Muhammad Rakeh Saleem *Ph.D.*

445 Waupelani Drive, State College, PA 16801, USA
(814)321-4441 rakeh.muhammad@gmail.com rakeh-saleem rakehsaleem

I have over 5 years of experience in engineering and industry, with a strong background in academic research. My research focus lies within ***computational, construction automation, data science, and artificial intelligence*** for assessment and damage diagnosis of infrastructures. My passion lies in transforming complex infrastructure problems into actionable, data-driven solutions and my unique strength lies in combining domain expertise in civil infrastructure and automation with cutting-edge data science. For the past few years, I've developed AI solutions and predictive models for automated inspections and structural health monitoring that bridge the gap between traditional engineering and advanced machine learning.

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 2022 – Dec 2024**
Researcher – Built Environment Analytics and Modeling Lab *State College, USA*

- This project aims to develop a framework for post-disaster structural assessment capturing inspector's expertise using eye tracking data facilitating reconnaissance missions. The goal is to advance current AI methods using computer vision and CNNs for fast damage detection and mapping, leveraging machine learning models to improve the accuracy and reliability of post-disaster assessments, and fostering more effective human-machine collaboration in disaster response efforts.

Pennsylvania State University **Sep 2020 – May 2022**
Researcher – Built Environment Analytics and Modeling Lab *State College, USA*

- This project aims to capture how an expert interacts with a structure during a facade inspection so that more detailed and situationally aware inspections can be done with autonomous robots in the future. It will facilitate information-sharing and decision-making during the inspection processes for collaborative human-robot teams, enabling unmanned aerial vehicles for future building inspection through artificial intelligence support.

Chung-Ang University **Sep 2018 – Aug 2020**
Research Assistant– Smart Infrastructure and Technology Lab *Seoul, S. Korea*

- This project aims to design and develop an image-capturing and geo-tagging system (ICGT), allowing synchronized GPS, IMU, and Lidar data using computer vision and image stitching techniques to render and handle high-resolution images for accurate and better detection of damage. This will be integrated into deep CNN-based hardware for UAV-based inspection.

Chung-Ang University **Jun 2019 – Dec 2019**
Researcher – Construction Technology Innovation Lab *Seoul, S. Korea*

- This project aims to develop a convolutional neural network (CNN) based construction workers safety monitoring system using computer vision techniques for identifying risk compliance and unsafe behavior at construction job-site.

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*

- My responsibilities as TA for this course includes **1)** moderating class and delivering in-class lectures, **2)** grading assignments and conducting office hours, and **3)** supervising the wood workshop for prototyping.

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

Development Engineer *Islamabad, Pakistan*

- Designed and developed a wireless sensor system for fault identification and localization, from system-level schematic to software framework and hardware prototype for an IoT-based solution. A microcontroller (Arduino)-based non-contactable hardware prototype for transmission lines with an advanced dashboard showing data visualization and analysis on live data streams using the ThingSpeak Cloud platform to demonstrate the proof-of-concept functionality of the IoT system.

Academic Skills

In today's fast-paced world, I have demonstrated communication skills, teamwork, problem-solving, adaptability, time management, leadership, creative thinking, and work ethic, knowing that having the right skills is crucial for career success and achieving successful outcomes. My skillset encompasses:

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

Technical Reports

- **M.R. Saleem**, R. Napolitano, ... 2021 Midwest Tornado Outbreak PVRR-EARR (*Field Research*), NSF NHERI, DesignSafe, 2021

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.