Sanjiv Kumar

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EDUCATION

Carnegie Mellon University, Pittsburgh, USA **Aug 2000 - June 2005 (expected)**
Ph.D. in Robotics, School of Computer Science
Thesis Advisor: Prof Martial Hebert
QPA: 4.00/4.00

Indian Institute of Technology, Madras, India **Aug 1994 - Dec 1996**
M. S. in Robotics
CGPA: 9.81/10.00

Birla Institute of Technology and Science, Pilani, India **July 1990 - July 1994**
B.E. in Mechanical Engineering (Robotics)
CGPA: 9.11/10.00, Distinction

FIELDS OF INTEREST: Statistical Learning, Graphical Models, Applications to Computer Vision, Medical Imaging and Robotics

RESEARCH EXPERIENCE

Graduate Researcher, Carnegie Mellon University, USA **Aug 2000 - June 2005**
Advisor: Prof. Martial Hebert
Developed models for spatial interactions in natural images for detection and classification problems.

- Introduced new probabilistic graphical models in computer vision that combine local discriminative classifiers with interactions among image components for robust classification. They capture spatial dependencies in the labels as well as the observed data on arbitrary graphs.
- Investigated fast and robust parameter learning procedures, which are also applicable to other conventional models.
- Obtained improved solutions to challenging tasks such as texture classification, semantic segmentation, image denoising and object detection. An application to man-made structure detection is currently being used for real-time robotic landmark detection and video retrieval.

Summer Intern, Microsoft Research, Cambridge, UK **May 2004 - Aug 2004**
Advisors: Prof. Andrew Blake and Dr. Carsten Rother
Worked on an image synthesis problem to create a single image that summarizes a photo album. The output (*digital tapestry*) can be used either as a virtual thumbnail or as an image retrieval engine.

- Formulated the synthesis task as a classification problem on an undirected graph.
- Posed inference on the graph as a matching problem with hard constraints, and solved it using a modified expansion-move algorithm.

Summer Intern, Kodak Imaging Lab, Rochester, USA **May 2001 - Sept 2001**
Advisor: Dr. Alexander C. Loui
Developed observation-constrained models for probabilistic classification of natural image regions.

- Proposed a new technique to combine supervised learning on training data with unsupervised learning on test data to alleviate the data overlap problem.
- Developed a model selection scheme for unsupervised learning using KL-Divergence.

Research Engineer, NREC, Carnegie Mellon University, USA **April 1999 - July 2000**
Worked on vision sensor integration, model-based 3D pose estimation using multiple images, and structured light (laser) based object localization.

Research Fellow, Department of Surgery, NUS, Singapore **April 1997 - March 1999**
Worked on the image analysis aspect of a medical robotics project: *Development of an Intelligent Microrobotic Colonoscope.*

- Developed a new technique for barrel distortion correction in endoscopic images using polynomial radial expansion.
- Proposed differential region growing and adaptive thresholding techniques for real-time extraction of lumen from colonoscopic images for automatic characterization and navigation.

Graduate Researcher, Indian Institute of Technology, India **Aug 1994 - Dec 1996**
Advisor: Prof. Y. G. Srinivasa
Worked on laser based navigation and path planning of an autonomous mobile robot.

Undergraduate Intern, Lucas TVS Ltd., India **Jan 1994 - June 1994**
Advisor: Dr. Srinivasa Murthy
Worked on automation of a fuel filter assembly line using computer aided design and planning.

Undergraduate Intern, National Physical Laboratory, India **May 1992- July 1992**
Advisor: Dr. Anand
Worked on computer aided design of a remote-sensing satellite accessory.

AWARDS AND SCHOLARSHIPS

- Robotics Institute Graduate Student Fellowship, Carnegie Mellon University, 2000-Present.
- Graduated the Bachelors program with Distinction (Top four in the department), 1994.
- Institute merit scholarship during the entire undergraduate program, 1990-1994.
- Third rank in XII grade examination taken by approximately 0.8 million students, 1990.

PROFESSIONAL ACTIVITIES

- Reviewer for International journal of Computer Vision (IJCV), IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI), IEEE Transactions on Medical Imaging (TMI), IEE Journal of Medical & Biological Engineering & Computing (MBEC), Journal of Electronic Imaging (JEI), Neural Information Processing Systems (NIPS), IEEE International Conference on Computer Vision and Pattern Recognition (CVPR), and IEEE International Conference on Robotics and Automation (ICRA).

