



RADHIKA RAVI, PhD (she/her/hers)

Postdoctoral Research Fellow, Robotics Institute, University of Michigan

 [radhikaravi1.github.io](https://github.com/radhikaravi1)
 rradhika@umich.edu

 [radhika-ravi](https://www.linkedin.com/in/radhika-ravi)
 +1 765 476 6183

 [RadhikaRavi](https://twitter.com/RadhikaRavi)
 Ann Arbor, MI

SUMMARY

- **Research Interests:** Robot Vision, Computer Vision, Image Processing, Autonomous Vehicles, Machine Learning, Localization and Mapping, Sensor Fusion, Calibration
- Conducted individual and collaborative research leading to 11 peer-reviewed journal publications (6 first-author), 11 peer-reviewed conference publications (7 first-author), and 2 technical reports with 330+ citations and h-index of 9

EDUCATION

Ph.D. | Civil Engineering (Geomatics) | Purdue University  IN, USA  2019–2022

- Dissertation: Automated Calibration and GNSS/INS Trajectory Enhancement for Mobile LiDAR Mapping Systems

M.S. | Civil Engineering (Geomatics) | Purdue University  IN, USA  2016–2019

- Thesis: Interactive Environment for Calibration and Visualization of Multi-Sensor Mobile Mapping Systems

B.Tech. (Dual Majors) | Civil Engg. & Electrical Engg. | IIT Kanpur  UP, India  2011–2016

- Thesis: Implementation of Obstacle Navigation System for Visually Impaired People using Stereo Vision

PUBLICATIONS

Peer-reviewed Journal Papers

Manish, R., Hasheminasab, S. M., Liu, J., Koshan, Y., Mahlberg, J. A., Lin, Y. C., **Ravi, R.**, Zhou, T., McGuffey, J., Wells, T., Bullock, D., Habib, A. (2022). Image-Aided LiDAR Mapping Platform and Data Processing Strategy for Stockpile Volume Estimation. *Remote Sensing*, 14(1), 231.

Ravi, R., Habib, A. (2021). Least Squares Adjustment with a Rank-Deficient Weight Matrix and Its Applicability to Image/Lidar Data Processing. *Photogrammetric Engineering & Remote Sensing*, 87(10), 717-733.

Patel, A., Cheng, Y. T., **Ravi, R.**, Lin, Y. C., Bullock, D., Habib, A. (2021). Transfer Learning for LiDAR-Based Lane Marking Detection and Intensity Profile Generation. *Geomatics*, 1(2), 287-309.

Manish, R., Lin, Y. C., **Ravi, R.**, Hasheminasab, S. M., Zhou, T., Habib, A. (2021). Development of a Miniaturized Mobile Mapping System for In-Row, Under-Canopy Phenotyping. *Remote Sensing*, 13(2), 276.

Ravi, R., Habib, A. (2020). Fully Automated Profile-based Calibration Strategy for Airborne and Terrestrial Mobile LiDAR Systems with Spinning Multi-beam Laser Units. *Remote Sensing*, 12(3), 401.

Zhou, T., Hasheminasab, S. M., **Ravi, R.**, Habib, A. (2020). LiDAR-Aided Interior Orientation Parameters Refinement Strategy for Consumer-Grade Cameras Onboard UAV Remote Sensing Systems. *Remote Sensing*, 12(14), 2268.

Lin, Y. C., Cheng, Y. T., Zhou, T., **Ravi, R.**, Hasheminasab, S. M., Flatt, J. E., Troy, C., Habib, A. (2019). Evaluation of UAV LiDAR for Mapping Coastal Environments. *Remote Sensing*, 11(24), 2893.

- Ravi,R.**, Cheng, Y. T., Lin, Y. C., Lin, Y. J., Hasheminasab, S. M., Zhou, T., Flatt, J.E., Habib, A. (2019). Lane Width Estimation in Work Zones Using LiDAR-Based Mobile Mapping Systems. *IEEE Transactions on Intelligent Transportation Systems*.
- 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 Multi-camera Mobile Mapping Platform. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 11(5), 1694-1714.
- 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 Multi-beam Laser Scanners. *IEEE Transactions on Geoscience and Remote Sensing*, 56(9), 5261-5275.

