Muhammad Rakeh Saleem *Ph.D.*

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A highly driven Researcher Engineer with a Ph.D. and over 5 years of experience in **computer vision, machine learning infrastructure, and system development**. Expertise includes end-to-end ML model lifecycle: **data processing, optimization, deployment, and debugging/resolution** for high-impact applications. Proven experience in image processing, object detection, and implementing algorithms in production code. Open to work in a ***Research Engineer*** or ***Applied Scientist*** role with an active and approved work authorization.

Education

Pennsylvania State University **Aug 2020 – Dec 2024**

PhD in Engineering *State College, USA*

- Topic: From Gaze to Insight: Leveraging Eye Tracking for Structural Assessment and Evaluation

Chung-Ang University **Sept 2018 – Jun 2020**

Master in Engineering *Seoul, S. Korea*

- Thesis: Bridge Inspection Using an Unmanned Aerial Vehicle by Image Capturing and Geo-tagging System and Deep Convolutional Neural Network

Bahria University Islamabad **Aug 2013 – Jun 2017**

Bachelor in Electrical Engineering *Islamabad, Pakistan*

- Thesis: FPGA-based Digital Signal Processing of Under-sea Range Finder

Research Experience

Pennsylvania State University **Sep 2020 – Dec 2024**

Researcher – Built Environment Analytics and Modeling Lab *State College, USA*

- Led a multi-year research agenda to build and deploy complex **computer vision and deep learning** solutions, demonstrating technical leadership and full-stack ownership.
- Developed and optimized CNN models for high-resolution image analysis, achieving **95% accuracy** in object detection while **reducing inference time by 40%** via model optimization and efficient serving layers.
- Designed and implemented machine learning pipelines for production use, leveraging user perception data (eye-tracking) to inform model training and **novel evaluation techniques** for human-AI systems.
- Developed algorithms for **visual search** and **image classification/processing** that translated human expert knowledge into quantifiable ML features for autonomous navigation systems.
- Published **multiple peer-reviewed articles** in different journals, including **Nature**, on these research projects, showcasing contributions to the broader research community.

Chung-Ang University **Sep 2018 – Aug 2020**

Research Assistant – Smart Infrastructure and Technology Lab *Seoul, S. Korea*

- Developed and deployed **deep convolutional neural networks (deep CNNs)** for real-time visual analysis, including a system for construction worker safety monitoring that **achieved a 25% improvement in risk detection speed.**
- Designed the **end-to-end development** of an integrated UAV imaging system, involving **hardware-software integration** and **image stitching algorithms** to render high-resolution data from 50 inspection flights.
- Focused on applied ML, implementing CNN models **on-device** to demonstrate a full-stack, embedded programming solution from data acquisition to intelligent analysis, a key skill for production systems.

Work Experience

Pennsylvania State University **Sep 2024 – Dec 2024**

Teaching Assistant— AE 430: Indeterminate Structures *State College, USA*

- Teaching undergraduate course that involves a combination of leading in-class practicum, lectures, and design problems. As a teaching assistant, my responsibilities included **1)** moderating class and delivering in-class practicums, **2)** grading class assignments, quarterly assessments and holding office hours, and **3)** carried computational sessions with ETABS for structural analysis.

Pennsylvania State University **Sep 2021 – Aug 2023**

Teaching Assistant— EDSGN 100: Cornerstone Engineering Design *State College, USA*

- Developed and delivered technical lectures and practical sessions on complex engineering and computational methods to undergraduate students.
- Fostered a collaborative learning environment and demonstrated strong communication and mentorship skills by guiding students through intricate design and computational challenges.

Smart Grid and Power Lab **Feb 2018 – May 2018**

Development Engineer *Islamabad, Pakistan*

- Led the design and development of an **end-to-end IoT system,** from embedded programming to software framework and cloud-based data visualization within a 3-month timeline.
- Engineered a wireless sensor system for fault identification and localization, implementing an embedded programming solution on a microcontroller that **achieved 97% data transmission reliability.**
- Built a proof-of-concept for a **real-time data analysis and visualization dashboard** on the ThingSpeak Cloud platform, showcasing experience with data pipelines and back-end systems, and UX layers.

