MADHURI NAGARE

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Summary

- Proficiency in Image Processing (medical and satellite images), Computational Imaging, Machine Learning
- Skilled in implementing deep learning framework
- 8 years of research experience in industry and academia
- Successful collaborations with cross-cultural and multidisciplinary teams

Education

May 2024 (Expected)	Ph.D. in Electrical and Computer Engineering Purdue University, West Lafayette, USA Advisor: Prof. Charles A. Bouman CGPA: 3.93/4
June 2015	Master of Technology in Geoinformatics and Natural Resources Engineering Indian Institute of Technology Bombay (IITB), India CGPA: 9.86/10, Department **rank** 1
June 2013	Bachelor of Technology in Electronics and Telecommunication Engineering College of Engineering, Pune (COEP), India CGPA: 9.44/10, Department **rank** 1

Publications

- **M. Nagare**, J. Tang, O. Rahman, B. Nett, R. Melnyk, K. D. Sauer, and C. A. Bouman, "A noise preserving sharpening filter for CT image enhancement," in *ICIP - IEEE International Conference on Image Processing*, 2022
- **M. Nagare**, R. Melnyk, O. Rahman, K. D. Sauer, and C. A. Bouman, "A bias-reducing loss function for CT image denoising," in *ICASSP - IEEE International Conference on Acoustics, Speech and Signal Processing*, 2021
- O. Rahman, **M. Nagare**, K. D. Sauer, C. A. Bouman, R. Melnyk, B. Nett, and J. Tang, "MBIR training for a 2.5D DL network in x-ray CT," in *16th Intl. Meeting on Fully 3D Image Recon. in Radiology and Nuclear Medicine*, 2021
- **M. Nagare**, E. Kaneko, M. Toda, H. Aoki, and M. Tsukada, "Cloud shadow removal based on cloud transmittance estimation," in *IGARSS - IEEE International Geoscience and Remote Sensing Symposium*, 2018
- **M. Nagare**, H. Aoki, and E. Kaneko, "A unified method of cloud detection and removal robust to spectral variability," in *IGARSS - IEEE International Geoscience and Remote Sensing Symposium*, 2017
- P. P. Shingare, **M. Nagare**, and C. P. Joshi, "Improved active contour model for satellite images," in *ICIIP - IEEE Second International Conference on Image Information Processing*, 2013

Patents

June 2022 (filed)	Noise Preserving Models and Methods for Resolution Recovery of X-Ray Computed Tomography Images **Madhuri Nagare**, *Jie Tang, Roman Melnyk, Obaidullah Rahman, Brian Nett, Ken D. Sauer, Charles A. Bouman* USPTO Application Number 17/807,779
May 2022 (filed)	Systems and Methods for Computed Tomography Image Denoising with a Bias-Reducing Loss Function **Madhuri Nagare**, *Roman Melnyk, Obaidullah Rahman, Ken D. Sauer, Charles A. Bouman* USPTO Application Number 17/662,161
Aug. 2018	System, Method, and Non-Transitory, Computer-Readable Medium Containing Instructions for Image Processing (Cloud Removal) **Madhuri Nagare**, *Eiji Kaneko, Masato Toda, Masato Tsukada* Patent Number US 10,650,498 B2, Published Feb. 2020
Jan. 2018	Image Processing Device, Image Processing Method and Storage Medium (Cloud Removal) **Madhuri Nagare**, *Eiji Kaneko, Masato Toda, Masato Tsukada* Patent Number WO2019150453A1, US 2020/0364835 A1, Published Aug. 2019
Sept. 2017	Image Processing Device, Image Processing Method and Storage Medium (Cloud Shadow Removal) **Madhuri Nagare**, *Hirofumi Aoki, Kazutoshi Sagi* Patent Number WO2019049324A1, US 11,227,367 B2, Published Mar. 2019
Dec. 2016	Image Processing Device, Image Processing Method and Storage Medium (Cloud Removal) **Madhuri Nagare**, *Hirofumi Aoki, Eiji Kaneko* Patent Number WO2018116367A1, US 11,017,507 B2, Published June 2018

Technical Skills

Programming Languages:	Python, C, Matlab, Swift
Libraries:	Keras, TensorFlow, NumPy, SciPy, OpenCV, GDAL
Softwares:	ENVI, ERDAS Imagine, ArcGIS, KEIL, XILINX ISE, Multisim
Key Courses:	Computer Vision, Model Based Image Processing, Topics in Machine Learning, Digital Image Processing, Digital Signal Processing, Signals and Systems, Advanced Satellite Image Processing, Optimization Methods for Systems and Control, Random Signals and Stochastic Processes, Electromagnetic Waves
Languages:	Marathi (Native), English (Fluent), Hindi (Fluent), Japanese (Basic)

