

# Soma Biswas

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## Research Interests

My research interest is in computer vision, image processing and pattern recognition. I have worked on illumination-invariant object representation and matching, shape indexing for matching and retrieval, 2D face recognition, 3D face and object matching, fingerprint classification and related problems.

## Education

**PhD in Electrical and Computer Engineering**, University of Maryland, College Park.  
August 2004 – Present  
Advisor: Prof. Rama Chellappa

**Masters in Electrical Engineering**, Indian Institute of Technology (IIT) Kanpur, India.  
August 2002 – May 2004 (GPA : 10.0/10.0)  
Advisor: Prof. Govind Sharma

**Bachelors in Electrical Engineering**, Jadavpur University, Kolkata, India.  
July 1997 – May 2001 (GPA : 3.8/4.0)

## Research & Professional Experience

**Graduate Research Assistant**  
August 2004 – Present  
Advisor: Prof. Rama Chellappa

**Center for Automation Research**  
University of Maryland, College Park

- **Albedo and Shape Estimation from a Single Image.** We propose a non-stationary stochastic filtering framework for albedo and shape estimation using a Non-stationary Mean Non-stationary Variance model for the true unknown albedo. The framework is extended to deal with images illuminated by multiple sources without having any information about the number or placement of light sources.
- **Articulation Invariant Shape Matching and Indexing.** In this work, we develop an approach to index each shape based on a variety of simple and easily computable features that are invariant to articulations of part structures and rigid transformations. Shapes are retrieved using an efficient scheme that does not involve costly shape-wise alignment or correspondence establishment.
- **Invariant Geometric Representation of 3D Point Cloud for Matching and Registration.** In this work, we develop isosurface-based representation to derive smooth and approximate characterization of input point clouds. Implicit function values on a set of suitably placed concentric spheres around the object are used as the features. Geometric invariance is achieved by spherical harmonic decomposition.
- **2D and 3D Face Recognition.** I worked on the Face Recognition Grand Challenge (FRGC) as part of the University of Maryland team. We developed and analyzed algorithms for matching faces across varying illumination conditions. For 3D face recognition, we use implicit surface representation that obviates the need for precise correspondence between surface points.
- **A Non-generative Approach for Face Recognition Across Aging.** Given the innumerable different ways in which a face can potentially age, it is very difficult to predict how a person will appear at a different age. In this work, we bypass the synthesis step and analyze the various aging effects directly from a matching perspective. Our analysis is based on the observation that facial appearance changes in a coherent manner as people age.
- **Role of Symmetry in Illumination-invariant Image Matching.** We show that images are hardly ambiguous for the class of bilaterally symmetric Lambertian objects. The set of such objects can be partitioned into equivalence classes such that it is always possible to distinguish between

two objects belonging to different equivalence classes using just one image per object. Based on the theoretical analysis, we propose a provably correct illumination-invariant matching algorithm.

#### Technical Co-op

May 2007 – August 2007

Mentor: Dr. Niels Haering (CVUE).

#### Object Video

Reston, Virginia

- **A Geometric Approach to Illumination Color Estimation and Specularity Removal in Images.** In this work, we develop a purely geometric approach to estimate illumination chromaticity and separate diffuse and specular reflectance components from a single image. The approach is provably correct for dichromatic surfaces and degrades gracefully when the dichromatic properties are not strictly satisfied.

#### Technical Co-op

June 2006 – August 2006

Mentors: Dr. Nalini Ratha and Dr. Ruud Bolle (Exploratory Computer Vision Group).

#### IBM T.J. Watson Research Center

Hawthorne, New York

- **Exploring Curvature Information for Fingerprint Matching and Classification.** In this work, we highlight the significance of high curvature points in fingerprints. We show that the curvature information is reproducible and contains signature information important for the task of matching and classification. We provide experimental evidence that curvature-based classification helps in reducing the load of fingerprint indexing system without compromising on the accuracy.

#### Masters Research

August 2002 – May 2004

Advisor: Dr. Govind Sharma

#### Image Processing Lab

IIT, Kanpur

- **Fitting and Tracking in 2D and 3D Images Using Wavelet Based Deformation Model.** In this work, we define a probabilistic model that gives the prior distribution for contour deformation. The wavelet models are expressed in shape spaces for robustness. The deformable model is also used to generate a prior dynamical model for contour evaluation in time and tracking is performed using Kalman filter.

