Althaf Shajihan

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RESEARCH AREAS

- Autonomous Structural Health Monitoring
- Smart Sensing and Internet of Things (IoT)
- Computer Vision and Generative AI
- Smart-Cities and Digital-Twins for Disaster Resilience
- Scientific Machine Learning and Physics-Informed Neural Networks (PINN)

EDUCATION

Ph.D. in Civil and Environmental Engineering (Focus: Structural Engineering) *Exp.* 2025
University of Illinois Urbana-Champaign (UIUC), Urbana, IL
Research area: AI and Smart Sensing Framework for Infrastructure Assessment | **GPA: 4.00/4.00**
Advisor: Prof. Billie F. Spencer, Jr.

M.S. in Computer Science 2024
University of Illinois Urbana-Champaign (UIUC), Urbana, IL
Research area: Physics-informed Neural Networks for Structural Systems | **GPA: 3.95/4.00**
Advisor: Prof. Girish Chowdhary

M.S. in Structural Engineering 2018
Indian Institute of Technology Bombay (IIT-B), Bombay, India
Research Area: Structural Health Monitoring of Masonry Arch Bridges | **GPA: 9.92/10.00**
Departmental 1st Rank | Institute Silver Medal | Advisor: Prof. Pradipta Banerji

B.S. in Civil Engineering 2016
National Institute of Technology Calicut (NIT-C), Calicut, India
Departmental 3rd Rank | **GPA: 9.21/10.00**

AWARDS AND HONORS

- **First Runner-up**, 7th–Midwest Smart Structures Colloquium, University of Illinois Urbana-Champaign 2025
- **Graduate College Conference Presentation Award**, University of Illinois Urbana-Champaign 2024
- **First Runner-up**, 6th–Midwest Smart Structures Colloquium, Purdue University 2024
- **Outstanding Student Contributor**, Academy for Excellence in Engineering Education, UIUC 2023
- **Mavis Future Faculty Fellowship**, University of Illinois Urbana-Champaign 2022-23
- **Insight Leadership program**, Illinois Leadership Center, University of Illinois Urbana-Champaign 2023
- **International Liu Huixian Earthquake Engineering Scholarship**, U.S – China E.E. Foundation 2022
- **Editor's Choice Journal Article**, MDPI Sensors journal 2021
- **Excellence Award**, 1st Intl. SHM competition – Data Anomaly Detection Challenge (*out of 330 students*) 2020
- **Bronze Award**, 1st Intl. SHM competition – Image based crack identification in bridges (*out of 112 teams*) 2020
- **Ravindar K. and Kavita Kinra Fellowship**, University of Illinois Urbana-Champaign 2018-19
- **Institute Silver Medal**, felicitated by Prime Minister of India for Dept. 1st Rank, IIT Bombay, India 2018

- **First Place**, Research Poster Competition, National Civil Engineering Research Expo, IIT Madras, India 2016
- **99.4th Percentile (Top 0.6%)** among 120,000 candidates, Graduate Aptitude Test in Engg. (GATE), India 2016

RESEARCH EXPERIENCE

StructureIQ, Inc – Champaign, IL

○ **Hardware Research Intern** 2025 – Present

- Research on design of next-generation wireless smart sensor for structural health monitoring.

Smart Structures Technology Lab – University of Illinois Urbana-Champaign, IL

○ **Bridge Monitoring using Smart Sensors and Physics-informed Neural Networks** 2022 – Present

- Design and implementation of a novel unsupervised physics-informed neural network (PINN) based damage detection framework for railroad truss bridges, achieving over 95% accuracy in damage identification for simulated scenarios of train crossings on the full-scale Calumet Bridge, Chicago, IL.
- Integration of multi-modal data sources (site inspections, drone surveys, FEM models) directly into deep learning pipeline for context-aware model updating.
- Developing a framework for holistic condition assessment of railroad bridges using multi-modal Internet-of-Things (IoT) sensor data and physics-based deep learning.

