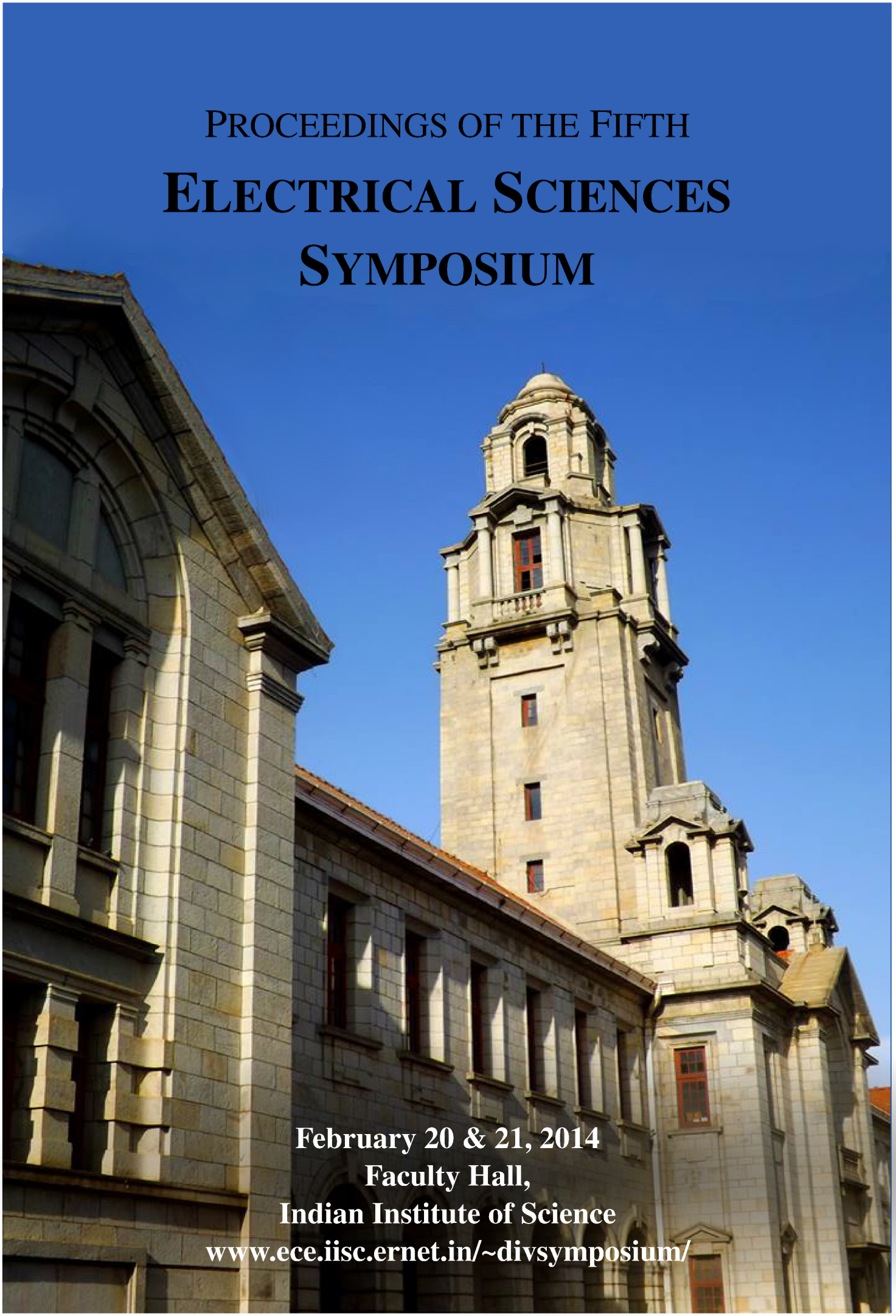
PROCEEDINGS OF THE FIFTH

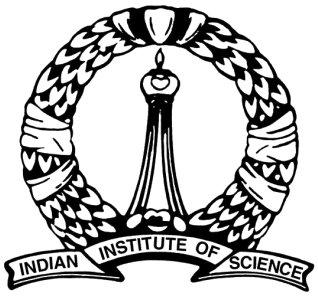
# ELECTRICAL SCIENCES SYMPOSIUM



**February 20 & 21, 2014**
**Faculty Hall,**
**Indian Institute of Science**
**www.ece.iisc.ernet.in/~divsymposium/**

Proceedings of the Fifth

# Electrical Sciences Symposium




Indian Institute of Science
Bangalore, India

February 20 & 21, 2014

# Foreword

The departments of the Electrical Sciences Division, and the Supercomputer Education and Research Center together comprise faculty members specializing in electronics, power engineering, communications, computer science, control, electromagnetics, photonics and signal/image processing. With a view to establish a forum that would present a cross-section of the research being conducted in the broad areas of electrical engineering and computer science, in IISc, an annual in-house symposium was started in 2010. Each year, several senior Ph.D. students present short talks on their work, to an audience comprising faculty members, industry invitees, and students. The idea of such an annual symposium originated during a feedback session with the students in 2009. In keeping with these origins, the symposium is organized mainly by Ph.D. students, with guidance from a faculty committee with one member from each department. There are invited short talks from the faculty members, which started from last year, is continued for this year as well. In this, the fifth symposium, the organizers have introduced two new features:

1. Masters level research students were also included in the symposium and
2. A compilation of the abstracts of the talks to be presented, including their contacts.

I would like to congratulate the organizers for setting up an excellent program, and for taking the above novel initiatives. I hope that the symposium will give the attendees a chance to obtain a glimpse of the diversity and quality of the research being conducted in the broad areas of electrical engineering.

**Anurag Kumar**

Chair, Electrical Sciences Division

# Organizing Committee & Schedule

## Committee

**Faculty Coordinators**

| | |
|---|---|
| Phaneendra Yalavarthy | SERC |
| K.V. Raghavan | CSA |
| Gaurab Banerjee | ECE |
| Chandra Sekhar Seelamantula | EE |
| Shayan Srinivasa Garani | ESE |

**Student Organizers**

| | |
|---|---|
| Jaya Prakash, Calvin B. Shaw | SERC |
| Ashish Mishra, Govind Sharma | CSA |
| Neeraj Sharma, Keerthan P. | ECE |
| Satish, Aniruddha | EE |
| R. Sudharshan Kaarthik, Nithin Raveendran | ESE |
| Nivedita Datta | Cover photo |

| Schedule | |
|---|---|
| **Time** | **February 20, 2014 (Thursday)** |
| 08.30 - 08.50 | **Registration** |
| 08.50 - 09.00 | Opening Remarks from Prof. Anurag Kumar (ECE),<br>Divisional Chair of Electrical Sciences, IISc |
| 09.00 - 09.30 | **Faculty Talk (SERC)**<br>Speaker: **R. Venkatesh Babu**<br>Title: Image processing using Approximate Nearest Neighbor Fields |
| 09.30 - 10.50 | **Computer Vision**<br>**Session Chair: Pandu R Devarakota (Canon, India)**<br>**Pushkar Gorur** - Computer Vision as applied to Video Surveillance (Ph.D., ECE)<br>**Kolar Rajagopal Anoop** - Dynamic Head Pose Classification and Application of Human Visual Interest Prediction (Ph.D., EE)<br>**Sovan Biswas** - Motion Based Video Analysis (M.Sc.[Engg], SERC)<br>**Avinash Ramakanth** - Approximate Nearest Neighbour Field Computation and Applications (M.Sc.[Engg], SERC) |
| **10.50 - 11.20** | **Tea Break** |
| 11.20 - 12.40 | **Imaging & Optimization**<br>**Session Chair: M. S. Dinesh (GE Healthcare, India)**<br>**Dilip Thomas** - Symmetry Detection in Scalar Fields (Ph.D., CSA)<br>**Calvin Shaw** - Development of Computationally Efficient and Quantitative Image Reconstruction methods for Multi-modal Biomedical Optical Imaging. (Ph.D., SERC)<br>**Jayaprakash** - Model Resolution Matrix based Deconvolution for Biomedical Optical Imaging (Ph.D., SERC)<br>**Vasudevan Rengasamy** - Message-driven Parallel Applications on GPU (M.Sc.[Engg], SERC) |
| **12.40 - 14.00** | **Lunch (Venue: Main Guest House Lawn, IISc)** |
| 14.00 - 14.30 | **Faculty Talk (ECE)**<br>Speaker: **Gaurab Banerjee**<br>Title: Integrated Circuits for Efficient Spectrum Usage |
| 14.30 - 15.50 | **Social Networks & Machine Learning**<br>**Session Chair: Yogesh Simmhan (IISc)**<br>**Saurabh Aggarwal** - Give and Take criteria based Social Groups (Ph.D., ESE)<br>**Srinivasan Venkatramanan** - Information Spread Models in Social Networks (Ph.D., ECE)<br>**Balamurugan P** - Efficient Algorithms for Structured Output Learning (Ph.D., CSA)<br>**Srijith P.K.** - Gaussian Processes for Machine Learning (Ph.D., CSA) |
| **15.50 - 16.20** | **Tea Break** |

