SUBEESH VASU

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Image Processing and Computer Vision lab
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Research Interests

Broad Areas: Image processing, computer vision, computational photography, and deep learning.
Specific Areas/Thesis Topics: Analyzing effects of camera motion in global shutter (GS) and rolling shutter (RS) cameras, scene inference, image registration and restoration, and underwater imaging.

Education

Indian Institute of Technology Madras, Chennai, India [May 2013 - present]
Ph.D, Image Processing and Computer Vision
Guide: Prof. A. N. Rajagopalan
CGPA: 9.57/10

National Institute of Technology Calicut, Kerala, India   [2010 - 2012]
Master of Technology, Signal Processing
CGPA: 8.63/10

Government Engineering College Idukki, Kerala, India   [2005 - 2009]
Bachelor of Technology, Electronics and Communication Engineering
Percentage: 71.4 %

Research Projects

Global Shutter (GS) Cameras:

- **Blind Motion Deblurring** - The objective of blind motion deblurring is to estimate the blur-free image from a given motion blurred image. In this work, we investigated the relation between the edge profiles present in a motion blurred image and the underlying camera motion responsible for causing the motion blur. A novel approach to use edge profiles 'alone' for direct camera motion estimation from a single motion blurred image was proposed. This method was then extended by incorporating a suitably derived constraint from edge profiles into an existing blind deblurring framework to demonstrate improved restoration performance.

- **Non-blind Motion Deblurring** - Non-blind deblurring aim to restore the image using a given motion blurred image and kernel estimate. For this task, a convolutional neural network-based approach was proposed to handle kernel uncertainty in non-blind motion deblurring. Unlike existing works that assume the availability of ground truth blur kernel, the proposed approach was meant to improve the restoration quality in the absence of exact ground truth kernel.

- **Underwater Imaging** - Proposed an approach to remove the detrimental effects of skew and motion blur when imaging is done such that the camera and scene of interest are in two different media. Introduced the notion of virtual depth map to transform the deskewing problem into a space-variant

deblurring and then performed the image restoration task via an alternating minimization scheme meant for removal of depth-dependent space-variant blur. Another work introduced a novel pipeline to solve the problem of mosaicing deep underwater images degraded by haze, color changes, and non-uniform illumination. Proposed a framework to sequentially perform image restoration, scene geometry recovery, and depth-aware mosaicing.

- **Registration and Rectification in Rolling Shutter (RS) Cameras** - In this project, we first addressed the problem of registering images of planar scenes taken from GS and RS cameras and reveal the constraints on camera motion that admit registration, change detection, and rectification. This work was followed by an attempt to perform occlusion-aware RS rectification for 3D scenes. The focus was on a specific scenario of a fast moving camera wherein the rolling shutter distortions not only are predominant but also become depth-dependent which in turn results in intra-frame occlusions. To solve the problem of 3D RS rectification, a first-of-its-kind pipeline was developed to sequentially recover the camera motion, scene structure, and the rectified image while accounting for RS and occlusion effects.

- **Perceptual Single image SR** - Proposed enhanced perceptual super-resolution network to investigate the perception-distortion trade-off effect suffered by single image super-resolution algorithms.

Publications	**Journals**

1. *Subeesh Vasu*, A. N. Rajagopalan, and Guna Seetharaman. "Camera Shutter-Independent Registration and Rectification," IEEE Transactions on Image Processing. (TIP), Vol. 27, No. 4, pp. 1901 - 1913, April 2018.

Conferences

1. *Subeesh Vasu*, Abhijeet Shenoi, and A. N. Rajagopalan. "Joint HDR and Super-resolution Imaging in Motion Blur," in International Conference on Image Processing (ICIP), October 2018.

2. *Subeesh Vasu*, Nimisha T. M., and A. N. Rajagopalan. "Analyzing Perception-Distortion Tradeoff using Enhanced Perceptual Super-resolution Network," in Eurpean Conference on Computer Vision Workshops (ECCVW), September 2018

3. *Subeesh Vasu*, Venkatesh Reddy, and A. N. Rajagopalan. "Non-blind Deblurring: Handling Kernel Uncertainty with CNNs," in IEEE Conference on Computer Vision and Pattern Recognition (CVPR), June 2018.

