Nilanjan Ray

Professor

Department of Computing Science, University of Alberta, Canada

Web: https://webdocs.cs.ualberta.ca/~nray1/

Email: nray1@ualberta.ca, Phone: 780-492-2285, Fax: 780-492-1071

Areas of Interest

Medical image and video analysis and general computer vision problems including segmentation, registration, object detection and classification.

Education

Ph.D. in Electrical and Computer Engineering — Aug 2000 – May 2003
University of Virginia, Charlottesville, Virginia, USA

Master of Technology in Computer Science with distinction — Aug 1995 – July 1997
Indian Statistical Institute, Kolkata, India

Bachelor of Mechanical Engineering with honors — Aug 1991 – June 1995
Jadavpur University, Kolkata, India

Employment

Professor — July 2020 –
Computing Science, University of Alberta, Canada

Associate Professor — July 2013 – June 2020
Computing Science, University of Alberta, Canada

Assistant Professor — July 2006 – June 2013
Computing Science, University of Alberta, Canada

Senior Research Scientist — Aug 2005 – June 2006
UtopiaCompression Corporation, Los Angeles, CA, USA

Postdoctoral Fellow — June 2003 – July 2005
ECE, University of Virginia

Research Engineer — Oct 1998 – Dec 1999
Indian Statistical Institute, Kolkata, India

Software Engineer — Aug 1997 – Sep 1998
Price Waterhouse Associates, Kolkata, India

Research Grants

NSERC DG: $145,000 2020-2025
Differentiable Programming for Computer Vision and Medical Image Analysis

University of Alberta-Huawei Joint Innovation Centre: $185,500 2019-2022
Neural Model Compression for Real-time Comp. Vis. on Mobile Devices

MITACS E-Acceleration Grant: $165,000 2019-2022
Implementation and Analysis of Polymeric Pressure Sensor to Estimate Blood Pressure in the Brachial Artery (with Dr. Preetam Anbukarasu)

Intuit, Canada: $42,000 2019-2020
End-to-End Document Transcription using Computer Vision and Natural Language Processing with Deep Learning

Compute Canada RAC allocation, worth $4,900 2019

NSERC Engage Grants: $25,000 2019
Real-time Document Registration with Deep Learning

NSERC Engage Grants: $25,000 2017
Using Deep Learning to Detect and Track all Modes in Traffic Videos

NSERC CRD: $290,000 2017-2019
Oilsand Slurry Image and Video Analysis (with Dr. Hong Zhang, PI)

NSERC DG: $90,000 2015-2020
Compressed Sensing for Computer Vision

NIH sub-grant: $6,000 2015-2016
Segmentation of 2-photon Microscopy Image, Grant holder: LIAI, USA

NSERC Engage Grants: $25,000 2015-2016
Background Subtraction with Deep Learning

NSERC Engage Plus Grants: $15,000 2014
Intel. Consumer Video Monitoring With Cloud Based Deep Neural Net.

NSERC Engage Grants: $25,000 2013-2014
Cloud-based Com. Vis. for Consumer Video Monitoring Application

NSERC CRD: $200,000 2012-2015
Counting Passengers and Vehicles with Computer Vision Techniques

Industrial donation for Edmonton LRT passenger counting: $6,000 2012

Industrial donation for Edmonton LRT passenger counting: $10,000 2011

AICML Grant: $4000 2011
Image Proc. for the breast cancer research (with Dr. Russ Greiner, PI)

NSERC DG: $125,000 2011-2015
Feature Correspondence for Image Analysis

NSERC DG: $60,000 2006-2010
Hybrid computational strategies for im. Segment. and obj. tracking

Startup Grant: $60,000 2006-2009
Computing Science, University of Alberta

Supervision of Students and Scholars

Postdoctoral Fellows

Dr. Preetam Anbukarasu 2019-2022
- MITACS E-Accelerate grant
- Working on development of continuous blood pressure monitoring system

Dr. Li He 2016-2017
- Worked on efficient spectral clustering methods
- **Assistant Professor** at School of Electromechanical Engineering, Guangdong University of Technology, Guangzhou, China
- Joint supervision with Dr. Hong Zhang

Dr. Mohamed Ben Salah 2012-2013
- Worked on object-tracking methods
- Employed at Intel, USA
- Joint supervision with Dr. Hong Zhang

PhD Students: Independent Supervision

Baidya Nath Saha 2006-2011

- Thesis: The evolution of snake toward automation for multiple blob-object segmentation
- MITACS Accelerate 2009 & 2010, $45,000
- **Assistant Professor** at Centro de Investigacion en Matematics, Monterrey, Mexico

Sharmin Nilufar 2008-2011

- Thesis: Scale-space feature selection with multiple kernel learning and it application to oil sand image analysis
- **iCORE PhD scholarship** ($36,000 per annum) in ICT 2008-2010
- Employed at CRA Canada

Satarupa Mukherjee 2010-2014

- Thesis: A novel framework for unique people count from videos
- MITACS Accelerate internship 2010, $15,000
- Employed at SpeedInfo, USA

Yao Xue 2014-2018

- Thesis: Cell Counting and Detection in Microscopy Images using Deep Neural Network
- Awarded PhD scholarship from **China Scholarship Council**
- Postdoctoral fellow at Shenzhen Institutes of Advanced Technology (SIAT), Chinese Academy of Sciences

Fateme Bahri 2014-

- Thesis: Moving object detection using neural networks
- Awarded $26,000 as Computing Science **graduate entrance scholarship**

Amir Akbarnejad 2019-

- Starting in the fall term of 2019

PhD Students: Joint Supervision

Homa Foroughi 2012-2017

- Thesis: Learning Sparse Representations for Comp. Vision Applications
- **AITF scholarship** recipient in 2014-2015
- Employed at Intuit Canada, Edmonton
- Joint supervision with Dr. Hong Zhang