○ **Autonomous Infrastructure Assessment with Edge Computing and UAVs** 2020 – Present

- Developed a low-cost, deployable wireless machine-vision system for autonomous long-term displacement monitoring of railroad bridges with up to 25 days of battery operation; achieved state-of-the-art synchronization accuracy across multiple wireless camera nodes.
- Designed an algorithm for UAV-based full-field displacement estimation using moving-reference based ego-compensation without stationary reference points.
- Developed a Dynamic Tracker to be installed on bridges for amplifying the motion to aid vision based measurement of sub-millimeter vibrations; used a Kalman-Filter based algorithm to solve the inverse-problem.
- Developing a pipeline for 3D damage localization in bridges from 2D drone inspection videos in GPS-denied environments using sparse point-cloud reconstruction; created a custom dataset for damage severity quantification in steel truss bridges, validated on a 100-year-old pedestrian bridge in Mahomet, IL.
- Advancing the development of a custom-built drone by integrating a gimbal-stabilized stereo-vision system for on-board machine learning and autonomous structural inspection.

○ **Synchronized Wireless Sensing & Anomaly Detection with Deep Learning** 2018 – 2020

- Developed hardware and software for synchronized sensing with external sensors in Wireless Smart Sensors, achieving state-of-the-art data-sync precision of up to 8 µsec and reducing false-positives in SHM.
- Automated anomaly identification in sensor data with deep learning, achieving 96% classification accuracy even using a small training dataset.

Indian Institute of Technology Bombay, India

○ **Structural Health Monitoring of Masonry Arch Bridge using Multi-Model Updating** 2017 – 2018

- Performed condition assessment of a 90-year-old masonry arch railroad bridge for increased train axle loads using a multi-model updating technique. Developed a new computationally efficient 1D formulation for abutment soil-structure interaction considering the influence of moving train loads.

○ **Seismic Base Isolation using Periodic Foundation** 2016 – 2017

- Designed and validated a novel periodic foundation system with 1D composite meta-materials achieving wider low-frequency band gaps for seismic wave attenuation, offering a cost-effective solution to be used in bridge piers for earthquake force mitigation.

National Institute of Technology Calicut, India

- **Experimental and Numerical Study on Composite RC Deep Beams** 2015 – 2016
  - Optimized reinforced concrete deep beam performance through experimental testing and FE analysis, incorporating steel fibers and shredded rubber additives, resulting in improved ultimate failure capacity, ductility, and better crack distribution for enhanced structural warning before failure.

GRANTS & RESEARCH FUNDING

Full-Scale Laboratory Testing of Welded, Debonded Miter Gate Anchorages for Fatigue Life Assessment 2026 – 2027

U.S. Army Corps of Engineers (USACE), PI: B.F. Spencer, Jr., Co-authored on behalf of Prof. B.F. Spencer, Jr. *Grant Amount: $232,500*

Innovative Technologies in Structural Health Monitoring for Condition Assessment and Future Reliability Prediction 2025 – 2026

U.S. Army Corps of Engineers (USACE), PI: B.F. Spencer, Jr., Co-authored on behalf of Prof. B.F. Spencer, Jr. *Grant Amount: $423,335*

Condition Assessment of Railroad Bridges using Wireless Smart Sensors 2018 – 2020

U.S. Department of Transportation, Federal Railroad Administration (FRA), PI: B.F. Spencer, Jr., Co-author of closure report. *Grant Amount: $355,388*

JOURNAL PUBLICATIONS

[J1] Lawal, O., **V. Shajihan, S. A.**, Mechitov, K., & Spencer Jr, B. F. (2024). Edge Integration of Artificial Intelligence into Wireless Smart Sensor Platforms for Railroad Bridge Impact Detection. Sensors, 24(17), 5633. https://doi.org/10.3390/s24175633

[J2] Wang, S., Rodgers, C., Fillmore, T., Welsh, B., Golecki, T., **V. Shajihan, S. A.**, & Spencer, B. F. (2023). Vision-based model updating and evaluation of miter gates on inland waterways. Engineering Structures, 280, 115674. https://doi.org/10.1016/j.engstruct.2023.115674

[J3] Lawal, O., **V. Shajihan, S. A.**, Mechitov, K., & Spencer Jr, B. F. (2023). An event-classification neural network approach for rapid railroad bridge impact detection. Sensors, 23(6), 3330. https://doi.org/10.3390/s23063330