Peer-reviewed Conference Papers

- Ravi,R.**, Bullock, D., Habib, A. (2021). Pavement Distress and Debris Detection using a Mobile Mapping System with 2D Profiler LiDAR. *Transportation Research Record*, 2675(9), 428-438.
- Ravi,R.**, Habib, A., Bullock, D. (2020). Pothole mapping and patching quantity estimates using LiDAR-based mobile mapping systems. *Transportation Research Record*, 2674(9), 124-134.
- Ravi,R.**, Bullock, D., Habib, A. (2020). Highway and Airport Runway Pavement Inspection using Mobile LiDAR. *The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 43, 349-354.
- Ravi,R.**, Habib, A. (2019). Image-LiDAR Interactive Visualization Environment (I-LIVE) for Mobile Mapping Systems. In *Proceedings of the 11th International Symposium on Mobile Mapping Technology*, 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*, Shenzhen, China.
- Ravi,R.**, Hasheminasab, S.M., Zhou, T., Masjedi, A., Quijano, K., Flatt, J.E., Crawford, M., Habib, A. (2019). 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), Baltimore, MD, USA. International Society for Optics and Photonics.
- Ravi,R.**, Lin, Y. J., Shamseldin, T., Elbahnasawy, M., Masjedi, A., Crawford, M., Habib, A. (2018). Wheel-Based LiDAR Data for Plant Height and Canopy Cover Evaluation to Aid Biomass Prediction. In *IEEE International Geoscience and Remote Sensing Symposium* (pp. 3242-3245), Valencia, Spain. IEEE.
- Ravi,R.**, Lin, Y. J., Shamseldin, T., Elbahnasawy, M., Crawford, M., Habib, A. (2018). Implementation of UAV-Based Lidar for High Throughput Phenotyping. In *IEEE International Geoscience and Remote Sensing Symposium* (pp. 8761-8764), Valencia, Spain. IEEE.
- Shamseldin, T., **Ravi,R.**, Elbahnasawy, M., Lin, Y. J., Habib, A. (2018). Bias Impact Analysis and Calibration of UAV-Based Mobile Lidar System. In *IEEE International Geoscience and Remote Sensing Symposium* (pp. 8769-8772), Valencia, Spain. IEEE.
- Elbahnasawy, M., Shamseldin, T., **Ravi,R.**, Zhou, T., Lin, Y. J., Masjedi, A., Flatt, J.E., Crawford, M., Habib, A. (2018). Multi-sensor integration onboard a UAV-based mobile mapping system for agricultural management. In *IEEE International Geoscience and Remote Sensing Symposium* (pp. 3412-3415), Valencia, Spain. IEEE.

Lin, Y.J., **Ravi,R.**, Shamseldin, T., Elbahnasawy, M., Bullock, D., Habib, A. (2017). Comparative Analysis of Potential Calibration Alternatives for a Multi-unit LiDAR System. In *Proceedings of the 10th International Symposium on Mobile Mapping Technology*, Cairo, Egypt.

Technical Reports

Habib, A., Bullock, D., Lin, Y.C., Manish, R., **Ravi,R.** (2022). Field Test Bed for Evaluating Embedded Vehicle Sensors with Indiana Companies. *Joint Transportation Research Program*, SPR-4438, Purdue University.

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*, SPR-4126, Purdue University.

Thesis/Dissertation

Ravi,R. (2022). Automated System Calibration and GNSS/INS Trajectory Enhancement for Mobile LiDAR Mapping Systems. *Doctoral Dissertation*, Purdue University Graduate School.

Ravi,R. (2019). Interactive Environment For The Calibration And Visualization Of Multi-sensor Mobile Mapping Systems. *Masters Thesis*, Purdue University Graduate School.

