the observation and the shape+motion as the hidden state, is defined to represent an activity. Particle filters are used to track the HMM. Abnormal activity is defined as a change in the HMM, which can be slow or drastic and whose parameters are unknown. This motivated the change detection problem discussed above.
- **Image Classification Using Linear Subspaces**  
We proposed a new pattern classification technique using linear subspaces which is similar to Subspace Linear Discriminant Analysis (SLDA). We derived bounds on its classification error probability and compared it with SLDA both analytically and experimentally. Experimental results have been shown on various image classification problems and also on a video retrieval problem.
- **Infra-Red Image Compression**  
We developed fast compression algorithms for IR images using wavelet decomposition followed by 2D predictive DPCM within and across wavelet subbands. We have experimented with combining non-iterative zerotree coding with 2D predictive DPCM for compression of the wavelet subbands and only DPCM for the low frequency subband. We compared compression

ratios of scalar and geometric vector quantization, zerotree coding and DPCM for compressing IR images.

## References

- Prof. Rama Chellappa (Advisor)  
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