Curriculum Vitae

Personal Information

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DBPL: https://dblp.org/pid/26/3767.html

Education

08/2004–07/2011 **Ph.D., Electrical and Computer Engineering**
University of Maryland, College Park, MD, USA
Thesis: Statistical Models and Optimization Algorithms for High-Dimensional Computer Vision Problems
Advisor: Prof. Rama Chellappa

08/2001–01/2003 **Master of Engineering (M.E.), Telecommunication Engineering**
ECE Department, Indian Institute of Science, Bangalore, India

08/1998–07/2001 **Bachelor of Technology (B.Tech.), Radiophysics and Electronics**
University of Calcutta, Kolkata, India

08/1995–07/1998 **Bachelor of Science (B.Sc.), Physics Honors**
Presidency College, University of Calcutta, Kolkata, India

Professional Experience

01/2015–Current **IIT Madras**
Position: Assistant Professor

Department: Electrical Engineering

08/2011–11/2014 **Rice University, Houston, USA**
Position: Postdoctoral Research Associate
Department: Electrical and Computer Engineering

08/2004–07/2011 **University of Maryland, College Park, USA**
Position: Graduate Research Assistant
Department: Electrical and Computer Engineering

02/2003–07/2004 **Samsung India Software Operations, Bangalore, India**
Position: Senior Software Engineer

Courses Taught

- Computational Photography (EE5176)
- Deep Learning for Imaging (EE5179, taught under EE6132)
- Modern Computer Vision (EE5178, taught under EE6132)
- Machine Learning for Computer Vision (EE5177)
- Data Analytics Lab (EE4708)
- Probability Foundations for Electrical Engineers (EE3110)
- Signals and Systems (EE1101)
- Digital Signal Processing (EE2004)

Teaching Excellence Plan

I have offered a total of 16 courses (some multiple times) in IITM and my overall TCF rating is 0.84. Below, I mention about my three best courses.

Computational Photography (EE5176)

My main focus of research is Computational Photography/Imaging and when I joined the institute there was no course on this subject. Thus, I introduced a course on Computational Photography (EE5176) to train students in this new and exciting topic. Over the years students have really appreciated the course. I have offered the course five times over a span of seven years and the average TCF for the course and myself is 0.89.

The topics covered in this course are: 1) Basics of imaging, where we discuss camera optics and camera controls such as aperture, focus, shutter speed and their limitations, 2) Image sensors, where we discuss the basic principles, various sensor noises and image processing pipeline, 3) Coded computational photography, where we introduce coded exposure imaging for handling motion blur and coded aperture imaging for extended-depth-of-field imaging, 4) Multi-image techniques for image denoising, image deblurring and high dynamic range imaging, 5) Light field imaging, where we cover its advantages in post-capture focus and view control and also discuss about various light field camera designs, 6) Compressive Sensing, its principle for recovering sparse signals and dictionary learning, 7) Compressive Cameras such as those for capturing high speed video and high spatio-angular light field data.

To give a better feel for the subject, students are given 3-4 programming assignments on topics covered in the first half of the course. In the later half of the course, the class is divided into various groups of 3 students and each group is given a term project to work on. Each term project deals with a current research topic of Computational Photography and is carefully designed by myself and the TAs. We make sure that each term project has scope for new research and if properly executed could lead to a paper in a conference/journal. For example, a term-project on low light imaging has led to publication in a journal (IEEE TIP 2020), another on coded exposure imaging has led to publication in a conference (IEEE ICPR 2020) and more recently a project on 3D Lensless Imaging has led to a submission in a journal.

This course has had quite an impact on the students, my lab, and the institute as a whole. Several of the students who did the course developed interest in the topic and joined my lab for their BTP and DDP projects. After doing their BTech/MTech projects, many went on to pursue MS/PhD in premier institutes across the world, creating a mark for the department and the institute. Here is a list of students who have pursued or are pursuing Computational Imaging for their graduate studies abroad: 1) Varun Sundar (BTP 2020) is doing his PhD in the Wisconsin Computational Imaging and Vision Lab at University of Wisconsin, Madison, 2) Pradyumna Venkatesh Chari (BTP 2019) is doing his PhD in the Visual Machines Group at University of California, Los Angeles, 3) Akshat Dave (DDP 2017) is doing his PhD in the Computational Imaging Lab at Rice University, 4) Dr Sreyas Mohan (BTP 2017) graduated with a PhD from the Laboratory for Computational Vision at New York University, and 5) Dr. Praneeth Chakravarthula (DDP 2016) graduated with a PhD from the Graphics and Virtual Reality Lab at UNC, Chapel Hill.

Data Analytics Lab (EE4708)

The second course of significance is a core UG lab course on Data Analytics (EE4708) for interdisciplinary Dual Degree Data Science students. I have co-instructed this course three times. The best version of this lab course was offered in July-Nov 2019, when it got a TCF rating of 0.91. The course was designed by myself and Prof. Venkatesh R.

The goal of this lab course is to introduce students to practical aspects of data analytics. The course starts with a basic introduction to various python toolkits followed by using these toolkits for developing various supervised and unsupervised machine learning algorithms. The topics that we covered were: 1) Introduction to various Python toolkits such as Numpy, SciPy, Matplotlib, Pandas and SciKit Learn library, 2) Linear regression models such as Least Squares, Ridge Regression and Lasso, 3) Linear classification models such as Linear Discriminant Analysis (LDA), Logistics regression, Linear Support

Vector Machine (SVM) and l2 and l1 regularized versions of these algorithms, 4) Non-linear algorithms such as Kernel SVM, Random forest and Neural Network, 5) Unsupervised learning techniques such as Dimensionality Reduction, Principal Component Analysis (PCA), Clustering techniques such as k-Means clustering and Agglomerative clustering.

A crucial aspect of this course was to make students understand the basic concepts of machine learning and be able to apply them for solving real-world problems. To give students a basic understanding of each ML technique, we asked students to code-up a most simplified version of that technique without using any machine learning library. Next we introduced them to appropriate functions from the SciKit Learn library and asked them to experiment with the various function parameters. We finally gave them some real dataset and asked them to apply relevant machine learning concepts. We started each class with a short programming exam to test the concepts learned in the last class. After the short test, we taught them the current concepts based on well-designed programming exercises and ended the class by giving them some programming assignments to be completed by next week.

