

Samarjit Das

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Summary

I am interested in statistical signal processing and machine learning applications for perception tasks involving visual data as well as other sensor modalities. I have worked on statistical modeling and learning frameworks for motion activity modeling, tracking and abnormality detection involving video, motion capture and wearable sensors like IMUs. My doctoral work focused on stochastic deformable shape models for vision applications as well as robust visual tracking of spatio-temporal events using novel large dimensional particle filtering and sequential compressive sensing algorithms. Currently, I am working on weakly supervised learning techniques for wearable monitoring and activity analysis using visual features as well as inertial sensors.

Research Areas

- **Computer Vision:** Visual contexts for motion interpretation, motion activity modeling and tracking from visual inputs, abnormality detection, robust visual tracking under dynamic scene parameters
- **Statistical Signal Processing:** sequential Monte Carlo techniques and Bayesian filtering on large dimensional state spaces, stochastic deformable shape models, and sparse tracking with sequential compressive sensing
- **Machine Learning:** weakly supervised learning algorithms for discriminative pattern segmentation and classification in time series data, model switching and change detection in complex high dimensional systems

Academic and Professional Affiliations

- **Postdoctoral Researcher - Special Faculty Member** Dec 2010 – Present
The Robotics Institute (RI), School of Computer Science, Carnegie Mellon University (CMU), Pittsburgh PA, USA
Affiliation: The Vision and Autonomous Systems Center (VASC) and CMU Graphics Lab
Sponsors: Prof. Jessica Hodgins and Prof. Fernando De la Torre
- **Graduate Research Assistant** Sept 2006 – Nov 2010
Department of Electrical and Computer Engineering, Iowa State University, Ames IA, USA
Supervisor: Prof. Namrata Vaswani
- **Research Intern** May 2009 – Aug 2009
Multimedia Group, Mitsubishi Electric Research Laboratories (MERL), Cambridge, MA, USA
Collaborators: Dr. Shantanu Rane and Dr. Anthony Vetro
- **Research Intern** May 2005 - July 2005
Digital Signal Processing Laboratory, The Chinese University of Hong Kong (CUHK), Hong Kong
Host: Prof. P. C. Ching (Pro-vice Chancellor, CUHK)

Education

- PhD, Electrical and Computer Engineering Sep 2006 - Nov 2010
Iowa State University (ISU), Ames IA USA
 - Major: Electrical Engineering
 - Dissertation: Particle Filters on Large Dimensional State Spaces and Applications in Computer Vision
- B.Tech, Electronics and Communication Engineering Aug 2002 - May 2006
Indian Institute of Technology (IIT) Guwahati INDIA
 - Major: Electronics and Communication Engineering
 - Dissertation: Identification of Writers from Word Models using Cursive Handwriting Scripts

Awards and Honors

- Teaching Excellence Award, Iowa State University, 2007
- Postdoctoral fellowship from MIT department of Brain and Cognitive Sciences, September, 2010 (Declined)
- Best Presentation award in Emergency Medicine at the 10th Annual Symposium in Resuscitation Research, 2012
- Summer research fellowship from the Chinese University of Hong Kong (CUHK), 2005

- Ranked 3rd in the department of Electronics and Communications Engineering at IIT during the junior undergrad year
- Ranked 8th in the statewide high school final board examination taken by nearly 100,000 seniors. Highest distinction in Physics, Chemistry and Mathematics (Assam, India, 2002)

Patents

- A Method for Hiding Information inside Structured Shapes. Inventors: Shantanu Rane, Samarjit Das and Anthony Vetro. (US Patent No. 12/650,289, pending)
- Vision Based Assessment of Cardiopulmonary Resuscitation (CPR) with Smart Phones. Principal Inventor: Samarjit Das (In the process of joint filing by CMU and University of Pittsburgh Medical Center)

Academic and Professional Work Experiences

Postdoctoral Research Fellow

Dec 2010 – Present

The Robotics Institute, School of Computer Science, Carnegie Mellon University

- **Wearable Sensing of Movement Anomalies:** Developed Multiple Instance Learning based detection of abnormal movement patterns in uncontrolled home environments using IMUs. The weakly supervised approach was designed owing to the incomplete ground truth information which is a major bottleneck in adapting supervised learning approaches for wearable monitoring during daily living. Currently, working with wearable cameras and vision based functional object categorization for providing visual contexts towards motion understanding.
- **Vision-based Computational Emergency Medicine:** Started several collaborative efforts with the University of Pittsburgh Medical Center (UPMC) and STAT Helicopter emergency service. The goal is to improve emergency care under challenging scenarios (e.g. road-side, air-ambulance) using noninvasive wearable sensors and vision-based approaches. Used motion capture, wearable IMUs as well as video camera enabled medical instruments for visuo-motor analysis of paramedic performances. Also developed video based assessment of Cardiopulmonary Resuscitation (CPR) using smart phones for roadside assistance as well as techniques for interactive video laryngoscopy for Endotracheal Intubation (ETI), a critical emergency medical procedure.