Internships

May 2019- Aug. 2019 | **Ph.D. Intern**
GE Healthcare, Waukesha, USA

Project | **To denoise low-dose CT images**

Approach & Results
- Studied concepts of medical imaging systems and reconstruction algorithms
- Implemented Deep Neural Network (**DNN**) based methods to denoise CT scans
- Proposed a robust approach to get MBIR (model-based iterative reconstruction) quality CT images from FBPs (Filtered back-projections) by adding noise to the training data set
- Achieved on an average 1.5 dB gain in the peak signal-to-noise ratio
- **Coordinated with clinicians** for the real-world evaluation of proposed solutions

Academic Research

Sep. 2018- Ongoing | **Quality Enhancement of X-ray Computed Tomography (CT) Images**
Advisor: Prof. Charles A. Bouman (Purdue University, USA)

Goal | To develop computationally efficient techniques to produce high quality CT images

Approach & Results
- Analyzed a limitation of machine learning (ML) approaches of producing over-smooth (biased) results lacking texture and proposed solutions to retain texture while denoising and deblurring
- Designed ML algorithms to operate at specific points on the bias-variance tradeoff curve
- Developed a **bias-reducing loss function** that allows to train a denoiser so that the amount of texture and detail retained can be controlled through an adjustable parameter
- Verified clinically that the proposed loss function **improves texture and detail** in denoised images
- Proposed a **noise preserving sharpening filter** to deblur CT images while maintaining good texture
- Demonstrated **robustness** of the method for various levels of input noise and sharpening produced
- Proposed a **generative model** to produce desired texture while denoising and deblurring
- Implemented and evaluated proposed solutions in a deep learning framework
- **Collaborated with multidisciplinary teams** of researchers, engineers and clinicians

July 2014- June 2015 | **Decision Tree Classifiers (DTC) for Satellite Images (Master's Thesis)**
Advisor: Prof. Krishna Mohan Buddhiraju (IITB, India)

Goal | To develop a decision tree classifier which is more flexible and accurate than existing DTCs

Approach & Results
- Proposed a DTC to extract **nonlinear** class boundaries in a feature space by utilizing different classifiers and features at distinct nodes of the tree
- Employed a **genetic algorithm** (GA) to determine an appropriate design for the DTC
- Built a C library which is used by the MATLAB script of GA to train and to test the DTC
- Achieved higher accuracy for land use classification than the conventional CART (Classification And Regression Trees) algorithm

July 2012- June 2013 | **Improved Active Contour Model (ACM) for Edge Detection in Satellite Images (Bachelor's Thesis)**
Funded by Indian Space Research Organization (ISRO)
Advisor: Prof. Pratibha Shingare (COEP, India)

Goal | To devise an algorithm for detecting edges in satellite images efficiently

Approach & Results
- Improved the conventional gradient vector flow ACM to detect weak edges in satellite images by amplifying the external energy with an additive gain factor
- Devised pre- and post-processing techniques for reducing the ACM's sensitivity to initialization, noise, and the number of objects in an input image
- Implemented the method in MATLAB and simulated in Xilinx ISE for an FPGA realization
- Detected edges **1.6** times faster as compared to conventional techniques

Leadership

Apr. 2021- Apr. 2022 | **International Student Ambassador | International Students and Scholars (ISS), Purdue University**
- **Organized** various activities in the weeks-of-welcome for incoming international undergraduate and graduate students to help them acclimatize with the Purdue campus and policies
- Designed strategies to increase social media presence of the ISS office

Aug. 2019- Dec. 2019 | **Treasurer | Indian Graduate Students at Purdue, Purdue University**
- **Secured funding** from the Student Organization Grant Allocation Board for Diwali celebrations, one of the biggest cultural events on campus
- **Coordinated** with a team of 6 members to successfully organize the event for 800 students

Nov. 2016- May 2017 | **Group leader | Machine Learning Reading Group, NEC Corporation**
- **Initiated** a reading group for colleagues interested in learning the concepts of machine learning
- Coordinated readings and discussions of a book on machine learning by Kevin P. Murphy

