

Ibne Farabi Shihab, Ph.D.

Assistant Professor (Candidate)

AI · Computer Vision · Transportation Systems

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RESEARCH OVERVIEW AND TEACHING PHILOSOPHY

My research advances artificial intelligence at the intersection of computer vision, Large Language Models, and safety-critical transportation systems. I develop interpretable and efficient AI methods that integrate multimodal learning, reinforcement learning, and quantum computing to enhance real-time decision-making in autonomous systems, with applications demonstrated through industry partnerships and federal funding. This research directly informs my teaching, where I create learning environments that bridge theory, application, and societal impact.

My courses emphasize hands-on projects with real-world datasets drawn from my research collaborations, inclusive pedagogy accommodating diverse learning styles through flipped classrooms and collaborative coding, and ethical AI literacy with modules on bias and responsible AI deployment. Through project-based learning connecting students to cutting-edge problems in video understanding, crash detection, and autonomous systems, I prepare them not only to master technical skills but also to understand the broader implications of AI in society, fostering both immediate career success and lifelong learning in this rapidly evolving field.

EDUCATION

- **Ph.D., Computer Science, Ames, IA, Iowa State University** October 2025
Dissertation: "Resource-Efficient AI for Real-World Applications: Model Compression, Sample-Efficient Learning, and Inference Optimization Across Traffic Safety, Quantum Systems, and Sequential Decision-Making"
Advisor: Dr. Anuj Sharma
- **M.S., Artificial Intelligence, Ames, IA, Iowa State University** January 2024
Thesis: "Robust and precise sidewalk detection with ensemble learning: Enhancing road safety and facilitating curb space management"
Advisor: Dr. Anuj Sharma
- **B.Sc., Computer Science & Engineering, Dhaka, Bangladesh, BRAC University** August 2018
Thesis: "Where will you setup your business next?: a machine learning approach to suggest ideal geographical location for new restaurant establishment"
Advisor: Dr. Hossain Arif

RESEARCH INTERESTS

- **Computer Vision & Video Analytics:** Safety-critical transportation systems, temporal action localization, multimodal video-text understanding using Large Language Models
- **Machine Learning for Autonomous Systems:** Reinforcement learning for vehicle control and decision-making, sparse-reward learning, LLM-guided policy optimization
- **Quantum Computing Applications:** Quantum neural networks for network security, few-shot learning for quantum spin systems, zero-trust architectures
- **AI Safety & Robustness:** Model pruning for resource-constrained environments, reward function design, counterfactual reasoning in LLMs

RESEARCH EXPERIENCE

- **Graduate Research Assistant, Iowa State University, Ames, IA** January 2022 – May 2025
 - **Transportation Safety Research:** Led DOT-funded projects with Iowa DOT (\$1M+ total funding) developing AI-based navigation systems for snowplow operations, real-time crash detection frameworks, and ADAS enhancement under extreme weather conditions. Published 5+ papers in premier transportation conferences (ITSC, TRC).
 - **Computer Vision & LLM Integration:** Pioneered novel frameworks integrating computer vision with Large Language Models for automated crash narrative generation from video data. First-authored papers on EMNLP. Developed synthetic crash video simulation pipeline for enhanced model training. Co-authored CVPR 2024 paper on temporal action localization with change point detection.

- **Quantum Computing Applications:** Developed innovative Quantum Neural Network architectures increasing anomaly detection accuracy by 10% for next-generation network security. Established methodologies for quantum-driven zero trust frameworks. Published in *Measurement: Digitalization* (2025).
- **Interdisciplinary Research:** Implemented reinforcement learning algorithms for cellular simulations optimizing CAR T-cell therapy parameters, published in *Biotechnology and Bioengineering* (2024, Impact Factor: 3.8).

