Muhammad Zohaib Sarwar

Senior AI / ML Scientist | Signal Processing | Predictive Maintenance | Uncertainty Aware Industrial AI

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Profile

Senior AI and machine learning scientist with a Ph.D. in Engineering from NTNU and strong experience developing **signal ML, uncertainty aware analytics, predictive maintenance, and condition monitoring workflows** for industrial assets. Experienced with high frequency operational sensor data, vibration signals, onboard train systems, control system data, IoT monitoring, and production oriented analytics. Proven ability to move research into practical industrial workflows through structured experimentation, model validation, stakeholder collaboration, Azure hosted dashboards, and deployment focused implementation. Strong fit for industrial energy use cases where model confidence, calibration, out of distribution behaviour, and safe automation thresholds matter.

Core Expertise

Signal ML and Acoustic Analytics	Signal processing, acoustic signal processing, vibration diagnostics, spectral analysis, envelope analysis, feature extraction, time series modeling, anomaly detection, degradation modeling
Uncertainty Aware AI	Probabilistic deep learning, uncertainty quantification, model calibration, confidence scoring, out of distribution behaviour, robustness testing, safe automation thresholds
Industrial AI Deployment	Predictive maintenance, equipment monitoring, condition based decision support, industrial IoT, operational analytics, model validation, production ready workflows
Evaluation Rigor	Experiment design, baseline comparison, performance tracking, version controlled experiments, reproducible pipelines, peer reviewed scientific code, evaluation standards
Programming and ML	Python, SQL, C/C++, MATLAB, Java, Verilog, Scikit learn, TensorFlow, PyTorch, NumPy, Pandas, statistical modeling
Cloud and Engineering Tools	Azure, AWS, Docker, Git, Power BI, Apache Spark, COMSOL, ABAQUS, ABB AC 800PEC, sensor integrated systems
Collaboration	Cross functional engineering, stakeholder communication, technical documentation, mentoring students and junior researchers, industrial partner coordination

Professional Experience

Industrial Postdoctoral Fellow, NTNU and Norske Tog *Sep 2023 to Present*

Project: Condition Monitoring for the Norwegian Rail Network

- Developed AI and signal processing workflows for condition monitoring of railway assets using high frequency operational data from onboard train systems.
- Architected and validated end to end data pipelines across multiple train units, enabling scalable monitoring, diagnostics, and engineering analytics in an operational rail environment.
- Built Python based applications for processing, structuring, and interpreting traction and auxiliary system signals under noisy real world operating conditions.
- Designed KPI frameworks and Azure hosted dashboards to support diagnostics, asset monitoring, degradation insight, and maintenance decision support.
- Applied structured validation, model evaluation, and uncertainty aware thinking to translate raw operational measurements into reliable engineering insight.
- Coordinated integration and validation with ABB and Stadler Rail, supporting deployment oriented workflows across control systems, onboard systems, and analytics layers.

Contractor, Vibration Analysis and Machine Learning, Resonant Engineering *2025 to Present*

- Develop signal processing and machine learning workflows for machinery diagnostics, vibration based condition monitoring, and industrial asset health assessment.
- Build Python acquisition and analysis pipelines that connect sensor hardware, processed signals, diagnostic rules, and reporting outputs for customer facing industrial use.
- Use physics informed features, spectral methods, anomaly detection, and model comparison to support equipment monitoring and predictive maintenance decisions.
- Translate industrial problems into structured analytical workflows with clear assumptions, validation logic, uncertainty considerations, and actionable outputs.

Freelance Data Scientist / ML Consultant *2025 to Present*

Signal Based Modeling, Forecasting, and Optimization

- Developed machine learning workflows for industrial and commercial applications involving multimodal data, forecasting, anomaly detection, and operational optimization.
- Designed preprocessing, feature engineering, model comparison, validation, and performance reporting workflows for real world datasets with heterogeneous inputs.

- Delivered decision support outputs aligned with planning, performance improvement, reliability, and operational decision making.

Engineering Intern, ABB Ltd. *Jan 2024 to Mar 2024*

Project: Digitization of Railway Systems

- Developed Python tools to extract live control system signals from ABB AC 800PEC systems for downstream monitoring, diagnostics, and analytics.
- Configured interfaces between control systems and analytical environments, supporting structured operational data access for industrial AI workflows.
- Validated signal quality and documented repeatable engineering workflows for reliable data use in monitoring and analysis.