Academic Skills

- PCB Designing
- Computer Vision
- Internet of Things
- Building Diagnostics
- Machine/Deep Learning
- Eye Tracking
- Data Structures
- Mixed-Signal I.C.
- Hardware Prototyping
- Statistical Data Analysis
- Drone Piloting
- Circuit Designing
- Structural Assessment
- Coding and Debugging
- Embedded programming

Software & Technical Skills

- **Programming & Data Science:** Python, C++, MATLAB, Sci-kit Learn, PyTorch, TensorFlow, Statistical Analysis
- **AI & Computer Vision:** Computer Vision, Image Processing, Machine Learning, Deep Learning, Object Detection, Predictive Modeling, Algorithm Development
- **Eye Tracking Systems:** Eye Tracking Hardware/ Software, User Study Design, Validation and Evaluation, Data Collection and Processing, Embedded Systems
- **Tools & Software:** Pro Lab, Unity, Visual Studio, PyCharm, LaTeX, SPSS, NVivo, Altium Designer

Publications

- F. Alhassani and **M.R. Saleem**. From Data to Insight: A Statistical Approach to Analyzing Sustainability Modules Within Engineering, 2025 (drafted)
- F. Alhassani, **M.R. Saleem**, and John Messner. Developing Sustainability Modules for Architectural Engineering: An Exploratory Study, **Sustainability**, 2025 (under-review)
- F. Alhassani, **M.R. Saleem**, and John Messner. Integrating Sustainability in Engineering: A Global Review, **Sustainability**, 17(15), 6930, 2025
- **M.R. Saleem**, R. Mayne, and R. Napolitano. Evaluating Human Expert Knowledge In Damage Assessment Using Eye Tracking: A Disaster Case Study, **Buildings**, 14(7), 2114, 2024
- **M.R. Saleem** and R. Napolitano. Comparative Analysis of Saliency Map Algorithms in Capturing Visual Priorities for Building Inspections, **Journal of Building Engineering**, 97, 1106, 2024
- **M.R. Saleem**, R. Mayne, and R. Napolitano. Analysis of gaze patterns during facade inspection to understand inspector sense-making processes. **Scientific Reports**, 13(1), 2929, 2023
- **M.R. Saleem**, J.W. Park, J.H. Lee, H.J. Jung, and M.Z. Sarwar. Instant bridge visual inspection using an unmanned aerial vehicle by image capturing and geo-tagging system and deep convolutional neural network, **Structural Health Monitoring**, 20(4), 1760-1777, 2021
- N. Khan, **M.R. Saleem**, D, Lee, M.W. Park, and C. Park. Utilizing safety rule correlation for mobile scaffolds monitoring leveraging deep convolution neural networks, **Computers in Industry**, 129, 2021
- M.Z. Sarwar, **M.R. Saleem**, J-W. Park, D.S. Moon, and D.J. Kim. Multimetric Event-Driven System for Long-Term Wireless Sensor Operation for SHM Applications, **IEEE Sensors Journal**, 20(10), 5350-5359, 2020

Research Grants

National Science Foundation (NSF) **2020 – 2022**

Bridging the Arctic: Community-Driven Innovation for Resilient Bridges in Rural Alaska Communities *PennState, USA*

- $300K in funding from NSF, USA for two years from 2021-2023.
- The project aim is to understand the importance of bridges for the well-being of remote rural communities and to develop a protocol for other remote communities to work together to identify and apply funds for, construct, monitor, and maintain bridges. This project is designed to encourage a collaborative, working relationship between the research team and local communities.

National Research Foundation (NRF) **2018 – 2020**

Development of Rapid Diagnosis and Vision-based Inspection using UAVs *Chung-Ang, S. Korea*

- $50K in funding from National Research Foundation (NRF), Korea, for two years from 2018-2020.
- This project aims to conduct modal analysis in a non-contact manner without the cumbersome process of installing sensors. The goal is to develop an integrated camera and inertial module system for acquiring high-quality images with 6-DoF of camera position. The developed system allows rapid image stitching 3D reconstruction for visual inspection.

Industry Partner **2018 – 2020**

Development of portable wireless sensor for bridge inspection *Chung-Ang, S. Korea*

- $14K in funding from Creative Solutions, Inc.
- The goal is to develop a high-resolution, wireless, portable sensor system for vibration and acceleration measurement.

Workshops & Invited Talks

From Gaze to Insight: Leveraging Artificial Intelligence for Structural Inspections **Sep 2024**

Thornton Tomasetti (AI Community of Practice) *Online, USA*

Eye Tracking Winter School **Jan 2023**

Swiss Federal Institute of Technology (ETH Zürich) *Zürich, Switzerland*

Digital twins and AI-enabled structural health monitoring **Nov 2020**

The Partnership for Achieving Construction Excellence (PACE) *PennState, USA*

Proceedings & Presentations

Conference Proceedings

- **M.R. Saleem**, A. Straus and R. Napolitano. Comparative Interpretation of historic structures for non-invasive assessment using eye tracking. Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci. 2021 https://doi.org/10.5194/isprs-archives-XLVI-M-1-2021-653-2021
- **M.R. Saleem** and R. Napolitano. Eye tracking Metrics in Perception and Visual Attention Research for Human-Infrastructure Interaction. International Conference on Structural Health Monitoring of Intelligent Infrastructure: Transferring Research into Practice, SHMII-10, 2021
- M. Z. Sarwar, **M.R. Saleem**, M. M. Haider and J. Imtiaz. Increasing energy efficiency with channel condition based activation for a cognitive radio mobile network, International Conference on Communication, Computing and Digital Systems (C-CODE), Islamabad, 2017, pp. 107-111, doi: 10.1109/C-CODE.2017.7918911.