June 2014- June 2015 | **Executive Member | Graduate Academic Council, IITB**
- **Led** a team of 15 coordinators to organize the institute-wide orientation for 1300+ graduate freshmen
- Awardee of organization special mention in Institute Gymkana Awards for exemplary performance

July 2014- June 2015 | **Student Coordinator | Resources Engineering Association (REA), CSRE, IITB**
- Led a council of 15 members to arrange departmental activities such as technical workshops, improving departmental library, raising funds for REA
- **Managed finances** for the departmental events

July 2013- June 2014 | **Graduate Cultural Coordinator | Graduate Cultural Council, IITB**
- Coordinated with 10 team members to organize a cultural fest for 3500+ students
- Publicized and managed the dance genre which witnessed 100% y-o-y increase in participation

Industrial Research

Oct. 2015- Aug. 2018 | **Assistant Researcher**
NEC Corporation, Tokyo, Japan

Project 1 | **To design a cloud removal algorithm for the atmospheric correction module of multispectral images**

Approach & Results
- Developed a technique to remove thin clouds from an image based on a radiometric transfer model and a spectral **unmixing** technique while accommodating for **variability** in the cloud **spectrum**
- Proposed a clustering method based on spatial - spectral properties of a cloud to identify its variants
- Achieved **22%** higher accuracy than the state-of-the-art method for cloud removal
- Verified the performance over diverse geographical locations and land covers to ensure robustness
- Implemented codes for NEC's atmospheric correction software module
- Adapted to the cross-cultural professional and social environment

Project 2 | **To develop an algorithm for cloud shadow removal**

Approach & Results
- Extended the cloud removal technique to include cloud shadow removal
- Proposed a method to derive attenuation factors of direct solar irradiance, a key component required to be estimated for cloud shadow removal
- Derived the factors by employing cloud transmittance values extracted during cloud removal
- Improved accuracy of the removal by **5%** as compared to the existing de-shadowing method

Achievements

- Awardee of the **Institute Silver Medal** for securing the departmental rank 1 at IIT Bombay
- Awardee of the **Institute Gold Medal** for securing the departmental rank 1 at COE Pune
- Secured **Rank 4** in the 2009 Maharashtra Health and Technical Common Entrance Test among 216725 candidates
- Won honorable mention for poster presentation at Purdue Engineering Graduate Showcase 2021

Extracurricular & Volunteering

2021 | Invited panelist: Graduate Women in ECE, Student panel during weeks-of-welcome
2020 | Led a group of volunteers to explain programming basics to 5^{th}-6^{th} grade students
2019 | Mentored a group of high school girls for 'Introduce a Girl to Engineering' Day (2019, 2020)
2019 | Coordinated with a team of volunteers to proctor MathCounts 2019, 2020
2012 | Contributed in the Guinness World Record of 'Most people solving Rubik's Cube'
2009 | Participated in NSS (National Service Scheme) activities in India such as plantation, village survey
2005 | Earned 'Certificate A' of NCC (National Cadet Corps), India

Mentorship

Fall 2018	**Teaching Assistant** for Probabilistic Methods at Purdue University • Supported a class of 80 students in understanding the concepts of probability, random variables and processes along with their Python implementation
Fall 2014	**Teaching Assistant** for Satellite Image Processing at IITB • Mentored a batch of 27 students for the coursework and lab work • Conducted MATLAB training sessions for the batch

Invited Talks

Topic	**A noise preserving sharpening filter for CT image enhancement**
2022	GE Healthcare Global Teams
Topic	**Research on satellite image processing at NEC Corporation**
July 2018	Signal Processing Laboratory LTS4, École Polytechnique Fédérale de Lausanne (EPFL)
July 2017	Department of Geographical Sciences, University of Maryland, College Park
Topic	**How to to prepare for competitive entrance exams**
2009	At various schools and coaching centers in the Pune district

Professional Communities

- Reviewer for
  - IEEE International Conference on Image Processing
  - Journal of Medical Imaging
  - Journal of the Indian Society of Remote Sensing
- Member of IEEE Eta Kappa Nu (HKN)

References

Prof. Charles A. Bouman
Email: bouman@purdue.edu
Webpage: https://engineering.purdue.edu/~bouman/

Prof. Greg Buzzard
Email: buzzard@purdue.edu
Webpage: https://www.math.purdue.edu/buzzard/

Prof. Krishna Mohan Buddhiraju
Centre of Studies in Resources Engineering, IIT Bombay
Email: bkmohan@csre.iitb.ac.in
Webpage: http://www.csre.iitb.ac.in/bkmohan/