Abhijith Punnappurath

2052 Lassonde Building, Dept EECS
4700 Keele Street, York University
Toronto, Ontario M3J 1P3, Canada

Email: jithuthatswho@gmail.com
Email: pabhijith@eecs.yorku.ca
Web page: abhijithpunnappurath.github.io

Currently a Postdoctoral Fellow at the Department of Electrical Engineering and Computer Science, York University, Toronto, Ontario, Canada.

EDUCATION

Degree	Duration of study	University	CGPA/Percentage	Specialization
MS + PhD (Dual degree)	July 2010 - Sept 2017	Indian Institute of Technology Madras	8.84	Image Processing & Computer Vision
BTech	Aug 2005 - May 2009	Jawaharlal Nehru Technological Univ.	77.3%	Electronics & Comm. Engg.

RESEARCH INTERESTS

Broad Areas: Image processing and computer vision.

Specific Areas: Face recognition, super-resolution, dynamic object segmentation, change detection, motion deblurring, deep learning.

PUBLICATIONS

Journal Publications

1. M. Afifi, A. Punnappurath, G. Finlayson, and M. Brown, "As-projective-as-possible bias correction for illumination estimation algorithms," *Journal of the Optical Society of America A* **(JOSA-A)**, vol. 36, no. 1, pp. 71-78, Jan. 2019.

2. A. Punnappurath, T. M. Nimisha, and A. N. Rajagopalan, "Multi-image blind super-resolution of 3D scenes," *Image Processing, IEEE Transactions on* **(TIP)**, vol. 26, no. 11, pp. 5337-5352, Nov. 2017.

3. A. Punnappurath and A. N. Rajagopalan, "Recognizing blurred, nonfrontal, illumination, and expression variant partially occluded faces," *Journal of the Optical Society of America A* **(JOSA-A)**, vol. 33, no. 9, pp. 1887-1900, Sept. 2016.

4. A. Punnappurath, A. N. Rajagopalan, S. Taheri, R. Chellappa, and G. Seetharaman, "Face recognition across non-uniform motion blur, illumination, and pose," *Image Processing, IEEE Transactions on* **(TIP)**, vol. 24, no. 7, pp. 2067-2082, July 2015.

   [Listed in IEEE Signal Processing Magazine (March 2016 issue) as **one of the top ten most downloaded papers in IEEE Transactions on Image Processing** in the last one year.]

Conference Publications

1. A. Abuolaim, A. Punnappurath, and M. Brown, "Revisiting autofocus for smartphone cameras", in *Proceedings of the European Conference on Computer Vision* **(ECCV)**, pp. 523-537, Springer, Munich, Germany, Sept. 2018.

2. A. Punnappurath, Y. Balaji, M. Mohan, and A. N. Rajagopalan, "Deep decoupling of defocus and motion blur for dynamic segmentation", in *Proceedings of the European Conference on Computer Vision* **(ECCV)**, pp. 750-765, Springer, Amsterdam, the Netherlands, Oct. 2016.

3. V. Rengarajan, A. Punnappurath, A. N. Rajagopalan, and G. Seetharaman, "Rolling shutter super-resolution in burst mode," in *Proceedings of the IEEE International Conference on Image Processing* **(ICIP)**, pp. 2807-2811, Pheonix, Arizona, USA, Sept. 2016.

4. A. Punnappurath, V. Rengarajan, and A. N. Rajagopalan, "Rolling shutter super-resolution," in *Proceedings of the IEEE International Conference on Computer Vision* **(ICCV)**, pp. 558-566, Santiago, Chile, Dec. 2015.

5. V. Rengarajan, A. Punnappurath, A. N. Rajagopalan, and G. Seetharaman, "Efficient change detection for very large motion blurred images," in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition Workshop on Registration of Very Large Images* **(CVPRW)**, pp. 315-322, Columbus, Ohio, USA, June 2014.

6. A. Punnappurath, A. N. Rajagopalan, and G. Seetharaman, "Blind restoration of aerial imagery degraded by spatially varying motion blur," in *Proceedings of SPIE Defense + Security, International Society for Optics and Photonics* **(SPIE)**, Baltimore, Maryland, USA, May 2014.

7. A. Punnappurath, A. N. Rajagopalan, and G. Seetharaman, "Registration and occlusion detection in motion blur," in *Proceedings of the IEEE International Conference on Image Processing* **(ICIP)**, pp. 2519-2523, Melbourne, Australia, Sept. 2013.

RESEARCH WORK

Overview:
Traditional algorithms designed for the tasks of face recognition, super-resolution, dynamic object segmentation and change detection typically assume that the camera is stationary *during* the exposure time of each image. However, given today's ubiquity of hand-held imaging devices such as mobile phones and point-and-shoot cameras, this condition is quite restrictive. We model the degradations that arise from relaxing the assumption of a static camera (motion blur in CCD and rolling shutter effect in CMOS sensors), and attempt to solve the above problems under the challenging scenario where the camera is unconstrained and free to move during exposure time.

