Radhika **Ravi**

Ph.D. Student in Civil Engineering (Geomatics)

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research interests

Machine Learning and Computer Vision Techniques for Automatic Feature Extraction and Object Detection from **LiDAR and Photogrammetric Data**
Calibration of Airborne and Terrestrial **Mobile Mapping Systems** comprising LiDAR Units and Cameras;

education

Master of Science in Civil Engg. (Thesis-based)
Primary Advisor: Prof. Ayman Habib
Purdue University
CGPA: 4/4 (2016–2018)

Bachelor of Technology, Dual Majors
Dept. of Civil Engg. & Dept. of Electrical Engg.
Indian Institute of Technology Kanpur
CGPA: 7.5/10 (2011–2016)

work experience

Graduate Research Assistant, Jan'17-Present
Digital Photogrammetry Research Group (DPRG)
Lyles School of Civil Engineering
Purdue University, U.S.A.

Graduate Teaching Assistant, Aug–Dec'16
Recitation Instructor for Calculus-1
Department of Mathematics
Purdue University, U.S.A.

publications

Journal Papers

Ravi, R., Lin, Y.J., Elbahnasawy, M., Shamseldin, T., Habib, A. (2018). Bias Impact Analysis and Calibration of Terrestrial Mobile LiDAR System With Several Spinning Multibeam Laser Scanners. *IEEE Transactions on Geoscience and Remote Sensing*.

Ravi, R., Shamseldin, T., Elbahnasawy, M., Lin, Y.J., Habib, A. (2018). Bias Impact Analysis and Calibration of UAV-Based Mobile LiDAR System with Spinning Multi-Beam Laser Scanner. *Applied Sciences, 8(2), 297*.

Ravi, R., Lin, Y.J., Elbahnasawy, M., Shamseldin, T., Habib, A. (2018). Simultaneous System Calibration of a Multi-LiDAR Multicamera Mobile Mapping Platform. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 11(5), 1694-1714*.

Peer-reviewed Conference Papers

Ravi, R., Habib, A. (2019, May). Image-LiDAR Interactive Visualization Environment (I-LIVE) for Mobile Mapping Systems. In *Proceedings of the 11th International Symposium on Mobile Mapping Technology*, May 6-8, Shenzhen, China.

Cheng, Y.T., Lin, Y.C., **Ravi, R.**, Habib, A. (2019, May). Detection and Visualization of Narrow Lane Regions in Work Zones Using LiDAR-based Mobile Mapping Systems. In *Proceedings of the 11th International Symposium on Mobile Mapping Technology*, May 6-8, Shenzhen, China.

Ravi, R., Hasheminasab, S.M., Zhou, T., Masjedi, A., Quijano, K., Flatt, J.E., Crawford, M. and Habib, A. (2019, May). UAV-based multi-sensor multi-platform integration for high throughput phenotyping. In *Autonomous Air and Ground Sensing Systems for Agricultural Optimization and Phenotyping IV* (Vol. 11008, p. 110080E). International Society for Optics and Photonics.

Habib, A., Hasheminasab, S. M., Zhou, T., **Ravi, R.**, Flatt, J. E., Bullock, J., Wu, R. T., Jahanshahi, M. R., Troy, C.D. (2018, December). Prosumer- and Consumer-grade Unmanned Airborne Systems (UAS) for the Assessment of Coastal Changes: Comparative Study. In *AGU Fall Meeting Abstracts*.

Ravi, R., Lin, Y.J., Shamseldin, T., Elbahnasawy, M., Masjedi, A., Crawford, M., Habib, A. (2018, July). Wheel-based LiDAR Data for Plant Height and Canopy Cover Evaluation to aid Biomass Prediction. In *Geoscience and Remote Sensing Symposium (IGARSS), 2018 IEEE International*.

Ravi, R., Lin, Y.J., Shamseldin, T., Elbahnasawy, M., Crawford, M., Habib, A. (2018, July). Implementation of UAV-based LiDAR for High Throughput Phenotyping. In *Geoscience and Remote Sensing Symposium (IGARSS), 2018 IEEE International*.

Shamseldin, T., **Ravi, R.**, Elbahnasawy, M., Lin, Y.J., Habib, A. (2018, July). Bias Impact Analysis and Calibration of UAV-based Mobile LiDAR System. In *Geoscience and Remote Sensing Symposium (IGARSS), 2018 IEEE International*.

Elbahnasawy, M., Shamseldin, T., **Ravi, R.**, Zhou, T., Lin, Y.J., Masjedi, A., Flatt, E., Crawford, M., Habib, A. (2018, July). Multi-sensor Integration onboard a UAV-based Mobile Mapping System for Agricultural Management. In *Geoscience and Remote Sensing Symposium (IGARSS), 2018 IEEE International*.

Lin, Y.J., **Ravi, R.**, Shamseldin, T., Elbahnasawy, M., Bullock, D., Habib, A. (2016). Comparative Analysis of Potential Calibration Alternatives for a Multi-unit LiDAR System. In *Proceedings of the 10th International Symposium on Mobile Mapping Technology*, May 6-8, Cairo, Egypt.