Abhineet Singh 2016-

- Tentative thesis: End-to-end object detection and tracking
- Internship at ACAMP, Edmonton
- Joint supervision with Dr. Hong Zhang

Ameneh Sheikhjafari 2017-

- Tentative thesis: Deformable image registration using neural networks
- Teaching and research assistantship
- Joint supervision with Dr. Kumaradevan Punithakumar

Sara Elkerdawy 2017-

- Tentative thesis: Deep model compression for mobile devices
- Teaching and research assistantship
- Joint supervision with Dr. Hong Zhang

MSc Students: independent supervision

Nhật Nguyễn Minh 2016-2018

- Thesis: Differentiable Programming
- 2016 MITACS entrance scholarship ($10000)
- Employed at Huawei Technologies, Edmonton

Md. Toukir Imam 2016-2017

- Course-based MSc.
- Developed microscopy image segmentation software funded by NIH grant
- Employed at Industry

Yuchen Yang 2018-

- Tentative thesis: Object detection with deep learning
- Internship at ACAMP

Ayantha Randika Ponnamperuma Arachchige 2019-

- Tentative thesis: End-to-end document image processing
- Teaching and research assistantship

Aaron Liu 2019-

- Starting from the fall term of 2019

MSc Students: joint supervision

Amritpal Saini 2012-2014

- Thesis: Real time spatio-temporal segmentation of RGBD cloud and applications
- **Runner-up CS Outstanding Thesis Award,** QE II Scholarship, 2011-2013
- Employed with Clearpath Robotics, Canada
- Joint supervision with Dr. Hong Zhang

Andy Hess 2012-2015

- Thesis: Deep synthetic viewpoint prediction
- QE II Scholarship, 2013-2014
- Employed at Jumio, Montreal
- Joint supervision with Dr. Hong Zhang

2013-2015

Muhammad Usman Aziz

- Thesis: Real-time free viewpoint video system based on a new panorama stitching framework
- Employed at Huawei Technologies, Toronto
- Joint supervision with Dr. Pierre Boulanger

Jiuyu Sun 2012-2014

- Thesis: Ultrasound heart image segmentation using active contours.
- Employed at Google, Canada
- Joint supervision with Dr. Hong Zhang

Mahdi Shooshtari 2014-2016

- Thesis: Computing Velocity of Multiple Objects in Sequences of Images With an Application In Water-Based Bitumen Extraction Process
- Employed at industry
- Joint supervision with Dr. Hong Zhang

Jakaria Rabbi 2018-

- Tentative thesis: Satellite Image Processing with Deep Learning
- Internship at Alberta Energy Regulator, Edmonton
- joint supervision with Dr. Matthias Schubert

Alexander Wong 2019-

- Tentative thesis: Budget aware deep model compression
- Teaching and research assistantship
- joint supervision with Dr. Abram Hindle

Abhishek Nan 2019-

- Tentative thesis: Image analysis for diabetic retinopathy

- Teaching and research assistantship
- joint supervision with Dr. Matt Tennant

Soumyadeep Pal 2019-
- Tentative thesis: Image sequence synthesis for diabetic retinopathy
- Teaching and research assistantship
- joint supervision with Dr. Matt Tennant

Undergraduate Students:

Stephanie Gil 2014
- U of Alberta undergraduate
- Software development for automated people counting

Krishna Kanth Nakka 2014
- MITACS Globallink summer intern
- MRI image segmentation

Nhật Nguyễn Minh 2015
- MITACS Globallink summer intern
- Deep unsupervised learning

Jinxin Xu 2015
- U of Alberta undergraduate
- Software development for microscopy image analysis

Sayan Ghosal 2016
- MITACS Globallink summer intern
- Deep image registration

Tesnim Hadhri 2017
- MITACS Globallink summer intern
- Deep interactive image segmentation

Martin Humphreys 2017-2018
- U of Alberta undergraduate
- Software development for slurry analysis

Kevin Gordon 2017-2018
- U of Alberta undergraduate

· Software development for automated object tracking

Sandip Saha Joy 2019
· U of Alberta undergraduate
· Software development for breast cancer image analysis

Professional Services

Associate Editor:
IEEE Transactions on Image Processing 2013-2017
IET Image Processing 2016-2019

General Co-Chair: AI/GI/CRV Conference, Edmonton, AB 2017

Organizing Committee Member: IROS 2017, ICRA 2019 2017, 2019

Proposal Reviewer: NSERC DG, NSERC CRD. 2008-

Session Chair / Review Committee: IEEE ICIP 2010 (Technical session chair), IEEE Asilomar Conference on Signals, Systems, and Computers 2009 (Technical session chair), IEEE Southwest Symposium on Image Analysis and Interpretation (Review committee), 6th International Conference on Advances in Patt. Rec. (Review committee), 41st National Annual Convention (CSI-2006), Nov. 23-25, 2006, Kolkata Chapter (Committee member). 2006-

Journal and Conference Reviewer: Pattern Recognition, IEEE Trans. on Image Processing, IEEE Signal Processing Letters, Pattern Recognition Letters, ICCV, CVPR, IEEE ICIP, IEEE IGVGIP, IEEE ICAPR. 2006-

University / Departmental Services

Mentoring at the University Grants Assist Program 2018-

Information Technology Oversight Committee 2017-

Faculty of Science Academic Appeals Committee 2017-

Computing Science Undergraduate Curriculum Committee 2016-2018

Computing Science Graduate Admissions Committee	2007-
Distinguished Lecture Series Coordinator	2014
College of Reviewers Committee, University of Alberta	2010-2011

Courses Taught

Undergraduate

CMPUT 328: Visual Recognition **New course conceptualized, designed and offered** at Computing Science, University of Alberta.	2014-
CMPUT 398: Introduction to GPU Programming Along with Dr. Pierre Boulanger **conceptualized, designed and offered this new course** at Computing Science, University of Alberta.	2017-
CMPUT 206: Introduction to Digital Image Processing	2010-
CMPUT 300: Computers and Society	2010
CMPUT 306: Image Processing: Algorithms and Applications	2011
CMPUT 307: 3D Graphics and Animation with 3dsMax	2011
CMPUT 340: Introduction to Numerical Methods	2008, 2011
CMPUT 466/551: Introduction to Machine Learning	2007, 2009