POSTDOCTORAL RESEARCH

FORD CENTER FOR AUTONOMOUS VEHICLES, UNIVERSITY OF MICHIGAN

DyE-NeRF: Neural Radiance Fields for Dynamic Scenes using Event Cameras 📅 Apr'22–Present

- Developing deep learning model for dynamic scene novel view synthesis using monochrome event camera
- Utilizing event camera functioning principle along with NeRF for photorealistic scene rendering while mitigating motion blur and lighting challenges that are presented by frame cameras

M-DAWG: Michigan Dataset for Adverse Weather with Ground Truth 📅 Apr'22–Present

- Collaborating with research team to develop multi-sensor platform for data acquisition in various weather (rain, snow, fog) and lighting (day, night) conditions to facilitate autonomous vehicle and robotics research
- Conducting sensor fusion for LiDAR, stereo monochrome/RGB cameras, stereo event cameras, stereo thermal cameras, and tactical-grade GNSS/INS
- Devising intrinsic and extrinsic calibration strategy for all onboard sensors to facilitate data fusion for mapping and localization research

DISSERTATION & THESIS RESEARCH

DIGITAL PHOTOGRAMMETRY RESEARCH GROUP, PURDUE UNIVERSITY

Automated Calibration and GNSS/INS Trajectory Enhancement for Mobile LiDAR Mapping Systems | PhD Dissertation 📅 2019–2022

Least Squares Adjustment (LSA) with Rank-deficient Weight Matrix

- Presented physical and mathematical interpretations of rank-deficient weight matrices in LSA models
- Proposed solution to said LSA models for photogrammetric and LiDAR mapping applications

Mobile Mapping System (MMS) Calibration for 3D and 2D LiDARs


- Proposed a non-linear optimization framework for fully automated targetless extrinsic calibration between 3D LiDAR and GNSS/INS sensors for airborne and terrestrial MMS

- Modified MMS calibration strategy to mitigate challenges posed by 2D LiDAR scanning mechanism and devised optimal target/drive-run configuration to minimize correlations among mounting parameters
- Achieved calibration accuracy of less than 2 cm and 1 cm for MMS equipped with 3D and 2D LiDARs, respectively, along with GNSS/INS sensors

LiDAR-aided GNSS/INS Trajectory Enhancement in Forest and Urban Environments

- Developed fully automated loosely-coupled algorithm for trajectory enhancement in GNSS-denied forest and urban environments
- Improved localization and mapping accuracy from over 2 m to under 8 cm

Interactive Environment for the Calibration and Visualization of Multi-sensor Mobile Mapping Systems | Masters Thesis

 2016–2019

Bias Impact Analysis for Calibration

- Analyzed impact of LiDAR-to-GNSS mounting parameters on point cloud georeferencing accuracy
- Established optimal target/drive-run configuration for accurate extrinsic calibration

Multi-LiDAR Multi-Camera Terrestrial and Airborne System Calibration

- Devised calibration procedure using geometric features for multi-sensor airborne and terrestrial MMS
- Experimentally demonstrated resultant point cloud and image georeferencing accuracy of under 5 cm


Image-LiDAR Interactive Visualization Environment (I-LIVE): C++/Qt-based UI

- Developed UI forked from CloudCompare for integrated point cloud and image visualization
- Designed for quality control of sensor fusion among LiDAR, cameras, and GNSS/INS
- Equipped with tools to aid image and LiDAR-based transportation and agricultural applications

RESEARCH PROJECTS


DIGITAL PHOTOGRAMMETRY RESEARCH GROUP, PURDUE UNIVERSITY

Highway and Airport Runway Pavement Inspection using Mobile LiDAR

 Jan'20–Aug'20


- Proposed an algorithm for above/below-ground anomaly detection over pavement surfaces
- Achieved 100% detection for potholes and foreign object debris greater than 2 cm in dimensions

