GANDHIMATHI (MATHI) PADMANABAN

Ph.D. Candidate | University of Michigan-Dearborn gmathi@umich.edu - Website - GitHub - LinkedIn

RESEARCH PROFILE

Ph.D. candidate specializing in applied machine learning and geometry-informed computer vision, with a focus on building tools and frameworks for transportation safety and safety-critical autonomous systems. My dissertation develops data-driven pipelines that integrate vehicle kinematics and projective geometry to analyze driver behavior and vehicle-bicyclist interactions. Working at the intersection of applied AI and transportation safety has deepened my grounding in AI foundations, particularly in the limits of learned models in dynamic, open-world environments and the importance of designing systems that humans can understand, oversee, and trust. I am interested in continuing my research on safe, trustworthy, and reliable AI, especially perception and vision systems that support effective human-AI teaming in high-stakes domains.

EDUCATION

Aug 2026 **Ph.D., Industrial and Systems Engineering** - *University of Michigan-Dearborn, USA*
Dissertation: "Examining Transportation Safety and Road User Behaviors through Machine Learning and Vision Transformers"
Advisor: Dr. Fred Feng

2021 **M.S., Human Centered Design and Engineering** - *University of Michigan-Dearborn, USA*
Thesis: "Computational Human Performance Modeling using Queuing Network in an Open-Source Platform"
Advisor: Dr. Fred Feng

2013 **B.E., Computer Science and Engineering** - *Anna University, India*
Thesis: "Automated Detection of Modifications in Software Requirement Traceability Links"
Advisor: Prof. Ramachandran Alagarsamy

Certifications: Connected & Automated Transportation Certificate (*Apr 2026*); Rackham DEI Certificate (2025); Post Graduate Diploma in Computer Applications (2011)

RESEARCH EXPERIENCE

2022–*Now* **Graduate Student Research Assistant** - *University of Michigan-Dearborn, USA*
Advisor/PI: Dr. Fred Feng

- Designed and implemented an **experimental platform for driver-bicyclist interactions** using integrated RGB camera and LiDAR sensor systems with computer vision pipelines, achieving 98.7% overtaking detection precision on real world driving data.
- Developed a **physics-informed perception framework** combining Vision Transformers (ViT) with perspective geometry constraints for fine-grained vehicle classification and trajectory analysis, reducing reliance on large labeled datasets by incorporating explicit geometric priors.
- Designed a monocular overtaking distance estimation system integrating learned visual features with explicit geometric models (9.5 cm MAE), demonstrating that physically constrained formulations maintain spatial accuracy without requiring depth sensors.
- Led manuscript preparation across 5 peer-reviewed venues.
- Mentored undergraduate and master's students in computer vision, Python-based data pipelines, and experimental design; supervised student contributions to open-source tooling.

2011–13 **Research Assistant** - *Anna University, India*
Advisor/PI: Prof. Ramachandran Alagarsamy

- Contributed to software testing research group; led development of university applications including exam cell software, attendance management software and sports management application using full-stack development approaches.
- Developed automated detection system for modifications in software requirement traceability links (Bachelor's thesis)

PUBLICATIONS (4 PEER-REVIEWED; 1 UNDER REVIEW; 2 IN PREPARATION)

Peer-Reviewed Works

1. Gandhimathi Padmanaban, Rayane Moustafa, and Fred Feng. "A Geometry-Informed Computer Vision Method for Detecting and Examining Overtaking Vehicles From A Bicycle". *TRB Annual Meeting*. 2026.
2. Rayane Moustafa, Gandhimathi Padmanaban, and Fred Feng. "Quantifying Drivers-Overtaking-Bicyclists with Surrogate Safety Measures Derived from High-Resolution Digital Lidar". *TRB Annual Meeting*. 2026.