Graduate

CMPUT 617: Visual Recognition with Convolutional Neural Networks	2016, 2018
MM 803: Image and Video Processing	2015, 2016
CMPUT 617: Graph Algorithms for Image Analysis	2012
CMPUT 615: Optimizations in Image Analysis	2010

CMPUT 615: Applications of Machine Learning in Image Analysis 2008

CMPUT 617: Advanced Image Analysis 2007

CMPUT 605: Individual Studies on Visual Recognition 2017

CMPUT 605: Individual Studies on Semantic Segmentation 2016

CMPUT 605: Individual Studies on Image Thresholding 2015

CMPUT 605: Individual Studies on Semantic Segmentation 2014

CMPUT 605: Individual Studies on Medical Image Segmentation 2013

CMPUT 605: Individual Studies on Object Detection 2011

Invited Talks and Tutorial

Alberta Centre for Advanced MNT Products (ACAMP) Symposium, Edmonton 2018
Computer Vision and Deep Learning (30 min)

Indian Statistical Institute, Kolkata, India 2017
Tutorial title: Image Caption Generation using Deep Learning (3hr 30min)

Electrical and Computer Engineering, University of Alberta 2014
Title: Registering In Vivo Microscopy Image Sequence (1hr)

University of Virginia, Charlottesville, VA, USA 2013
Title: Counting people from monocular videos (1hr)
Title: Snake computation with dynamic programming (1hr)

Aston University, Birmingham, UK 2011
Title: Correspondence analysis with image pairs (1hr)
Title: Quick brain tumor detection (1hr)

Jadavpur University, Kolkata, India 2011
Title: Optical flow computation with global outlier identification (1hr)

Washington State University, USA 2011
Title: Image Segmentation with Snakes: Progression From User Interaction To Complete Automation (1hr)

American Welding Society, Atlanta, Georgia, USA 2010
Abstract Presentation and Software Demonstration, Nov 2010 (0.5 hrs)

Bose Institute, Kolkata, India 2008
Title: Using Bhattacharya coefficient for object detection, segmentation, and visual tracking (1hr)

Indian Statistical Institute 2004
Title: Tracking rolling leukocytes from intravital microscopic video (1hr)

Publications

Google Scholar link: http://scholar.google.ca/citations?hl=en&user=E3wuLqAAAAAJ
Advisee students and scholars are underlined.

Books

[1] S.T. Acton and N. Ray, "*Biomedical image analysis: Tracking*," Morgan & Claypool Pub., 2006.

[2] S.T. Acton and N. Ray, "*Biomedical image analysis: Segmentation*," Morgan & Claypool Publishers, 2009.

PhD Dissertation

[3] N. Ray, "*Tracking rolling leukocytes in vivo using active contours with motion gradient vector flow*," Electrical and Computer Engineering, University of Virginia, May 2003.

Journal Articles

[4] J Rabbi, N Ray, M Schubert, S Chowdhury, D Chao, "Small-Object Detection in Remote Sensing Images with End-to-End Edge-Enhanced GAN and Object Detector Network," Remote Sensing 12 (9), 1432. May 2020.

[5] A. Singh, H. Kalke, M. Loewen and N. Ray, "River Ice Segmentation With Deep Learning," in IEEE Transactions on Geoscience and Remote Sensing, doi: 10.1109/TGRS.2020.2981082. April 2020.

[6] Y. Xue, G. Bigras, J. Hugh, N. Ray, "Training convolutional neural networks and compressed sensing end-to-end for microscopy cell detection," in *IEEE Transactions on Medical Imaging*. doi: 10.1109/TMI.2019.2907093. 10 pages.

[7] L. He, N. Ray, Y. Guan, H. Zhang, "Fast large-scale spectral clustering via explicit feature mapping," in *IEEE Transactions on Cybernetics*, vol. 49, no. 3, pp. 1058-1071, March 2019. doi: 10.1109/TCYB.2018.2794998

[8] H. Foroughi, N. Ray, H. Zhang, "Object classification with joint projection and low-rank dictionary learning," in *IEEE Transactions on Image Processing*, vol. 27, no. 2, pp. 806-821, Feb. 2018. doi: 10.1109/TIP.2017.2766446

[9] S. Ghosal, N. Ray, "Deep deformable registration: Enhancing accuracy by fully convolutional neural net," *Pattern Recognition Letters*, vol. 94, pp.81–86, 2017. https://doi.org/10.1016/j.patrec.2017.05.022

[10] L. He, N. Ray, H. Zhang, "Error bound of Nyström-approximated NCut eigenvectors and its application to training size selection," *Neurocomputing*, vol.239, pp.130-142, 2017. https://doi.org/10.1016/j.neucom.2017.02.011

[11] N. Alsufyani, A. Hess, M. Noga, N. Ray, Mohammed AQ Al-Saleh, Manuel O Lagravère, Paul W Major, "New algorithm for semiautomatic segmentation of nasal cavity and pharyngeal airway in comparison with manual segmentation using cone-beam computed tomography," *American Journal of Orthodontics and Dentofacial Orthopedics*, vol. 150, no.4, pp. 703-712, 2017. https://doi.org/10.1016/j.ajodo.2016.06.024

[12] N. Ray, S. McArdle, S.T. Acton, K. Ley, "MISTICA: Minimum spanning tree-based coarse image alignment for microscopy image sequences," *IEEE Journal of Biomedical and Health Informatics*, vol.20, no.6, pp.1575-1584, 2016. 10.1109/JBHI.2015.2480712

[13] H. Foroughi, N. Ray, H. Zhang, "Robust people counting using sparse representation and random projection," *Pattern Recognition*, vol.48, no.10, pp.3038-3052, 2015. https://doi.org/10.1016/j.patcog.2015.02.009

[14] S. McArdle, G. Chodaczek, N. Ray, K. Ley, "Intravital live cell triggered imaging system (ILTIS) reveals monocyte patrolling and macrophage migration in atherosclerotic arteries," *Journal of Biomedical Optics*, vol.20, no.2, 2015. doi:10.1117/1.JBO.20.2.026005, 10 pages.