Engineering Intern, Stadler Rail *Jan 2024 to Mar 2024*

Project: Condition Based Monitoring of Railway Wheel Wear

- Supported commissioning, subsystem validation, and troubleshooting during train testing and monitoring preparation.
- Verified software and firmware configurations affecting signal availability, system readiness, and condition monitoring workflows.
- Contributed to practical validation across software, control systems, and asset level monitoring requirements.

Industrial Researcher, NTNU Concrete Group with Maturix and Betonmast *Sep 2022 to Jul 2023*

- Developed cloud connected monitoring workflows integrating IoT sensor systems, analytical pipelines, and reporting tools for industrial process monitoring.
- Structured large scale datasets for analysis, optimization, and software supported engineering decisions.
- Applied predictive analytics in an industrial research context with practical deployment constraints and external stakeholder collaboration.

Doctoral Researcher, NTNU *Sep 2019 to Aug 2022*

Project: Automated Structural Condition Assessment for Concrete Bridges

- Developed probabilistic machine learning models for structural condition assessment using sensor derived response data from vehicles and infrastructure systems.
- Built complete pipelines for preprocessing, feature extraction, anomaly sensitive inference, uncertainty quantification, validation, and robustness evaluation.
- Conducted rigorous experiments on model behaviour under real world variability, sparse labels, noisy measurements, and changing operating conditions.
- Published peer reviewed work in high impact journals and translated scientific findings into implementation oriented engineering methods.

Research Assistant, Smart Infrastructure Technology Laboratory, Chung Ang University *Aug 2017 to Apr 2019*

- Designed and implemented multi sensor data acquisition systems for long term monitoring applications.
- Worked with embedded sensing, low power wireless systems, signal processing, and field oriented data collection workflows.
- Supported hardware integration, testing, and validation of sensor driven monitoring systems.

SELECTED PROJECTS

2025 to Present	**Industrial Condition Monitoring Workflows**: Develop practical workflows combining sensing, signal processing, machine learning, physics informed diagnostics, and reporting for machinery health applications.
2024 to Present	**Wheel Wear Modeling from Continuous Signals**: Build feature engineering and analytical pipelines linking continuous railway measurement signals to degradation behaviour and maintenance insight.
2023 to Present	**Railway Monitoring Applications**: Develop Python and Azure based software and analytics workflows using operational engineering data to support diagnostics of complex railway systems.
2022 to 2023	**Cloud Connected Industrial Monitoring**: Built IoT based monitoring and analytics workflows for industrial process improvement using sensor integrated data systems.
2018 to 2019	**UAV Based Bridge Inspection**: Built drone based inspection workflows and deep learning based visual defect detection for infrastructure monitoring.

Education

2019 to 2023	**Ph.D. in Engineering**, Norwegian University of Science and Technology, Trondheim, Norway Thesis: Vehicle-assisted bridge damage assessment using Probabilistic deep learning.
2017 to 2019	**M.Sc. in Engineering**, Chung Ang University, Seoul, South Korea Thesis: Event Driven Structural Displacement Estimation Using a Multi metric Ultra Low Power Wireless Sensing System.
2013 to 2017	**B.Sc. in Electronic Engineering**, Bahria University, Islamabad, Pakistan Thesis: FPGA Based Sea Range Finder.

Selected Publications

1. Sarwar, M.Z.; Cantero, D. (2024). *Probabilistic autoencoder based bridge damage assessment using train induced responses*. Mechanical Systems and Signal Processing.
2. Sarwar, M.Z.; Cantero, D. (2023). *Vehicle assisted bridge damage assessment using probabilistic deep learning*. Measurement.
3. Sarwar, M.Z.; Cantero, D. (2021). *Deep autoencoder architecture for bridge damage assessment using responses from multiple vehicles*. Engineering Structures.
4. Cheema, M.A.; Sarwar, M.Z.; Rossi, S.; Cantero, D. (2025). *Clustered Federated Learning for Population Based Structural Health Monitoring*. IEEE Internet of Things Journal.
5. Cheema, M.A.; Sarwar, M.Z.; Rossi, S.; Cantero, D. (2024). *Computationally efficient structural health monitoring using graph signal processing*. IEEE Sensors Journal.

Languages

English: Professional working proficiency | Norwegian: A2/B1, actively improving | Urdu: Native | Korean: Beginner