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|---|---|
| 16.20 - 17.40 | **Power Engineering**<br>**Session Chair: R. S. Shivakumara Aradhya (CPRI)**<br>**Arun Karuppaswamy Balasubramanian** - High Power Grid-Connected Inverters (Ph.D., EE)<br>**V S S Pavan Kumar Hari** - Space-Vector-Based Pulse Width Modulation Strategies to Reduce Pulsating Torque in Induction Motor Drives (Ph.D., EE)<br>**P.R. Rakesh** - Split Phase Induction motor drive (M.Sc.[Engg], EE)<br>**Ashish Kumar** - Hall-Effect Current Sensors and its Performance Validation (M.Sc.[Engg.], EE) |
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| **Time** | **February 21, 2014 (Friday)** |
|---|---|
| 08.30 - 09.00 | **Registration** |
| 09.00 - 09.30 | **Faculty Talk (ESE)**<br>Speaker: **Mayank Shrivastava**<br>Title: On-Chip ESD Devices and Circuits: Essentials and Research Opportunities |
| 09.30 - 10.50 | **Communication Engineering**<br>**Session Chair: Girish Chandra (TCS)**<br>**Manikandan R** - A 2.4GHz Energy Efficient BFSK/ASK Transmitter using Frequency Multiplication Technique (Ph.D., ECE)<br>**Sainath Bitragunta** - Optimal Amplify-and-Forward Relaying for Cooperative Relay Systems and Underlay Cognitive Radio (Ph.D., ECE)<br>**Kaushik Ghosal** - Power Scalable Wireless Receivers for 2.4GHz Sensor Networks (Ph.D., ECE)<br>**S.N. Ananya** - Throughput Analysis of Best-m Feedback in OFDM Systems with Uniformly Correlated Sub-channels (M.Sc.[Engg], ECE) |
| **10.50 - 11.10** | **Tea Break** |
| 11.10 - 11.40 | **Faculty Talk (EE)**<br>**Speaker: Soma Biswas**<br>Title: Face Recognition in Unconstrained Environment |
| 11.40 - 12.40 | **Signal Processing & Electronic Systems**<br>**Session Chair: Prasanta Kumar Ghosh**<br>**Harshavardhan Sundar** - Who Spoke What, When and Where? A Latent Variable *Formulation* using Multiple Microphones for analyzing Acoustic Scenes (Ph.D., ECE)<br>**Abhiram Bhanuprakash** - Characterization of the Voice source by the DCT and its application to Speaker Recognition (M.Sc.[Engg], EE<br>**Neha Sharan** - Compact Modeling of Double gate MOSFETs (Ph.D., ESE) |

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|---|---|
| **12.40 - 14.00** | **Lunch (Venue: Main Guest House Lawn, IISc)** |
| 14:00 - 14:30 | **Faculty Talk (CSA)**<br>**Speaker: Arnab Bhattacharyya**<br>Title: On the convergence of the Hegselmann-Krause model |
| 14.30 - 16.00 | **Panel Discussion : Next Step: Industry Vs Academia**<br>**Panelists**: Jayant Haritsa (SERC, IISc), K.V. S. Hari (ECE, IISc), Ramesh Venkatesan (GE Health Care) & Venkat Padmanabhan (Microsoft Research, India)<br>**Moderator**: Javed G S (ECE) |
| 16.00 - 16.20 | Closing and Vote of Thanks |
| **16.20** | **High Tea** |

# Contents

# Session 1

# Invited Talk: Supercomputer Education and Research Centre

## Image processing using Approximate Nearest Neighbor Fields

**Speaker: R. Venkatesh Babu**

**Abstract:** Nearest neighbor computation, a critical step in diverse problems like classification, regression, retrieval etc., is indeed a major challenge while dealing with large data. Practically, however it suffices to find the computationally simpler "approximate near neighbor" instead. This is specially true for image processing applications, where the relationships between images can be computed very efficiently with such approximations. Of late, several algorithms to compute the"approximate nearest neighbo", such as Patch Match, CSH, Feature Match etc., have emerged, leading to their extensive use in a wide range of applications that include image editing, completion, re-targeting, denoising, dense correspondence fields, object detection, label propagation etc. This talk briefly introduces the above listed algorithms and their applications.

**Brief Biography:** R. Venkatesh Babu received his Ph.D. from the Dept. of Electrical Engg., Indian Institute of Science, Bangalore, India in 2003. He held postdoctoral positions at NTNU, Norway and IRISA/INRIA, Rennes, France, through ERCIM fellowship. Subsequently he worked as a research fellow at NTU, Singapore. He spent couple of years working in industry. Currently he is working as Assistant Professor at Supercomputer Education and Research Centre (SERC), Indian Institute of Science, Bangalore, India. His research interests include video analytics, human computer interaction, computer vision and compressed domain video processing. He is a senior member of IEEE.

# Session 2

# Contributed Session: Computer Vision

### Session Chair: Pandu R Devarakota (Canon, India)

**Brief Biography:** Pandu Devarakota received the M.Tech. degree in Instrument Technology from the Indian Institute of Technology (IIT), New Delhi, India in 2003 and the Ph.D. degree in signal processing from the Royal Institute of Technology (KTH), Stockholm, Sweden in 2008. His Ph.D. program was carried in cooperation with the University of Luxembourg and IEE S.A. of Luxembourg. As a part of his Masters degree studies, he was an exchange student at the Laboratory of Communication Engineering, University of Karlsruhe, Karlsruhe, Germany, in 2002. From January 2008 to mid of 2012, Dr. Devarakota was Member of Technical Staff at Algorithms Research group at Siemens Technology Centre, Bangalore, India. Currently Dr. Devarakota is working as Manager at India Software Development Centre, Canon India Pvt Ltd, Bangalore, India. His research interests include image analysis and processing, high performance computing, machine learning, computer-aided diagnosis (CAD), object detection and tracking in medical and industrial imaging.

## 2.1 Video Algorithms as applied to Camera based Surveillance Systems

**Speaker:** Pushkar Gorur

**Contact:** pushkar.gorur@gmail.com

**Abstract:** This thesis looks at applications of computer vision to video surveillance. A large number of high definition surveillance cameras are being installed to improve security in cities and towns. High definition H.264 videos require network bandwidth in the range of 2 - 4 Mbps. The number of cameras that can be deployed would be severely limited due to this large bandwidth requirement. The power consumption of the camera nodes would also be very high and would prevent long term operation of a battery-powered system. Hence, it is essential to develop low complexity algorithms which can reduce data rate of the compressed video stream and at the same time retain

high image fidelity. We propose techniques to reduce bandwidth and computational cost of static camera surveillance video encoders without affecting detection and recognition performance. A spatial sampler is proposed to sample pixels which are segmented using a Gaussian Mixture Model (GMM). Modified weight updates are derived for the parameters of the mixture model to reduce floating point computations. Segmentation results of the sampled pixels are used to perform skip selection. Experimental results show bit rate savings of up to 94% over methods proposed in literature on video surveillance data sets. The proposed techniques also provide up to 87% reduction in compression complexity, without increasing the distortion over the foreground regions in the video sequence.