Apart from these regular tests and programming assignments, we also arranged a programming contest towards the end of the semester. In this contest we gave them raw unprocessed data to work with. We also encouraged them to explore new techniques beyond what was taught in the course. Overall students very much appreciated the lab course and gave comments such as:

- "well structured course. course was very fun to do. background knowledge was also sufficiently provided."
- "Amazingly structured course. Have never had such concept clarity ever! Well planned assignments. Got an intuitive feel for all the algorithms and ideas. Thanks for the well thought course!"
- "very good lab i ever had"
- "The course was structured in a nice way and it made us learn without putting pressure on us. I really appreciate the student friendly nature of the professors at the same time educating us."

Deep Learning for Imaging (EE5179)

Another course of significance is Deep Learning for Imaging (EE5179), which myself and Prof. A. N. Rajagopalan offered three times under Advanced Topics in Signal Processing (EE6132). In this course we concentrate on deep architectures that have shown promise in solving computer vision and image processing problems. We cover topics such as Multi-layer Perceptron, Error back-propagation algorithm, Convolutional Neural Network (CNN), Autocoders, Recurrent Neural Networks (RNN), Generative Adversarial Networks (GAN) and Deep Generative Models. We also cover recent papers on deep architectures for solving various computer vision and image processing problems.

After covering each module, we give students programming assignments related to that module. This gives students a practical feel for the topics. In one version of our offering we also had term projects for those who were interested in pursuing them. We made groups of 2 students and gave them a choice of recent papers that appeared in top conferences and journals. Each group then took up one paper, implemented it and were encouraged to come up with better versions of the algorithms.

Over three offerings of this course, the students gave an average TCF course rating of 0.83. The main feedback of the students regarding this course was that they had to work much more than the 9 credits allocated for the course (under EE6132 Advanced Topics in Signal Processing). This has been corrected as we have recently floated a 12 credits new course, EE5179 Deep Learning for Imaging, exclusively for this topic.

Other courses

Apart from the above courses, I have taught two core UG courses: Signals and Systems (EE1101) and Digital Signal Processing (EE2004), and a stream elective course Probability Foundations for Electrical Engineers (EE3110). I have twice taught a module (Modern Computer Vision) in an institute level course Machine Intelligence and Brain Research (ID 7123), offered by the Center for Computational Brain Research.

From the perspective of industrial relevance, I have co-taught a Web-Enabled M.Tech. course on Modern Computer Vision under Advanced Topics in Signal Processing (EE6132w). Employees from Qualcomm, Bharat Electronics Limited, Valeo and Signalchip did this course. I personally know of at least one Qualcomm employee who has greatly benefited by doing this course.

Research Vision

My research interests are in Computational Imaging, Image Processing and Computer Vision. Traditionally, camera optics design and imaging inference (image processing, computer vision algorithms) have been done more or less independently. However, in Computational Imaging the camera optics and the processing/inference algorithms are co-designed so that we can capture more information about the visual scene. In the following, I highlight the research achievements of my lab in these areas.

Light Field Reconstruction from Compressive and Sparse Measurements

A classical example of a computational imaging system is a Light Field (LF) camera. A conventional camera only captures 2D spatial resolution, whereas, a LF camera captures both 2D spatial and 2D angular resolutions. There are various advantages in capturing the LF of a scene. For example, by capturing the LF of a scene, one can render 2D images of the scene with different focus settings (post-capture refocusing), render novel views of the scene (novel-view synthesis), change depth of focus and also compute scene depth.

In the most popular and portable LF camera design, a lenslet-array is placed in between the main lens and the sensor. However, the major drawback of this LF camera is that it sacrifices the spatial resolution for capturing the angular resolution. For example, if the sensor is of resolution 4000×4000 and let's say we are interested in capturing a LF with an angular resolution of 16×16, then each of the $16 \times 16 = 256$ angular views will have a spatial resolution of 250×250, which is a huge loss of spatial resolution. We have tackled this important problem by proposing an unified learning based framework for various compressive LF acquisition techniques.

It is predicted that LF displays are going to revolutionize VR headsets in the next few years. For generating LF contents for such displays, it is essential to make LF capture easy and affordable. Current LF cameras require specialized hardware and hence it is not easily accessible. Thus, an active area of research is to reconstruct LF from sparse views such as those captured using a stereo camera or even from a monocular camera. This will enable LF reconstruction from smartphone captures. Recently, we have looked at the challenging problem of reconstructing LF videos from stereo and monocular videos.

Some important publications from this line of work are as follows:

- A K Vadathya, S Girish, K Mitra, "A unified learning-based framework for light field reconstruction from coded projections", IEEE Transactions on Computational Imaging, 2019.
- P Shedligeri, F Schiffers, S Ghosh, O Cossairt, K Mitra,"SeLFVi: Self-supervised Light-Field Video Reconstruction from Stereo Video", IEEE/CVF International Conference on Computer Vision, 2021.
- Shrisudhan G, P Shedligeri, Sarah, K Mitra, "Synthesizing Light Field Video from Monocular Video", Accepted in European Conference on Computer Vision 2022.

The last two papers have been presented or accepted in two of the premier Computer Vision conferences, ICCV and ECCV. This work also led to Dr. Prasan Shedligeri (my first PhD graduate) and Shrisudhan G. (DDP, 2022) winning the prestigious Qualcomm Innovation Fellowship (QIF) award for the year 2021. Currently, we are exploring Dual Pixel cameras for LF video reconstruction. We also want to port these LF reconstruction algorithms to smartphones.

Lensless Imaging: Reconstruction, Inference and Design

Emerging applications such as wearables, augmented reality, virtual reality, biometrics, and many others are driving an acute need for highly miniaturized imaging systems. Unfortunately, current-generation cameras are based on lenses – and these lenses typically account for more than 90 percent of the cost, volume and weight of cameras. Over the last decade, lensless imaging systems have emerged as a potential solution for light-weight, ultra-compact, inexpensive imaging. The basic idea in lensless imaging is to replace the lens with an amplitude or a phase mask; typically placed quite close to the sensor.