Technical Reports

Habib, A., Lin, Y.J., **Ravi, R.**, Shamseldin, T., Elbahnasawy, M. (2018). LiDAR-based Mobile Mapping System for Lane Width Estimation in Work Zones (Joint Transportation Research Program). West Lafayette, IN: Purdue University.

research experience

Lane Width Estimation in Work Zones using LiDAR-based Mobile Mapping Systems Aug'18–Present
Mentor: Prof. Ayman Habib

- Proposed a methodology for lane width estimation using LiDAR point cloud from a mobile mapping system
- Developed an algorithm to detect and report areas with ambiguous lane markings, narrow lanes, and/or wide lanes.
- Built a software for the visualization of reported areas in 3D point cloud as well as 2D RGB imagery.

***MS Thesis:* Interactive Environment for the Calibration and Visualization of Multi-sensor Mobile Mapping Systems** Jan'17–Jul'18
Primary Advisor: Prof. Ayman Habib;
Committee Members: Prof. Melba Crawford, Prof. Wolfgang Förstner

Bias Impact Analysis:

- Analyzed the potential impact of bias in mounting parameters of a LiDAR unit on resultant point cloud.
- Established an optimal target primitive and drive-run configuration for most accurate calibration.
- Developed an outdoor multi-unit LiDAR system calibration procedure for a terrestrial mobile mapping platform.

Multi-LiDAR Multi-Camera System Calibration:

- Extended the calibration procedure to use conjugate points and geometric features to calibrate multi-LiDAR multi-camera systems onboard airborne or terrestrial mobile platform.
- Experimentally evaluated the proposed technique by calibrating several mobile mapping platforms with varying number of LiDAR units and cameras.

Image-LiDAR Interactive Visualization Environment (I-LIVE): *UI integrated with CloudCompare*

- Facilitates the visualization of point clouds, imagery data, and their registration quality.
- Aids the qualitative evaluation of calibration results for a generic mobile mapping system.
- Tool for qualitative quality control of GNSS/INS-derived trajectory and LiDAR-camera system calibration.
- Allows forward and backward projections to/from LiDAR and imagery data.
- Equipped with several tools to aid image and LiDAR-based transportation and agricultural applications.

Bias Impact Analysis and Development of Optimal Flight-line Configuration for Calibration of UAV-based Mobile Mapping Systems Aug–Dec'17

Mentor: Prof. Ayman Habib

- Conducted a theoretical analysis of 3D LiDAR point positioning equation to estimate the potential impact of bias in mounting parameters of a LiDAR unit (onboard a UAV) on resultant point cloud
- Devised an optimal flight-line configuration for an efficient calibration and designed experiments to validate the accuracy of calibration

Wheel-based and UAV-based LiDAR Data for Plant Height and Canopy Cover Estimation to aid High Throughput Phenotyping Aug–Dec'17

Mentor: Prof. Ayman Habib

- Generated Crop Surface Models (CSMs) at 30^{th}, 60^{th}, and 90^{th} percentile heights to evaluate the ability of system to penetrate the plant structure.
- Combined CSMs with a Digital Terrain Model (DTM) to obtain the canopy cover for each plot in an agricultural field.
- Obtained the time-series plant height and canopy cover estimates for several genotypes in order to utilize the phenotypic traits for biomass prediction

Reconstruction of Complex Digital Building Models from LiDAR Point Clouds through a Tightly-integrated Recursive Minimum Bounding Rectangle and Least Squares Adjustment Procedure Jan–Aug'17

Mentor: Prof. Ayman Habib

- Devised a strategy for modeling of buildings from airborne LiDAR point cloud data using Recursive Minimum Bounding Rectangle (RMBR) and Least Squares Adjustment (LSA)
- Developed and validated (using experiments) a water-tight building model strategy to remove gaps between contiguous building models

Implementation of Obstacle Navigation System for Visually Impaired People using Stereo Vision Jan-Dec'15

Mentors: Prof. Bharat Lohani, Prof. K. S. Venkatesh

- Implemented 3D Data Acquisition System using two web-cameras and Stereo-Vision Algorithms
- Coded the entire framework in C++ using OpenCV to isolate the closest obstacle and convey distance information through amplitude of sound

relevant projects

Thumb Rule to Locate Optimal Point of Observation to Determine Tower Height Using REM (Remote Elevation Measurement) Technique Jan-Dec'14

Mentor: Prof. Bharat Lohani

Performed Analytical Computations, MATLAB Simulations, Field Experiments and analysis using Genetic Algorithm to invent a method to increase the accuracy in measuring the height of high-rise towers and suggested a thumb rule to determine position of observation.

Knock! Knock! Who is it?" Probabilistic Person Identification in TV-Series Jan-Apr'16

Mentor: Prof. Vinay P. Namboodiri

Implemented the paper by *M Tapaswi et al. (2012)*. Executed different algorithms for scene and shot change detection in an episode, face detection and tracking, and clothing detection in the video. Integrated these results in a probabilistic manner to identify and tag the person(s) in each frame.