[15] S. Mukherjee, S. Gil, N. Ray, "Unique people count from monocular videos," *The Visual Computer*, Vol.31, no.10, pp 1405-1417, October 2015. https://doi.org/10.1007/s00371-014-1022-6

[16] R. Chatterjee, M. Ghosh, A.S. Chowdhury, N. Ray, "Cell tracking in microscopic video using matching and linking of bipartite graphs," *Computer Methods and Programs in Biomedicine*, vol.112, no.3, pp.422-431, 2013. doi: 10.1016/j.cmpb.2013.08.001

[17] H. Wang, H. Zhang, N. Ray, "Adaptive shape prior in graph cut image segmentation," *Pattern Recognition*, vol.46, no.5, pp.1409-1414, 2013. doi: 10.1016/j.patcog.2012.11.002

[18] H. Wang, H. Zhang, N. Ray, "Clump Splitting Via Bottleneck Detection and Shape Classification," *Pattern Recognition*, vol.45, no.7, pp.2780-2787, 2012. https://doi.org/10.1016/j.patcog.2011.12.020

[19] Z. Wang, M.B. Salah, H. Zhang, N. Ray, "Shape based appearance model for kernel tracking" *Image and Vision Computing*, vol.30, no.4, pp.332-344, 2012. https://doi.org/10.1016/j.imavis.2012.03.003

[20] S. Nilufar, N. Ray, H. Zhang, "Object detection with DoG scale-space: A multiple kernel learning approach," *IEEE Transactions on Image Processing*, vol.21, no.8, pp.3744-3756, 2012. doi: 10.1109/TIP.2012.2192130

[21] D.P. Mukherjee, N. Ray, "Contour interpolation using level set analysis," *International Journal of Image and Graphics*, vol.12, no.1, 2012. https://doi.org/10.1142/S0219467812500040

[22] J. Shi, N. Ray, H. Zhang, "Shape based local thresholding for binarization of document images," *Pattern Recognition Letters*, vol.33, pp.24-32, 2012. https://doi.org/10.1016/j.patrec.2011.09.014

[23] B. Saha, N. Ray, R. Greiner, A. Murtha, H. Zhang, "Quick detection of brain tumors and edemas: A bounding box method using symmetry," *Computerized Medical Imaging and Graphics*, vol.36, no.2, pp.95-107, 2012.

[24] N. Ray, "Computation of fluid and particle motion from time sequenced image pair: a global outlier identification approach," *IEEE Transactions on Image Processing*, vol.20, no.10, pp.2925-2936, 2011. doi: 10.1109/TIP.2011.2142005

[25] D.P. Mukherjee, I. Cheng, N. Ray, V. Mushahwar, A. Basu, "Automatic segmentation of spinal cord MRI using symmetric boundary tracing," *IEEE Trans. on Information Tech. in Biomedicine*, vol.14, pp.1275-1278, 2010. doi: 10.1109/TITB.2010.2052060

[26] B. Saha, N. Ray, H. Zhang, "Snake validation: A PCA-based outlier detection method," *IEEE Signal Processing Letters*, vol.16, pp.549-552, 2009. doi: 10.1109/LSP.2009.2017477

[27] B. Saha, N. Ray, "Image thresholding by variational minimax optimization," *Pattern Recognition*, vol.42, no.5, pp.843-856, May 2009. https://doi.org/10.1016/j.patcog.2008.09.033

[28] J. Cui, N. Ray, S.T. Acton, Z. Lin, "An affine transformation invariance approach to cell tracking," *Computerized Medical Imaging and Graphics*, vol.32 , no.7, pp.554-565, June 2008. doi: 10.1016/j.compmedimag.2008.06.004

[29] N. Ray, R. Greiner, A. Murtha, "Using symmetry to detect abnormalities in brain MRI," *Computer Society of India Communications*, vol.31, issue.10, pp.7-10, January 2008.

[30] N. Ray, S.T. Acton, “Inclusion filters: a class of self-dual connected operators,” *IEEE Transactions on Image Processing*, vol. 14, no.11, pp. 1736-1746, Nov. 2005. doi: 10.1109/TIP.2005.857251

[31] N. Ray, S.T. Acton, “Data acceptance for automated leukocyte tracking through segmentation of spatiotemporal images,” *IEEE Transactions on Biomedical Engineering*, vol.52, no. 10, pp.1702-1712, Oct. 2005. doi: 10.1109/TBME.2005.855718

[32] G. Dong, N. Ray, S.T. Acton, “Intravital leukocyte detection using the gradient inverse coefficient of variation,” *IEEE Transactions on Medical Imaging*, Vol.24, no.7, pp. 910-924, July 2005. doi: 10.1109/TMI.2005.846856

[33] A.K. Chattopadhyay, N. Ray, S.T. Acton, “Universality in the merging dynamics of parametric active contours: a study in MRI based lung segmentation,” *New Journal of Physics*, vol. 7, pp. 148-159, 2005. doi: 10.1088/1367-2630/7/1/148

[34] N. Ray, S.T. Acton, “Motion gradient vector flow: An external force for tracking rolling leukocytes with shape and size constrained active contour,” *IEEE Trans. Medical Imaging*, vol. 23, no. 12, pp. 1466-1478, 2004. doi: 10.1109/TMI.2004.835603

[35] D.P. Mukherjee, N. Ray, S.T. Acton, “Level set analysis for cell detection and tracking,” *IEEE Trans. Image processing*, vol.13, no.4, pp.562-572, 2004. doi: 10.1109/TIP.2003.819858

[36] N. Ray, S.T. Acton, T. Altes, E.E. de Lange, J.R. Brookeman, “Merging parametric active contours within homogeneous image regions for MRI-based lung segmentation,” *IEEE Trans. Medical Imaging*, vol.22, no. 1, pp.189-199, 2003.