Because of the absence of the focusing lens, the lensless camera captures a highly multiplexed measurement of the scene and the main challenge is to reconstruct a sharp image from it. There are traditional methods of recovering the image such as Wiener deconvolution, however, the recovered images are not sharp enough. We have proposed a two-stage network with the first stage being an inversion network that produces an intermediate image followed by a refinement network to produce the final image. We have further proposed a learning based algorithm for finding optimal phase masks for reconstruction as well as for solving inference tasks such as face detection and optical flow estimation. We have also extended our approach to estimate depth and intensity from a single lensless measurement. The following publications/submissions have resulted from this line of research work, which mostly constitutes the PhD work of my student Salman Siddique Khan:

- S. S. Khan, V. R. Adarsh, V. Boominathan, J. Tan, A. Veeraraghavan and K. Mitra, "Towards photorealistic reconstruction of highly multiplexed lensless images", IEEE International Conference on Computer Vision, 2019.

- S. S. Khan and V. Sundar and V. Boominathan and A. Veeraraghavan and K. Mitra, “FlatNet: Towards Photorealistic Scene Reconstruction from Lensless Measurements”, IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), 2020.
- S. S. Khan, V. Boominathan, A. Veeraraghavan and K. Mitra, “Joint Design of Phase Mask and Inference Algorithms for Thin Lensless Cameras”, under review in Pattern Recognition Letters.
- D. Bagadthey, S. Prabhu, S. S. Khan, V.. Boominathan, A. Veeraraghavan and K. Mitra, “FlatNet3D - Intensity And Absolute Depth from Single-shot Lensless Capture”, under review in Journal of the Optical Society of America A (JOSA A).

The first two papers have appeared in premier Computer Vision conference ICCV and journal TPAMI, respectively. Based on this line of work, my PhD student Salman Siddique Khan has won the prestigious Qualcomm Innovation Fellowship (QIF) award for the year 2020. Currently, we are exploring various applications of lensless imaging, such as 3D endoscopy and AR/VR. We also have an on-going project on 3D endoscopy under the Technology Innovation Hub (TIH) IIT Madras Pravartak Technologies Foundation. Recently, we got supplementary funding under Indo-US collaboration (NSF-TIH) with US PI Prof Ashok Veerarhavan of Rice University.

Real-time Restoration of Extremely Dark (Single and Multiview) Images

Images captured in extreme low-light conditions such as night-time suffer from significant sensor noise and poor color capture. Restoring such low-light images will have immense applications in surveillance and advanced driver assistance systems. In recent years, researchers have tried to tackle this problem using deep learning architectures. Existing methods, however, only target restoration quality and compromise on speed and memory requirements, raising concerns about their real-world deployability. We have proposed light-weight and fast models with low memory utilization. We have further proposed light-weight and fast models for restoration of stereo and light field images while preserving their epipolar geometry. The following publications have resulted from this line of research work, which mostly constitutes the PhD work of my student Mohit Lamba, who is about to submit his PhD thesis:

- M Lamba, A Balaji and K Mitra,“Towards Fast and Light-Weight Restoration of Dark Images”, British Machine Vision Conference (BMVC), 2020.
- M Lamba, K Rachavarapu and K Mitra,“Harnessing Multi-View Perspective of Light Fields for Low-Light Imaging”, IEEE Transactions on Image Processing (TIP), 2021.
- M Lamba and K Mitra,“Restoring Extremely Dark Images in Real Time”, IEEE Computer Vision and Pattern Recognition (CVPR), 2021.
- M Lamba and K Mitra, “Fast and Efficient Restoration of Dark Light Fields”, Winter Conference on Applications of Computer Vision (WACV), 2022.

The second and third papers are published in premier journal (IEEE TIP) and conference (IEEE CVPR), respectively. We also have filed a couple of patents. We are currently exploring applications of low-light image enhancement for Advanced Driver Assistance Systems (ADAS). We have an on-going project on "Night time Image Sensing for ADAS" under the Technology Innovation Hub (TIH) IIT Madras Pravartak Technologies Foundation. Recently, we also got supplementary funding under Indo-US collaboration (NSF-TIH) with US PI Prof Aswin Sankaranarayanan of Carnegie Mellon University (CMU).

Other Topics in Computational Imaging and Image Processing

Apart from the above major research themes, I have also worked on topics such as:

- Physics based data driven algorithm for Fourier Ptychography Microscopy, which has been recently accepted in European Conference on Computer Vision (ECCV), a premier conference in Computer Vision. This is the MS work of my recently graduated MS student, Atreyee Saha.
- Reconstruction and inference from neuromorphic or events cameras, which resulted in two journal publications and is part of the PhD work of my first PhD graduate, Dr. Prasan Shedligeri.
- Thermal image super-resolution, which has resulted in a IEEE Transactions on Image Processing paper and is the MS work of Honey Gupta.
- Reflection removal from images, which has been presented in the prestigious IEEE CVPR conference. This is the ongoing work of my external PhD student, Pawan Prasad.
- Solving inverse computational imaging problems using deep generative models, which resulted in a journal publication in IEEE Transactions on Computational Imaging. This was the Dual Degree project of my student Akshay Dave.

Three Best Papers

The three best papers from my lab in recent years are as follows:

1. S. S. Khan, V. Sundar, V. Boominathan, A. Veeraraghavan, K. Mitra, "FlatNet: Towards Photorealistic Scene Reconstruction from Lensless Measurements", IEEE Transactions on Pattern Analysis & Machine Intelligence (TPAMI), 2020.
2. M. Lamba and K. Mitra, "Restoring Extremely Dark Images in Real Time", IEEE Computer Vision and Pattern Recognition (CVPR), 2021.
3. Shrisudhan G, P Shedligeri, Sarah, K Mitra, "Synthesizing Light Field Video from Monocular Video", accepted in European Conference on Computer Vision 2022.