Face recognition across blur:
We propose two methodologies for face recognition in the presence of non-uniform (i.e., space-varying) motion blur. The first approach for recognizing faces across blur, lighting, and pose, employs an alternating minimization scheme, and is based on the result that the set of all images obtained from a face image in a given pose by non-uniform blurring and changing the illumination forms a bi-convex set. The second technique leverages the alpha matte of pixels that straddle the boundary between the probe face and the background for blur estimation, and is capable of handling illumination, pose, and expression variations, as well as partial occlusion.

Super-resolution from CMOS cameras:
Conventional multi-image super-resolution (SR) algorithms, designed for CCD cameras, assume that the motion between the images is global. However, due to the row-wise acquisition mechanism employed, CMOS cameras violate this assumption if there is a motion of the camera relative to the scene during exposure. We undertake a detailed analysis of the hitherto unexplored topic of multi-image SR in CMOS cameras. Based on our observation model that explicitly accounts for the row-wise distortions (called the "rolling shutter" (RS) effect), we propose a unified RS-SR framework to obtain an RS-free high resolution image from distorted low resolution images.

Dynamic object segmentation:
We address the challenging problem of segmenting dynamic objects given a single space-variantly blurred image of a 3D scene captured using a hand-held camera. We develop a deep convolutional neural network to predict the probabilistic distribution of the composite kernel which is the convolution of motion blur and defocus kernels at each pixel. We segment the image into different depth layers based on the defocus component, and then judiciously exploit the motion component to unambiguously separate out the dynamic objects at each depth layer.

Change detection:
The problem of automatically detecting occluded regions given a blurred/unblurred image pair of a scene taken from different viewpoints and at different times is addressed in this work. The occlusion can be due to single or multiple objects. We propose a framework for detecting occluder(s) that is reasonably robust to non-uniform motion blur as well as variations in camera pose (without the need for deblurring).

AWARD

Institute Research Scholar Award for excellence in research awarded by IIT Madras in April 2017.

PROGRAMMING SKILLS

Matlab, MatConvNet, Python, PyTorch, C/C++

PROFESSIONAL EXPERIENCE

Indian Institute of Technology Madras (July 2010 – September 2017)

Coursework:

Computer Vision	Mathematical Methods and Algorithms for Signal Processing
Digital Signal Processing	Probability Foundations for Signal Processing
Image Signal Processing	Geometry and Photometry-based Computer Vision
Detection and Estimation Theory	Numerical Linear Algebra

Teaching assistant:

Assisted in preparing and evaluating lab assignments and class tutorials for the following courses:

Networks and Systems	Basic Electrical Engineering
Image Signal Processing	Introduction to Digital Signal Processing
Digital Signal Processing	Advanced Topics in Digital Signal Processing

Reviewer:

- Computer Vision and Pattern Recognition (CVPR), 2019.
- Winter Conference on Applications of Computer Vision (WACV), 2019.
- British Machine Vision Conference (BMVC), 2018.
- Journal of the Optical Society of America A (JOSA-A), 2018.
- Computer Vision and Image Understanding (CVIU), 2017.

Assisted Prof. A. N. Rajagopalan in reviewing for the following conferences and journals:

- Navigation Systems and Signal Processing Applications (NSSP), 2013.
- National Conference on Computer Vision, Pattern Recognition, Image Processing and Graphics (NCVPRIPG), 2013.
- Indian Conference on Vision, Graphics and Image Processing (ICVGIP), 2014.
- International Conference on Advances in Pattern Recognition (ICAPR), 2015.
- National Conference on Computer Vision, Pattern Recognition, Image Processing and Graphics (NCVPRIPG), 2015.
- International Conference on Signal Processing and Communications (SPCOM), 2016.
- National Conference on Communication (NCC), 2017.
- ACM Computing Surveys, 2017.

Selected list of conferences/workshops attended:

"The European Conference on Computer Vision", Munich, Germany, September 2018.
"The European Conference on Computer Vision", Amsterdam, Netherlands, October 2016.
"Summer School on Deep Learning for Computer Vision", IIIT Hyderabad, July 2016.
"The International Conference on Computer Vision", Santiago, Chile, December 2015.
"Digital Video Analytics and Processing", IIT Madras, December 2012.
"The Indian Conference on Computer Vision, Graphics and Image Processing", IIT Madras, December 2010.

REFERENCES

Michael S. Brown
Professor
Dept EECS
York University
Toronto, Canada
Email: mbrown@eecs.yorku.ca
Phone: +14167362100

A. N. Rajagopalan
Professor
Dept EE
IIT-M
Chennai, India
Email: raju@ee.iitm.ac.in
Phone: +914422574433

Kaushik Mitra
Assistant Professor
Dept EE
IIT-M
Chennai, India
Email: kmitra@ee.iitm.ac.in
Phone: +914422574411