[J4] **V. Shajihan, S. A.**, Hoang, T., Mechitov, K., & Spencer Jr, B. F. (2022). Wireless SmartVision system for synchronized displacement monitoring of railroad bridges. Computer-Aided Civil and Infrastructure Engineering, 37(9), 1070-1088. https://doi.org/10.1111/mice.12846

[J5] Lawal, O., Najafi, A., Hoang, T., **V. Shajihan, S. A.**, Mechitov, K., & Spencer Jr, B. F. (2022). Development and validation of a framework for smart wireless strain and acceleration sensing. Sensors, 22(5), 1998. https://doi.org/10.3390/s22051998

[J6] **V. Shajihan, S. A.**, Wang, S., Zhai, G., & Spencer Jr, B. F. (2022). CNN based data anomaly detection using multi-channel imagery for structural health monitoring. Smart Structures Systems, 29(1), 181-193. https://doi.org/10.12989/sss.2022.29.1.181

[J7] Zhai, G., Narazaki, Y., Wang, S., **V. Shajihan, S. A.**, & Spencer, B. F. (2022). Synthetic data augmentation for pixel-wise steel fatigue crack identification using fully convolutional networks. Smart Structures Systems, 29(1), 237-250. https://doi.org/10.12989/sss.2022.29.1.237

[J8] **V. Shajihan, S. A.**, Chow, R., Mechitov, K., Fu, Y., Hoang, T., & Spencer Jr, B. F. (2020). Development of synchronized high-sensitivity wireless accelerometer for structural health monitoring. Sensors, 20(15), 4169. https://doi.org/10.3390/s20154169

[J9] Jain, S., **V. Shajihan, S. A.**, Laskar, A., & Alam, A. (2020). Application of innovative one-dimensional periodic isolation systems for seismic response reduction of bridges. Advances in Structural Engineering, 23(7), 1397-1412. https://doi.org/10.1177/1369433219895918

[J10] **V. Shajihan, S. A.**, Mechitov, K., Chowdhary, G., & Spencer Jr, B. F., Physics-informed neural network based model updating and damage identification in railroad truss bridges. arXiv preprint arXiv:2502.00194. (*under review*)

[J11] **V. Shajihan, S. A.**, Lawal, O., Golecki, T., Mechitov, K., & Spencer Jr, B. F., Deep learning-based prediction and localization of damage severity in steel truss bridges from drone surveys. (*under review*)

[J12] **V. Shajihan, S. A.**, Lawal, O., Mechitov, K., & Spencer Jr, B. F., Multi-point displacement estimation using drones by ego-motion compensation without relying on static background features. (*in preparation, to be submitted in June 2025*)

CONFERENCE PAPERS & TECHNICAL PRESENTATIONS

[1] **V. Shajihan, S. A.**, "Automated deep-learning based damage mapping in steel truss bridges from drone surveys", 7th Midwest Smart Structures Colloquium (MSSC), Univ. of Illinois Urbana-Champaign, IL, May 20-22, (2025).

[2] **V. Shajihan, S. A.**, "Physics-Informed Neural Network for Damage Identification in Railroad bridges", 6th Midwest Smart Structures Colloquium 4MSSC), Purdue University, IN, April 26-28, (2024).

[3] Rodgers, C., Wang, S., Welsh, B., **V. Shajihan, S. A.**, Golecki, T., Eick, B., & Spencer, B. F., "Vision-Based Displacement Estimation of Large-Scale Infrastructure — A Case Study." in the 14th International Workshop on Structural Health Monitoring (IWSHM), Stanford University, CA, September 12-14, (2023).

[4] Lawal, Omobolaji, **V. Shajihan, S. A.**, Mechitov, K., and Spencer Jr, B. F., "A Decision Tree-based Neural Network Approach for Railroad Bridge Event Classification": ASCE Engineering Mechanics Institute (EMI) 2023 Conference, Georgia Tech, Atlanta, June 6 - 9, (2023).