[1] FlatNet: Towards Photorealistic Scene Reconstruction from Lensless Measurements: Emerging applications such as wearables, augmented reality, virtual reality, biometrics, and many others are driving an acute need for highly miniaturized imaging systems. In traditional cameras, the lenses account for most of the cost, volume and weight of the cameras. Recently, lensless imaging systems have emerged as a potential solution for light-weight, ultra-compact, inexpensive imaging. In lensless imaging, the lens is replaced with an amplitude or a phase mask; typically placed quite close to the sensor. However, due to the absence of any focusing element, the sensor measurements recorded in a lensless imager are no longer photographs of the scene but rather highly multiplexed measurements. Reconstruction algorithms are needed to undo the effects of this multiplexing and produce photographs of the scene being imaged.

In this paper, we proposed a feedforward deep neural network for photorealistic lensless reconstruction, which we refer to as FlatNet. FlatNet consists of two stages: the first stage is a learnable inversion stage that brings the multiplexed measurements back to image space. This stage depends on the camera model. The second stage enhances this intermediate reconstruction using a fully convolutional network. The two stages are trained in an end-to-end manner. We showed high-quality reconstructions by performing extensive experiments on real and challenging scenes using two different types of lensless prototypes: one which uses a separable forward model and another, which uses a more general non-separable cropped-convolution model. We also proposed an initialization scheme for the general non-separable lensless model that doesn't require explicit PSF calibration. Our end-to-end approach is fast, produces photorealistic reconstructions, and is easy to adopt for other mask-based lensless cameras. We also collected a dataset of unconstrained indoor lensless measurements paired with corresponding unaligned webcam images which is finally used to finetune our proposed FlatNet to robustly deal with unconstrained real-world scenes.

[2] Restoring Extremely Dark Images in Real Time: Images captured in extreme low-light conditions such as night-time suffer from significant sensor noise and poor color capture. Restoring such low-light images will have immense applications in surveillance and advanced driver assistance systems. Recently, a few deep learning algorithms have been proposed for enhancing extreme low-light images captured in near zero lux conditions ($0.1 - 5$ lux). Restoring extreme low-light restoration is a very challenging problem because colors are hard to recover and noise suppression is significantly challenging. Thus, the predominant trend is to forsake model speed and computational efficiency for better restoration, raising concerns for their real-world deployability.

In this paper, we proposed a new deep learning architecture for extreme low-light single image restoration, which despite its fast and lightweight inference, produces a restoration that is perceptually at par with state-of-the-art computationally intensive models. To achieve this, we do most of the processing in the higher scale-spaces, skipping the intermediate-scales wherever possible. Also unique to our model is the potential to process all the scale-spaces concurrently, offering an additional 30% speedup without compromising the restoration quality. Pre-amplification of the dark raw-image is an important step in extreme low-light image enhancement. Most of the existing state of the art methods need ground-truth exposure value to estimate the pre-amplification factor, which is not practically feasible. We proposed an amplifier module that estimates the amplification factor using only the input raw image and can be used "off-the-shelf" with pre-trained models without any fine-tuning. We showed that our model can restore an ultra-high-definition 4K resolution image in just 1 sec. on a CPU and at 32 fps on a GPU and yet maintain a competitive restoration quality. We also showed that our proposed model, without any fine-tuning, generalizes well to cameras not seen during training and to subsequent tasks such as object detection.

[3] Synthesizing Light Field Video from Monocular Video: Cameras have become cheap and ubiquitous in the modern world, giving consumers a capability to acquire photos and videos anywhere and anytime. The last decade saw an accelerated improvement in image sensors and lens quality, leading to a significant improvement in the picture quality from these tiny cameras. Towards the end of the decade, the focus shifted towards providing the consumers with more and more innovative features such as background-blur, bokeh effects and novel view synthesis, which provided a sense of '3D' to the otherwise flat pictures. However, there's no straightforward way of extending these features to videos. In the last few years, videos have certainly become a more powerful means of communication, knowledge-sharing and entertainment. Light Field (LF) imaging could provide an intuitive way of bringing these features to videos. However, there's no easy way to capture LF videos yet. Traditionally, LF imaging required use of bulky or complex hardware setups such as camera arrays and micro-lens arrays. We instead focus on existing camera hardware and aim to reconstruct LF videos from any ordinary monocular camera.

LF video reconstruction from monocular video poses a special challenge as acquiring ground-truth for training these models is hard. Hence, in this paper, we proposed a self-supervised learning-based algorithm for LF video reconstruction from monocular videos. We used self-supervised geometric, photometric and temporal consistency constraints inspired from our own recent learning-based technique for LF video reconstruction from stereo video [P Shedligeri et. al., ICCV, 2021]. Additionally, we proposed three key techniques that are relevant to our monocular video input. We proposed an explicit disocclusion handling technique that encourages the network to use information from adjacent input temporal frames for inpainting dis-occluded regions in a LF frame. This is crucial for a self-supervised technique as a single input frame does not contain any information about the dis-occluded regions. We also proposed an adaptive low-rank representation that provides a significant boost in performance by tailoring the representation to each input scene. Finally, we proposed a novel refinement block that is able to exploit the available LF image data using supervised learning to further refine the reconstruction quality. Our qualitative and quantitative analysis demonstrated the significance of each of the proposed building blocks and also the superior results compared to previous state-of-the-art monocular LF reconstruction techniques. We further validated our algorithm by reconstructing LF videos from monocular videos acquired using a commercial GoPro camera.

Publications

Underline indicates students guided by me.