Presentations

- **M.R. Saleem** and R. Napolitano. Gaze Informed Path Optimization of Building Inspection for Automated Damage Diagnostics, Engineering Mechanics Institute conference, 2023
- **M.R. Saleem**, Q. Ali, and F. Russo . Gaze Inspection of Damage to the Building Fabric Including Hierarchy of Damage Severity, Eye Tracking- Experimental Design, Implementation, and Analysis, ETH Winter School, 2023
- **M.R. Saleem** and R. Napolitano. Agent-based Unmanned Aerial Vehicle (UAV) in Simulated Environment for Collaborative Inspection, Engineering Mechanics Institute conference 2022
- **M.R. Saleem** and R. Napolitano. Analysis of Eye Tracking Metrics for Façade Inspection to Understand Human-Infrastructure Interactions in Built Environment, Engineering Mechanics Institute conference, 2022
- **M.R. Saleem** and R. Napolitano. Eye tracking metrics in perception and visual attention research for human-infrastructure interaction (virtual), Engineering Mechanics Institute conference, 2021
- **M.R. Saleem**, M.Z. Sarwar and J. Park. Ultra-low Power Wireless Sensor with Event-Triggered Based Operation, Proceeding of Korea Concrete Institute Annual Conference, 2018

Academic Activities

Journal/Organization (Reviewer)

- Scientific Reports
- Artificial Intelligence Review
- The Journal of Supercomputing
- Journal of Civil Structural Health Monitoring
- Processes
- Applied Sciences
- Journal of Cleaner Production
- Reviews on Advanced Materials Science

Honors & Awards

- **2024:** *Graduate Research Assistantship* award from Penn State, **College of Engineering**, full funding for one year of Graduate studies
- **2023:** *Graduate Research Assistantship* award from Penn State, **Architectural Engineering**, full funding for one year of Graduate studies
- **2023:** *Travel Award* by **ETH Zurich** for an invited talk and to attend eye tracking winter school in Switzerland
- **2022:** *Marlene & Joseph Borda Fellowship* award from Penn State, **Architectural Engineering**, for exhibiting academic excellence in the graduate program
- **2022:** *Graduate Teaching Assistantship* award from Penn State, **Architectural Engineering**, full funding for one year of Graduate studies
- **2021:** *Graduate Teaching Assistantship* award from Penn State, **School of Engineering Design, Technology, and Professional Programs (SEDTAPP)**, full funding for one year of Graduate studies
- **2020:** *Graduate Research Assistantship* award from Penn State, **College of Engineering**, full funding for one year of Graduate studies
- **2019:** *Excellence Award* from SITL research group at **Chung-Ang University**, South Korea, acknowledging outstanding achievements and demonstrating exceptional research performance, entailing academics and leadership skills
- **2019:** *Travel Award* from SCaIS research group at **KAIST University**, South Korea, to conduct research work and field experiments in collaboration
- **2018:** *Graduate Research Assistantship* award by the **Chung-Ang University**, South Korea, full funding for two years of Graduate studies
- **2018:** *Excellence Award* award by the **Prime Minister**, Pakistan, for excellent academic records and exceptional endeavor during undergraduate studies

Research Mentees

- **Robert Mayne:** *Research Experience for Teachers Program* (2022-2023), on the topic of analyzing gaze data for post-disaster case study.
- **Nathan Leo:** *Penn State University* (2021-2022), on the topic of image processing for post-disaster images.
- **Ivy Jones:** *North Carolina State University* (Summers 2022), on the topic of disaster inspection and reconnaissance.
- **Aaron Straus:** *Research Experience for Teachers Program* (Summers 2021), on the topic of gaze-based data analysis.
- **Ella Hill:** *Penn State University* (2021-2022), on the topic of computer vision for damage detection.
- **Julian Groenendaal:** *Penn State University* (2020-2021), on the topic of damage detection using eye tracking.
- **Junyoung Park:** *Chung-Ang University* (2019-2020), on the topic of low-cost IoT sensor for sewer fumes detection.
- **Kisun Park:** *Chung-Ang University* (2018-2019), on the topic of the development of the smart concrete sensor for SHM.