## 2.2 Dynamic Head Pose Classification and Application of Human Visual Interest Prediction

**Speaker:** Anoop Kolar Rajagopal

**Contact:** anoopkr@ee.iisc.ernet.in

**Abstract:** In the first part, head pose classification from surveillance images acquired with distant, large field-of-view cameras is addressed. Domain adaptation approaches are useful for transferring knowledge from the training (source) to the test (target) data when they have different attributes, minimizing target data labeling efforts in the process. We examine the use of transfer learning for multi-view head pose classification with minimal target training data under three challenging situations:

1. range of head poses in the source and target images is different,
2. source images capture a stationary person while target images capture a moving person whose facial appearance varies under motion due to changing perspective, scale and
3. a combination of (1) and (2).

In the second part, we address the the problem of human visual interest prediction. Being able to predict salient and informative Regions of Interest (ROIs) through a sequence of eye movements, is a challenging problem. Applications such as content aware re-targeting of videos to different aspect ratios while preserving informative regions can significantly be improved using the predicted ROIs. An interactive human-in-loop framework to model eye-movements and predict visual salience into yet-unseen frames is proposed. Eye-tracking and video content is used to model visual attention in a manner that accounts for important eye-gaze characteristics such as temporal discontinuities due to sudden eye movements, noise and behavioral artifacts. Our robust salience prediction is instantiated for two challenging and exciting applications.

## 2.3 Motion Based Video Analysis

**Speaker:** Sovan Biswas

**Contact:** sovan@ssl.serc.iisc.in

**Abstract:** Motion is a key feature in video, which captures the essence of the moving object. Thus, it can effectively help one to perform human action recognition or anomaly detection. This motion can be captured through optical flow in pixel level processing and readily available as compression parameters in compressed videos. In this work, the focus has been to analyze motion patterns in order to do various computer vision tasks such as action recognition etc. The first application we looked into, was large scale video classification based on motion vectors. Here, we proposed Histogram of Oriented Motion Vector (HOMV) feature that captures different motion pattern effectively but with a drastic reduction in computation. In second application, we analyzed motion vector patterns to perform anomaly detection. This done through local modeling of usual behavior by capturing different feature such as magnitude and orientation for each moving object. We also proposed modeling local HOMV feature through sparse coefficients for anomaly detection which helped in better detection than previous approaches. In all above, the focus was to bring reduction in computation. Crowd flow segmentation, another application, was performed by detecting dominant crowd flow segments through super pixels on accumulated motion patterns generated using motion vectors. In pixel level processing, we looked into application of anomaly detection based on motion computed through optical flow. We extracted short local trajectories of moving objects and build local models using HMM for anomaly detection.

## 2.4 Approximate Nearest Neighbor Field Computation and Applications

**Speaker:** Avinash Ramakanth

**Contact:** avinashrs@ssl.serc.iisc.in

**Abstract:** Approximate Nearest-Neighbor Field (ANNF) maps between two related images are commonly used by computer vision and graphics community for image editing applications. In this work, we generalize this framework to unrelated image pairs. For accurate ANNF map computation we propose 'FeatureMatch', in which the low-dimensional features, approximate the patches along with global color adaptation. Unlike existing approaches, the proposed algorithm does not assume any relation between image pairs and thus generalizes ANNF maps to any unrelated image pairs. This generalization enables ANNF approach to handle a wider range of vision applications more efficiently. The following applications were developed using the proposed 'FeatureMatch' framework. The first application addresses the problem of detecting the optic disk from retinal images. The combination of ANNF maps and salient properties of optic disks leads to an efficient optic disk detector that does not require tedious training or parameter tuning.

The proposed approach is evaluated on many publicly available datasets and an average detection accuracy of 99% is achieved with computation time of 0.2 s per image. The second application aims to super-resolve a given synthetic image using a single source image as dictionary, avoiding the expensive training involved in conventional approaches. In the third application, we make use of ANNF maps to accurately propagate labels across video for segmenting video objects. The proposed approach outperforms the state-of-the-art on widely used benchmark dataset. Finally, ANNF maps obtained between two consecutive video frames are enhanced for estimating sub-pixel accurate optical flow, a critical step in many vision applications.

# Session 3

# Contributed Session: Imaging and Optimization

### Session Chair: M. S. Dinesh (GE Healthcare, India)

**Brief Biography:** Dr. M. S. Dinesh obtained his Ph.D. from University of Mysore in the year 2000 in the area of Pattern recognition and Image Processing. He has more than 13 years of industrial/research experience in the area of medical imaging. He worked at Siemens and GE at various capacities, where he is currently Senior Scientist (Systems - architect) of Molecular Imaging Group, GE Healthcare, John F. Welch Technology Center, Bangalore. He has filed 12 patents (6 granted and 6 in pipeline) and published more than 30 technical research papers in international/national journals/conferences.

## 3.1 Symmetry Detection in Scalar Fields

**Speaker:** Dilip Thomas

**Contact:** dilthoms@gmail.com

**Abstract:** Scalar fields are used to represent physical quantities measured over a domain of interest. Scientists are often interested in studying symmetric or repeating patterns in scalar fields to gain insights about the underlying scientific experiment. In this work, we propose three methods to detect symmetry in scalar fields. The first method models symmetry detection as a subtree matching problem in the contour tree, which is an abstract graph representation of the scalar field. The contour tree captures features at different scales and hence, our method can detect symmetry at different scales. The second method identifies symmetry by comparing distances between representative elements from each symmetric region. The distance computation is robust and hence, this method can detect symmetry even in the presence of significant noise. The above methods compare pairs of regions to identify symmetry instead of grouping the entire set of symmetric regions as a cluster. This motivates the third method which uses a clustering based analysis for symmetry detection. In this method, the contours of a scalar field are mapped to points in a descriptor space, such that the points corresponding to similar contours lie in close proximity to each other. Symmetry is identified by clustering the points in the

descriptor space. We show through experiments on various datasets that these methods can detect symmetry under different types of transformations. Extraction of symmetry information helps users in visualization and data analysis and we show applications that enhance visualization and exploration of scalar fields.

## 3.2 Model Resolution Matrix based Deconvolution for Biomedical Optical Imaging

**Speaker:** Jaya Prakash

**Contact:** pnjayaprakash88@gmail.com

**Abstract:** Biomedical optical imaging uses near infrared light (600 nm - 900 nm) as the probing media, is a promising imaging modality that provides functional information of the soft biological tissues, with prime imaging applications including breast and brain tissue in-vivo. Model resolution matrix based framework was proposed and shown to induce blur in the $\ell_2$-norm based regularization framework for diffuse optical tomography. This model-resolution matrix framework was later seen as a optical image deconvolution problem. Hence, a basis pursuit deconvolution based on *Split Augmented Lagrangian Shrinkage Algorithm* (SALSA) was used along with the Tikhonov regularization step, making the image reconstruction into a two-step procedure. This new two-step approach was found to be robust with noise and was able to better delineate the structures. In the next part of the work, model-based image reconstruction approaches in photo-acoustic tomography is studied, as it is known that these methods have a distinct advantage compared to traditional analytical methods for cases where limited data is available. These model-based methods deploy Tikhonov based regularization scheme to reconstruct the initial pressure from the boundary acoustic data. Again, a model-resolution for these cases tend to represent the blur induced by the regularization scheme. A method that utilizes this blurring model and performs the basis pursuit deconvolution to improve the quantitative accuracy of the reconstructed photo-acoustic image is proposed and shown to be superior compared to other traditional methods. Moreover, this deconvolution including the building of model-resolution matrix is achieved via the Lanczos bi-diagonalization ,making this approach attractive in real-time.