[37] N. Ray, S.T. Acton, K.F. Ley, “Tracking leukocytes in vivo with shape and size constrained active contours,” *IEEE Trans. Medical Imaging*, special issue on Image Analysis in Drug Discovery and Clinical Trials, vol.21, no. 10, pp. 1222-1235, 2002. doi: 10.1109/TMI.2002.808354

[38] N. Ray, B. Chanda, J. Das, “A fast and flexible multiresolution snake with a definite termination criterion,” *Pattern Recognition*, vol. 34, pp.1483-1490, 2001. https://doi.org/10.1016/S0031-3203(00)00077-7

[39] N. Ray, D.P. Mukherjee, J. Das, “Identification of tracer cloud: A shape based approach” Current Science, Vol. 76, No.7, 1999, a publication from Indian Academy of Sciences.

[40] S. Jeyamkondan, N. Ray, G.A. Kranzler, N. Biju, “Computer vision segmentation of the longissimus dorsi for beef quality grading,” Transactions of the ASAE, vol. 47, no. 4, pp.1261-1268, 2004. doi: 10.13031/2013.16560

Conference Publications

[41] L. Gilmour, N. Ray, “Locating Cephalometric X-Ray Landmarks with Foveated Pyramid Attention,” MIDL 2020.

[42] N.M. Nguyen, N. Ray, “End-to-end learning of convolutional neural net and dynamic programming for left ventricle segmentation,” MIDL 2020.

[43] A. Nan, M. Tennant, U. Rubin, N. Ray, “DRMIME: Differentiable Mutual Information and Matrix Exponential for Multi-Resolution Image Registration,” MIDL 2020.

[44] S. Scheideman, N. Ray, H. Zhang, “A Flexible Method for Performance Evaluation of Robot Localization,” ICRA 2020.

[45] S. Elkerdawy, M. Elhoushi, A. Singh, H. Zhang, N. Ray, “One -shot layer-wise accuracy approximation for layer pruning,” ICIP 2020.

[46] S. Ghosh, N. Ray, P. Boulanger, K. Punithakumar and M. Noga, "Automated Left Atrial Segmentation from Magnetic Resonance Image Sequences Using Deep Convolutional Neural Network with Autoencoder," 2020 IEEE 17th International Symposium on Biomedical Imaging (ISBI), Iowa City, IA, USA, 2020, pp. 1756-1760, doi: 10.1109/ISBI45749.2020.9098646.

[47] A. Singh, M. Pietrasik, G. Natha, N. Ghouaiel, K. Brizel, N. Ray, “Animal Detection in Man-made Environments,” The IEEE Winter Conference on Applications of Computer Vision (WACV), 2020, pp. 1438-1449.

[48] S. Elkerdawy, H. Zhang, N. Ray, “Lightweight monocular depth estimation model by joint end-to-end filter pruning,” accepted at *26th IEEE International conference on image processing (ICIP)*, 2019. 5 pages. https://arxiv.org/abs/1905.05212

[49] N.M. Nguyen, N. Ray, “Generative adversarial networks using adaptive convolution,” accepted at *16th Conference on Computer and Robot Vision (CRV)*, 2019. 6 pages. https://arxiv.org/abs/1802.02226

[50] S. Elkerdawy, N. Ray, H. Zhang, “Fine-grained vehicle classification with unsupervised parts co-occurrence learning,” *15th European Conference on Computer Vision* (ECCV) Workshops, Munich, Germany, 2018. 6 pages.

[51] F. Bahri, M. Shakeri, N. Ray, "Online Illumination Invariant Moving Object Detection by Generative Neural Network," *11th Indian Conference on Computer Vision, Graphics and Image Processing (ICVGIP)*, Hyderabad, India, 2018. arXiv: https://arxiv.org/abs/1808.01066, 7 pages.

[52] Y. Xue, N. Ray, "Output encoding by compressed sensing for cell detection with deep convnet," Workshop on Artificial Intelligence Applied to Assistive Technologies and Smart Environments at *32nd AAAI Coneference on Artificial Intelligence, New Orleans, USA.* 7 pages. https://aaai.org/ocs/index.php/WS/AAAIW18/paper/view/16188

[53] A. Sheikhjafari, K. Punithakumar, N. Ray, "Unsupervised deformable image registration with fully connected generative neural network," *International Conference on Medical Imaging and Deep Learning* (MIDL), Amsterdam, Netherlands, 2018. 9 pages. https://openreview.net/forum?id=HkmkmW2jM

[54] S. Ghosh, A. Banerjee, N. Ray, P. Wood, P. Boulanger, R. Padwal, "Using accelerometric and gyroscopic data to improve blood pressure prediction from pulse transit time using recurrent neural network," *2018 43rd IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Calgary, AB, Canada, 2018. 5 pages.

[55] S. Valipour, M. Siam, M. Jagersand, N. Ray, "Recurrent fully convolutional networks for video segmentation," *2017 IEEE Winter Conference on Applications of Computer Vision (WACV)*, Santa Rosa, CA, 2017, pp. 29-36.

[56] M. Siam, S. Valipour, M. Jagersand, N. Ray, S. Yogamani, "Convolutional gated recurrent networks for video semantic segmentation in automated driving," *2017 IEEE 20th International Conference on Intelligent Transportation Systems (ITSC)*, Yokohama, 2017, pp. 1-7.