[5] **V. Shajihan, S. A.**, "Synchronized Displacement Monitoring with Multiple Wireless Smart Cameras", 5th Midwest Smart Structures Colloquium, Univ. of Illinois Urbana-Champaign, IL, April 15-16, (2023).

[6] **V. Shajihan, S. A.**, and Hoang, T. Mechitov, K., and Spencer, B. F., "Cyber-Physical Framework for Efficient Evaluation of Vision-based Displacement Tracking Systems", 8th World Conference on Structural Control and Monitoring (8WCSCM), Orlando, FL, June 5-8, (2022).

[7] **V. Shajihan, S. A.**, and Hoang, T., "Wireless Vision-based Synchronized Displacement Monitoring", The 2nd ZHITU Symposium on Advances in Civil Engg., UNIST, South Korea, Sep 28-29, (2021).

[8] **V. Shajihan, S. A.**, and Banerji, P., "Structural Health Monitoring of Masonry Arch Bridge using Multi-Model Updating", 4th Midwest Smart Structures Colloq. (4MSSC), Purdue Univ., IN, April 12, (2019).

[9] **V. Shajihan, S. A.**, Aishwarya, T., Shruthi, V., E. Mathew, S., Manoj, A., "Study on Concrete Deep Beams", Poster presentation in Civil Engineering Research Expo, IIT Madras, India, March 12-13, (2016).

TEACHING EXPERIENCE

Lead Teaching Assistant (TA) 2022 – 2023

CEE Strategic Instructional Innovations Program, University of Illinois

- Led curriculum enhancement initiative, managing a team of four TAs and working with 12 faculty members to integrate advanced computational elements and coding across CEE courses.
- Introduced Jupyter Notebook-based lab worksheets using Python for the course CEE300: Behavior of Materials, replacing inefficient Word/Excel worksheets for student lab submissions. Iteratively revised

materials based on course TA feedback to ease student adaptation to the new platform.

- Prepared discussion materials to foster interdepartmental collaboration in weekly meetings with Education Innovation Fellows and faculty. Presented annual progress representing CEE Dept. at "Celebration of Teaching" event held by Academy for Excellence in Engineering Education (AE3). Honored as ***Outstanding Student Contributor*** by AE3 in 2023.

Interim Lecturer Fall 2023

CEE 472: Structural Dynamics, Dept. of Civil Engineering, University of Illinois

- Delivered substitute lectures to the class of 60+ students, covering topics in structural dynamics of single and multi degree-of-freedom systems.

Head Teaching Assistant Spring 2020

CEE 598: Structural Damping, Dept. of Civil Engineering, University of Illinois

- Supervised group presentations, held office hours, graded assignments, and managed the course website.
- Designed Matlab homework problems on optimal damper design for seismic resilience of buildings.

Teaching Assistant Fall 2019

CEE 472: Structural Dynamics, Dept. of Civil Engineering, University of Illinois

- Led in-person and Zoom office hours for 50+ students, offering clarification on conceptual topics and assisting with debugging Matlab-based assignments and projects.

Teaching Assistant 2017 – 2018

Structures Mechanics II, Indian Institute of Technology Bombay, India

- Provided one-on-one assistance during office hours; graded assignments and exams for the course of 100+ students.

Lab Teaching Assistant 2016 – 2017

Heavy Structures Lab, Indian Institute of Technology Bombay, India

- Guided 120+ students in conducting experimental tests on an indeterminate beam setup, overseeing measurement collection and structural analysis.

Student Coordinator 2015 – 2016

Student Guidance Cell, National Institute of Technology Calicut, India

- Tutored freshmen in an Introductory Computer Science course on C/C++ and held one-on-one office hours.

PROFESSIONAL EXPERIENCE

Project Team Lead Summer 2022

UIUC Bahl Smart Bridge, University of Illinois

- Designed and implemented a real-time computer vision and AI-based pedestrian traffic monitoring system, integrating live 3D pose rendering within a simulated Digital Twin of the Smart Bridge.
- Collaborated with the National Center for Supercomputing Applications (NCSA), Urbana, IL, to develop this system into an open to public interactive smartphone application. By fusing camera and accelerometer data, and utilizing both edge and cloud computing, the system provides a real-time experience for users.

