Muhammad Faizan

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Research Summary

My research aims to develop physics-informed neural network frameworks that integrate domain knowledge of MRI acquisition with data-driven learning. Specifically, I investigate methods for multiband fMRI reconstruction, particularly in infant imaging, where motion presents a significant challenge, and aim to jointly estimate and correct motion directly in k-space, where the raw signal contains richer and less-processed information compared to the image domain. By operating in k-space, the goal is to more accurately model motion-induced artifacts and improve the fidelity of reconstructed fMRI data.

Education

Trinity College Dublin (TCD) — Dublin, Ireland
Doctor of Philosophy (PhD) in Psychology — *Sep 2025 – Present*

- **Thesis:** Joint Reconstruction and Motion Correction of Infant Functional MRI Using Physics-Informed Deep Neural Networks
- **Advisor:** Prof. Rhodri Cusack

National University of Sciences and Technology (NUST) — Islamabad, Pakistan
MS Robotics and Intelligent Machine Engineering — ***CGPA: 3.85/4.00*** — *Sep 2022 – Feb 2025*

- **Thesis:** Hybrid 3D Neural Network Architecture for Multi-Modal MRI Brain Tumor Segmentation
- **Advisor:** Dr. Sara Baber Sial
- Recipient of the **NTF Merit Scholarship** and the **Prime Minister High Achievers Award** (2023)

University of Engineering and Technology (UET) — Peshawar, Pakistan
Bachelor of Science in Mechatronics Engineering — ***CGPA: 3.35/4.00*** — *Sep 2016 – Sep 2020*

- Recipient of the **USAID Merit Scholarship** (2017–2020)

Experience

Research Associate — Sep 2023 – April 2025
Radar Research Lab, NUST — *Islamabad, Pakistan*

- Led development of **RailGuard**, a real-time AI safety system that fuses infrared and visible streams for track obstacle detection; introduced a novel detection-guided fusion approach that directly optimizes images for downstream detection.
- Built an open source RRL 10k paired annotated IR–RGB dataset and achieved SOTA accuracy–efficiency trade-off (AP@0.5: 0.751) with real-time edge inference (2.5 ms Tesla T4 GPU / 3.0 ms Jetson Orin Nano, 0.04M params), reducing false negatives in adverse conditions and supporting driver-assist deployment (manuscript under review).

Machine Learning Engineer — April 2022 – June 2023
Web Solutions Plus — *Islamabad, Pakistan*

- Trained YOLOv5 on 1M+ annotated images across five classes (person, head, car, trolley, falling person), achieving a **7.5% improvement in F1-score** over the baseline; deployed the model on **NVIDIA Jetson Nano** for edge inference.
- Redesigned the YOLOv5 backbone to reduce redundant computation, delivering a **27% throughput improvement** on NVIDIA RTX 3090 and a **3 FPS gain** on Axis communication cameras.
- Integrated a centroid-based re-identification module into StrongSORT, reducing identity switches in occluded multi-person tracking scenarios and improving downstream surveillance accuracy.

Projects

3D SegUX-Net: Hybrid Neural Network for Brain Tumor Segmentation | code — Feb 2025

- Designed a novel U-shaped encoder-decoder integrating large-kernel depth-wise convolution and point-wise convolution to expand receptive fields for volumetric MRI segmentation without sacrificing computational efficiency.
- Outperformed 10 state-of-the-art models on BraTS 2023: **+2.18% Mean Dice over SwinUNETR** and **+0.29% over SegResNet**, establishing a new benchmark for hybrid CNN-transformer medical segmentation.

Foundcog infants Multi-band fMRI Reconstruction | code Jan 2026

- Developed a high-performance Split-Slice GRAPPA reconstruction pipeline for multiband fMRI k-space data, enabling efficient reconstruction of large-scale neuroimaging datasets comprising 139 infant subjects, over **400,000 volumes**, and **3.6 million** raw multiband slices.
- Established an fMRI reconstruction framework that provides clean, artifact-aware inputs for downstream motion modeling in k-space, building upon the reconstruction pipeline and forming the foundation for ongoing PhD work on joint motion correction and reconstruction to improve robustness in motion-corrupted infant and adult datasets.

Selected Additional Projects

- Chest Radiograph Recognition and Grad-CAM Localisation (code).
- Diffusion based transformer model to denoise the images with text prompt guidance (code).
- RAG-powered LLM chatbot for SINES NUST, integrating document retrieval with GPT-based generation (code).
- Sentence grammar classification with end-to-end MLOps pipeline (CI/CD, model registry, monitoring) (code).
- Multi-layer Perceptron built from scratch using NumPy, including backprop and regularisation (code).

Publications

Hafiz Muhammad Ali Zeeshan, **Muhammad Faizan**, Usman Zia. "RAG Powered LLMs for QA: Evolution, Challenges, Applications, and Future Directions." *Proceedings of the 5th International Conference on Communication Technologies (ComTech-2025)*, 2025. **(Best Paper Award)**

Ahmad, A., Ali, A., Khan, F. A., Habib, Z., Din, Z. U., Ali, M. Z., & **Faizan, M.** "Vehicle Recognition using Multi-Layer Perceptron and SMOTE Technique." *Proceedings of the 2nd International Conference of Smart Systems and Emerging Technologies (SMARTTECH)*, Riyadh, Saudi Arabia, 2022.

Faizan, M., Ali, S., & Zia, U. (2025). **3D SegUX-Net: Multi-Modal MRI Segmentation Using Large Kernels**. School of Mechanical & Manufacturing Engineering, NUST. *(Manuscript Under Review in Computerized Medical Imaging and Graphics (CMIG))*

Faizan, M., Cheema, H. M., Rafique, A., & Hammad, M. (2025). **RailGuard: A Detection-Guided Infrared and Visible Image Fusion Framework for Enhanced Rail Safety**. School of Interdisciplinary Engineering & Sciences, NUST. *(Manuscript Under Review in IEEE Transactions on Vehicular Technology)*

Technical Skills

Languages: Python, C/C++, MATLAB, R
ML Frameworks: PyTorch, TensorFlow, Scikit-learn, Keras, MONAI, NLTK
Developer Tools: Git, Docker, Google Cloud Platform, VS Code, PyCharm, Jupyter Lab
Libraries: NumPy, Pandas, OpenCV, ITK, Matplotlib, Seaborn, Scipy, Spacy

Honors and Awards

Best Paper Award — ComTech 2025 NUST | April 2025

Prime Minister High Achievers Award NUST | Aug 2023

NUST NTF Merit Scholarship NUST | Jan 2023

USAID Merit Scholarship UET Peshawar | Sep 2017

KPK Government Scholarship GCT Attock | Sep 2013

Certifications

- Deep Learning Specialization
- Machine Learning
- TensorFlow in Practice Specialization
- Mathematics for ML: Linear Algebra
- Mathematics for ML: Calculus
- Generative AI with Large Language Models
- Introduction to ML in Production
- AI for Medical Diagnosis
- Weights & Biases 101
- MATLAB Onramp