

# MUHAMMAD ZOHAIB SARWAR

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## SUMMARY

My research interests broadly lie in AI for infrastructure and transportation systems, at the intersection of computational engineering, machine learning (ML), and structural health monitoring (SHM):

- **ML & Data Science:** Probabilistic deep learning, time-series modeling, graph neural networks, anomaly detection, federated learning.
- **Computational Engineering:** Structural dynamics, numerical simulation, finite element modeling, sensor and data fusion, digital twin technologies.
- **Signal Processing:** Advanced signal processing techniques, vibration analysis, graph signal processing, physics-informed neural networks.
- **Industrial Applications:** Predictive maintenance, intelligent infrastructure monitoring, rail systems monitoring, automated structural condition assessment of bridges and transportation networks.

## EDUCATION

- Sep 2019–Jun 2023** **Ph.D. in Structural Engineering**, Norwegian University of Science and Technology (NTNU), Trondheim, Norway.  
*Thesis: Vehicle-Assisted Bridge Damage Assessment Using Probabilistic Deep Learning.*
- Aug 2017–Jul 2019** **M.Sc. in Structural Engineering**, Chung-Ang University (CAU), Seoul, South Korea.  
*Thesis: Event-Driven Structural Displacement Estimation Using a Multi-metric Ultra-Low-Power Wireless Sensing System.*
- Aug 2013–Jun 2017** **B.Sc. in Electronic Engineering**, Bahria University, Islamabad, Pakistan.  
*Thesis: FPGA Based Sea Range Finder.*

## EXPERIENCE

### Academic Experience

- Sep 2023–Present** **Industrial Postdoctoral Fellow**, NTNU & Norske Tog (Full-time).  
*Project: Condition Monitoring for the Norwegian Rail Network.*  
Developed data-driven models for rail wheel wear prediction and optimized maintenance strategies in collaboration with industry partners. Analyzed large-scale sensor data from trains to extract actionable insights and improve the efficiency and reliability of the rail network.
- Sep 2019–Aug 2022** **Doctoral Researcher (Ph.D. Candidate)**, NTNU, Dept. of Structural Engineering.  
*Research Project: Automated Structural Condition Assessment for Concrete Bridges.*  
Conducted research on indirect bridge monitoring techniques using data from passing vehicles and advanced machine learning models. Developed sensor fusion algorithms combining vehicle-induced signals with physics-based approaches for real-time bridge health evaluation. Published findings in high-impact journals and conferences.
- Aug 2017–Apr 2019** **Research Assistant**, Smart Infrastructure Technology Laboratory, Chung-Ang University, Seoul, South Korea.  
Designed and implemented multi-sensor data acquisition systems for long-term structural health monitoring. Developed computer vision and signal processing algorithms for real-time displacement estimation and damage detection in civil structures.

### Industry Experience

Jan 2024–Mar 2024	<b>Engineering Intern</b> , ABB Ltd. (Part-time). <i>Project: Digitization of Railway Systems.</i> Gained hands-on experience with ABB’s traction control hardware (AC 800PEC) and real-time simulation platforms. Implemented a data acquisition pipeline and a software tool to crawl and extract live data from control systems for analysis.
Jan 2024–Mar 2024	<b>Engineering Intern</b> , Stadler Rail (Part-time). <i>Project: Condition-Based Monitoring of Railway Wheel Wear.</i> Assisted with commissioning traction control systems and performing test runs on trains under various braking conditions. Verified software requirements and updated firmware on train subsystems to facilitate condition monitoring of wheel wear.
Sep 2022–Jul 2023	<b>Industrial Researcher</b> , NTNU Concrete Group (in collaboration with Maturix & Beton-mast). <i>Project: Intelligent Concrete Drying (European Eurostars Project).</i> Investigated concrete curing processes and developed an AI-driven model for optimizing the industrial concrete drying cycle. Integrated sensor data from smart curing devices to reduce CO <sub>2</sub> footprint and improve drying time predictions.

## PROJECTS

2023–Present	<b>Predictive Maintenance for Railways</b> – Developed a machine learning pipeline to predict railway wheel wear using time-series data from onboard sensors. <i>Tech: Python, TensorFlow, Azure Cloud, Signal Processing.</i>
2022–2023	<b>Intelligent Concrete Drying System</b> – Collaborated on a cloud-connected platform to monitor and optimize concrete curing in construction projects (Eurostars ICD project). <i>Tech: IoT Sensors, Python, Machine Learning, Cloud Analytics.</i>
2017–2019	<b>IoT-Based Digital Twin for Prefab Structures</b> – Created a wireless sensor network to track prefab concrete elements from factory to site and assess their structural health in real time. <i>Tech: Python, Arduino, Cloud Computing, Data Analytics.</i>
2018–2019	<b>Autonomous UAV for Bridge Inspection</b> – Built a custom drone equipped with camera and IMU modules for automated bridge inspection and crack detection using deep learning. <i>Tech: Python, Computer Vision, Deep Learning (TensorFlow).</i>

## TEACHING & MENTORING

2025	<b>Research Mentor</b> – Research mentor a PhD researcher (Muhammad Asaad Cheema) at NTNU Department of Electronic Engineering.
2023	<b>Research Mentor</b> – Supervised a master thesis, Exploring machine learning in the design of reinforced concrete beams at NTNU Department of Structural Engineering.
2018	<b>Teaching Assistant</b> – Assisted in teaching the Structural Dynamics course at Chung-Ang University (graduate level). Held office hours, guided lab sessions, and graded exams for a class of 50 students.
2017	<b>Student Mentor</b> – Supervised an undergraduate capstone project at Chung-Ang University on dynamic displacement estimation using accelerometer sensors. Guided the student (Won-Tae Jung) in experimental design, data collection, and analysis.