[57] B. Saha, N. Ray, S. McArdle, K. Ley, "Selecting the optimal sequence for deformable registration of microscopy image sequences using a two-stage minimum spanning tree (MST)-based clustering algorithm," *20th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, Quebec City, Quebec, Canada, 2017. MICCAI 2017, Part I, LNCS 10433, pp. 353–361, 2017.

[58] Y. Xue, N. Ray, J. Hugh, B. Gilbert, "A novel framework to integrate convolutional neural network with compressed sensing for cell detection," *2017 IEEE International Conference on Image Processing (ICIP)*, Beijing, 2017, pp. 2319-2323.

[59] S. Ghosh, P. Boulanger, S.T. Acton, S.S. Blemker, N. Ray, "Automated 3D muscle segmentation from MRI data using convolutional neural network," *2017 IEEE International Conference on Image Processing (ICIP)*, Beijing, 2017, pp. 4437-4441.

[60] M. Siam, S. Valipour, M. Jagersand, N. Ray, "Convolutional gated recurrent networks for video segmentation," *2017 IEEE International Conference on Image Processing (ICIP)*, Beijing, 2017, pp. 3090-3094.

[61] B. Saha, N. Ray, S. McArdle, K. Ley, "A two-stage minimum spanning tree (MST)-based clustering algorithm for 2D deformable registration of time sequenced images," *2017 IEEE International Conference on Image Processing (ICIP)*, Beijing, 2017, pp. 1472-1476.

[62] H. Foroughi, M. Shakeri, N. Ray, H. Zhang, "Face recognition using multi-modal low-rank dictionary learning," *2017 IEEE International Conference on Image Processing (ICIP)*, Beijing, 2017, pp. 1082-1086.

[63] S. Ghosh, N. Ray, P. Boulanger, "A Structured deep-learning based approach for the automated segmentation of human leg muscle from 3D MRI," *2017 14th Conference on Computer and Robot Vision (CRV)*, Edmonton, AB, 2017, pp. 117-123.

[64] S. Ghosh, A. Banerjee, N. Ray, P.W. Wood, P. Boulanger, R. Padwal, "Continuous blood pressure prediction from pulse transit time using ECG and PPG signals," *2016 IEEE Healthcare Innovation Point-Of-Care Technologies Conference (HI-POCT)*, Cancun, 2016, pp. 188-191.

[65] S. Ghosh, A. Banerjee, N. Ray, P.W. Wood, P. Boulanger, R. Padwal, "Non-invasive and continuous blood pressure prediction from pulse transit time using ECG and PPG signals," Poster presented at: *Canadian Hypertension Congress Hypertension Canada*; October 2016; Montreal, Quebec.

[66] S. Ghosh, N. Ray, P.W. Wood, P. Boulanger, R. Padwal, "Pulse transit time computation using signal sparsity for continuous blood pressure prediction," Poster presented at: *38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*; August 2016; Orlando, Florida.

[67] Y. Xue, N. Ray, J. Hugh, G. Bigras, "Cell counting by regression using convolutional neural network," 14th *European Conference on Computer Vision Workshop*, pp.274-290, 2016.

[68] A. Hess, N. Ray, H. Zhang, "Synthetic Viewpoint Prediction," *2016 13th Conference on Computer and Robot Vision (CRV)*, Victoria, BC, pp. 391-398, 2016.

[69] H. Foroughi, M. Sakeri, N. Ray, H. Zhang, "Joint feature selection with low-rank dictionary learning," In Xianghua Xie, Mark W. Jones, and Gary K. L. Tam, editors, Proceedings of the *British Machine Vision Conference* (BMVC), pages 97.1-97.13. BMVA Press, September 2015.

[70] N. Ray, S. Mukherjee, K. Kanth, S.T. Acton, S.S. Blemker, "3D-To-2D mapping for user interactive segmentation of human leg muscles from MRI data," *2014 IEEE Global Conference on Signal and Information Processing (GlobalSIP)*, Atlanta, GA, pp. 50-54, 2014.

[71] S. McArdle, S.T. Acton, K. Ley, N. Ray, "Registering sequences of in vivo Microscopy Images for Cell Tracking Using Dynamic Programming and Minimum Spanning Trees," *2014 IEEE International Conference on Image Processing (ICIP)*, Paris, pp. 3547-3551, 2014.

[72] B.N. Saha, A. Saini, N. Ray, R. Greiner, J. Hugh, M. Tambasco, "A robust convergence index filter for breast cancer cell segmentation," *2014 IEEE International Conference on Image Processing (ICIP)*, Paris, pp. 922-926, 2014.

[73] J. Sun, N. Ray, H. Zhang, "VFCCV snake: A novel active contour model combining edge and regional information," *2014 IEEE International Conference on Image Processing (ICIP)*, Paris, pp. 927-931, 2014.

[74] H. Foroughi, N. Ray, H. Zhang, "People counting with image retrieval using compressed sensing," *2014 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Florence, 2014, pp. 4354-4358.

[75] S. Mukherjee, N. Ray, S.T. Acton, "Counting cells from microscopy videos without tracking individual cells," *2014 IEEE 11th International Symposium on Biomedical Imaging (ISBI)*, Beijing, 2014, pp. 465-468.

[76] S. Mukherjee, N. Ray, D.P. Mukherjee, "Tracking objects with rigid body templates: An iterative constrained linear least squares approach," In: Maji P., Ghosh A., Murty M.N., Ghosh K., Pal S.K. (eds) *Pattern Recognition and Machine Intelligence*. *PReMI 2013*. Lecture Notes in Computer Science, vol 8251, pp 396-403, Springer, Berlin, Heidelberg, 2013.

[77] B.N. Saha, G. Kunapuli, N. Ray, J.A. Maldjian, S. Natarajan, "AR-boost: Reducing overfitting by a robust data-driven regularization strategy," Joint European Conference on Machine Learning and Knowledge Discovery in Databases. ECML PKDD 2013: Machine Learning and Knowledge Discovery in Databases pp 1-16, 2013.