TALKS

- **Microsoft Research, Cambridge, UK** **Aug 2004**
  Digital Tapestry
- **Snowbird Learning Workshop, Utah, USA** **April 2004**
  Multiclass Discriminative Fields for Deformable Object Detection (Invited)
- **Neural Information Processing Systems, Vancouver, Canada** **Dec 2003**
  Discriminative Fields for Modeling Spatial Dependencies in Natural Images (Spotlight)
- **Int. Conf. on Computer Vision, Nice, France** **Oct 2003**
  Discriminative Random Fields: A Discriminative Framework for Contextual Interaction
- **Int. Conf. on Computer Vision and Pattern Recognition, Madison, USA June 2003**
  Man-Made Structure Detection in Natural Images using a Causal Multiscale Random Field
- **ECCV Workshop on Gen. Models Based Vision, Copenhagen, DK** **June 2002**
  Probabilistic Classification of Image Regions using an Observation-Constrained Approach
- **Kodak Imaging Research Labs, Rochester, USA** **Sept 2001**
  Probabilistic Classification of Natural Image Regions
- **National Seminar on Mechatronics, Madras, India** **March 1997**
  Development of a Self-Guided Vehicle with Laser based Navigation System (Invited)

TEACHING

- **Teaching Assistant, Carnegie Mellon University, USA** **Aug 2002 - Dec 2002**
  Computer Vision (graduate)
- **Teaching Assistant, Indian Institute of Technology, India** **July 1995 - Dec 1995**
  Engineering Graphics (undergraduate)

MISCELLANEOUS

- *Software Skills:* C/C++, Matlab, Mathematica, Autolisp, Linux/Unix, Windows.
- *Selected Courses:* Computer Vision, Advanced Computer Vision, Pattern Recognition, Machine Learning, Statistical Approaches to Learning, Stochastic Processes, Estimation Detection and Identification, Computational Perception and Scene Analysis, Robotics.

PERSONAL

- *Visa Status:* Indian Citizen on F1 Student Visa.
- *Marital Status:* Married.
- *Languages:* English, Hindi.

PATENTS

- A. C. Loui and S. Kumar, *Methods for Image Regions Classification Using Unsupervised and Supervised Learning.* US Serial No. 10/072756, Filed Feb 2002.
- C. Rother, A. Blake and S. Kumar, *Digital Tapestry.* Application in process, 2004.

PUBLICATIONS

Refereed Journals

[1] S. Kumar and M. Hebert, *Discriminative Random Fields,* In review, International Journal of Computer Vision (IJCV), *submitted* 2004.

[2] S. Kumar, A. C. Loui, and M. Hebert, *An Observation-Constrained Generative Approach for Probabilistic Classification of Image Regions,* Image and Vision Computing, 21, pp. 87-97, 2003.

[3] K. V. Asari, S. Kumar, and D. Radhakrishnan, *A New Approach for Nonlinear Distortion Correction in Endoscopic Images based on Least Squares Estimation,* IEEE Transactions on Medical Imaging, vol. 18, no. 4, pp. 345-354,1999.

[4] S. Kumar, K. V. Asari, and D. Radhakrishnan, *Real-Time Automatic Extraction of Lumen Region and Boundary from Endoscopic Images,* IEE Journal of Medical & Biological Engineering & Computing, vol. 37, pp. 600-604, 1999.

[5] K. V. Asari, S. Kumar, and D. Radhakrishnan, *Technique of Distortion Correction in Endoscopic Images using a Polynomial Expansion,* IEE Journal of Medical & Biological Engineering & Computing, vol. 37, no. 1, pp. 8-12, 1999.

[6] S. Kumar, M. I. Kassim, and K. V. Asari, *Design of a Vision-guided Microrobotic Colonoscopy System,* International Journal of Advanced Robotics, vol. 14, no. 2, pp. 87-104, 2000.

[7] K. V. Asari, S. Kumar, and M. I. Kassim, *A Fully Automatic Microrobotic Endoscopy System,* Journal of Intelligent and Robotic Systems, vol. 28, pp. 325-341, 2000.

[8] K. V. Asari, T. Srikanthan, S. Kumar, and D. Radhakrishnan, *A Pipelined Architecture for Image Segmentation by Adaptive Progressive Thresholding,* Journal of Microprocessors and Microsystems, vol. 23, no. 8-9, pp. 493-499, 1999.