## 3.3 Development of Computationally Efficient and Quantitative Image Reconstruction methods for Multi-modal Biomedical Optical Imaging

**Speaker:** Calvin Shaw

**Contact:** calvinshaw87@gmail.com

**Abstract:** Diffuse optical tomography (DOT) uses near infrared (NIR) light as the probing media to recover the distributions of tissue optical properties using the boundary measurements. It has a potential to become an adjunct imaging modality for breast and brain imaging. Traditional image reconstruction methods in diffuse optical tomography employ an L2-norm based regularization, which is known to remove high frequency components making the images appear smooth. Hence, a sparsity based image reconstruction has been deployed for diffuse optical tomography. These sparse recovery methods utilize the Lp-norm based regularization in the estimation problem with $0 <= p < 1$. In addition, an approximation to utilize the L0-norm, has been used for the reconstruction of diffuse optical images, to explore the utility of these sparse recovery methods for diffuse optical imaging. Photo acoustic tomography (PAT) is an emerging hybrid imaging modality combining optics with ultrasound imaging. PAT provides structural and functional imaging in diverse application areas, such as breast cancer imaging and brain imaging. Quantitative PA imaging in limited data cases has been an active area of research, where the emphasis is on obtaining the optimal reconstruction parameters in real-time in an automated fashion. A computationally efficient approach that computes the optimal regularization parameter for the Tikhonov-minimization scheme is developed for PAT. This approach is based on the least squares-QR (LSQR) decomposition, a well-known dimensionality reduction technique for a large system of equations. It is shown that the proposed framework is effective in terms of quantitative and qualitative reconstructions of initial pressure distribution enabled via finding optimal regularization.

## 3.4 Message-driven Parallel Applications on GPU

**Speaker:** Vasudevan Rengasamy

**Contact:** vasudevan@ssl.serc.iisc.in

**Abstract:** The effective use of GPUs for accelerating applications depends on a number of factors including effective asynchronous use of heterogeneous resources, reducing memory transfer between CPU and GPU, increasing occupancy of GPU kernels, overlapping data transfers with computations, reducing GPU idling and kernel optimizations. Overcoming these challenges require considerable effort on the part of the application developers and most optimization strategies are often proposed and tuned specifically for individual applications. We have developed G-Charm, a generic framework with an adaptive runtime system for efficient execution of message-driven parallel applications

on hybrid systems. The framework is based on Charm++, a message-driven programming environment and runtime for parallel applications. In our first work, we perform runtime optimizations that include dynamic scheduling of work on CPU and GPU cores, maximizing reuse of data present in GPU memory, data management in GPU memory and combining multiple kernels. We obtain upto 14% improvement in execution time for Cholesky factorization implemented in MAGMA library due to better data management in GPU memory. Our second work includes compile-time code generation to improve programmability, while also including runtime optimizations focusing on irregular applications like $N$-body simulations.

# Session 4

# Invited Talk: Department of Electrical Communication Engineering

## Integrated Circuits for Efficient Spectrum Usage

**Speaker: Gaurab Banerjee**

**Abstract:** The electromagnetic spectrum, traditionally used for wireless communication, has become an extremely scarce natural resource. While sub-10 GHz frequencies have been widely used for cellular telephony, broadcasting and wireless local area networks, higher frequencies have been off-limits due to limitations in fabricating high volume CMOS integrated circuits. Due to continued CMOS scaling, such limitations no longer exist, and consequently, the industry is slowly transitioning to operating frequencies much higher than 10 GHz. At the same time, for sub-10 GHz frequencies, new techniques are being explored to improve spectrum usage.

In this talk, I will discuss two of the research areas that are being proposed to improve the efficiency of spectrum usage - "Cognitive radios" and "60 - GHz radios". I will talk about some of the existing challenges in the design of integrated circuits for such applications.

**Brief Biography:** Gaurab Banerjee received the B.Tech (Hons.). degree in Electronics and Electrical Communication Engineering from the Indian Institute of Technology, Kharagpur, India, and the Ph.D. degree in Electrical Engineering from the University of Washington, Seattle, in 1997 and 2006, respectively.

In 1999, he joined Intel Corporation, Hillsboro, OR, to design analog and mixed-signal circuits for the first Pentium-4 microprocessor. Between 2001 and 2007, he was a research scientist with Intel Labs, working on CMOS based analog, mixed-signal and RF circuits for wireless and wire-line communication systems. Between 2007 and 2010, he was a staff engineer with Qualcomm Inc., Austin, TX, working on RFIC design for mobile broadcast video applications. Since May 2010, he has been an Assistant Professor in

the Department of Electrical Communication Engineering, Indian Institute of Science, Bangalore, India.

His research interests are in Analog and RF Integrated Circuits and systems for communication and sensor applications. He has published more than 20 papers on semiconductor devices and circuits and has about 10 patents granted or pending. Between 2008 and 2010, Dr. Banerjee was an Associate Editor of IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS-I. He has also served as a reviewer for many IEEE journals and on the technical program committees of many conferences. Dr. Banerjee is a National Talent Search Scholar of India, and a Senior Member of IEEE.

# Session 5

# Contributed Session: Social Networks and Machine Learning

### Session Chair: Yogesh Simmhan (IISc)

**Brief Biography:** Yogesh Simmhan is an Assistant Professor at the Supercomputer Education and Research Centre (SERC) at IISc. Previously, he was a Research Assistant Professor in Electrical Engineering at the University of Southern California, Los Angeles and Associate Director of the USC Center for Energy Informatics. As head of the DREAM:Lab at SERC, his research explores abstractions, algorithms and applications on distributed data computing systems and commodity Clouds. Advanced knowledge on scalable computing offers a practitioner's insight on building software systems to empower dynamic, distributed and Big Data applications. Yogesh has a Ph.D. in Computer Science from Indiana University and was earlier a Postdoc at Microsoft Research, San Francisco. He is a Senior Member of IEEE and ACM.

## 5.1 Give and Take criteria based Social Groups

**Speaker:** Saurabh Aggarwal

**Contact:** saggarwal@cedt.iisc.ernet.in

**Abstract:** A Social Group refers to a group of users in a Social Network having similar interests. The users in a Social Group do not necessarily know one another, but are linked by their common interests. We consider scenarios in which users of the Social group seek a common universe of data segments. Users can either access an expensive resource for downloading data segments or use the well-connected low cost local network for exchanging segments among themselves. The objective of each user is to acquire the universe via exchanges. However, selfish users attempt to download segments from others, while not uploading anything in return. We propose the 'Give and Take Criterion' (GT criterion), which prohibits such non-reciprocating users. Two users would exchange their entire segment sets, if each user gains some new segments from the other. Mandating the GT criterion for exchange among users in social groups, we study various scenarios of interest. We consider the problem of downloading the universe at least cost, from

the perspective of a newly entered user. We analyze this NP-hard problem, and propose optimal and sub-optimal algorithms for choosing initial segments and users for exchange. We compare the performance of these algorithms with a few existing P2P downloading strategies in terms of cost and running time. Secondly, we consider the problem of maximizing the aggregate cardinality of the users segment sets. We present a randomized algorithm, whose analysis yields an approximation ratio of 1/4 under some conditions. Also, four other algorithms are proposed and conditions under which some of these algorithms are optimal are identified. Lastly, we plan to analyze scenarios in which each users' objective is to maximize its own cardinality. Users' behavior and equilibrium scenarios will be studied.

## 5.2 Delay-Cost Optimal Coupon Delivery in Mobile Opportunistic Networks

**Speaker:** Srinivasan Venkatramanan

**Contact:** vsrini@ece.iisc.ernet.in

**Abstract:** With the astonishing growth of smart devices in circulation (tablets, smart phones, wearable computing, etc.), opportunistic content forwarding among mobile devices is becoming increasingly viable. It has also become imperative to consider a mobile ecosystem where user recommendations (via online and offline social networks), e-retail services (e.g., Amazon, Flipkart, etc.) and coupon services (e.g., Groupon) co-exist and co-evolve. In this work, we propose an application framework which enables opportunistic dissemination of coupons to a population of mobile users. For a single coupon, the users may or may not be interested in the related product. We also model the evolution of interest in the product, due to pairwise interactions between mobile users (i.e., influence spread). The content provider is interested in delivering the coupon to the interested nodes, while using the not-yet-interested nodes as relays. The relays can be incentivized to aid in coupon delivery (which costs the content provider). In this setting, we derive a delay-cost optimal policy for coupon delivery, establish its time-threshold structure and numerically demonstrate the effect of various system parameters on the optimally controlled process.