[78] N. Ray, S.T. Acton, H. Zhang, "Seeing through clutter: Snake computation with dynamic programming for particle segmentation," *Proceedings of the 21st International Conference on Pattern Recognition (ICPR2012)*, Tsukuba, pp. 801-804, 2012.

[79] S. Nilufar, N. Ray, H. Zhang, "Wavelet subband-based steam detection by multiple kernel learning," *2012 19th IEEE International Conference on Image Processing (ICIP)*, Orlando, FL, pp. 1153-1156, 2012.

[80] S. Nilufar, N. Ray, M.K.I. Molla, K. Hirose, "Spectrogram based features selection using multiple kernel learning for speech/music discrimination," *2012 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Kyoto, pp. 501-504, 2012.

[81] S. Mukherjee, B. Saha, I. Jamal, R. Leclerc, N. Ray, "A novel framework for automatic passenger counting," *2011 18th IEEE International Conference on Image Processing*, Brussels, pp. 2969-2972, 2011.

[82] H. Wang, H. Zhang, N. Ray, "Clump splitting via bottleneck detection," *2011 18th IEEE International Conference on Image Processing*, Brussels, pp. 61-64, 2011.

[83] N. Ray, "Median filter with absolute value norm spatial regularization," *2011 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Prague, pp. 1437-1440, 2011.

[84] N. Ray, "A concave cost formulation for parametric curve fitting: Application to leukocyte detection from intravital microscopy images," *2010 IEEE International Conference on Image Processing*, Hong Kong, pp. 53-56, 2010.

[85] A.S. Chowdhury, R. Chatterjee, M. Ghosh, N. Ray, "Cell tracking in video microscopy using bipartite graph matching," *2010 20th International Conference on Pattern Recognition*, Istanbul, pp. 2456-2459, 2010.

[86] B. Saha, N. Ray, H. Zhang, "Automating snakes for multiple objects detection," *Asian Conference on Computer Vision (ACCV)* 2010, Part III, LNCS 6494, pp.39-51, 2010.

[87] S. Nilufar, N. Ray, H. Zhang, "Optimum kernel function design from scale space features for object detection," *2009 16th IEEE International Conference on Image Processing (ICIP)*, Cairo, pp. 861-864, 2009.

[88] Z. Wang, H. Zhang, N. Ray "Tracking of multiple interacting objects using a novel prediction model," *2009 16th IEEE International Conference on Image Processing (ICIP)*, Cairo, pp. 869-872, 2009.

[89] J. Shi, H. Zhang, N. Ray, "Solidity based local threshold for oil sand image segmentation," *2009 16th IEEE International Conference on Image Processing (ICIP)*, Cairo, pp. 2385-2388, 2009.

[90] N. Ray, B. Saha, S.T. Acton, "Oil sand image segmentation using the inclusion filter", invited paper in special session on connected operators at *2008 15th IEEE International Conference on Image Processing*, San Diego, CA, pp. 2188-2191, 2008.

[91] N. Ray, B. Saha, H. Zhang, "Change detection and object segmentation: A histogram of features-based energy minimization approach," *2008 Sixth Indian Conference on Computer Vision, Graphics & Image Processing*, Bhubaneswar, pp. 628-635, 2008.

[92] S. Nilufar, N. Ray, "Automatic blood cell classification by joint histogram based feature and Bhattacharya kernel," *2008 42nd Asilomar Conference on Signals, Systems and Computers*, Pacific Grove, CA, pp. 1915-1918, 2008.

[93] S. Zabuawala, H. Wei, C. Raju, N. Ray, J. Yadegar, "Automated image processing and fusion for remote sensing applications," In the *Proceedings of Computational Imaging VII*, SPIE. vol. 7246 (724612, Feb. 2, 2009). 8 pages.

[94] H. Wang, N. Ray, H. Zhang, "Graph-cut optimization of the ratio of functions and its application to image segmentation", *2008 15th IEEE International Conference on Image Processing*, San Diego, CA, pp. 749-752, 2008.

[95] B. Saha, N. Ray, H. Zhang, "Computing oil sand particle size distribution by snake-PCA algorithm," *2008 IEEE International Conference on Acoustics, Speech and Signal Processing*, Las Vegas, NV, pp. 977-980, 2008.

[96] D. Zhou, H. Zhang, N. Ray, "Texture based background subtraction," In *2008 IEEE International Conference on Information and Automation*, pp.601-605, Zhang Jia Jie, China. June 2008.

[97] N. Ray, B. Saha, "Edge sensitive variational image thresholding," *2007 IEEE International Conference on Image Processing*, San Antonio, TX, 2007, pp. VI - 37-VI – 40, 2007.

[98] N. Ray, B. Saha, M. Brown, "Locating brain tumor from MR imagery using symmetry," *2007 Conference Record of the Forty-First Asilomar Conference on Signals, Systems and Computers*, Pacific Grove, CA, pp. 224-228, 2007.

[99] N. Ray, D.P. Mukherjee, "Image registration and object tracking via affine combination," *Proc. 6th Int. Conf. on Advances in Pat. Recog*., pp.175-179, January, 2007.

[100] S. Sahoo, N. Ray, S.T. Acton, "Rolling leukocyte detection based on teardrop shape and the gradient inverse coefficient of variation," *International Conf. on Medical Information Visualisation - BioMedical Visualisation 2006*. MediVis 2006, pp. 29-33, 5-7 July 2006.

[101] J. Cui, N. Ray, S.T. Acton, Z. Lin, "Application of the affine transform invariant model to cell tracking," *IEEE Southwest Symposium on Image Analysis and Interpretation*, pp.56-60, March 2006.

[102] N. Ray, G. Dong, S.T. Acton, "Tracking multiple cells by correspondence resolution in a sequential Bayesian framework," *Proceedings of IEEE ICIP*, vol.1, pp.705-708, Sept. 2005.