TEACHING EXPERIENCE

- **Lecturer, Computer Science Department, Dallas College, Dallas, TX** *August 2025 – January 2025*
 - **COSC 1436: Programming Fundamentals I (C++; two sections, hybrid format, 40 students):** Taught foundational programming concepts using C++. Designed assignments emphasizing algorithmic thinking, syntax mastery, and structured programming. Integrated LeetCode-based problem-solving sessions to strengthen students' logical reasoning and technical interview preparation.
 - **COSC 1437: Programming Fundamentals II (Java; 5 students):** Taught object-oriented programming principles using Java following completion of COSC 1436. Developed projects demonstrating inheritance, interfaces, and data structures. Introduced case studies linking Java applications to real-world systems and reinforced algorithmic efficiency through practical coding exercises from Leetcode.
 - **ITSE 1329: Programming Logic and Design (Kotlin; 20 students):** Introduced programming logic and software design using Kotlin, emphasizing readability, modularity, and efficiency. Developed beginner-friendly lab modules transitioning students from pseudocode to Kotlin implementation. Integrated LeetCode-based challenges to reinforce syntax fluency, logical reasoning, and real-world problem-solving skills.
 - **Student Mentorship & Support:** Held eight office hours weekly and mentored three students on independent and capstone projects. Created supplemental learning materials and personalized study plans to support diverse/advance learning needs.
 - **Curriculum Development & Institutional Service:** Designed project-based curricula connecting theoretical computing principles with applied research in real world project building.
- **Graduate Teaching Assistant, Iowa State University, Ames, IA** *August 2020 – December 2021; September 2024 – May 2025*
 - **COM S 576: Motion Planning for Robotics and Autonomous Systems (25 students):** Assisted in course delivery as a grader and recitation leader. Held weekly office hours to help students understand motion planning algorithms, robotics fundamentals, and lab assignments in ROS/CARLA environments. Conducted recitation sessions explaining lab objectives and demonstrating practical implementation approaches.
 - **COM S 327: Advanced Programming Techniques in C++ (40 students):** Served as grader and instructional assistant for advanced C++ programming. Guided students during lab sessions to strengthen understanding of object-oriented design, memory management, and algorithm optimization. Held eight hours of office hours weekly to explain complex C++ concepts, assist with debugging, and support project development.
 - **COM S 113: Introduction to Programming in Java (four lab sections; 80 students):** Conducted weekly lab sessions across four sections, guiding students through programming exercises and debugging practices. Explained core programming concepts and problem-solving techniques in each session. Held four hours of office hours weekly to provide individualized assistance and clarify course materials.
 - **Student Support & Mentorship:** Provided guidance to undergraduate and graduate students during lab sessions and independent study projects. Offered individualized academic support and promoted collaborative problem-solving through structured help sessions.
- **Graduate Teaching Assistant, University of Vermont, Burlington, VT** *August 2019 – May 2020*
 - **CS 254: Machine Learning:** Assisted the course instructor in designing assignments, creating assessment rubrics, and supporting course structure development. Conducted recitation sessions to reinforce lecture materials and explain algorithmic concepts such as supervised learning, model evaluation, and optimization techniques. Graded student projects and provided detailed feedback to improve understanding of core ML methods.
 - **CS 354: Deep Learning (Special Topics):** Collaborated with the instructor in developing new course content and lab materials focused on neural networks and computer vision applications. Held weekly recitations and office hours to clarify theoretical concepts and guide students through coding assignments. Assisted in grading and refining evaluation criteria to ensure fairness and consistency across student submissions.

TEACHING INTERESTS & COURSE DEVELOPMENT

- **Undergraduate Courses:** Programming Fundamentals (C++, Java, Kotlin), Data Structures & Algorithms, Introduction to AI, Machine Learning, Computer Vision, Deep Learning, Motion Planning & Robotics, Programming Logic & Design, Ethics in AI

- **Graduate Courses:** Advanced Machine Learning, Deep Learning for Computer Vision, Motion Planning for Robotics & Autonomous Systems, Reinforcement Learning, NLP with LLMs, AI Safety & Robustness
- **Specialized Topics:** Robotics & Autonomous Systems, Transportation AI, Video Analytics & Computer Vision, AI for Social Good, Applied ML with Real-World Datasets
- **Pedagogical Approaches:** Project-based learning connecting theory to real-world applications; LeetCode integration for algorithmic thinking and technical interview preparation; Hybrid and flipped classroom models with active learning; Lab-driven instruction with hands-on coding; Integration of ethics and practical case studies throughout curriculum; Personalized learning plans for diverse student needs

DIVERSITY, EQUITY & INCLUSIVE TEACHING

- **Inclusive Pedagogy:** Developed beginner-friendly course materials accommodating diverse learning styles and prior programming experience. Created supplemental learning materials and personalized study plans to support students with varying backgrounds and learning needs.
- **Student Mentorship:** Mentored undergraduate and graduate students on independent and capstone projects. Provided individualized academic support through extensive office hours (8+ hours weekly) and structured help sessions promoting collaborative problem-solving.
- **Community Engagement:** Served as judge for 2025 State Science & Technology Fair of Iowa.
- **Open Educational Resources:** Advocate for open-source pedagogy; course repositories and supplemental materials publicly available on GitHub to reduce barriers and textbook costs for students.