## 5.3 Efficient Algorithms for Structured Output Learning

**Speaker:** Balamurugan P.

**Contact:** bala@csa.iisc.ernet.in

**Abstract:** The task of classifying an input into one of the two known classes, called binary classification is a well-studied problem in machine learning. For multi-class classification problems, there may be more than two distinct output classes. However, such

simple output spaces containing distinct output classes are not always available. Instead, the output might be a complex and structured object like a tree, graph or an image. Structured output learning, the task of learning a parametrized classification rule for structured outputs, is done by minimizing the regularized empirical loss obtained over a set of labeled training examples. This is computationally intensive due to the combinatorial nature of the output space. Structural SVMs (SSVMs) have emerged as a popular tool for structured output learning. As part of my thesis, I worked on developing a sequential dual method for SSVM, which was an order-of-magnitude faster than state-of-the-art algorithms. I also developed efficient algorithms for a variant of SSVMs called least summed error SSVM. The models obtained from typical SSVM formulation contain millions of non-zero entries which lead to slow prediction and storage issues. I considered the elastic net regularizer for SSVM which results in sparse models having very few non-zero components. An efficient sequential alternating proximal method to solve elastic net regularized SSVM was proposed. I also considered the semi-supervised structured output learning problem, when the training set contains a very few labeled examples and a large amount of unlabeled data and proposed an efficient and simple label-switching procedure for solving the resultant problem.

## 5.4 Gaussian Processes for Machine Learning

**Speaker:** Srijith P.K.

**Contact:** srijith@csa.iisc.ernet.in

**Abstract:** Gaussian processes (GPs) are non-parametric Bayesian models which provide a probabilistic approach to learning in a kernel based framework. Recently, GPs have gained attention in the machine learning community because of their ability to let the complexity of the model to grow with the data size. They also provide a systematic approach to perform model selection. We discuss the application of GPs to solve various machine learning problems such as ordinal regression, multi-task learning and sequence labeling. Ordinal regression problem arises in situations where users have to rate an item on an ordinal scale. We discuss our GP based approach to solve the ordinal regression problem which avoids complex approximate inference techniques required when working with ordinal labels. In most of the real world applications, the ordinal labels are hard to obtain. We discuss a semi-supervised approach to Gaussian process ordinal regression to address such situations. Multi-task learning is used in situations where one has to solve several similar learning problems where each learning problem is associated with a very limited data set. We discuss the use of GPs to solve such problems using a joint feature selection approach. The approach captures similarity by selecting features common across all the tasks. Sequence labeling addresses the problem of assigning a sequence of labels to a sequence of inputs. It arises most commonly in natural language processing tasks such as part of speech tagging. We address this problem using GPs and provide a variational approach to learning with GPs.

# Session 6

# Contributed Session: Power Engineering

### Session Chair: R. S. Shivakumara Aradhya (CPRI)

**Brief Biography:** Dr. R.S. Shivakumara Aradhya obtained B.E. (Electrical) and M.E. (Power Systems) from UVCE, Bangalore in 1978 and 1981 respectively. He obtained Ph.D. degree in High Voltage Engineering from I.I.Sc., Bangalore, in 1994. He joined Central Power Research Institute (CPRI) in 1981 and has been serving in various technical and administrative capacities. Presently, he is working as Additional Director incharge of High Voltage division, Power Systems Division, Diagnostics, Cables & Capacitors Division and Research and Development Coordination Division of CPRI. He has published more than 100 peer reviewed articles and a holder of four patents.

## 6.1 High Power Grid-Connected Inverters

**Speaker:** Arun Karuppaswamy

**Contact:** post2akp@gmail.com

**Abstract:** There has been a surge in the use of grid-connected inverters in the recent past owing to increased use of power quality inverters and inverters interfacing distributed energy sources with the ac grid. The power level of these inverters have increased to a few MWs. In this context, high power grid-connected inverters gain importance and is a natural motivation for the present work. The work focuses on issues related to high power inverters connected to the grid. Grid-connected inverters require a third-order LCL filter to keep the harmonics injected into the grid to be within IEEE recommended limits. However, the use of a LCL filter introduces resonance. Resonance can be damped by active or passive means. The first part of the work focuses on the split-capacitor resistive-inductive (SC-RL) passive damping scheme. A component selection procedure that ensures a low loss in the damping circuit while keeping the system well damped has been proposed. The same has been validated experimentally. For better reliability, it is desirable to test grid-connected inverters for the thermal response of the semi-conductor switches at the rated operating conditions. Thermal time constants being large, the

inverter needs to be run for longer durations during the test. At higher power levels, this increases the production cost and requires dedicated sources and loads of higher power. In the second part of the work, a novel test method to test high power grid-connected inverters is proposed. The proposed method does not require a high power source and load. Only the losses in the system are consumed from the grid. The method has been experimentally validated on a 24 kVA inverter.The methods proposed in this research help reduce the cost of building a high power converter, while ensuring high levels of efficiency, reliability and performance.

## 6.2 Space-Vector-Based Pulse Width Modulation Strategies to Reduce Pulsating Torque in Induction Motor Drives

**Speaker:** V.S.S. Pavan Kumar Hari

**Contact:** pavan@ee.iisc.ernet.in

**Abstract:** Voltage source inverter (VSI) is used to control the speed of an induction motor by applying AC voltage of variable amplitude and frequency. The semiconductor switches in a VSI are turned on and off in appropriate fashion to vary the output voltage of a VSI. Various pulse width modulation (PWM) methods are available to generate gating signals for the switches. The process of PWM ensures proper fundamental voltage but introduces harmonics at the output of a VSI. Ripple in the developed torque of induction motor, also known as pulsating torque, is a prominent consequence of the harmonic content. Two space-vector-based PWM techniques to reduce the torque ripple in a two-level VSI-fed induction motor are proposed. Space-vector-based approach to PWM facilitates a larger number of switching patterns or switching sequences to operate the switches in a VSI. The process of modulation in space-vector-based switching sequences of a three-phase two-level VSI is analyzed from a per-phase perspective and a computationally efficient methodology to realize the sequences is derived. This methodology simplifies simulation and implementation of PWM techniques with different switching sequences on a digital control platform. A quick-simulation tool to evaluate a wide range of PWM methods employing different sequences is developed. Reduction of pulsating torque with the proposed PWM methods, compared to existing PWM techniques, is demonstrated by simulation as well as experimental results on a 5 hp induction motor drive.

## 6.3 Split Phase Induction motor drive

**Speaker:** Rakesh P.R.

**Contact:** rakpr.eee@gmail.com

**Abstract:** Induction motors are popularly used for electromechanical energy conversion on account of their rugged construction. A split-phase induction motor is obtained by

splitting each of the three phases of the stator winding of the induction motor into two equal halves. This results in two sets of three-phase windings with a spatial angle difference of 30 degrees (electrical) between them. The two sets of windings are fed from two different voltage-source inverters for speed control of the split-phase motor drive. Each inverter consists of power semiconductor switches, the gating signals for which are produced using a pulse width modulation (PWM) technique. The work focuses mainly on developing new pulse width modulation (PWM) techniques for split-phase induction motor drive. The proposed PWM techniques can produce higher ac voltage than sine-triangle PWM for a given dc input voltage of the inverter (i.e. improved dc bus utilization). Unlike some existing PWM methods, these methods do not cause low- order harmonics in the motor current. The performances of the proposed methods are compared with those of existing methods both theoretically and experimentally. The thesis also discusses improved techniques for measurement of equivalent circuit parameters of a split-phase induction motor.