Journal Publications

1. <u>H. Gupta</u>, K. Mitra, "Toward Unaligned Guided Thermal Super-Resolution," in IEEE Transactions on Image Processing, vol. 31, 2021.
   Citation: 1, Journal Impact Factor: 10.86

2. <u>P Shedligeri</u>, K Mitra, "High frame rate optical flow estimation from event sensors via intensity estimation," Computer Vision and Image Understanding, vol. 208-209, 2021.
   Citation: 0, Journal Impact Factor: 4.89

3. <u>P Shedligeri</u>, <u>S Anupama</u>, K Mitra, "CodedRecon: Video reconstruction for coded exposure imaging techniques," Software Impacts, vol. 8, 2021.
   Citation: 0, Journal Impact Factor: 1.8

4. M. Lamba, K. Rachavarapu, K. Mitra, "Harnessing Multi-View Perspective of Light Fields for Low-Light Imaging," IEEE Transactions on Image Processing (TIP), 2020.
   Citation: 7, Journal Impact Factor: 10.86

5. S. S. Khan, V. Sundar, V. Boominathan, A. Veeraraghavan, K. Mitra, "FlatNet: Towards Photorealistic Scene Reconstruction From Lensless Measurements," in IEEE Transactions on Pattern Analysis and Machine Intelligence, 2020.
   Citation: 22, Journal Impact Factor: 24.3

6. P. Shedligeri, K. Mitra, "Photorealistic image reconstruction from hybrid intensity and event-based sensor", Journal of Electronic Imaging 28 (6), 063012, 2019.
   Citation: 25, Journal Impact Factor: 1.05

7. S.M. Shankaranarayana, K. Ram, K. Mitra, M. Sivaprakasam, "Fully convolutional networks for monocular retinal depth estimation and optic disc-cup segmentation", IEEE Journal of Biomedical and Health Informatics 23 (4), 1417-1426, 2019.
   Citation: 50, Journal Impact Factor: 5.77

8. A.K. Vadathya, S. Girish, K. Mitra, "A Unified Learning-Based Framework for Light Field Reconstruction From Coded Projections", IEEE Transactions on Transactions on Computational Imaging,6, 304-316, 2019.
   Citation: 13, Journal Impact Factor: 4.71

9. A. Dave, A. K. Vadathya, R. Subramanyam, R. Baburaj, K. Mitra, "Solving Inverse Computational Imaging Problems using Deep Pixel-level Priors", IEEE Transactions on Computational Imaging, 5 (1), 37-51, 2018.
   Citation: 26, Journal Impact Factor: 4.71

10. J. Holloway, K. Mitra, S. Koppal, A. Veeraraghavan, "Generalized Assorted Camera Arrays: Robust Cross-channel Registration and Applications," IEEE Transactions on Image Processing (TIP), vol. 24(3), March 2015.
    Citation: 24, Journal Impact Factor: 10.86

11. A. Ito, S. Tambe, K. Mitra, A. Sankaranarayanan, A. Veeraraghavan, "Compressive Epsilon Photography for Post-Capture Control in Digital Imaging," ACM Trans. Graphics (TOG) / SIGGRAPH, vol. 33(4), July 2104.
    Citation: 16, Journal Impact Factor: 7.71

12. K. Mitra, O. Cossairt and A. Veeraraghavan, "A Framework for Analysis of Computational Imaging Systems: Role of Signal Prior, Sensor Noise and Multiplexing," IEEE Transactions on Pattern Analysis and Machine Learning (TPAMI), vol. 36(10), Oct 2014.
    Citation: 28, Journal Impact Factor: 24.3

13. K. Mitra, A. Veeraraghavan, A. Sankaranarayanan and R. G. Baraniuk, "Towards Compressive Camera Networks," IEEE Computer, vol. 47(5), May 2014.
    Citation: 4, Journal Impact Factor: 2.26

14. P. Vageeswaran, K. Mitra and R. Chellappa, "Blur and Illumination Robust Face Recognition via Set-Theoretic Characterization," IEEE Transactions on Image Processing (TIP), vol. 22(4), April 2013.
    Citation: 68, Journal Impact Factor: 10.86

15. K. Mitra, A. Veeraraghavan and R. Chellappa, "Analysis of Sparse Regularization Based Robust Regression Algorithms," IEEE Transactions on Signal Processing (TSP), 2013.
    Citation: 38, Journal Impact Factor: 5.27

Conference Publications

7.2.1 Premier Conferences

1. Shrisudhan G, P Shedligeri, Sarah, K Mitra, "Synthesizing Light Field Video from Monocular Video", Accepted in European Conference on Computer Vision (ECCV) for Oral presentation (acceptance rate 2.7%), 2022.
   Citation: 0, Conference H5 index: 146

2. A Saha, S S Khan, S Sehrawat, S Prabhu, S Bhattacharya, K Mitra, "LWGNet - Learned Wirtinger Gradients for Fourier Ptychographic Phase Retrieval", Accepted in European Conference on Computer Vision (ECCV), 2022.
   Citation: 0, Conference H5 index: 146

3. P. Shedligeri, F. Schiffers, S. Ghosh, O. Cossairt, K. Mitra, "SeLFVi: Self-Supervised Light-Field Video Reconstruction From Stereo Video", IEEE/CVF International Conference on Computer Vision (ICCV), 2021.
   Citation: 1, Conference H5 index: 172

4. B. H. P. Prasad, G. Rosh K S, L. R. Boregowda, K. Mitra, S. Chowdhury, "V-DESIRR: Very Fast Deep Embedded Single Image Reflection Removal", IEEE/CVF International Conference on Computer Vision (ICCV), 2021.
   Citation: 3, Conference H5 index: 172

5. M. Lamba, K. Mitra, "Restoring Extremely Dark Images in Real Time", IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2021.
   Citation: 6, Conference H5 index: 301

6. S.S. Khan, V.R. Adarsh, V. Boominathan, J. Tan, A. Veeraraghavan, K. Mitra, "Towards photorealistic reconstruction of highly multiplexed lensless images", IEEE International Conference on Computer Vision (ICCV), 7860-7869, 2019.
   Citation: 30, Conference H5 index: 172

7. K. Mitra, S. Sheorey, R. Chellappa, "Large-Scale Matrix Factorization with Missing Data under Additional Constraints," Advances in Neural Information Processing Systems (NIPS) 2010.
   Citation: 63, Conference H5 index: 192

8. K. Mitra, A. Veeraraghavan and R. Chellappa, "Robust RVM Regression Using Sparse Outlier Model," IEEE Conference on Computer Vision and Pattern Recognition (CVPR) 2010. Citation: 33, Conference H5 index: 301

7.2.2 Other Conferences

1. M. Lamba, K. Mitra, "Fast and Efficient Restoration of Dark Light Fields" Winter Conference on Applications of Computer Vision (WACV), 2022.

2. P. Shedligeri, K. Mitra, "A unified framework for compressive video recovery from coded exposure techniques," IEEE/CVF Winter Conference on Applications of Computer Vision, 2021.

