Ibne Farabi Shihab

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Education

- **Ph.D., Computer Science, Ames, IA, Iowa State University** *Graduated OCT 2025*
- **M.S., Artificial Intelligence, Ames, IA, Iowa State University** *Graduated JAN 2024*
- **B.Sc., CSE, Dhaka, Bangladesh, BRAC University** *Graduated AUG 2018*

Research Interests

My research focuses on the intersection of artificial intelligence, Large Language Model, transportation systems, and quantum computing, with particular emphasis on:

- Computer Vision and Video Analytics for Safety-Critical Transportation Systems using Large Language Model
- Reinforcement Learning for Autonomous Vehicle Control and Decision Making
- Quantum Neural Networks for Enhanced Security and Privacy in Next-Generation Networks
- Synthetic Data Generation and Simulation for Traffic Safety and Predictive Modeling
- Machine Learning Applications in Environmental Data Analysis and Digital Agriculture

Academic Experience

- **Graduate Research Assistant, Iowa State University, Ames, IA** *January 2022 – May 2025*
  - **Transportation Safety Research**: Led multiple funded projects with the Iowa DOT developing AI-based navigation systems for snowplow operations, real-time crash detection, and ADAS enhancement under extreme weather conditions.
  - **Computer Vision & LLM Integration**: Pioneered novel frameworks integrating computer vision with Large Language Models for automated crash narrative generation from video data, implementing synthetic crash video simulation for enhanced model training.
  - **Quantum Computing Applications**: Developed innovative Quantum Neural Network architectures that increased anomaly detection accuracy by 10% for next-generation network security, establishing new methodologies for quantum-driven zero trust frameworks.
  - **Interdisciplinary Research**: Implemented reinforcement learning algorithms for cellular simulations optimizing CAR T-cell therapy parameters, demonstrating AI applications in biomedical research.

Teaching Experience

- **Lecturer, Dallas College, Dallas, TX** *August 2025 – Present*
  - **Course Instruction**: Taught classes in accordance with course descriptions and syllabi, maintained a regular schedule of teaching and office hours, and provided timely feedback to students.
  - **Curriculum Development**: Developed and enhanced curriculum and instructional materials, employing diverse and innovative teaching methods to accommodate various student learning styles.
  - **Student Assessment**: Designed and implemented a variety of assessment methods to evaluate student learning and progress toward course objectives.
  - **Institutional Service**: Actively supported the college's mission and goals by serving on departmental and college-wide committees and participating in curriculum review.
  - **Graduate Teaching Assistant, Iowa State University, Ames, IA** *August 2020 – December 2021*
    - **Course Development**: Contributed significantly to curriculum development for Machine Learning and Deep Learning courses, designing hands-on labs, programming assignments, and assessment materials.
    - **Advanced Technical Courses**: Served as teaching assistant for Motion Planning for Robotics and Autonomous Systems and Advanced Programming Techniques, providing specialized instruction in computational methods and algorithm development.
    - **Student Mentorship**: Guided undergraduate and graduate students through research projects, providing technical supervision and academic mentoring.
    - **Graduate Teaching Assistant, University of Vermont, Burlington, VT** *Aug 2019 – May 2020*
      - **AI Education**: Delivered comprehensive instruction in machine learning and deep learning fundamentals, focusing on mathematical foundations and practical implementations.
      - **Curriculum Enhancement**: Developed innovative teaching materials and project-based assessments that increased student engagement with complex technical concepts.