## 6.4 Hall-Effect Current Sensors and its Performance Validation

**Speaker:** Ashish Kumar

**Contact:** `ashishk@ee.iisc.ernet.in`

**Abstract:** Closed loop current sensors used in power electronics applications are expected to have high bandwidth and minimal measurement transients. A closed loop compensated Hall-effect current sensor is modeled, and is used to tune the sensor's compensator. Analytical expression of step response is used to evaluate the performance of the PI compensator in the current sensor. This analysis is used to devise a procedure to design parameters of the PI compensator for fast dynamic response and for small dynamic error. A prototype current sensor is built in the laboratory. A PI compensator based on the procedure devised earlier is designed for the sensor. To verify the simulation results experimentally a power electronics based universal current source is developed in the laboratory. The hardware of the current source is designed to be portable, and requires minimal active power from the mains power supply. The current source can generate a falling step current of peak value 100 A and fall time less than 200 ns, which is sufficient to emulate a step input to check step response of the sensor. It can generate a current of adjustable $di/dt$ upto 500 $A/\mu s$ to check the limit of $di/dt$ tracking capability of the device under test. The same current source can also produce continuous sinusoidal reference current of magnitude 150 A pk-pk and adjustable frequency ranging from 10 Hz to 2000 Hz. The online adjustment in the frequency eases the recording of frequency response within the set range. This current source is used to verify the transient and the steady state performance of the laboratory current sensor. The rise time of the sensor at 100 A step input is observed to be less than 1 $\mu s$. Its frequency response is verified at 150 A pk-pk sinusoidal current in the range 10 Hz-2000 Hz. Its bandwidth, measured with commercial network analyzer, is found to be 265 kHz. The transient performance of the laboratory current sensor is superior to commercial current sensors.

# Session 7

# Invited Talk: Department of Electronic Systems Engineering

## On-Chip ESD Devices and Circuits: Essentials and Research Opportunities

**Speaker: Mayank Shrivastava**

**Abstract:** ESD is a serious reliability threat to semiconductor chips, however chip technology, process, device and circuit co-design requirements for ESD protection is often not known to researchers exploring device, materials, process and design options for future nano-electronic products. This talk will provide an introduction to the essential concepts of on-chip ESD protection devices and circuits. Moreover, research options for researchers in the area of materials, nano-electronic devices, circuits and compact modeling will be highlighted. Finally, an outlook on the ESD device research in the advanced CMOS technologies will be given.

**Brief Biography:** Prof. Mayank Shrivastava has a wide experience and interest in the field of Nanoscale device design and modeling, ESD devices and circuits, device-circuit co-design, drain extended MOS devices and electro-thermal modeling. He has taken several positions within the semiconductor industry. During 2008 and again in 2010, he was a Visiting Scholar at Infineon Technologies AG, Munich, Germany. During 2010-2011, he worked for Infineon Technologies, East Fishkill, NY, USA and later Intel, Mobile & Communications Group, Hopewell Junction, NY, USA. From October 2011 till August 2013 he was with Intel, Mobile & Communications Group, Munich Germany. Since September 2013 he is with DESE at IISc Bangalore.

Prof. Shrivastava has over 35 publications in international journals/conferences and has 18 United States patents issued or pending in his field of interest. He was a recipient of the India TR35 award for the year 2010 (Young Innovator Award from MIT Technology Review 35); 2008 Best Research Paper Award in circuit design category from Intel Corporation Asia Academic Forum; the 2010 Industrial Impact Award from IIT Bombay; the biography publication by the International Biographical Center, Cambridge, U.K., in the 2000 Outstanding Intellectuals of the 21st Century in 2010; the Excellence in Thesis work for his Ph.D. thesis from IIT Bombay and Infineon PhD fellowship for 3 years.

# Session 8

# Contributed Session: Communication Engineering

## Session Chair: Girish Chandra (TCS)

**Brief Biography:** Dr. M. Girish Chandra obtained his BE in Electronics from University Visvesvaraya College of Engineering (UVCE), Bangalore, India and M.Tech from IIT Madras in Communication Systems and High Frequency Technology. He obtained his Ph.D. (and subsequently the DIC) as a Commonwealth Scholar in Digital Communication from Imperial College, London. He is a Senior Scientist with the TCS Innovation Labs- Bangalore from Jan 2005. Earlier, he was with the Aerospace Electronics Division of National Aerospace Laboratories (NAL), Bangalore, India, holding the position of Assistant Director. His research interests are in the broad areas of Communications and Signal Processing, including Source Separation, Compressive Sensing, Error Control Coding, Channel Equalization, Geo-location, Cognitive Radio and Networks, Cross-Layer Design, Adaptive and Multimedia Signal Processing as well as Nonlinear Signal Processing using Neuro-Fuzzy and Soft Computing techniques. He has more than 50 publications in Journals/ Conferences and has filed more than 10 patents (with co inventors). He has given many invited lectures (including four key-note addresses) and short courses on topics related to Communications and Signal Processing. He was a guest faculty at UVCE, an Adjunct Visiting Professor in the Department of Information and Communication Technology at Manipal Institute of Technology, India and an adjunct faculty at IIIT, Bangalore, handling master-level courses. He has served as a Technical Program Committee member for many international and national conferences on Communications and Signal Processing. Further, he has been a session chair on five occasions and a member for panel discussion in many conferences/symposiums. He was a co-chair for three Workshops/ Symposiums, quite recent one being the Cognitive Radio and Networks Symposium of IEEE GLOBECOM 2012.

## 8.1 A 2.4 GHz Energy Efficient BFSK/ASK Transmitter using Frequency Multiplication Technique

**Speaker:** Manikandan R.R.

**Contact:** manikandanrr.87@gmail.com

**Abstract:** A 2.4 GHz energy efficient fully integrated BFSK/ASK transmitter (TX) using frequency multiplication technique is presented. The TX mainly consists of three blocks : Integer-$N$ charge-pump PLL, Edge combiner and Class D power amplifier (PA). The PLL used for frequency synthesis operates at a lower frequency (800 MHz) thereby reducing the power

consumption of VCO & divider circuits, a static logic gate based edge combiner generates 2.4 GHz RF carrier by combining the outputs of different stages of ring oscillator VCO and the Class D PA drives the 50 ohm antenna load. The BFSK & ASK modulations are done by directly modulating the VCO and PA respectively. The design is implemented in a 0.13 um CMOS technology. The TX consumes 14 mA current from a 1.3 V supply voltage. The maximum data rate of TX are 3 Mb/s and 20 Mb/s for BFSK and ASK modulations respectively and the corresponding energy efficiencies of the transmitter are 3.6 nJ/bit (BFSK) and 0.91 nJ/bit (ASK). The class D PA delivers a maximum output power of -9.6 dBm. The normalized energy efficiency of the TX with transmitting power are 55 nJ/bit.mW (BFSK) and 8.3 nJ/bit.mW (ASK).

## 8.2 Optimal Amplify-and-Forward Relaying for Cooperative Systems and Underlay Cognitive Radios

**Speaker:** Sainath Bitragunta

**Contact:** lsnb290580@gmail.com

**Abstract:** Cooperative relay communications is a wireless technology in which different nodes collaborate with each other in forwarding messages from source to a desired destination. Relaying provides spatial diversity and leads to an increase in capacity and robustness to variations in the wireless channel. Different relaying protocols such as Amplify and Forward (AF) and Decode and Forward (DF) have been proposed for a variety of wireless systems. In the first part, we propose an optimal relaying policy for two-hop AF cooperative relay systems. In this, an average power constrained relay adapts its gain and transmit power to minimize the symbol error probability (SEP) at the destination. We also analyze its SEP. The proposed policy yields significant energy savings of 2.0-7.7 dB at the source and relay, when compared to fixed-gain and fixed-power relaying schemes, which have been extensively studied in the literature. We also characterize optimal AF relay placement for the proposed policy and show that it is different from that for fixed-gain or fixed-power AF relaying. In the second part, we propose a novel optimal relay gain adaptation policy for an interference-constrained AF relay. Here, the relay adapts its gain as a function of its local channel gain to the source and destination and also the primary. The proposed policy minimizes the SEP of the CR system subject to constraints on average relay transmit power and average interference. We then present a near-optimal, simpler relay gain adaptation policy that is easy to implement. Both the proposed policies are generalizations of the conventional AF relaying paradigms considered in the CR literature.