Data Hiding using Discrete Wavelet Transform (DWT) based Steganography Aug-Dec'15

Mentor: Prof. Sumana Gupta

Used OpenCV to implement DWT based Steganography to maximise embedded confidential data (invisible to human perception) and protect the data from external attacks: Rotation, Cropping, Scratching of image.

Statistical Analysis of Multispectral Images in MATLAB Aug-Dec'14

Mentor: Prof. Bharat Lohani

Computed the OIF for two multispectral images from LANDSAT 8 and WorldView 2. Identified the best 3-band combination in each image for identification and extraction of various features present in the region of interest.

Nesting Algorithm to Optimize the Layout of Slices of 3D Model in 123D Make Software (Autodesk) May-Jul'14

Organisation: Autodesk India (Full-time Internee)

Developed algorithms to slice a 3D model and lay out the irregularly shaped slices on 2D Sheets with minimal wastage of material (filling holes and adjusting notches) and in minimal amount of time (unlike heuristic algorithms)

relevant courses

Geomatics
Surveying and Geoinformatics
Adjustment of Geospatial Observations
Laser Scanning
Digital Photogrammetric Systems
Multi and Hyperspectral Remote Sensing

Mathematics
Linear Algebra and Its Applications
Calculus
Probability and Statistics
Partial Differential Equations
Optimization Methods for System and Control
Random Variables

Computer Science
Machine Learning
Computer Vision and Image Processing
Deep Learning
Data Structures and Algorithms
Data Mining and Knowledge Extraction

Electrical Engineering
Digital and Statistical Signal Processing
Digital Electronics
Principles of Communication
Mathematical Structures of Signals and Systems
Microelectronics
Power Systems and Power Electronics

extracurricular activities

Sports **Best Incoming Sportsperson**, 2011 from amongst more than 800 students of my batch.

Basketball
Member of Basketball Team, representing IIT Kanpur in Inter-IIT Sports Meet since 2011.
Gold Medals in Udghosh 2013 and MNIT Sports Meet, 2012 (Inter-College Tournaments).
Silver Medals in Kanpur District Sports Meet, 2014 and Udghosh 2014.
Bronze Medal in Inter-IIT Sports Meet 2012.

Athletics
Gold Medals in Shotput, Discus Throw, 100 m, 200 m and 400 m, 4x100 m Relay, Long Jump in Josh 2011 (Intra-College Tournament).

Others Solving Rubik's Cubes (2x2x2, 3x3x3, 4x4x4, 5x5x5, Mirror Cube, Pyraminx, Megaminx).
Guinness Book of World Records Attempt: Succeeded as a team in solving 1884 Rubik's Cubes simultaneously.

volunteer work

Counselling Service, IIT Kanpur 2013–14
Senior Academic Mentor: Provided direct academic help to batchmates and juniors.
Student Guide: Helped 6 fresher students adapt to an entirely new environment at IIT Kanpur.

Coordinator, SOCE (Society of Civil Engineers), IIT Kanpur 2013–14
Organized events, informative sessions and workshops for the welfare of students of Civil Engineering.

Executive, TEDx, IIT Kanpur 2013
Served as a link between institute and pioneers of various fields by putting forth purpose of the event and pursuading them to deliver insightful talks.

scholastic achievements

Won **People's Choice Award** in 3MT® (Three-Minute Thesis) Competition during the 6th ABE Graduate Industrial Research Symposium on March 25th, 2019. Topic – **I-LIVE: Image-LiDAR Interactive Visualization Environment**

Secured **First Position** in 3MT® (Three-Minute Thesis) Competition on Plant Phenomics and Related Studies organized by the Institute for Plant Sciences, Purdue University on:

- February 21st, 2019: **I-LIVE: Image-LiDAR Interactive Visualization Environment for High Throughput Phenotyping**
- July 31st, 2018: **Multi-sensor Mobile Mapping Systems: Calibration and Applications**

Achieved **All India Rank (AIR) 1934** in IIT-JEE 2011 amongst 0.5 million candidates

Selected for **KVPY Scholarship**, 2011 by Dept. of Science and Technology, Govt. of India

Acknowledged with **Best Presentation-cum-Internee** Award by Civil Engineering Department, IIT Kanpur for "Estimation of Evapotranspiration using Trained ANN Hydrologic Models"

Secured **International Rank 17** in International Mathematics Olympiad, 2011

Secured **AIR 77** in National Level Science Talent Search Examination, 2011 by Unified Council (ISO 9001:2000 Certified Organisation)

Certificate of Merit for being placed in **Statewise Top 1%** in National Standard Examination in Physics

Secured **AIR 57** and 99.55 Percentile in National Science Olympiad, 2011

Qualified National Level Olympiads of Mathematics (INMO) and Astronomy (INAO) in 2010