[103] N. Ray, S.T. Acton, "Spatiotemporal segmentation for validation of rolling leukocyte tracking data," *Proceedings of IEEE ICASSP*, vol.2, pp. 129-132, Philadelphia, 2005.

[104] R. Janiczek, N. Ray, F. Epstein, S.T. Acton, "A Markov chain Monte Carlo method for tracking myocardial borders," invited paper at IS&T/SPIE's *17th annual symposium on electronic im. science and technology*, Jan.16-20, 2005.

[105] G. Dong, N. Ray, S.T. Acton, "Automated leukocyte detection in vivo," *Proc. of 38th Asilomar conf. on Signals, Systems and Computers*, vol.2, pp.1832-1837, Pacific Groove, CA, Nov 7-Nov.10, 2004.

[106] S.T. Acton, N. Ray, "Detection and tracking of rolling leukocytes from intravital microscopy," invited paper in *2004 IEEE International Symposium on Biomedical Imaging*: *From Nano to Macro*, Arlington, Virginia, April 15- 18, 2004.

[107] N. Ray, S.T. Acton, "Tracking rolling leukocytes with motion gradient vector flow", *The Thrity-Seventh Asilomar Conference on Signals, Systems & Computers, 2003*, Pacific Grove, CA, USA, pp. 1948-1952 Vol.2, 2003.

[108] N. Ray, S.T. Acton, "Self-dual inclusion filters for grayscale imagery," *Proceedings of IEEE ICIP*, vol.1, pp. 321-324, Barcelona, Spain, September 14-17, 2003.

[109] N. Ray, S.T. Acton, "Tracking fast-rolling leukocytes in vivo with active contours," *Proc. of IEEE ICIP 2002*, vol.3, pp.165-168. **Won best student paper award from IBM Signal Processing Society**.

[110] N. Ray, S.T. Acton, "Active contours for cell tracking," *Proceedings Fifth IEEE Southwest Symposium on Image Analysis and Interpretation*, Sante Fe, NM, USA, pp. 274-278, 2002.

[111] J. Tang, G. Dong, N. Ray, S.T. Acton, "Evaluation of intravital tracking algorithms," *IEEE International Midwest Symposium on Circuits and Systems*, Tulsa, Oklahoma, August, 2002. 4 pages.

[112] N. Ray, S.T. Acton, "Adaptive image processing via snake filters," *35th Asilomar Conference on Signals, Systems and Computers (Cat.No.01CH37256)*, Pacific Grove, CA, USA, pp. 337-341 vol.1, 2001.

[113] N. Ray, J. Havlicek, S.T. Acton, M. Pattichis, "Active contour segmentation guided by AM-FM dominant component analysis," *Proceedings 2001 International Conference on Image Processing (ICIP)*, Thessaloniki, Greece, pp. 78-81 vol.1, 2001.

[114] N. Ray, S.T. Acton, T. Altes, E.E. de Lange "MRI ventilation analysis by merging parametric active contours," *Proceedings of IEEE ICIP 2001*, pp.861-864.

[115] N. Ray, S.T. Acton, "Image segmentation by curve evolution with clustering," In the proceedings of *34th Asilomar conference on Signals, Systems and Computers*, Pacific Grove, CA, pp.495-498, Oct 29-Nov.1, 2000.

[116] S. Jeyamkondan, N. Ray, G.A. Kranzler, and B. Nisha, "Beef quality grading using machine vision," *In the Proceedings of SPIE*, Vol. 4203, pp.91-101, 2000.

[117] S. Jeyamkondan, N. Ray, G.A. Kranzler, J. Nelson, "Adaptive segmentation of longissimus dorsi using fuzzy c- means and convex hull," Presented at *the Oklahoma section of the American Society of Agricultural Engineering meeting*, 27 October 2000.

[118] B. Chanda, N. Ray, P. Pal, J. Das, "A 3-D erosion model for image processing with special reference to cloud IR image," in The *4th International Conference on Advances in Pattern Recognition and Digital Techniques*, December 27-29, 1999, Indian Statistical Institute, Calcutta, India.

Research Collaborations

I have worked or have been working with the following researchers.

Dr. Dipti Prasad Mukherjee (Professor, Indian Statistical Institute, India)
Dr. Scott Acton (Professor, ECE, University of Virginia, USA)
Dr. Klaus Ley (Professor and Division Head, Division of Inflammation Biology, LIAI, USA)
Dr. Russ Greiner (Professor, Computing Science, University of Alberta)
Dr. Hong Zhang (Professor, Computing Science, University of Alberta)
Dr. Anup Basu (Professor, Computing Science, University of Alberta)
Dr. Ananda S Chowdhury (Associate Professor, ECE, Jadavpur University, Kolkata, India)
Dr. Noura Alsufyani (Assistant Professor, Medicine & Dentistry, University of Alberta)
Dr. Paul Major (Professor and Department Chair, Medicine & Dentistry, U of Alberta)
Dr. Judith Hugh (Professor of Medicine & Dentistry, U of Alberta)
Dr. Pierre Boulanger (Professor, Computing Science, University of Alberta)
Dr. Kumaradevan Punithakumar (Assistant Professor, Dept. of Radiology, U of Alberta)
Dr. Martin Jagersand (Professor, Computing Science, University of Alberta)
Dr. Mark Loewen (Professor, Civil & Environmental Engineering, University of Alberta)
Dr. Bigras Gilbert (Medical Lead Edmonton IHC Lab, Cross Cancer Institute, Edmonton)
Dr. Raj Padwal (Professor of Medicine & Dentistry, University of Alberta)
Dr. Armin Gamper (Assistant Professor, Department of Oncology University of Alberta)
Dr. Dennis Chao (Alberta Energy Regulator, Edmonton)
Dr. Matthias Schubert (Apl. Professor, Ludwig-Maximilians-Universität München, Germany)
Dr. Yasser Mohamed (Professor, Hole School of Construction Engineering)