## ACADEMIC ACTIVITIES

Journal / Organization	Role
IEEE Transactions on Industrial Informatics	Reviewer
Mechanical Systems and Signal Processing	Reviewer
IEEE Sensors Journal	Reviewer
Measurement	Reviewer
Sensors MDPI	Reviewer
Scientific Reports (Nature Portfolio)	Reviewer
Bridge Engineering	Early Career Reviewer Board Member
Swiss National Science Foundation (SNSF)	International Expert Reviewer (SPIRIT Program)

## PUBLICATIONS

### Journal Articles:

1. Cheema A., **Sarwar M. Z.**, Rossi S., Pierluigi D., Cantero D. (2025). Clustered Federated Learning for Population-Based Structural Health Monitoring. *IEEE Internet of Things Journal*. (IF: 8.2)
2. Cantero, D.; **Sarwar, M.Z.**; Malekjafarian, A.; Corbally, R.; Makki Alamdari, M.; Cheema, P.; Noh, H.Y.; Liu, J.; Aggarwal, J. (2024). Numerical benchmark applied to four data-driven methods for road bridge damage detection from passing vehicles responses. *Archives of Civil and Mechanical Engineering*, 24, 190. (IF: 4.4)
3. Cheema, M.A.; **Sarwar, M.Z.**; Salvo Rossi, P.; Cantero, D. (2024). Computationally-efficient structural health monitoring using graph signal processing. *IEEE Sensors Journal*, 24(7), 11895–11905. (IF: 4.3)
4. **Sarwar, M.Z.**; Cantero, D. (2024). Probabilistic autoencoder-based bridge damage assessment using train-induced responses. *Mechanical Systems and Signal Processing*, 208. (IF: 8.4)
5. **Sarwar, M.Z.**; Cantero, D. (2023). Vehicle-assisted bridge damage assessment using probabilistic deep learning. *Measurement*, 201. (IF: 5.1)
6. **Sarwar, M.Z.**; Cantero, D. (2021). Deep autoencoder architecture for bridge damage assessment using responses from multiple vehicles. *Engineering Structures*, 246. (IF: 5.5)
7. Saleem, M.R.; Park, J.W.; Lee, J.H.; Jung, H.J.; **Sarwar, M.Z.** (2021). Instant bridge visual inspection using a UAV by image capturing and geo-tagging system and deep convolutional neural network. *Structural Health Monitoring*, 20(4), 1760–1777. (IF: 6.6)
8. **Sarwar, M.Z.**; Saleem, M.R.; Park, J.W.; et al. (2020). Multimetric event-driven system for long-term wireless sensor operation for SHM applications. *IEEE Sensors Journal*, 20(10), 5350–5359. (IF: 4.3)
9. **Sarwar, M.Z.**; Park, J.W. (2020). Bridge displacement estimation using a co-located acceleration and strain sensor. *Sensors*, 20(4), 1109. (IF: 3.9)

### Technical Reports:

1. **Sarwar, M.Z.**; Cantero, D.; Hendriks, M.; Geiker, M.R. (2023). *Concrete Drying Model*. Department of Structural Engineering, NTNU, Norway.

### Conference Papers:

1. **Sarwar, M.Z.**; Cantero, D. (2022). Data-driven bridge damage detection using multiple passing vehicle responses. In *Proc. of IABMAS 2022*, Barcelona, Spain, pp. 1003–1010.
2. **Sarwar, M.Z.**; Cantero, D. (2021). Unsupervised deep learning-based bridge damage detection using a fleet-sourcing concept. Presented at an international symposium, Porto, Portugal, June 2021.
3. Park, J.W.; **Sarwar, M.Z.** (2018). Ultra low-power smart wireless sensor network with event-based operation. In *Proc. of SMAR 2018*, Spain.

## HONORS & AWARDS

- Fully Funded PhD Fellowship from Department of Structural Engineering. (4 million NOK), 2019
- Chung-Ang University Young Scientist Scholarship (CAYSS), 2017
- Best Poster Award, Conference of the Korean Society of Civil Engineers (COSEIK), 2018
- Undergraduate Merit Scholarship, Bahria University, 2013–2017

## TECHNICAL SKILLS

<b>Programming</b>	Python, C/C++, Java, SQL,
<b>ML &amp; Data Science</b>	Scikit-Learn, TensorFlow, Keras, PyTorch, NumPy, Pandas
<b>Big Data</b>	Apache Spark
<b>Signal Processing</b>	Time-series analysis, spectral analysis, vibration analysis
<b>Engineering Tools</b>	MATLAB, ABAQUS, COMSOL
<b>Cloud &amp; DevOps</b>	AWS, Azure, Git, Docker
<b>Hardware</b>	AC 800PEC, FPGA, Arduino, Raspberry Pi
<b>Soft Skills</b>	Project management, technical communication, leadership, teamwork

## REFERENCES & LANGUAGES

### **Dr. Daniel Cantero**

Associate Professor, Department of Structural Engineering, NTNU

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### **Languages:**

English: Professional Working Proficiency

Norwegian: Beginner

Urdu: Native (Mother Tongue)

Korean: Beginner