Graduate Research Assistant

Sept 2006 – Nov 2010

Department of Electrical and Computer Engineering, Iowa State University

- **Stochastic Shape Deformation Models for Motion Activities:** Developed dynamical models for nonstationary deformations of 2D/3D landmark shapes with improved performances over existing models such as Active Shape Models. Applications included motion activity modeling, tracking and recognition. Based on the nonstationary shape deformation model, we also developed an efficient compression algorithm for storing large volumes 2D and 3D landmark shape data, especially for biomedical applications.
- **Efficient Particle Filters for Visual Tracking:** Proposed efficient Particle Filtering algorithms in order to deal with large dimensional state-spaces and multimodality of the observation likelihood. Applications included tracking nonstationary shape deformations for automatic landmark extraction and motion activity tracking in videos under clutter and occlusion, spotting motion activity change or abnormal behavior of a group of interacting point objects and robust visual tracking under dynamic illumination conditions (in collaboration with *Siemens Research*).
- **Sparse Tracking with Sequential Compressive Sensing:** Proposed a novel algorithm called Particle Filtered Modified Compressive Sensing that leverages sequential sampling based Monte Carlo techniques and compressive sensing for robust large dimensional tracking under sparsity constraints. The algorithm utilized the fact that many large dimensional spatial signals can be sparsified with appropriate basis transformations. We demonstrated the tracking of spatio-temporal signals satisfying the sparsity constraints and implemented a visual tracking algorithm that can handle very complex illumination changes in real-life videos.

Research Intern

May 2009 – Aug 2009

Mitsubishi Electric Research Laboratories (MERL)

- **Information Hiding inside Structured Shapes:** Developed and implemented a new algorithm for information hiding inside structured geometric shapes (e.g. 3D graphics objects, text characters, glyphs etc.) with applications to imperceptible data embedding in printed text documents. The project involved the use of an efficient 2D/3D computer graphics tool called Adaptively Sampled Distance Fields (ADF) for rendering and manipulating structured shapes. It was required that any changes in the shape owing to the embedded message are invisible to a casual observer but detectable by a specialized decoder. The decoder engine was developed using computer vision/image processing algorithms coupled with statistical shape analysis.

Research Intern

May 2005 - July 2005

Department of Electronic Engineering, The Chinese University of Hong Kong (CUHK)

- **Hidden Markov Model based Keyword Spotter:** Worked on Hidden Markov Model (HMM) based speech recognition systems, especially, keyword spotters. Used unconstrained grammar network based Viterbi decoding for detecting keywords. Developed and implemented a foreign language keyword spotter in unconstrained English speech under HTK platform.

Journal Papers

- Samarjit Das and Namrata Vaswani, "Nonstationary Shape Activities: Dynamic Models for Landmark Shape Change and Applications", IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI), vol. 32, no. 4, pp. 579-592, Apr. 2010
- Samarjit Das, Amit Kale and Namrata Vaswani, "Particle Filter with Mode Tracking (PF-MT) for Tracking Across Illumination Changes", IEEE Transactions on Image Processing (TIP), vol. 21, no. 4, pp. 2340-2346, Apr. 2012
- Jestin N Carlson*, Samarjit Das*, Fernando De la Torre, Clifton W Callaway, Paul Phrampus, Jessica Hodgins, "Motion Capture Measures Variability in Techniques of Endotracheal Intubation", Journal of Simulation in Healthcare (SIH), 2012
- Rituparna Sarkar, Samarjit Das and Namrata Vaswani, "PaFiMoCS: Particle Filtered Modified-Compressive Sensing and Applications in Visual Tracking across Illumination Changes", *under review* in IEEE Transactions on Image Processing (TIP)
- Samarjit Das, Shantanu Rane and Anthony Vetro, "Hiding Information inside Structured Shapes", *to be submitted to* IEEE Transactions on Information Forensics and Security (TIFS)
- Samarjit Das, Fernando De la Torre and Jessica Hodgins, "Tracing Parkinson's Motor Symptoms: From Motion Capture to Continuous Wearable Sensing in Uncontrolled Home Environments", *to be submitted to* IEEE Transactions on Biomedical Engineering (TBE)

