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RESEARCH INTERESTS

Broad Areas: Image processing, computer vision, and computational photography.

Working On: Study of camera motion in various image acquisition mechanisms including global shutter, rolling shutter, and compressed sensing-based systems.

EDUCATION

Indian Institute of Technology Madras, Chennai, India August 2011–present
Ph.D., Electrical Engineering
Guides: Prof. A.N.Rajagopalan and Prof. R. Aravind
CGPA: 9.41/10

PSG College of Technology, Coimbatore, India August 2004–May 2008
Bachelor of Engineering, Electronics and Communication Engineering
CGPA: 9.48/10

PUBLICATIONS

1. *Vijay Rengarajan*, Yogesh Balaji, and A.N. Rajagopalan. “Unrolling the Shutter: CNN to Correct Motion Distortions,” in Accepted for an Oral Presentation at International Conference on Computer Vision and Pattern Recognition (**CVPR**), July 2017.
2. *Vijay Rengarajan*, A.N. Rajagopalan, R. Aravind, and Guna Seetharaman. “Image Registration and Change Detection under Rolling Shutter Motion Blur,” *IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI)*, November 2016.
3. *Vijay Rengarajan*, Abhijith Punnappurath, and A.N. Rajagopalan. “Rolling Shutter Super-resolution in Burst Mode,” in International Conference on Image Processing (**ICIP**), September 2016.
4. *Vijay Rengarajan*, A.N. Rajagopalan, and R. Aravind. “From Bows to Arrows: Single Image Rolling Shutter Rectification,” in International Conference on Computer Vision and Pattern Recognition (**CVPR**), June 2016.
5. Abhijith Punnappurath, *Vijay Rengarajan*, and A.N. Rajagopalan. “Rolling Shutter Super-resolution,” in the Proceedings of IEEE International Conference on Computer Vision (**ICCV**), December 2015.
6. *Vijay Rengarajan*, Sheetal B. Gupta, A.N. Rajagopalan, and Guna Seetharaman. “Illumination Robust Change Detection with CMOS Imaging Sensors,” in SPIE Defense + Security Symposium, International Society for Optics and Photonics, April 2015.
7. *Vijay Rengarajan*, A.N. Rajagopalan, and R. Aravind. “Change Detection in the Presence of Motion Blur and Rolling Shutter Effect,” in Computer Vision – **ECCV**, Springer International Publishing, September 2014.
8. *Vijay Rengarajan*, A.N. Rajagopalan, and R. Aravind. “Motion Estimation and Classification in Compressive Sensing from Dynamic Measurements,” in the Proceedings of IEEE International Conference on Pattern Recognition (**ICPR**), August 2014.
9. *Vijay Rengarajan*, Abhijith Punnappurath, A.N. Rajagopalan, and Guna Seetharaman. “Efficient Change Detection for Very Large Motion Blurred Images,” in the Proceedings of IEEE Conference on Computer Vision and Pattern Recognition Workshop on Registration of Very Large Images, June 2014.

RESEARCH PROJECTS

Rolling Shutter (RS) Cameras:

- **Change detection:**

Proposed a general framework to model both the RS effect and motion blur in CMOS cameras. A novel camera motion estimation method was developed modelling the row-wise camera exposure mechanism for change detection between images affected by these two artifacts. The algorithm was then expanded to account for illumination variations in the scene and the 3D nature of the scene.

- **Super-resolution:**

Introduced the RS super-resolution framework for the first time in literature. An alternating minimization framework was proposed to estimate the row-wise camera motion and the underlying clean high-resolution image from low-resolution images having RS artifacts.

- **Rectification:**

Addressed the problem of correcting geometric distortions due to the RS mechanism from a single image for the first time in literature. Two approaches are followed: in the geometric approach, the key idea was to exploit the information embedded in the curves of the RS image to reveal the underlying RS camera motion, and in the learning-based approach, a novel convolutional neural network architecture with long rectangular kernels is proposed to automatically choose and learn desired image features for motion estimation.

Camera Motion in Compressed Sensing Cameras:

Studied the effect of camera motion during image reconstruction in single pixel cameras. An algorithm based on recursive blockwise splitting of the compressively sensed vector was proposed to estimate the camera motion. The convergence of the algorithm was discussed based on the properties of the measurement matrix. The application of motion estimation was shown for face recognition under camera motion in compressed domain.

Motion Blur in Global Shutter Cameras:

Developed a motion blur estimation algorithm to reduce the time complexity while handling very large images. A study was done on how much the motion of the original image could be approximated by the motion experienced by small subimages. Several results were shown for change detection between large images having motion blur.

TEACHING EXPERIENCE

Teaching Assistant, Indian Institute of Technology Madras August 2011–present
Assisted in preparing and conducting lab assignments and class tutorials for the following courses:
Image Signal Processing - Prof. A.N. Rajagopalan
Digital Signal Processing and Probability Foundations - Prof. R. Aravind
Computational Photography - Prof. Kaushik Mitra

WORK EXPERIENCE

Motorola India Private Ltd., Bangalore, India August 2008–July 2011
Software Engineer
Software development and test engineer for CDMA-EVDO base station products.

Rice University, Houston, USA May – July 2016
Research Associate
Worked with Dr. Ashok Veeraraghavan, Electrical and Computer Engineering, to develop an algorithm for the estimation of heart rate from face videos.

AWARDS

Doctoral Consortium Participation and Travel Award at the IEEE Conference on Computer Vision and Pattern Recognition (CVPR) 2016
Institute Research Scholar Award for excellence in research awarded by IIT Madras in April 2015

**PROFESSIONAL
ACTIVITIES**

Reviewer for the Conference on Neural Information Processing Systems (NIPS 2016), IEEE Winter Conference on Applications of Computer Vision (WACV 2015 and 2016) and Indian Conference on Computer Vision, Graphics, and Image Processing (ICVGIP 2016)

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

- International Conference on Advances in Pattern Recognition (ICAPR 2015)
- Indian Conference on Computer Vision, Graphics, and Image Processing (ICVGIP 2014)
- International Workshop on Computational Cameras and Displays (CCD 2014)

**RELEVANT
COURSEWORK**

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| Image Signal Processing | Digital Video Processing |
| Digital Signal Processing | Pattern Recognition |
| Optimization Methods | Advanced Digital Signal Processing |
| Probability Foundations | Detection and Estimation Theory |
| Functional Analysis | Mathematical Methods and Algorithms |

REFERENCES

| | | |
|---|-------------------------|----------------------------|
| Prof. A.N. Rajagopalan | Prof. R. Aravind | Prof. Kaushik Mitra |
| Professor | Professor | Assistant Professor |
| raju@ee.iitm.ac.in | aravind@ee.iitm.ac.in | kmitra@ee.iitm.ac.in |
| Department of Electrical Engineering, Indian Institute of Technology Madras | | |