Team Leader Summer 2019

12th Asia-Pacific-Euro Summer School on Smart Structures Technology, Italy

- Led a team of 9 international graduate students in deploying accelerometers on the Annibaldi bridge in Sapienza University, Rome to conduct system identification and finite element (FE) based model updating.

Graduate Structural Designer 2017 – 2018

Team Shunya – Solar Decathlon China, U.S Dept. of Energy, IIT Bombay, India

- Led structural design for IIT-B's entry representing India in Solar Decathlon China'18, an international competition to build solar-powered, net-zero energy modular houses in 15 days.
- Designed I.S. code compliant steel superstructure and foundation, conducted FE analysis for floor-vibration comfort levels, and developed a rapid assembly process for modular shipment in a container.

Site Engineering Intern Summer 2014

Delhi Metro Rail Corporation Ltd. (DMRC), India

- Monitored RC bridge girder pre and post-tensioning; reviewed structural design drawings for the Kochi Metro Rail project, India.

MENTORING & UNIVERSITY SERVICE

Mentoring

Graduate Student Mentor – University of Illinois 2020 – Present

- Mentored Mr. Bolaji Lawal (Ph.D. Student) in microprocessor programming and soldering techniques for printed circuit boards, leading to the development of a wireless strain sensor for monitoring applications.
- Supervised experimental setup for shake table vibration tests with a real-time controller, guiding Ms. Casey Rodgers, Mr. Ray Ausan, Ms. Mengxiao Zhong, and Mr. Bolaji Lawal (Ph.D. Students).
- Led development of a custom autonomous drone for structural defect inspection, overseeing integration of machine-vision camera, gimbal control, vision-based path planning, and edge-computing with Mr. Thomas Ngare Matiki, Mr. Ray Ausan (Ph.D. Students), and Xinyang Li (B.S. Student).

Graduate Student Mentor – Indian Institute of Technology Bombay, India 2017

- Mentored Mr. Shubham Agarwal (B.S. Student) in nonlinear finite element modeling of a masonry arch bridge and automated Abaqus processes using Python scripting.

University Service

Vibration Monitoring Advisor – University of Illinois Spring 2022

- Diagnosed and resolved anomalous vibration noise on an anti-vibration table at the Environmental Engineering and Science Lab, Department of CEE, using a multiple accelerometer setup, identifying the source as a lamp and enabling new device installation.
- Conducted vibration analysis for a sensitive experimental setup at Loomis Laboratory, Department of Physics, using high-sensitivity wireless accelerometers.

TECHNICAL REVIEWER

- Measurement, Elsevier
- Engineering Structures, Elsevier
- Structure and Infrastructure Engineering, Taylor & Francis
- IEEE Transactions on Mobile Computing, IEEE Computer Society
- Remote Sensing, MDPI
- Sensing and Imaging, Springer Nature
- Journal of Civil Structural Health Monitoring, Springer Nature
- International Journal of Rail Transportation, Taylor & Francis

COMPETENCIES

Programming Languages:	Python, C/C++, Embedded C, Matlab, and R
Softwares and Tools:	Abaqus, Comsol, SAP2000, and Blender | Raspberry Pi, and Nvidia Jetson
Languages:	English, Hindi, and Malayalam

ENTREPRENEURIAL & OTHER POSITIONS

Shaan Consultants & Builders (Co-founder) – Cochin, India 2020 – Present

- Co-founded a family-run startup offering cost-effective construction and design solutions, successfully completing 15+ building construction and consultancy projects over three years.

Community Service Positions

- Coordinator – Shakes and Quakes program for children at Mahomet Elementary School, IL 2019 – 2024
- Organizer – Community-building activities and interfaith initiatives at CIMIC, Urbana, IL 2018 – 2023
- Student member – National Service Scheme, NIT-C, surveyed for high school construction, India. 2015

Professional Memberships

- American Society for Civil Engineers (ASCE) 2022 – Present
- Structural Engineering Institute (SEI) 2022 – Present
- American Railway Engineering and Maintenance-of-Way Association (AREMA) 2021 – Present