Abhijith Punnappurath

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Education

Degree	Duration of study	University/Board	CGPA/Percentage	Specialization
MS + PhD (Integrated)	Aug 2010 - May 2017 (Expected)	IIT Madras	8.74	Image Processing & Computer Vision
BTech	Aug 2005 - May 2009	Jawaharlal Nehru Technological Univ.	77.3%	Electronics & Comm. Engg.

Research Interests

Face recognition, super-resolution, dynamic object segmentation, change detection, motion deblurring, deep learning

Publications

Journal Publications

- 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)**, 33, pp. 1887-1900, 2016.
- 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

- 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, Oct. 2016.
- V. Rengarajan, A. Punnappurath, A. N. Rajagopalan, and G. Seetharaman, "Rolling shutter super-resolution in burst mode," in *Proceedings of the International Conference on Image Processing* **(ICIP)**, pp. 2807-2811, IEEE, Sept. 2016.
- A. Punnappurath, V. Rengarajan, and A. N. Rajagopalan, "Rolling shutter super-resolution," in *Proceeding of the International Conference on Computer Vision* **(ICCV)**, pp. 558-566, IEEE, Dec. 2015.

- 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* **(CVPRW)**, pp. 315-322. IEEE, June 2014.

- 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)**, May 2014.

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

Research Work

Overview:
Classical 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 duration 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 this assumption (motion blur in CCD cameras and rolling shutter effect in CMOS cameras), and attempt to solve the above problems under the scenario where the camera is free to move during image capture.

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:
Classical multi-image super-resolution (SR) algorithms, designed for CCD cameras, assume that the motion between the images is global. However, CMOS sensors do not respect this assumption if there is a motion of the camera relative to the scene during exposure due to the row-wise acquisition mechanism. We undertake a detailed analysis of the hitherto unexplored topic of multi-image SR in CMOS cameras. Based on our SR 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 automatically 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).

Programming Skills

Matlab, MatConvNet, Python, Torch, C/C++

Professional Experience

Indian Institute of Technology Madras (August 2010 – Present)

Coursework:
Probability Foundations for Signal Processing, Mathematical Methods and Algorithms for Signal Processing, Digital Signal Processing, Computer Vision, Image Signal Processing, Detection & Estimation Theory, Geometry and Photometry-based Computer Vision, Optimization Methods in Signal Processing

Teaching assistant:
Designed assignments and projects for the following courses.
Basic Electrical Engineering, Networks and Systems, Introduction to Digital Signal Processing, Image Signal Processing, Digital Signal Processing, Advanced Topics in Digital Signal Processing

Conference reviewer:
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.

Selected list of conferences/workshops attended:
"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

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