Refereed Conferences and Workshops

[9] S. Kumar and M. Hebert, *A Hierarchical Field Framework for Unified Context-Based Classification,* In review, IEEE International Conference on Computer Vision (ICCV), *submitted*, March, 2005.

[10] C. Rother, S. Kumar, V. Kolmogorov and A. Blake, *Digital Tapestry,* IEEE International Conference on Computer Vision and Pattern Recognition (CVPR), June, 2005 (poster, $\sim 25\%$ acceptance).

[11] S. Kumar and M. Hebert, *Discriminative Fields for Modeling Spatial Dependencies in Natural Images,* In Proc. Advances in Neural Information Processing Systems, NIPS 16, MIT Press 2004 (oral spotlight, 9% acceptance).

[12] S. Kumar and M. Hebert, *Discriminative Random Fields: A Discriminative Framework for Contextual Interaction in Classification,* In Proc. IEEE International Conference on Computer Vision (ICCV), vol. 2, pp. 1150-1157, 2003 (oral, 4% acceptance).

[**13**] S. Kumar and M. Hebert, *Man-Made Structure Detection in Natural Images using a Causal Multiscale Random Field,* In Proc. IEEE International Conference on Computer Vision and Pattern Recognition (CVPR), vol. 1, pp. 119-126, 2003 (oral, 6% acceptance).

[**14**] S. Kumar, A. C. Loui and M. Hebert, *Probabilistic Classification of Image Regions using an Observation-Constrained Generative Approach,* ECCV Workshop on Generative Models based Vision (GMBV), June 2002.

[**15**] B. Nabbe, S. Kumar, and M. Hebert, *Path Planning with Hallucinated Worlds,* In Proc. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), October 2004.

[**16**] S. Kumar, K. Vijayan Asari, and D. Radhakrishnan, *Online Extraction of Lumen Region and Boundary from Endoscopic Images Using a Quad Structure,* IEE Conference on Image Processing and its Applications (IPA), pp. 818-822, 1999.

[**17**] S. Kumar, K. Vijayan Asari, and D. Radhakrishnan, *A New Technique for the Segmentation of Lumen from Endoscopic Images by Differential Region Growing,* 42nd Midwest Symposium on Circuits and Systems, New Mexico, 1999.

Invited Workshops

[**18**] S. Kumar and M. Hebert, *Approximate Parameter Learning in Discriminative Fields,* in Snowbird Learning Workshop, Utah, April 2004.

[**19**] S. Kumar and M. Hebert, *Multiclass Discriminative Fields for Deformable Object Detection,* in Snowbird Learning Workshop, Utah, April 2004.

[**20**] S. Kumar and M. Hebert, *Discriminative Fields for Spatial Interactions in Natural Images,* in Object Recognition Workshop, Sicily, Sept 2003.

[**21**] S. M. Krishnan, S. Kumar, C. J. Yap, M. I. Kassim, and P. M. Y. Goh, *Development of a Microrobotic System for Intelligent Endoscopy,* 2nd Scientific Meet. of Biomed. Eng. Soc., Singapore, January 1999.

[**22**] S. M. Krishnan, S. Kumar, C. J. Yap, M. I. Kassim, and P. M. Y Goh, *A Computer-Based Endoscopic Image Segmentation Technique for Lumen Extraction,* 13th Int. Congress and Exhibition on Comp. Asst. Radio. Surgery, Paris, June, 1999.

[**23**] S. M. Krishnan, S. Kumar, C. J. Yap, M. I. Kassim, and P. M. Y Goh, *Computer-Assisted Intelligent Endoscopy,* 13th Int. Congress and Exhibition on Comp. Asst. Radio. Surgery, Paris, June, 1999.

[**24**] S. Kumar, M. Singaperumal and Y. G. Srinivasa, *Design of a Self Guided Vehicle (SGV) with Laser Based Navigation System,* National Seminar on Mechatronics, India, Madras, 1997.

Others

[**25**] S. Kumar and M. Hebert, *Hierarchical Discriminative Fields for Multilevel Interactions,* Tech. Report, *under preparation*, 2005.

[**26**] S. Kumar, *Development of a Self Guided Vehicle (SGV) with Laser Based Navigation System,* M.S. Thesis, Indian Institute of Technology, Madras 1997.

REFERENCES

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  Multimedia Communications, Kodak Imaging Research Laboratories
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