3. S Anupama, P Shedligeri, A Pal, K Mitra, "Video reconstruction by spatio-temporal fusion of blurred-coded image pair," 25th International Conference on Pattern Recognition (ICPR), 2021.

4. M. Lamba, A. Balaji and K. Mitra, "Towards Fast and Light-Weight Restoration of Dark Images", British Machine Vision Conference (BMVC), 2020.

5. J. Tan, S.S. Khan, V. Boominathan, J. Byrne, R. Baraniuk, K. Mitra, A. Veeraraghavan, "CANOPIC: Pre-Digital Privacy-Enhancing Encodings for Computer Vision", IEEE International Conference on Multimedia and Expo (ICME), 2020.

6. H. Gupta, K. Mitra, "Pyramidal Edge-Maps and Attention Based Guided Thermal Super-Resolution," Workshop in European Conference on Computer Vision, 2020.

7. V. Sundar, S. Hegde, D. Kothandaraman, K. Mitra, "Deep atrous guided filter for image restoration in under display cameras," Worshop in European Conference on Computer Vision, 2020.

8. M. Lamba, K. Mitra, "Multi-patch aggregation models for resampling detection", IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 2020.

9. H. Gupta, K. Mitra, "Unsupervised Single Image Underwater Depth Estimation", IEEE International Conference on Image Processing (ICIP), 624-628, 2019.

10. C. Chinni, A. Kulkami, D.M. Pai, K. Mitra, P.K. Sarvepalli, "Neural decoder for topological codes using pseudo-inverse of parity check matrix", IEEE Information Theory Workshop (ITW), 1-5, 2019.

11. S.M. Shankaranarayana, K. Ram, A. Vinekar, K. Mitra, M. Sivaprakasam, "A bottom-up saliency estimation approach for neonatal retinal images", Computational Pathology and Ophthalmic Medical Image Analysis, 336-343. 2018.

12. L. Boominathan, M. Maniparambil, H. Gupta, R. Baburajan, K. Mitra, "Phase retrieval for fourier ptychography under varying amount of measurements", British Machine Vision Conference (BMVC), 2018.

13. D. Mittal, A. Reddy, G. Ramadurai, K. Mitra, B. Ravindran, "Training a deep learning architecture for vehicle detection using limited heterogeneous traffic data" 10th International Conference on Communication Systems and Networks (COMSNETS), 2018.

14. A. K. Vadathya, S. Cholleti, G. Ramajayam, V. Kanchana, K. Mitra, "Learning light field reconstruction from a single coded image", Asian Conference on Pattern Recognition (ACPR), Nov 2017, Nanjing, China.

15. S. A. Baby, B. Vinod, C. Chinni, K. Mitra, "Dynamic Vision Sensors for Human Activity Recognition", Asian Conference on Pattern Recognition (ACPR), Nov 2017, Nanjing, China.

16. D. C. Kavarthapu, K. Mitra, "Hand Gesture Sequence Recognition using Inertial Motion Units(IMUs)", Asian Conference on Pattern Recognition (ACPR), Nov 2017, Nanjing, China.

17. A. Dave, A. K. Vadathya and K. Mitra, "Compressive image recovery using recurrent generative model," IEEE International Conference on Image Processing (ICIP), Sep 2017, Beijing, China.

18. P. Shedligeri, S. Mohan and K. Mitra, "A data driven approach for coded aperture design for depth-map recovery," IEEE International Conference on Image Processing (ICIP), Sep 2017, Beijing, China.

19. S. Honnungar, J. Holloway, A. K. Pediredla, A. Veeraraghavan and K. Mitra, "Focal-sweep for large aperture time-of-flight cameras," IEEE International Conference on Image Processing (ICIP) 2016.

20. R. Tadano, A. K. Pediredla, K. Mitra and A. Veeraraghavan, "Spatial Phase-Sweep: Increasing temporal resolution of transient imaging using a light source array," IEEE International Conference on Image Processing (ICIP) 2016.

21. S. Barua, K. Mitra and A. Veeraraghavan, "Saliency guided wavelet compression for low-bitrate image and video coding," IEEE Global Conference on Signal and Information Processing (GlobalSIP) 2015.

22. K. Mitra, O. Cossairt and A. Veeraraghavan, "Can we Beat Hadamard Multiplexing? Data-driven Design and Analysis for Computational Imaging Systems," IEEE International Conference on Computational Photography (ICCP) 2014.

23. V. Boominathan, K. Mitra and A. Veeraraghavan, "Improving Resolution and Depth-of-Field of Light Field Cameras Using a Hybrid Imaging System," IEEE International Conference on Computational Photography (ICCP) 2014.

24. K. Mitra, O. Cossairt and A. Veeraraghavan, "To Denoise or Deblur: Parameter Optimization for Imaging Systems," SPIE Electronic Imaging 2014.

25. O. Cossairt, A. Veeraraghavan, K. Mitra and M. Gupta, "Performance Bounds for Computational Imaging," Imaging and Applied Optics Technical Papers, OSA 2013.

26. O. Cossairt, K. Mitra and A. Veeraraghavan, "Performance Limits for Computational Photography," International Workshop on Advanced Optical Imaging and Metrology, Springer, 2013.

27. K. Mitra and A. Veeraraghavan, "Light Field Denoising, Light Field Superresolution and Stereo Camera Based Refocussing using a GMM Light Field Patch Prior," CVPR Workshop on Computational Cameras and Displays, 2012.

28. P. Thukral, K. Mitra and R. Chellappa, "A Hierarchical Approach For Human Age Estimation," IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP) 2012.

29. K. Mitra, A. Veeraraghavan and R. Chellappa, "Robust Regression Using Sparse Learning for High Dimensional Parameter Estimation Problem," IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP) 2010.

30. K. Mitra and R. Chellappa, "A Scalable Projective Bundle Adjustment Algorithm using the L_∞ Norm," Indian Conference on Computer Vision, Graphics and Image Processing (ICVGIP) 2008.

