Abhijith Punnappurath

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RESEARCH INTERESTS

Broad Areas: Computer vision and image processing.

Specific Areas: Face recognition, super-resolution, dynamic object segmentation, change detection, motion deblurring, reflection removal, white-balancing, image compression, raw reconstruction, deep learning.

EDUCATION

MS + PhD (Dual degree) — July 2010 – Sept 2017
Image Processing & Computer Vision — Tamil Nadu, India
Indian Institute of Technology Madras
Advised by Prof. A. N. Rajagopalan
CGPA : 8.84

BTech — August 2005 – May 2009
Electronics & Communication Engineering — Telangana, India
Jawaharlal Nehru Technological University
Percentage : 77.3%

EXPERIENCE

Samsung AI Center Toronto — October 2020 – Present
Research Scientist — Toronto, Canada

Samsung AI Center Toronto — March 2020 – August 2020
Intern — Toronto, Canada

York University — October 2017 – October 2020
Postdoctoral Fellow — Toronto, Canada
Advised by Prof. Michael S. Brown

PUBLICATIONS

Journal Publications

1. M. Afifi, A. Abdelhamed, A. Abuolaim, A. Punnappurath, and M. Brown, "CIE XYZ Net: Unprocessing images for low-level computer vision tasks," *Pattern Analysis and Machine Intelligence, IEEE Transactions on* **(TPAMI)**, Mar. 2021.

2. A. Punnappurath and M. Brown, "Learning raw image reconstruction-aware deep image compressors," *Pattern Analysis and Machine Intelligence, IEEE Transactions on* **(TPAMI)**, vol. 42, no. 4, pp. 1013-1019, Apr. 2020.

3. 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.

4. 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.

5. 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.

6. 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. Abdelhamed, A. Punnappurath, and M. Brown, "Leveraging the availability of two cameras for illuminant estimation," in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition* **(CVPR)**, Virtual, Jun. 2021.

2. A. Punnappurath and M. Brown, "Spatially aware metadata for raw reconstruction," in *Proceedings of the IEEE Winter Conference on Applications of Computer Vision* **(WACV)**, Waikoloa, Hawaii, USA, Jan. 2021.

3. A. Punnappurath and M. Brown, "Camera ISP modification to enable image de-rendering," in *28th IS&T Color Imaging Conference* (CIC28), Chiba, Japan, Nov. 2020.

4. A. Punnappurath, A. Abuolaim*, M. Afifi*, and M. Brown, "Modeling defocus-disparity in dual-pixel sensors," in *Proceedings of the International Conference on Computational Photography* **(ICCP)**, St. Louis, Missouri, USA, Apr. 2020.

5. M. Afifi, A. Punnappurath, A. Abdelhamed, H. C. Karaimer, A. Abuolaim, and M. Brown, "Color temperature tuning: Allowing accurate post-capture white-balance editing," in *27th IS&T Color Imaging Conference* (CIC27), Paris, France, Oct. 2019 **(CIC27 Best Paper Award)**.

6. A. Punnappurath and M. Brown, "Reflection removal using a dual-pixel sensor", in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition* **(CVPR)**, Long Beach, California, USA, Jun. 2019.

7. 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.

8. 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.

9. 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.

10. 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.

11. 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.

12. 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.

13. 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 – Postdoc
With the click of a button, we can capture an image. Concealed behind that click are a number of operations performed onboard the camera, collectively referred to as the in-camera imaging pipeline, that convert the linear raw-RGB image recorded by the sensor to the final nonlinear standard RGB (sRGB) output of the camera. Most computer vision tasks take the sRGB image which has been processed primarily for human perception as their starting point, and simply ignore the steps of the camera pipeline that produced it; this is sub-optimal. At the other end of the spectrum are computational photography approaches that entail a substantial redesign of the conventional imaging pipeline to make the camera's output better suited to solve the given computer vision task. However, such hardware modifications preclude the use of these techniques on off-the-shelf consumer cameras. My postdoctoral research has focused on carefully examining the various stages of the *existing camera pipeline* on present-day smartphone and DSLR cameras, and proposing practical mechanisms to simplify and improve the accuracy of various computer vision tasks either by tapping into the data generated by intermediate stages, or *minimally* modifying the existing pipeline.

Overview – MS + PhD
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.

AWARD

- **Institute Research Scholar Award** for excellence in research awarded by IIT Madras in April 2017.
- **Best Paper Award**, 27th IS&T Color Imaging Conference (CIC27), October 2019.

PROGRAMMING SKILLS

Matlab, MatConvNet, Python, PyTorch, Keras, 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, 2020, 2021.
- IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), 2020.
- IEEE Transactions on Image Processing (TIP), 2020.
- Computer Vision and Image Understanding (CVIU), 2017, 2019.
- Journal of the Optical Society of America A (JOSA-A), 2018.

- Pattern Recognition (PR), 2020.
- Winter Conference on Applications of Computer Vision (WACV), 2019, 2021.
- British Machine Vision Conference (BMVC), 2018.
- Conference on Computer and Robot Vision (CRV), 2019, 2020.

REFERENCES

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