3. Gandhimathi Padmanaban, Fred Feng, Edward Dai, Ankit Saini, Guopeng Hu, and Yanan Zhao. "A Comparative Analysis of Acceleration and Deceleration Profiles for Aggressive Driving Styles and Fuel Economy Test Cycles". *WCX SAE World Congress Experience*. 2025. DOI: http://dx.doi.org/10.4271/2025-01-8605.
4. Gandhimathi Padmanaban, Nathaniel P. Jachim, Hala Shandi, Lilit Avetisyan, Garrett Smith, Howrah Hammoud, and Feng Zhou. "An Autonomous Driving System - Dedicated Vehicle for People with ASD and their Caregivers". *AutomotiveUI '21 Adjunct: 13th International Conference on Automotive User Interfaces and Interactive Vehicular Applications*. Association for Computing Machinery, 2021, pp. 142–147. DOI: https://doi.org/10.1145/3473682.3480282.

Papers Under Review & In Preparation

1. "A Machine Learning Framework to Identify Aggressive Driving Based on Vehicle Kinematics and Driver Pedal Operations". *Submitted to Engineering Applications of Artificial Intelligence.*
2. "Perspective-Geometry-Informed Lateral Passing Distance Estimation from Monocular Video for Naturalistic Overtaking Safety Analysis". *In preparation for International cycling Safety conference, 2026.*
3. "An Open-Source Two-Stage Computer Vision Pipeline for Fine-Grained Vehicle Classification using Vision Transformers". *In preparation.*

TECHNICAL EXPERTISE

Programming	**Expert**: Python (TensorFlow, PyTorch, scikit-learn, OpenCV, pandas), Git, LaTeX; **Proficient**: Julia, R, MATLAB, C#, UI Frameworks, SQL; **HPC**: Great Lakes cluster (Slurm)
AI/ML Methods	Geometry-Informed Computer Vision, Deep Learning (CNN, RNN, Transformers), Supervised Learning, Ensemble Methods, Sequential and dynamical system modeling, Bayesian Methods, Physics-Informed Machine Learning, Uncertainty Quantification and Calibration, Out-of-Distribution Detection.
Autonomous Systems	Sensor fusion (camera + LiDAR), perception pipelines, on-road sensing platform design, vehicle kinematics modeling, ROS-compatible architectures
Tools & Frameworks	OpenCV, YOLOv5, RT-DETR, ByteTrack, Multi-Object Detection & Tracking, Multi-Modal Data Fusion, LiDAR
Foundations	Optimization, statistical learning, multivariable calculus, mathematical modeling, geometric computer vision, vision transformers, multimodal/VLM (pretraining, attention, evaluation), dynamical systems (geometry and stability)
Research	Experimental Design, Statistical Analysis, Scientific Writing, Peer Review, Institutional Review Board (IRB) Protocols, Cross-Validation, Academic Collaboration
Domains	Transportation Safety, Naturalistic Driving Studies, Driver Behavior Analysis, Driver–Bicyclist Interactions, Autonomous & Connected Vehicles, Human Factors Engineering, Safety-Critical Perception

AWARDS AND GRANTS

- Student Visionary Award - International Forum on Research Excellence Conference(IFoRE' 25), Sigma Xi-The Scientific Research Honor Society, 2025
- Upsilon Pi Epsilon (UPE) Scholarship - Awarded for exceptional academic performance, extracurricular involvement, and leadership within the computing community, 2024
- Global Finalist - NASA Space Apps Challenge, 2023
- Irma M. Wyman Scholar, *Center for the Education of Women (CEW+), University of Michigan*, 2020-2021 ($11,500)
- Non-Resident Graduate Student Scholar, *University of Michigan-Dearborn*, 2020-2021 ($13,000)
- Deloitte Hackathon Special Mention, 2017 | Syncfusion Hackathon 2nd Place, 2015 (INR 35,000)

TALKS AND PRESENTATIONS

Talks

- **WocCode – University of Michigan Ann Arbor**, Feb 2024
  NASA SpaceApps Experience: DigitwiML – Open-Source Project to model Digital Twin of C.elegans in Space
- **University of Michigan–Dearborn**, Sep 2021
  Guest Talk: IMSE 501 Human Factors & Ergonomics