#### Graduate Research Assistant

November 2001 – June 2002

**Document Image Processing.** The work involved dealing with challenges in automatic document image processing.

#### Indian Statistical Institute

Kolkata, India

#### Graduate Teaching Assistant

August 2002 – May 2004

Responsibilities included taking lab classes for the following courses

- Control Systems
- Principles of Electronics

#### Indian Institute of Technology (IIT)

Kanpur, India

#### Journal Publications

1. S. Biswas, G. Aggarwal and R. Chellappa. Robust Estimation of Albedo for Illumination-invariant Matching and Shape Recovery. *Accepted for publication in IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI), 2009.*
2. N. Ramanathan, R. Chellappa and S. Biswas. Age Progression in Human Faces : A Survey. *Accepted for publication in Journal of Visual Languages and Computing (Special Issue on Advances in Multimodal Biometric Systems), 2009.*
3. S. Biswas, G. Aggarwal and R. Chellappa. An Efficient and Robust Algorithm for Shape Indexing and Retrieval. *Under Review in IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI).*

#### Conference Publications

1. S. Biswas, G. Aggarwal and R. Chellappa. Robust Estimation of Albedo for Illumination-invariant Matching and Shape Recovery. *In Proceedings of IEEE International Conference on Computer*

*Vision (ICCV), October, 2007.*

2. S. Biswas, G. Aggarwal and R. Chellappa. Efficient Indexing for Articulation Invariant Shape Matching and Retrieval. *In Proceedings of IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR), June, 2007.*
3. G. Aggarwal, S. Biswas and R. Chellappa. Symmetric Shapes are Hardly Ever Ambiguous. *In Proceedings of IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR), June, 2007.*
4. S. Biswas, G. Aggarwal, N. Ramanathan and R. Chellappa. A Non-generative Approach for Face Recognition Across Aging. *IEEE Second International Conference on Biometrics: Theory, Applications and Systems, 2008.*
5. S. Biswas, N. K. Ratha, G. Aggarwal and J. Connell. Exploring Ridge Curvature for Fingerprint Indexing. *IEEE Second International Conference on Biometrics: Theory, Applications and Systems, 2008.*
6. M. K. Johnson, D. G. Stork, S. Biswas, Y. Furuichi. Inferring illumination direction estimated from disparate sources in paintings: An investigation into Jan Vermeer's Girl with a pearl earring. *SPIE Electronic Imaging: Computer image analysis in the study of art, vol. 6810, 2008.*
7. S. Biswas, G. Aggarwal and R. Chellappa. Invariant Geometric Representation of 3D Point Clouds for Registration and Matching. *In International Conference on Image Processing (ICIP), October, 2006.*
8. G. Aggarwal, S. Biswas and R. Chellappa. UMD Experiments with FRGC data. *In IEEE Workshop on Face Recognition Grand Challenge Experiments (CVPR), June, 2005.*
9. S. Biswas and K. Nandy. Application of Wavelets in Detection and Classification of Microcalcification in Digital Mammograms - Some Recent Advances. *International Conference on Mathematical Biology, 2004.*

### Professional Activities

- Reviewer: 1) IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR), 2) IEEE Transactions on Systems, Man, and Cybernetics - Part B, 3) IEEE Transactions on Information Forensics and Security (TIFS).

### Honours and Awards

- Graduate student fellowship at University of Maryland (2004 - 2006).
- Merit Certificate for academic excellence from Jadavpur University Alumni Association, 2001.
- B. N. Paul Memorial Gold Centred Silver Medal, Jadavpur University, 2001.
- Subodh Kumar Basu Memorial Medal, Jadavpur University, 2001.

### Relevant Coursework

Random Processes in Comm. and Control	Advanced Digital Signal Processing
Statistical and Neural Pattern Recognition	Digital Image Processing
Machine Learning	Estimation and Detection Theory
Image Understanding	Speech Processing

### References

- **Dr. Rama Chellappa**, Professor, Dept. of Electrical and Computer Engineering, University of Maryland, College Park, MD 20742. (rama@cfar.umd.edu)
- **Dr. Niels Haering**, Director, Government Science Development, Object Video, Reston, VA 20191. (NHaering@ObjectVideo.com)
- **Dr. Nalini Ratha**, Research Staff Member, Exploratory Computer Vision Group, IBM T.J. Watson Research Center, Hawthorne, NY. (ratha@us.ibm.com)