PUBLICATIONS

Published & Accepted

- **Shihab, I.F.**, Akter, S., Sharma, A. "Efficient unstructured pruning of mamba state-space models for resource-constrained environments." **EMNLP 2025**.
- **Shihab, I.F.**, Akter, S., Sharma, A. "Cache-Efficient Posterior Sampling for Reinforcement Learning with LLM-Derived Priors Across Discrete and Continuous Domains" **EMNLP 2025**.
- **Shihab, I.F.**, Akter, S., Sharma, A. "HMAE: Self-Supervised Few-Shot Learning for Quantum Spin Systems." **ECAI 2025**.
- Sivaraman, A.L., Adu-Gyamfi, K., **Shihab, I.F.**, and Sharma, A. "ClearVision: Leveraging CycleGAN and SigLIP-2 for Robust All-Weather Classification." **IEEE ITSC 2025** (Accepted).
- Bhagat, S.R., **Shihab, I.F.**, and Sharma, A. "Accuracy Is Not Agreement: Expert-Aligned Evaluation of Crash Narrative Classification Models." **IEEE ITSC 2025** (Accepted).
- Ahmed, S., **Shihab, I.F.**, and Khokhar, A. "Quantum-driven Zero Trust Architecture with Dynamic Anomaly Detection in 7G Technology." **Measurement: Digitalization**, 100005, 2025.
- **Shihab, I.F.**, Alvee, B.I., and Sharma, A. "Leveraging Video-LLMs for Crash Detection and Narrative Generation: Performance Analysis and Challenges." **Proc. TRC-30 Conference, 2024**.
- Rahman, M.S., **Shihab, I.F.**, Chu, L., and Sharma, A. "Deeplocalization: Using Change Point Detection for Temporal Action Localization." **IEEE/CVF CVPR, 2024**.
- Ferdous, S., **Shihab, I.F.**, Chowdhury, R., and Reuel, N.F. "Reinforcement Learning-Guided Control Strategies for CAR T-Cell Activation." **Biotechnology and Bioengineering**, 121(9), 2868-2880, 2024.
- **Shihab, I.F.**, Bhagat, S.R., and Sharma, A. "Robust and Precise Sidewalk Detection with Ensemble Learning." **IEEE ITSC**, pp. 5092-5099, 2023.
- Ferdous, S., **Shihab, I.F.**, and Reuel, N.F. "Effects of Sequence Features on Machine-Learned Enzyme Classification Fidelity." **Biochemical Engineering Journal**, 187, 108612, 2022.

Under Review

- **Shihab, I.F.**, Akter, S., and Sharma, A. "What Fundamental Structure in Reward Functions Enables Efficient Sparse-Reward Learning?" (Submitted to **ICLR 2026**).
- **Shihab, I.F.**, Akter, S., and Sharma, A. "Differentiable Entropy Regularization for Geometry and Neural Networks." (Submitted to **ICLR 2026**).
- Sanjeda Akter, **Shihab, I.F.**, and Anuj Sharma. "Counterfactual Sensitivity for Faithful Reasoning in Language Models." *arXiv preprint arXiv:2509.01544*, 2025.. (Submitted to **ICLR 2026**).

- Sanjeda Akter, **Shihab, I.F.**, and Anuj Sharma. "Selective Risk Certification for LLM Outputs via Information-Lift Statistics: PAC-Bayes, Robustness, and Skeleton Design." *arXiv preprint arXiv:2509.12527*, 2025.. (Submitted to **ICLR 2026**).
- **Shihab, I.F.**, and Sharma, A. "Crash Time Matters: HybridMamba for Fine-Grained Temporal Localization in Traffic Surveillance Footage." Submitted to **IEEE Trans. on Intelligent Transportation Systems**.
- Akter, S., **Shihab, I.F.**, and Sharma, A. "Image Segmentation with Large Language Models: A Survey with Perspectives for Intelligent Transportation Systems." Submitted to **IEEE Trans. on Intelligent Transportation Systems**.
- Bhagat, S., Kandiboina, R., **Shihab, I.F.**, et al. "Unlocking Insights: Addressing Alcohol Inference Mismatch through Database-Narrative Alignment." Submitted to **Journal of Safety Research**.

Complete publication list (25+ papers) available in Google Scholar. (H-index: 4, Citations: 60+).

GRANTS & FUNDING

- **Iowa DOT Transportation Safety Projects:** Contributed to \$500K+ in funded research projects developing AI-based navigation and crash detection systems (2022-2025). Role: Graduate Research Assistant.
- **Future Funding Plans:** Preparing NSF CRII proposal on "LLM-Guided Reinforcement Learning for Autonomous Vehicle Safety" (Target: \$175K, Submission: Spring 2026).

AWARDS & HONORS

- **Conference Acceptances:** 5 papers accepted to top-tier venues: CVPR (23.6% acceptance), ECAI, EMNLP (2), ITSC (3).
- **Research Impact:** H-index: 4, Total Citations: 60+, with publications spanning AI, Transportation, and Bioengineering.
- **Graduate Assistantship:** Fully-funded Ph.D. and M.S. assistantships at Iowa State University (2020-2025).