Conference Presentations

- **Transportation Research Board Annual Meeting**, Jan 2026 *(Poster)*
  A Geometry-Informed Computer Vision Method for Detecting and Examining Overtaking Vehicles From A Bicycle
- **International Forum on Research Excellence (IFoRE' 25)**, Oct 2025 *(Workshop Session)*
  Hybrid Physics-Data Modeling for Sustainable Transportation: Bridging Classical Models and Modern AI
- **WCX SAE World Congress Experience**, Sep 2021 *(Paper Presentation)*
  An Autonomous Driving System – Dedicated Vehicle for People with ASD and their Caregivers
- **Automotive User Interfaces (AutoUI) Conference**, Apr 2025 *(Paper Presentation)*
  A Comparative Analysis of Acceleration and Deceleration Profiles for Aggressive Driving Styles and Fuel Economy Test Cycles

RESEARCH SOFTWARE & OPEN SOURCE PROJECTS

- **DigitwiML** (NASA SpaceApps Global Finalist, 2023): Machine learning platform for digital twin modeling of biological dynamics in space environments. First application of data-driven dynamical modeling beyond transportation, demonstrating interest in scientific ML for physical systems - GitHub
- **Human Performance Modeling Tools**: Queuing network simulation platform for computational human performance modeling (Python)
- **Geometry-informed overtaking tracker** - Computer Vision system for tracking vehicle-bicyclist interactions (open-source, Python) - GitHub

PROFESSIONAL EXPERIENCE (INDUSTRY)

2017–18 **Development Lead/Consultant**
Deloitte (Offices of the US) – Bangalore, India
Led cross-functional teams; contributed to R&D projects requiring advanced algorithmic thinking and mathematical modeling; developed systematic approaches to complex problem-solving across diverse domains in commercial, healthcare, and education.

2015–17 **Programmer Analyst**
Cognizant – Chennai, India
Conducted internal technical trainings; authored knowledge-transfer documentation; contributed to full-stack development and UI technology research; Mentored junior engineers and cross-functional teams in the application of computational methods and optimization.

2013–15 **Software Engineer Level-II**
Syncfusion – Chennai, India
Shipped enterprise software features for developer tools; implemented software engineering best practices; recognized with hackathon achievement (2nd place).

TEACHING AND MENTORING

2024–*Now* **Certified Instructor** - *The Carpentries*
Hands-on computational methods workshops (Python data analysis, Git version control, Unix shell, OpenRefine) for researchers in biosciences, library science, and data-intensive fields.
University of Tennessee Knoxville (May 2025) | CZI Foundation (Nov 2024) | University of Michigan (Mar 2024)

2023–*Now* **Instructor & Mentor** - *WoCCode - University of Michigan-Ann Arbor*
Machine Learning and Python workshop: materials open-sourced. Machine Learning Workshop (Feb 2024) | Summer 2023 Boot Camp

2010–12 **Student Instructor / Teaching Assistant** - *Anna University, India*
Courses: Artificial Intelligence, Probability and Queuing Theory, Transforms and PDEs, Systems Software Laboratory

SERVICE AND LEADERSHIP

Leadership: President, Upsilon Pi Epsilon Michigan Beta Chapter (2024-2025) • Member: SAE International (AI in Simulation Task Force) (co-authoring technical guidelines on AI in simulation for ground vehicles), Sigma Xi, Alpha Pi Mu, Society of Industrial and Applied Mathematics, ACM, HFES

Reviewer: TRBAM 2026, ICIS 2025, AutoUI 2024, CHI 2024, AMCIS 2024, CUI 2024, IMX 2024, DIS 2024

Community: MIDAS AI Summit Student Volunteer (2023,2025) • WoC|CodeNova Hackathon Judge (2025) • WocCode Mentor • Carpentries Certified Instructor & Lesson Maintainer • NASA SpaceApps & MHacks Judge • STEM High School Tutor (2010-13)