Evaluation of UAV LiDAR for Mapping Coastal Environments

 Aug'18–Nov'19


- Evaluated image- and LiDAR-based mapping in terms of point density, accuracy, and area coverage
- Monitored shoreline recession over two actively eroding sandy beaches in Indiana
- Highlighted importance of coastal episodic events based on shoreline volume loss estimates

Mobile LiDAR-based Pothole Mapping and Patching Quantity Estimates

 Oct'18–Aug'19

- Compared 3D point cloud accuracy between medium-grade (Velodyne) and high-grade (Riegl/ZF) MMS
- Developed pavement pothole detection algorithm and severity-based classification strategy
- Conducted pothole volume estimation using region-growing and minimum convex hull techniques

Lane Width Estimation in Work Zones using Mobile LiDAR Mapping Systems


 Aug'18–Oct'19

- Proposed robust lane width estimation methodology using mobile LiDAR point cloud
- Developed algorithm to detect and report areas with ambiguous lane markings and narrow/wide lanes

- Assisted Indiana Department of Transportation (INDOT) with accurate work zone lane width monitoring

Wheel-based and UAV-based LiDAR Data for Plant Height and Canopy Cover Estimation to aid High Throughput Phenotyping  Aug'17–May'18

- Generated Crop Surface Models (CSMs) to compare crop field penetration of wheel/UAV-based LiDAR
- Combined CSMs with Digital Terrain Model to obtain canopy cover in agricultural fields
- Estimated time-series plant height and canopy cover to enable machine learning for biomass prediction

Reconstruction of Complex Digital Building Models from LiDAR Point Clouds through Tightly Integrated Recursive Minimum Bounding Rectangle (RMBR) and Least Squares Adjustment (LSA) Procedure  Jan'17–Aug'17

- Devised building modeling strategy using RMBR and LSA with airborne LiDAR point cloud
- Experimentally validated watertight building models to remove gaps between contiguous buildings

TECHNICAL SKILLS

Programming: C/C++, Python, MATLAB, R, Simulink

Sensors: LiDAR, RGB Camera, Event Camera, Thermal Camera, Hyper/Multi-spectral Sensor, Global Positioning System (GPS), Inertial Navigation System (INS/IMU)

Operating Systems: Windows, Linux, Robotic Operating System (ROS)

RELEVANT COURSEWORK

Geomatics

Surveying and Geoinformatics
Adjustment of Geospatial Observations
Laser Scanning
Digital Photogrammetry
Multi and Hyperspectral Remote Sensing
GNSS/INS Integration

Computer Science

Machine Learning
Computer Vision and Image Processing
Deep Learning; Deep Learning in Machine Vision
Data Structures and Algorithms
Data Mining and Knowledge Extraction
Programming Parallel Machines

Mathematics

Linear Algebra and its Applications
Calculus
Probability and Statistics
Partial Differential Equations
Random Variables
Applied Multivariate Analysis
Design of Experiment

Electrical Engineering

Optimization Methods for Systems and Control
Digital and Statistical Signal Processing
Digital Electronics
Principles of Communications
Mathematical Structures of Signals and Systems
Microelectronics
Power Systems and Power Electronics

ACHIEVEMENTS AND AWARDS

Endowed Roland S. Corning II Memorial Fund for excellence in Geomatics research	2021
Awarded Lyles Teaching Fellowship : 1 of 2 recipients amongst all PhD candidates in Civil Engg.	2020
Three-time Winner of 3MT[®] (Three-Minute Thesis) Competitions for research presentations	2018–19

LEADERSHIP EXPERIENCE

Co-President , University of Michigan Postdoctoral Association (UMPDA)	2022–Present
Social Chair , Michigan Postdoctoral Association of College of Engineering (MPACE)	2022–Present
Executive , TEDx IIT Kanpur	2013
Coordinator , Society of Civil Engineering, IIT Kanpur	2013–2014
Senior Academic Mentor , Counselling Service, IIT Kanpur	2013–2014
Student Guide , Counselling Service, IIT Kanpur	2013–2014