ACADEMIC SERVICE

- **Peer Review:** Program Committee member and reviewer for: IEEE/CVF CVPR ('24 -'26), ICCV 25, IEEE ITSC ('23 - '25), ACM Multimedia ('25), WACV ('26), ICLR ('26), IEEE Intelligent Vehicles Symposium 26. Total reviews: 35+.
- **Departmental Service:** Graduate Student Representative, Iowa State University Computer Science Committee (2022-2023); Member, University of Vermont Graduate Senate Education Committee (2019-2020).
- **Community Outreach:** Judge, 2025 State Science & Technology Fair of Iowa (SSTFI).

RELEVANT INDUSTRY EXPERIENCE

- **Applied Scientist II, Amazon, Sunnyvale, CA** *Jan 2026 – Present*
 - **Traffic Intelligence & Analytics:** Developing applied machine learning and statistical models for traffic engineering problems, including traffic flow analysis, congestion modeling, and large-scale transportation data understanding.
 - **Data-Driven Optimization:** Designing data-driven methods to support traffic optimization, monitoring, and decision-making under real-world operational constraints.
 - **Scalable Modeling Pipelines:** Building scalable data pipelines and evaluation frameworks for experimentation, model validation, and deployment in production environments.
 - **Cross-Functional Collaboration:** Collaborating with traffic engineers, software engineers, and product stakeholders to translate domain requirements into robust applied ML solutions.
- **Applied Scientist, Amazon, Seattle, WA** *June 2025 – August 2025*
 - **Unified Data Framework:** Developed a Knowledge Graph framework to unify diverse datasets by automating format detection and removing project-specific dependencies.
 - **Custom KGE Development:** Proposed a novel Knowledge Graph Embedding (KGE) model and an efficient evaluation methodology tailored to specific Amazon business requirements.
 - **Advanced Negative Sampling:** Pioneered a novel negative sampling technique for sparse knowledge graphs and implemented 8 state-of-the-art methods to boost model training effectiveness.
 - **Intelligent Model Recommendation:** Engineered a recommender system to automatically select optimal model architectures and sampling strategies based on dataset characteristics.
 - **Reproducible Research Toolkit:** Built a comprehensive toolkit for evaluation, analysis, and reproducible research, featuring automated dataset discovery and quality metrics.

- **Scalable Algorithm Design:** Designed and tested scalable algorithms in collaboration with senior scientists, contributing to production-level systems.

- **Data Scientist, SoilSerdem, Ames, IA**

Jan 2024 – Dec 2024

- **Precision Soil Mapping:** Engineered a precision Soil Mapping Engine that boosted mapping accuracy by 35%, enabling data-driven decisions for over 10 farms.
- **Cloud Processing Optimization:** Designed QGIS tool scripts for AWS integration, reducing hosting costs while increasing processing speed by 20%.
- **Infrastructure Cost Reduction:** Optimized cloud architecture to significantly reduce infrastructure costs while maintaining high-performance data processing.
- **Predictive Environmental Modeling:** Developed environmental data models to improve prediction capabilities for critical resource allocation decisions.
- **ML Initiative Leadership:** Led cross-departmental machine learning initiatives, enhancing data-driven decision-making across the company.

- **Data Engineer Intern, Etalyc Inc., Ames, IA**

May 2021 – Jul 2021

- **Analytics Protocol Development:** Developed analytics protocols that improved data processing efficiency and traffic prediction accuracy.
- **Pedestrian Safety Models:** Created machine learning models to predict pedestrian movement, contributing to improved safety at high-risk intersections.
- **Urban Planning Reports:** Generated data-driven reports identifying traffic optimization opportunities to inform urban planning decisions.

TECHNICAL EXPERTISE

- **AI & Machine Learning:** Deep Learning (PyTorch, Keras), Reinforcement Learning (Ray, RLlib), Computer Vision (OpenCV), Large Language Models (LangChain, Ollama), Generative AI
- **Specialized Research:** Traffic Simulation (SUMO, CARLA, Isaac Gym), Quantum Neural Networks (torchquantum, Qiskit, PennyLane), Knowledge Graph Embedding
- **Programming & Tools:** Python, C++, Java, R, MATLAB; AWS, Git, Docker; Statistical Analysis, Experimental Design
- **AI & Machine Learning:** Deep Learning (PyTorch, Keras), Reinforcement Learning (Ray, RLlib), Computer Vision (OpenCV), Large Language Models, Generative AI
- **Specialized Expertise:** Traffic Simulation (SUMO, CARLA), Quantum Neural Networks (torchquantum, Qiskit, PennyLane), Environmental Data Analysis
- **Programming:** Python, Java, C++, R, SQL, MATLAB
- **Research Infrastructure:** Cloud Computing (AWS), High-Performance Computing, Data Engineering (Spark), Version Control (Git)
- **Knowledge Graph:** Knowledge Graph Embedding, Negative Sampling