Awards, Patents, Prizes

Patents

- A Ito, A Veeraraghavan, K Mitra, S Tambe, "Image processing apparatus, image processing method, and program", US Patent 9,420,201, Publication date: 2016/8/16.

- Renju P B, K Mitra, "Miniglove based gesture recognition device", Applied for Indian Patent, No. 201641029418, 28/09/2017.

- Renju P B, K Mitra, "Finger-worn device operable as mouse/keyboard and method for realizing the same", Applied for Indian Patent, No. 202241009250, 22/02/2022.

- M Lamba, K Mitra, "Methods and system for real -time restoration of images captured in extreme low-light condition", Applied for Indian Patent, No. 202141026548, 15/06/2021.

- M Lamba, K Mitra, "Restoring Light Field (LF) views captured by LF cameras", Applied for Indian Patent, No. 202141055779, 01/12/2021.

- K Mitra, S Bhattacharya, A Saha, S S Khan, S Sehrawat, S Prabhu, “An imaging system and a method for Fourier ptychographic microscopy (FPM)”, Applied for Indian Patent, No. 202241041213, 19/7/2022.

Awards

- Students from my lab have won the prestigious Qualcomm Innovation Fellowship Award 4 times, for the years 2016, 2017 (super-winner), 2020 and 2021. I was the faculty mentor for all these awards.

- Graduate student fellowship at University of Maryland from 2004 - 2006

- Ranked Second in M.E. (Telecommunication Engineering) at IISc, Bangalore

- All India Rank Second in ECE, Graduate Apitute Test in Engineering (GATE) 2001

- Ranked first in B.Tech. (Radio Physics and Electronics) at University of Calcutta

- Ranked first in B.Sc. (Physics Honors) at University of Calcutta

Research Guidance

Graduated PhD students

1. Prasan Shedligeri (PhD, April 2022)
   Thesis title: Reconstructing High Temporal and Angular Resolution Videos from Low Data-Bandwidth Measurements
   Guidance role: Sole advisor

Graduated MS students

1. Atreyee Saha (MS, June 2022)
   Thesis title: Learned Wirtinger Gradients for Fourier Ptychographic Phase Retrieval
   Guidance role: Sole advisor

2. Honey Gupta (MS, July 2021)
   Thesis title: Guided Thermal Image Super-Resolution
   Guidance role: Sole advisor

3. Renju P B (MS, March 2020)
   Thesis title: Minimalist Hand Gesture Recognition using Deep Root Nodal Architecture
   Guidance role: Sole advisor

4. Sharath M S (MS, Aug 2019) Thesis title: Processing and Analysis of Neonatal and Adult Retinal Images
   Guidance role: Co-advisor

5. Anil Kumar Vadathya (MS, May 2019)
   Thesis title: A Unified Learning Based Framework for Light Field Reconstruction from Coded Projections
   Guidance role: Sole advisor

Ongoing PhD/MS students

Currently, I have 3 regular PhD students, 1 external PhD student and 3 MS students.

Sponsored and Consultancy Projects

Projects as PI

1. Title: Single-shot and compact 3D endoscopy using dual pixel sensor
   Funding agency: NSF - TIH (NSF-India Collaborative Research Program)
   Duration: Aug 2022 - Aug 2023
   Amount: Rs. 50,00,000
   Indian PI: **Kaushik Mitra**
   US PI: Prof. Ashok Veeraraghavan, Rice University, Houston, USA

2. Title: Enhancing Autonomous and Assisted Driving using Thermal-RGB Fusion
   Funding agency: NSF - TIH (NSF-India Collaborative Research Program)
   Duration: Aug 2022 - Aug 2023
   Amount: Rs. 41,80,000
   Indian PI: **Kaushik Mitra**
   US PI: Prof. Aswin C. Sankaranarayanan, Carnegie Mellon University, Pittsburg, USA

3. Title: Night-time image sensing and 3D Endoscopic imaging
   Funding agency: IITM Pravartak Technologies Foundation
   Duration: Jul 2021- Jul 2023
   Amount: Rs. 85,47,000
   PI: **Kaushik Mitra**
   Co-PIs: Prof. Mohanasankar Sivaprakasam (EE), Prof. C S Shankar Ram (ED)

4. Title: Super Resolution Microscopy for Point-of-Care Cancer Diagnosis
   Funding agency: Impacting Research Innovation and Technology - IMPRINT
   Duration: Jan 2019 - Jul 2022
   Amount: Rs. 56,76,000
   PI: **Kaushik Mitra**
   Co-PI: Prof. Shanti Bhattacharya (EE)

5. Title: Reflection free photography (Phase 1- Reflection Detection)
   Funding agency: Samsung R &D Institute India Bangalore Private Limited
   Duration: Oct 2020 - Sep 2022
   Amount: Rs 18,00,000
   PI: **Kaushik Mitra**
   Co-PI: None

6. Title: Self-supervised Light Field Video Reconstruction for Smartphones
   Funding agency: Qualcomm Technologies, Inc.
   Duration: Sep 2021 - Sep 2022
   Amount: Rs 10,00,000
   PI: **Kaushik Mitra**
   Co-PI: None

7. Title: Data-driven Reconstruction and Joint Design of Optics for Lensless Cameras
   Funding agency: Qualcomm Technologies, Inc.
   Duration: Oct 2020 - Jan 2022
   Amount: Rs. 10,00,000
   PI: **Kaushik Mitra**
   Co-PI: None

8. Title: Deep Generative Models for Computational Imaging
   Funding agency: Qualcomm Technologies, Inc.
   Duration: Sep 2016 - Dec 2019
   Amount: Rs. 20,00,000

PI: **Kaushik Mitra**
Co-PI: None

9. Title: Wide Field-of-view and Dense 3D Reconstruction of Underwater Archeological Sites
   Funding agency: Exploratory Research Project, IIT Madras
   Duration: Feb 2019 - Feb 2021
   Amount: Rs. 6,81,000
   PI: **Kaushik Mitra**
   Co-PI: None

10. Title: Thermal Imaging based Condition Monitoring
    Funding agency: Caterpillar India Private Limited
    Duration: Aug 2018 - Dec 2020
    Amount: Rs. 7,27,946
    PI: **Kaushik Mitra**
    Co-PI: None