Conference Papers

- Samarjit Das*, Jestin Carlson*, Fernando De la Torre, Adam Fisch, Frank Guyette, Jessica K. Hodgins and Donald M. Yealy, "A novel video content analysis system for interactive video laryngoscopy", National Association of Emergency Medicine Service Professional (NAEMSP) Annual Meeting, 2013, Bonita Springs, FL
- Samarjit Das*, Adam Fisch*, Joshua C. Reynolds, Jestin Carlson, Fernando De la Torre and Jessica Hodgins, "Video Assisted Feedback During CPR: Analysis of Smart Phone Video Footage Accurately Classifies Chest Compression Rate", National Association of Emergency Medicine Service Professional (NAEMSP) Annual Meeting, 2013, Bonita Springs, FL
- Samarjit Das, Breo Amoedo, Fernando De la Torre and Jessica Hodgins, "Detecting Parkinson's Symptoms in Uncontrolled Home Environments: A Multiple Instance Learning Approach", International Conference of the IEEE Engineering in Medicine and Biology Society (EMBS), San Diego, CA, 2012
- Samarjit Das, Jestin N Carlson, Fernando De la Torre, Paul E Phrampus, Jessica Hodgins, "Multimodal Feature Analysis for Quantitative Performance Evaluation of Endotracheal Intubation", IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 2012, Kyoto, Japan
- Jestin N Carlson*, Samarjit Das*, Fernando De la Torre, Clifton Callaway, Paul E Phrampus, Jessica Hodgins, "Motion Capture Measures Variability in Techniques of Endotracheal Intubation", NAEMSP Annual Meeting, 2012, Tucson, AZ
- Samarjit Das, Laura Trutoiu, Akihiko Murai, Dunbar Alcindor, Michael Oh, Fernando De la Torre and Jessica Hodgins, "Quantitative Measurement of Motor Symptoms in Parkinson's Disease: A Study with Full-body Motion Capture Data", International Conference of the IEEE Engineering in Medicine and Biology Society (EMBS), Boston, MA, 2011
- Samarjit Das and Namrata Vaswani, "Particle Filtered Modified Compressive Sensing (PF-mod-CS) for Tracking Signal Sequences", IEEE Signal Processing Society Asilomar conference, Pacific Grove CA, 2010
- Samarjit Das, Shantanu Rane and Anthony Vetro, "Hiding Information inside Structured Shapes", IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Dallas TX, March 2010
- Samarjit Das and Namrata Vaswani, "Efficient importance sampling techniques for large dimensional and multimodal posterior computations", IEEE Digital Signal Processing/SPE Workshop, Miami FL, Jan 2009
- Samarjit Das and Namrata Vaswani, "Model based Compression of Nonstationary Landmark Shape Sequences", IEEE International Conference on Image Processing (ICIP), San Diego CA, October 2008
- Namrata Vaswani and Samarjit Das, "Particle Filter with Efficient Importance Sampling and Mode Tracking (PF-EIS-MT) and its Application to Landmark Shape Tracking", IEEE Signal Processing Society Asilomar conference, Pacific Grove CA, October 2007
- A. Subramanian, Samarjit Das and S.R.M Prasanna, "Identification of Writers from Word Models using Principal Component Analysis", Workshop on Computer Vision, Graphics and Image Processing, Hyderabad India, 2006

Technical Reports

- Samarjit Das, "Hidden Markov Model based foreign language Keyword Spotting in Unconstrained English Speech", Submitted to the Department of Electronic Engineering, The Chinese University of Hong Kong, Hong Kong, July 2005
- Samarjit Das, "Sequential Monte Carlo Techniques and Bayesian Filtering: Applications in Tracking", Submitted to the Department Computer Science, Iowa State University December 2008

Grant Proposal Writing

- Title: Computer Vision Based Models for Psychomotor Skills: A Novel Tool for Evaluating Procedural Competency and Training. Agency: US Department of Defense (DoD). Role: Co-Investigator and lead author
- Title: Context-aware Wearable Sensors for Human Monitoring. Agency: National Science Foundation (NSF). Goal: To use wearable vision sensors and computer vision algorithms for context-aware motion sensing using IMUs. Role: Co-PI and lead author

Selected Technical Presentations

- “Learning Dynamic Models for Motion Activities and Its Applications: A Landmark Shape based Approach”, McGovern Institute of Brain Research, Massachusetts Institute of Technology (MIT), Cambridge, MA (Fall 2010)
- “Dynamical Models for Landmark Shape Evolution”, The Robotics Institute, Carnegie Mellon University, Pittsburgh, PA (Summer 2010)
- “Marker less Motion Capture with Dynamic Priors”, Organic Motion Inc., New York City, NY (Summer 2010)
- “Visual Tracking Under Variable Illuminations”, ECE Department Seminar, Iowa State University, Ames, IA (Fall 2009)
- “Learning Subtle Motion Cues: A Health Care Perspective”, Carnegie Mellon Graphics Lab, Carnegie Mellon University, Pittsburgh, PA (Spring 2012)
- “Smart Sensing and Signal Processing for Better Healthcare”, University of Pittsburgh Medical Center (UPMC), Pittsburgh, PA (Summer 2012)

Supervision Experience

I have closely worked with several student researchers at Carnegie Mellon as well as supervised two Masters’ students at Iowa State University. The projects have resulted into several conference and journal papers (ICASSP, EMBC, TIP).

1. Breogan Amoedo (Spain), visiting researcher at CMU
2. Pablo Navarro Sanz (Spain), visiting researcher at CMU
3. Xiang Li (China), Masters’ student, Iowa State University
4. Rituparna Sarkar (India), Masters’ student, Iowa State University
5. Yi Wang (China), visiting researcher at CMU

Academic and Professional Service

- **Journal review:** IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI), IEEE Transactions on Image Processing (TIP), IEEE Transactions on Signal Processing (TSP), Elsevier Journal of Information Fusion, IEEE Signal Processing Letters
- **Conference review:** IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), IEEE International Conference on Image Processing (ICIP), Asian Conference of Computer Vision (ACCV), Workshop on Information Forensics and Security (WIFS), IEEE Statistical Signal Processing Workshop

References

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