Selected Publications

- **Shihab, Ibne Farabi**, Sanjeda Akter, and Anuj Sharma. "HMAE: Self-Supervised Few-Shot Learning for Quantum Spin Systems." *arXiv preprint arXiv:2505.03140* (Accepted to **ECAI 2025**)
- **Shihab, Ibne Farabi**, Sanjeda Akter, and Anuj Sharma. "Efficient Unstructured Pruning of Mamba State–Space Models for Resource-Constrained Environments." *arXiv preprint arXiv:2505.08299*, 2025. (Accepted to **EMNLP 2025**)
- **Shihab, Ibne Farabi**, Sanjeda Akter, and Anuj Sharma. "Cache-Efficient Posterior Sampling for Reinforcement Learning with LLM-Derived Priors Across Discrete and Continuous Domains." *arXiv preprint arXiv:2505.07274*, 2025. (Accepted to **EMNLP 2025**)
- Sivaraman, Ashwin L., Kwadwo Adu-Gyamfi, **Shihab, Ibne Farabi**, and Anuj Sharma. "ClearVision: Leveraging CycleGAN and SigLIP-2 for Robust All-Weather Classification in Traffic Camera Imagery." *arXiv preprint arXiv:2504.19684* (Accepted to **ITSC 2025**)
- Bhagat, Sudesh Ramesh, **Shihab, Ibne Farabi**, and Anuj Sharma. "Accuracy Is Not Agreement: Expert-Aligned Evaluation of Crash Narrative Classification Models." *arXiv preprint arXiv:2504.13068* (Accepted to **ITSC 2025**)
- Ahmed, Shakil, **Shihab, Ibne Farabi**, and Ashfaq Khokhar. "Quantum-driven Zero Trust Architecture with Dynamic Anomaly Detection in 7G Technology: A Neural Network Approach." *Measurement: Digitalization*, Article 100005, 2025.
- **Shihab, Ibne Farabi**, B. I. Alvee, and A. Sharma. "Leveraging Video-LLMs for Crash Detection and Narrative Generation: Performance Analysis and Challenges." In **Proceedings of the TRC-30 Conference, 2024.**
- Rahman, Mohammed Shaiqur, **Ibne Farabi Shihab**, Lu Chu, and Anuj Sharma. "Deeplocalization: Using Change Point Detection for Temporal Action Localization." In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (**CVPR**)*, 2024.
- Ferdous, Sakib, **Shihab, Ibne Farabi**, Ratul Chowdhury, and Nigel F. Reuel. "Reinforcement Learning-Guided Control Strategies for CAR T-Cell Activation and Expansion." **Biotechnology and Bioengineering**, 121(9), 2868-2880, 2024.
- **Shihab, Ibne Farabi**, S. R. Bhagat, and A. Sharma. "Robust and Precise Sidewalk Detection with Ensemble Learning: Enhancing Road Safety and Facilitating Curb Space Management." In *Proc. 2023 IEEE 26th International Conference on Intelligent Transportation Systems (**ITSC**)*, Bilbao, Spain, 2023, pp. 5092-5099, doi: 10.1109/ITSC57777.2023.10422138.
- **Shihab, Ibne Farabi**, Sanjeda Akter, and Anuj Sharma. "What Fundamental Structure in Reward Functions Enables Efficient Sparse-Reward Learning?." *arXiv preprint arXiv:2509.03790*, 2025.. (Submitted to **ICLR 2026**)
- **Shihab, Ibne Farabi**, Sanjeda Akter, and Anuj Sharma. "Differentiable Entropy Regularization for Geometry and Neural Networks." *arXiv preprint arXiv:2509.03733*, 2025.. (Submitted to **ICLR 2026**)
- Sanjeda Akter, **Shihab, Ibne Farabi**, and Anuj Sharma. "Counterfactual Sensitivity for Faithful Reasoning in Language Models." *arXiv preprint arXiv:2509.01544*, 2025.. (Submitted to **ICLR 2026**)
- Sanjeda Akter ,**Shihab, Ibne Farabi** , 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, Ibne Farabi**, and Anuj Sharma. "Crash Time Matters: HybridMamba for Fine-Grained Temporal Localization in Traffic Surveillance Footage." *arXiv preprint arXiv:2504.03235*, 2025.. (Submitted to **IEEE ITS Transaction**)
- Akter, S., **Shihab, Ibne Farabi**, and A. Sharma. "Image Segmentation with Large Language Models: A Survey with Perspectives for Intelligent Transportation Systems." *arXiv preprint arXiv:2506.14096*, 2025..(Submitted to **IEEE ITS Transaction**).
- Islam, Md. Mazed Ul, Joyanta J. Mondal, and **Shihab, Ibne Farabi**. "Detecting Faulty Machinery of Waste Water Treatment Plant Using Statistical Analysis & Machine Learning." In *Proc. 2022 25th International Conference on Computer and Information Technology (**ICIT**)*, 2022.
- Ferdous, Sakib, **Shihab, Ibne Farabi**, and Nigel F. Reuel. "Effects of Sequence Features on Machine-Learned Enzyme Classification Fidelity." **Biochemical Engineering Journal**, 187, 108612, 2022.
- **Shihab, Ibne Farabi**, Maliha Moonwara Oishi, Samiul Islam, Kalyan Banik, and Hossain Arif. "A Machine Learning Approach to Suggest Ideal Geographical Location for New Restaurant Establishment." In *Proc. 2018 IEEE Region 10 Humanitarian Technology Conference (R10-HTC)*, 1-5, 2018.
- **Shihab, Ibne Farabi**, S. Akter, and A. Sharma. "Detecting and Mitigating Reward Hacking in Reinforcement Learning Systems: A Comprehensive Empirical Study." *arXiv preprint arXiv:2507.XXXX*, 2025. (Submitted to **ICSE 2026**)
- Bhagat, S., **Shihab, Ibne Farabi**, and J. Wood. "Identification of Potentially Misclassified Crash Narratives using Machine Learning (ML) and Deep Learning (DL)." *arXiv preprint arXiv:2507.03066*, 2025.

- Akter, S., **Shihab, Ibne Farabi**, and A. Sharma. "Large Language Models for Crash Detection in Video: A Survey of Methods, Datasets, and Challenges." *arXiv preprint arXiv:2507.02074*, 2025.
- Bhagat, S., R. Kandiboina, **Shihab, Ibne Farabi**, S. Knickerbocker, N. Hawkins, and A. Sharma. "Unlocking Insights Addressing Alcohol Inference Mismatch through Database-Narrative Alignment." *arXiv preprint arXiv:2506.19342*, 2025. (Submitted to **Journal of Safety Research**)

Relevant Industry Experience

* **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.

Academic Service

* **Peer Review**: Served as a program committee reviewer for premier conferences, including IEEE/CVF CVPR ('24, '25), IEEE ITSC ('23-'25), ACM Multimedia ('25) and ICLR 26 .
* **Academic Service**: Graduate Student Representative for the Iowa State University Computer Science Committee (2022-2023) and Member of the University of Vermont Graduate Senate Education Committee (2019-2020).
* **Community Outreach**: Served as a judge for the 2025 State Science & Technology Fair of Iowa (SSTFI)

Research & Technical Skills

* **Research Methodologies**: Experimental Design, Statistical Analysis, Simulation Modeling, Synthetic Data Generation, Quantum Algorithm Development
* **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