## 8.3 Power Scalable Wireless Receivers for 2.4 GHz Sensor Networks

**Speaker:** Kaushik Ghosal

**Contact:** kaushik@ece.iisc.ernet.in

**Abstract:** Low power operation is essential for wireless sensor network receivers, as longer

battery life becomes crucial. Low power receivers rely on various circuit configurations to reduce power consumption. However, conventionally these are designed for the worst input, i.e. minimum signal and maximum interference, resulting in a large dynamic range for the design. But in actual operation the conditions are seldom so. In such cases receiver performance can be relaxed, to just meet a required SNR at the ADC input, to satisfy BER. A power scalable receiver can provide such adaptability to lower it's power consumption under favorable input conditions. This work aims to address circuit architecture and algorithm-level implementation for such class of wireless receivers. The performance requirements of each block will vary differently for varying signal and interference conditions. The Low Noise Amplifier in the receiver is able to scale power for varying noise and linearity requirements. Other blocks in the receiver chain also have power scaling modes relevant to their specifications. A detailed receiver model has been developed which allows us to study the effect of power scaling on the block and receiver performances. The model is also used to determine the power settings for the receiver while it is in operation. A signal measurement system is discussed which is needed to estimate the signal and interference levels so that receiver settings can be computed. Receiver test chips were fabricated in 130 nm RF-CMOS process and tested to verify the power scalable receiver.

## 8.4 Throughput Analysis of Best-m Feedback in OFDM Systems with Uniformly Correlated Subchannels

**Speaker:** Ananya S.N.

**Contact:** ananyasn@ece.iisc.ernet.in

**Abstract:** Orthogonal frequency division multiplexing (OFDM) is the preferred downlink access technology in the next generation wireless systems such as Long Term Evolution (LTE). These systems achieve high data rates by employing frequency domain scheduling and rate adaptation, and support a large number of users. However, the scheduler at the base station (BS) requires channel state information (CSI) from the BS to the users in order to determine which user to transmit to and the rate of transmission. This information needs to be fed back by users on the uplink, and incurs an unacceptably large feedback overhead. Several feedback reduction schemes have been studied in the literature. Best$-m$ feedback is one such popular scheme, a variant of which is implemented in LTE. In it, each user feeds back only the information regarding its best m channel gains along with their indices. We analyze the downlink throughput of the best-m scheme for the practically important scenario of correlated OFDM sub- channels for the greedy, proportional fair and round robin schedulers. We do so for the tractable and insightful model in which the sub-channel gains are uniformly correlated. We show that the throughput decreases as the correlation among the sub-channels increases. Further, to gain insights, an asymptotic analysis with a large number of users and for small values of correlation is developed. We then generalize our model and analysis to incorporate outdated CSI due to feedback delays. Our approach is markedly different and more involved than the existing literature in which the sub-channels of a user are assumed to be independent.

# Session 9

# Invited Talk: Department of Electrical Engineering

## Face Recognition in Unconstrained Environment

**Speaker: Soma Biswas**

**Abstract:** Due to the increase in the installation of surveillance cameras, the problem of recognizing persons from their facial images captured by these cameras have become very important. Facial images captured by surveillance cameras usually have poor resolution in addition to uncontrolled poses and illumination conditions which adversely affect performance of face matching algorithms. In this talk, we will discuss these different challenges and different approaches that have been proposed to address them. This talk will also cover new and interesting areas of research in this field.

**Brief Biography:** Dr. Soma Biswas is an Assistant Professor at Indian Institute of Science, Bangalore. She received her Ph.D. from University of Maryland, College Park in 2009 and worked as a Research Assistant Professor in the Department of Computer Science and Engineering at the University of Notre Dame. She also worked as a Research Scientist at GE Global Research, Bangalore before joining IISc. Her research interests are in Computer Vision, Pattern Recognition, Image Processing and related areas.

# Session 10

# Contributed Session: Signal Processing and Electronic Systems

## Session Chair: Prasanta Kumar Ghosh (DST-INSPIRE Faculty Fellow)

**Brief Biography:** Prasanta Kumar Ghosh is a faculty fellow in the department of Electrical Engineering at Indian Institute of Science (IISc), Bangalore under the INSPIRE faculty fellowship program. He received his Ph.D. in Electrical Engineering from University of Southern California (USC), Los Angeles, USA in 2011. Prior to that he obtained his M.Sc.(Engineering) in Electrical Communication Engineering from IISc and B.E.(ETCE) in Electronics from Jadavpur University, Kolkata in 2006 and 2003 respectively. He has been a Research Intern at Microsoft Research India, Bangalore in the area of audio-visual speaker verification from March to July in 2006. During 2011-2012 he was with IBM India Research Lab (IRL) as a researcher.

Prasanta Kumar Ghosh was awarded the INSPIRE faculty fellowship from Department of Science and Technology (DST), Govt. of India in 2012. He was the winner of the first prize in Mr. BRV Varadhan Post-Graduate student paper contest in IEEE Bangalore chapter, in 2005. He received the best M.Sc.(Engg.) thesis award for the year 2006-07 in the Electrical Sciences division at IISc. He was awarded Center of Excellence in Teaching's award for excellence in teaching in the category of EE for the year 2010-11 in USC. He has also received the best teaching assistantship (TA) awards for the years 2007-08 and 2008-09 and the honorable mention for the best paper award in the EE, USC. He was also awarded Ming Hsieh Institute (MHI) Ph.D. scholar for the year 2010-11 in EE, USC. His research interests include non-linear signal processing methods for speech and audio, speech production and its relation to speech perception, and automatic speech recognition inspired by the speech production and perception link.

## 10.1 Who spoke What, When and Where? A Latent Variable Framework for Acoustic Scene Analysis

**Speaker:** Harshavardhan Sundar

**Contact:** harshas123@gmail.com

**Abstract:** Speech is by far the most natural mode of communication known to human beings. It is an information-rich signal and can be viewed as containing information at different levels. At one level, we humans as listeners, infer the identity of the speaker. At another level, we infer the language of the speaker. And at yet another level, we understand the content of what was spoken, along with the location of the speaker, his/her emotion, geographical origin of the speaker etc. being inferred at other different levels. Although there is no clear hierarchy between these levels of information, we tend to use the knowledge of information at one level to understand the information at another level better. Man-machine interaction has been far from natural with the use of different interface devices like kyboards, mouse, touch screen devices etc. In order to make man-machine interaction more natural and human-like, it is essential that the machine understands human speech at all these different levels. In this thesis, we formulate the problem of inferring information at different levels in speech signals using multi-microphone recordings in a Latent Variable (LV) framework. More specifically, we address the problem of who spoke what, when and where? Answering this fundamental question constitutes analyzing the acoustic scene also referred to as Acoustic Scene Analysis (ASA).The probability density function (p.d.f.) of the mixture signals containing simultaneous utterances of several speakers is modeled as a marginal of the joint distribution of mixture signal data and a set of LVs. Each LV is used to represent a particular level of information in speech. The LV densities are used to infer information at different levels and these densities are estimated in a Maximum Likelihood (ML) framework using an Expectation-Maximization (EM) algorithm. As part of this thesis, we have built a unique facility for promoting research on analyzing acoustic scene. The facility consists of an enclosure of size 8m $\times$ 6m *times* 5m in which the reverberation characteristics can be altered. Multiple microphones can be mounted in any given set of co-ordinates within the enclosure using a reconfigurable mounting setup. We use this facility to test the robustness of the proposed approach to reverberation. We finally present the details of a practical system built for man-machine interaction using the proposed LV based approach.