4. *Subeesh Vasu*, Mahesh Mohan M R, and A. N. Rajagopalan. "Occlusion-Aware Rolling Shutter Rectification of 3D Scenes. in CVPR 2018.

5. *Subeesh Vasu* and A. N. Rajagopalan. "From local to global: Edge profiles to camera motion in blurred images," in CVPR, July 2017.

6. Kuldeep Purohit, *Subeesh Vasu*, A. N. Rajagopalan, V Bala Naga Jyothi, and Ramesh Raju. "Mosaicing Deep Underwater Imagery," in Indian Conference on Computer Vision, Graphics and Image Processing (ICVGIP), December 2016.

7. Karthik Seemakurthy, *Subeesh Vasu*, and A.N. Rajagopalan. "Deskewing by space-variant deblurring," in British Machine Vision Conference (BMVC), September 2016.

8. *Subeesh Vasu*, A.N. Rajagopalan, and Guna Seetharaman. "Tapping Motion Blur for Robust Normal Estimation of Planar Scenes," in International Conference on Image Processing (ICIP), September 2015.

Book Chapters

A.N. Rajagopalan, Pratyush Sahay, and *Subeesh Vasu*, "A Methodology To Reconstruct Large Damaged Regions In Heritage Structures," *Digital Hampi: Preserving Indian Cultural Heritage.* Eds. A. Mallik, S. Chaudhury, V. Chandru, and S. Srinivasan, Springer, 2018.

Honors and Awards

- July 2017 : Google travel grant to attend CVPR 2017
- June 2018 : Google travel grant to attend CVPR 2018
- June 2018 : CVPR 2018 Doctoral Consortium
- July 2018 : Institute Research Scholar Award for excellence in research awarded by IIT Madras
- August 2018 : The team led by me (**IPCV_team**) was ranked No .1 (for achieving best perceptual quality for a specified strict upper bound on RMSE) in PIRM challenge on perceptual super-resolution held as part of the ECCV 2018

Professional Activities

Reviewer for the following conferences:
- National Conference on Communications (NCC) 2017
- International Conference on Advances in Pattern Recognition (ICAPR) 2017
- Winter Conference on Applications of Computer Vision (WACV) 2018
- International Conference on Image Processing (ICIP) 2018
- Indian Conference on Computer Vision, Graphics and Image Processing (ICVGIP) 2018
- Winter Conference on Applications of Computer Vision (WACV) 2019
- National Conference on Communications (NCC) 2019

Assisted Prof. A.N. Rajagopalan in reviewing for the following conferences/journals:
- International Conference on Advances in Pattern Recognition (ICAPR) 2015
- Journal of Visual Communication and Image Representation (JVCIR)
- Indian Conference on Computer Vision, Graphics and Image Processing (ICVGIP) 2016
- National Conference on Computer Vision, Pattern Recognition, Image Processing and Graphics (NCVPRIPG) 2017

Technical program committee Member
- for the workshop on CV applications, ICVGIP 2018

Invited Speaker
- for the special session on "Rolling shutter camera" at NCVPRIPG 2017
- for the inaugural Sabarmati Young Researchers Seminar, IIT Gandhinagar, October 2018

Coursework

Probability Foundations for Signal Processing	Optimization Methods in Signal Processing and Communications
Mathematical Methods and Algorithms for Signal Processing	Detection and Estimation Theory
Digital Signal Processing	Image Signal Processing
	Digital Video Processing

Teaching Experience

Teaching Assistant, Indian Institute of Technology Madras
Assisted in conducting lab assignments and class tutorials for the following courses:
Image Signal Processing and *Basic Electrical Engineering* - Prof. A.N. Rajagopalan
Probability Foundations for Electrical Engineers - Prof. Krishna Jagannathan
Deep learning for image processing - Prof. A.N. Rajagopalan and Prof. Kaushik Mitra

References

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Prof. Kaushik Mitra
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