11. Title: Computational imaging and computer vision
    Funding agency: New Faculty Initiation Grant, IIT Madras
    Duration: May 2015 - Nov 2017
    Amount: Rs. 5,03,202
    PI: **Kaushik Mitra**
    Co-PI: None

Projects as Co-PI

1. Title: Algorithms for Synthetic Vision System (SVS),Enhanced Vision System (EVS) and Automatic Target Recognition (ATR) implementations in a fighter aircraft
   Funding agency: Aeronautical Development Agency
   Duration: Mar 2022 - Mar 2024
   Amount: Rs 1,12,50,855
   PI: Prof. Palaniappan Ramu (ED)
   Co-PIs: Prof. Ganapathy Krishnamurthi (ED), **Kaushik Mitra**

2. Title: Underwater Image Processing and Computer Vision
   Funding agency: Department of Science & Technology
   Duration: Mar 2019 - Mar 2023
   Amount: Rs 60,46,000
   PI: Prof. A N Rajagopalan (EE)
   Co-PIs: **Kaushik Mitra**

3. Title: Virtual Reality and Haptics
   Funding agency: CoE, IIT Madras
   Duration: Feb 2021 - Dec 2026
   Amount: Rs. 1,39,00,000

PI: Prof. Manivannan (AM)
Co-PIs: Prof. Srinivasa Chakravarthy V (BT), Prof. Amit R K (DoMS),
Kaushik Mitra, Dr. Mansi Sharma (EE), Prof. Lata Dayaram (DoMS)

4. Title: Development of a Dynamic Traffic Congestion Prediction System for Indian Cities
   Funding agency: Tata Consultancy Services Limited
   Duration: April 2016 - Dec 2019
   Amount: Rs. 2,84,00,008
   PI: Prof. Lelitha Devi (CE)
   Co-PI: Prof. Ravindran B (CSE), Prof. Arun K Tangirala (CH),
   Prof. Shankar Ram (ED), Prof. Gitakrishnan Ramadurai (CE), **Kaushik Mitra**

5. Title: Design of optics for a Point of - Sample Collection Device
   Funding agency: Aindra Systems Private Limited
   Duration: Jan 2015 - Jul 2018
   Amount: Rs. 3,29,069
   PI: Prof. Shanti Bhattacharya (EE)
   Co-PI: **Kaushik Mitra**

6. Title: Scene understanding for identification of covert Geo locations, using a Hyper-Classifier based Visual Intelligent system
   Funding agency: Impacting Research Innovation and Technology - IMPRINT
   Duration: Aug 2017 - Mar 2022
   Amount: Rs. 1,87,00,000
   PI: Prof. Sukhendu Das (CSE)
   Co-PI: Prof. Ravindran B (CSE), **Kaushik Mitra**

Internationalization

International projects

Recently, two of my proposals have been selected for Indo-US collaborative research program. The details are as follows:

- Title: Single-shot and compact 3D endoscopy using dual pixel sensor
  Funding agency: NSF - TIH (NSF-India Collaborative Research Program)
  Duration: Aug 2022 - Aug 2023
  Amount: Rs. 50,00,000
  Indian PI: **Kaushik Mitra**
  US PI: Prof. Ashok Veeraraghavan, Rice University, Houston, USA

- Title: Enhancing Autonomous and Assisted Driving using Thermal-RGB Fusion
  Funding agency: NSF - TIH (NSF-India Collaborative Research Program)
  Duration: Aug 2022 - Aug 2023
  Amount: Rs. 41,80,000

Indian PI: **Kaushik Mitra**
US PI: Prof. Aswin C. Sankaranarayanan, Carnegie Mellon University, Pittsburg, USA

Joint publications

I have international collaborations with the following research labs:

- Rice Computational Imaging Group
  PI: Prof. Ashok Veeraghavan, ECE, Rice University, Houston, USA
- Comp Photo Lab
  PI: Prof. Oliver Cossairt, EECS, Northwestern University, USA
- Image Science Lab
  PI: Prof. Aswin Sankaranarayanan, ECE, Carnegie Mellon University, USA
- Wisconsin Computational Imaging and Vision Lab
  PI: Prof. Mohit Gupta, CS, University of Wisconsin, Madison, USA

Recent publications that are the outcome of these collaboration are as follows:

- P. Shedligeri, F. Schiffers, S. Ghosh, O. Cossairt, K. Mitra, "SeLFVi: Self-Supervised Light-Field Video Reconstruction From Stereo Video", IEEE/CVF International Conference on Computer Vision (ICCV), 2021.
- S. S. Khan, V. Sundar, V. Boominathan, A. Veeraraghavan, K. Mitra, "FlatNet: Towards Photorealistic Scene Reconstruction From Lensless Measurements," in IEEE Transactions on Pattern Analysis and Machine Intelligence, 2020.
- J. Tan, S.S. Khan, V. Boominathan, J. Byrne, R. Baraniuk, K. Mitra, A. Veeraraghavan, "CANOPIC: Pre-Digital Privacy-Enhancing Encodings for Computer Vision", IEEE International Conference on Multimedia and Expo (ICME), 2020.
- S.S. Khan, V.R. Adarsh, V. Boominathan, J. Tan, A. Veeraraghavan, K. Mitra, "Towards photorealistic reconstruction of highly multiplexed lensless images", IEEE International Conference on Computer Vision (ICCV), 7860-7869, 2019.

Other Activities

Book Chapter

- K. Mitra, P. Vageeswaran and R. Chellappa, "Recognition of Motion Blurred Faces," Motion Deblurring: Algorithms and Systems, Cambridge University Press, A. N. Rajagopalan and R. Chellappa (Editors), 2014.

Conference Organization

- Served as one of the Technical Program Committee Chairs for National Conference on Communications (NCC) 2017 held in IIT Madras.

Important service roles in IIT Madras

I have been the faculty adviser of the Computer Vision and Intelligence Group (which is a student-run club and part of the Center for Innovation, IIT Madras) for the past 5 years. I periodically meet the student heads and members of the club and discuss about the club projects and other club logistics.

[*CV compiled by Kaushik Mitra*]

August 4, 2022