## 10.2 Characterization of the Voice source by the DCT and its application to Speaker Recognition

**Speaker:** Abhiram Bhanuprakash

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**Abstract:** Speech production is generally modeled as an excitation source followed by

a filter. Physiologically, the source and the filter correspond to the vocal fold vibrations and the spectrum-shaping vocal tract, respectively. High speed videos of the larynx show that the vocal folds of different individuals vibrate differently and hence the voice source (VS) signal may be used for speaker recognition. In this study, it is hypothesized that a speakers' voice is characterized by the relative proportions of the harmonics of the fundamental frequency of the VS. Based on this hypothesis, the discrete cosine transform (DCT) coefficients of the VS are proposed as a characterization of the VS and a new feature for speaker recognition. Since the VS cannot be measured directly, the integrated linear prediction residual (ILPR) extracted from the speech signal is used as a VS estimate. The feature is tested by conducting speaker recognition trials using the Gaussian Mixture Model (GMM) classifier. On the TIMIT and YOHO databases, the feature gives a performance (recognition accuracy) comparable to that of the existing VS-based features. On the more challenging NIST 2003 database, the feature results in a 12% performance improvement, when combined with the traditional mel-frequency cepstral coefficients (MFCCs) of the speech signal, indicating that the proposed features capture speaker specific information, not captured by the MFCCs. The proposed features are found to suffer from handset variability. We intend to investigate the causes for this variability and attempt to alleviate it.

## 10.3 Compact Modeling of Double gate MOSFETs

**Speaker:** Neha Sharan

**Contact:** nehasharan@yahoo.com

**Abstract:** We discuss some novel device modeling techniques, which were developed for 'indDG', an in-house compact model for common and independent double gate (DG) MOS transistors. We talk about the relationship between the surface potentials, a so-far un-explored property of any DG MOSFET and how it could be used for developing efficient compact models in the presence of electrostatic asymmetry. We demonstrate how this relationship is used to develop continuity equation based and relaxation time approximation approached based non-quasi-static charge model. We also discuss how different small geometry effects (e.g. drain induced barrier lowering, velocity saturation etc.) are included in the 'indDG' model. Proposed model is implemented in a professional circuit simulator and validated against T-CAD simulation.

# Session 11

# Invited Talk: Department of Computer Science and Automation

## On the convergence of the Hegselmann-Krause model

**Speaker: Arnab Bhattacharyya**

**Abstract:** We discuss convergence of the following discrete-time non-linear dynamical system: $n$ agents are located in $R^d$ and at every time step, each moves synchronously to the average location of all agents within a unit distance of it. This popularly studied system was introduced by Krause to model the dynamics of opinion formation and is often referred to as the Hegselmann-Krause model. We prove the first polynomial time bound for the convergence of this system in arbitrary dimensions.

**Brief Biography:** Arnab Bhattacharyya is an assistant professor at the Indian Institute of Science. He received his Ph.D. in 2011 from the Massachusetts Institute of Technology. He also did postdoctoral work at Princeton University and Rutgers University. His research interests are algorithms, complexity and computational questions about natural systems.

# Session 12

# Panel Discussion
# Next Step: Industry Vs Academia

**Moderator** : **Javed G.S. (IISc)**
**Panelists** : Jayant Haritsa (SERC, IISc)
K.V.S. Hari (ECE, IISc)
Ramesh Venkatesan (G.E. Health Care)
Venkat Padmanabhan (Microsoft Research, India)

### Biography of the Moderator

**Javed G. S.** received the B.E. degree in Electronics and Communication engineering from M S Ramaiah Institute of Technology(MSRIT), Bangalore , India in 2008. He is currently working towards the Ph.D. degree in electrical communication engineering from the Analog/RF Systems and IC design lab, Indian Institute of Science(IISc), Bangalore, India.

He has worked in Bharat Electronics Limited(BEL), a defense public sector unit (MoD) from 2008 to 2010, on MIL-grade electronics sub-system design for air-borne surveillance systems. His doctoral work focuses on the design of low-power sensor interfaces and data converters.

### Biography of the Panelists

**Jayant Haritsa** has been on the faculty of the Supercomputer Education & Research Centre and the Computer Science & Education department at the Indian Institute of Science, Bangalore, for the past two decades. He received the B.Tech degree in Electrical Engineering from the Indian Institute of Technology (Madras), and the MS and Ph.D. degrees in Computer Science from the University of Wisconsin (Madison). He completed his post-doc at the University of Maryland (College Park), and spent sabbaticals at Lucent Bell Labs and IBM India Research Lab. His research interests are in the design and analysis of database systems.

**K.V.S. Hari** received his B.E. (1983), M.Tech(1985) and Ph.D.(1990) degrees from Osmania University, IIT Delhi, University of California at San Diego, respectively. Since 1992, he has been a Faculty Member at the Department of ECE, Indian Institute of Science (IISc), Bangalore, where he is currently a Professor and coordinates the activities of the Statistical Signal Processing Lab in the department. Currently, he is also an Affiliated Professor in the School of Electrical Engineering, KTH-Royal Institute of Technology, Stockholm, Sweden. He has been a visiting faculty member at Stanford University, KTH - Royal Institute of Technology and Helsinki University of Technology (now Aalto Univ). He also worked at DLRL, Hyderabad, and at the R&T unit for Navigational Electronics, Osmania University. His research interests are in developing signal processing algorithms for MIMO wireless communication systems, sparse signal recovery problems, indoor positioning, assistive technologies for elderly and DOA estimation. During his work at Stanford University, he worked on MIMO wireless channel modeling and is the coauthor of the WiMAX standard on wireless channel models for fixed-broadband wireless communication systems which proposed the Stanford University Interim (SUI) channel models. He is currently an Editor of Signal Processing published by Elsevier and Senior Associate Editor of Sadhana-Academy Proceedings in Engineering Sciences, published by Springer. He is also an academic entrepreneur and is a co-founder of the company ESQUBE Communication Solutions, Bangalore.

**Ramesh Venkatesan** was born in Chennai in India. He attended Anna University, and graduated with a B.E. Degree in Electronics and Communication Engineering in 1991. He then completed graduate study in Biomedical Engineering, earning an MS from Case Western Reserve University in 1993, and a D.Sc degree from Washington University in St Louis in 1997. He then worked as a research associate and as a research instructor at the Mallinkcrodt Institute of Radiology for slightly more than a year. After this stint in academics, Ramesh decided to move to industry and back home.

He joined the then GE Medical Systems' Indian affiliate Wipro GE Medical Systems in late 1998 as an MRI Advanced Applications scientist, which required developing advanced MRI clinical applications in collaboration with local hospitals. In early 2000, he was appointed as Technical Manager of the Clinical Applications group, which allowed him to interact and build a network with technical leaders in MRI, CT and vascular systems engineering. He then became the manager of the MR Applications Engineering team in 2003, and led the team for 2 years to establish a technically strong and globally recognized team in Bangalore. In 2005, Ramesh was appointed the Principal Engineer of the MR Applications Engineering team in Bangalore, putting him back in pursuit of a technical career path. He is currently the Principal Engineer for MR Software and Applications Engineering, with a focus on developing applications and systems of local relevance. He is also author of the book entitled 'Magnetic Resonance Imaging: Physical Principles and Sequence Design', which is world-wide recognized as reference book for MR imaging.

**Venkat Padmanabhan** is a Principal Researcher and Research Manager at Microsoft Research, India, Bangalore, where he founded and has led the Mobility, Networks, and Systems group since 2007. Venkat was previously with Microsoft Research, Redmond, for nearly 9 years. His research interests are broadly in networked and mobile systems, and

his current work is on indoor localization and battery-efficient mobile communication. He was General Co-Chair for ACM Sigcomm 2010 in New Delhi, program co-chair for ACM Sigcomm 2012, and Chair of the Sigcomm Conference Technical Steering Committee during February 2013 to January 2014. He has also served as an affiliate faculty member at the University of Washington, where he has taught and served on student thesis committees, and recently also taught a course at IIT Hyderabad. Venkat holds a B.Tech. from IIT Delhi and an M.S. and a Ph.D. from UC Berkeley, all in Computer Science. He has been elected a Fellow of the Indian National Academy of Engineering ( INAE) and of the IEEE, and is a Distinguished Scientist of the ACM.