Toufiq Musah

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Summary

A biomedical researcher and engineer working in Machine Learning, Deep Learning, & Computer Vision applications in Medicine, with works in Medical Imaging Analysis, Imaging Biomarkers, & Related Domains.

Education

University of Pennsylvania *Aug 2025 – Present*
M.S.E Data Science

- **Relevant Courses:** Machine Learning for Data Science, Computer Systems Programming, Big Data Analytics

Kwame Nkrumah University of Science and Technology (KNUST) *Jan 2021 – Nov 2024*
BSc. Biomedical Engineering - *First Class Honors*

- **Relevant Courses:** Research Methods, Biomechanics, Medical Imaging, Probability and Statistics, Linear Algebra, Calculus, C/C++, Biomaterials, Bioinstrumentation, Biosignal Processing and Analysis

Relevant Professional Experience

Research Assistant, Engineering Research *Kumasi, Ghana* *Oct 2024 – Oct 2025*
Kumasi Centre for Collaborative Research in Tropical Medicine (KCCR)

- Conducting interdisciplinary research and collaborating on systematic reviews in Digital Health, Artificial Intelligence, and Machine Learning within the Global Health & Infectious Diseases (GHID) Group.
- Developing context-specific Large Language Model (LLM) application utilizing Retrieval Augmented Generation and Efficient Fine-tuning, to function as a Clinical Decision Support tool for the management of Gestational Diabetes Mellitus, significantly improving information access and self-management for expectant mothers.

Research Assistant, Machine Learning Intern *Kumasi, Ghana* *Oct 2023 – Feb 2024*
Responsible Artificial Intelligence Lab (RAIL)

- Conducted extensive research across multiple domains of machine learning/deep learning, including Generative Adversarial Networks (GANs) and Machine Learning Applications in Biomedical Engineering.
- Built Generative Models for Computed Tomography (CT) denoising and upscaling (SRGAN), and CT-MRI translation/style-transfer (CycleGAN).

Research and Academic Work

Peer-Reviewed Workshop Publications

[P.1] **Musah Toufiq**, "*Large Kernel MedNeXt for Breast Tumor Segmentation and Self-normalizing Network for pCR Classification in Magnetic Resonance Images*". Artificial Intelligence and Imaging for Diagnostic and Treatment Challenges in Breast Care. Deep-Breath 2025. Lecture Notes in Computer Science, vol 16142. Springer, Cham. `https://doi.org/10.1007/978-3-032-05559-0_8`. [ArXiv] [Springer]

[P.2] **Musah Toufiq**, Adjei Prince Ebenezer and Otoo, Kojo Obed, "*Automated Segmentation of Ischemic Stroke Lesions in Non-Contrast Computed Tomography Images for Enhanced Treatment and Prognosis*". Medical Information Computing. MImA EMERGE 2024. Communications in Computer and Information Science, vol 2240. Springer, Cham. `https://doi.org/10.1007/978-3-031-79103-1_8`. [ArXiv] [Springer]

Accepted Workshop Papers | Preprints Awaiting Release

[P.3] **Musah Toufiq**, Kalaiwo Chinasa, Akram Maimoona, Abdulai Ubaida Napari, Adewole Maruf, Dako Farouk, Emegoakor Adaobi Chiazor, Anazodo Udunna C, Adjei Prince Ebenezer and Raymond, Confidence"*Towards Trustworthy Breast Tumor Segmentation in Ultrasound using Monte Carlo Dropout and Deep Ensembles for Epistemic Uncertainty Estimation*". *Accepted at:* Medical Image Computing in Resource Constrained Settings Workshop. 28th International MICCAI Conference, 2025. [ArXiv]

[P.4] Ankomah Claudia Takyi, Ayivor Livingstone Eli, Nyame Ireneaus, Wambo Leslie, Bonsu, Patrick Yeboah, Iorumbur Aondona Moses, Confidence Raymond and **Musah Toufiq** "*How We Won BraTS-SSA 2025: Brain Tumor Segmentation in the Sub-Saharan African Population Using Segmentation-Aware Data Augmentation and Model Ensembling*". *Accepted at:* Brain Tumor Segmentation, and Cross-Modality Domain Adaptation for Medical Image Segmentation (BraTS). 28th International MICCAI Conference, 2025. [ArXiv]

Selected Talks & Orals

Towards Trustworthy Breast Tumor Segmentation, MIRASOL Workshop, MICCAI Conference, 2025 [P.3]

Large Kernel MedNeXt for Breast Tumor Segmentation, MIDL Young Researcher Showcase, 2025 [P.1]

Automated Medical Image Segmentation: Toward Trustworthy Clinical Tools, COMPASS, 2025 [P.1,3,4]

Optimisation Techniques in Machine Learning, Ghana Data Science Summit, Tutorial, 2025

Relevant Projects

Multi-Modal Data Integration for Head and Neck Tumor Prognostication
Developed a multimodal learning framework to predict 5-year survivability and recurrence rates in head and neck tumor cases. Integrated whole-slide image features from CLAM with structured clinical data, laboratory analytes, surgical notes, and patient history. Converted free-text data into embeddings using ClinicalBERT and combined modalities through a low-rank bilinear fusion, achieving an AUC of 0.75 across tasks.

Vision-Language Surgical Scene Understanding & Panoptic Segmentation
Designed an end-to-end system integrating surgical video data and panoptic segmentations as multimodal inputs for automated understanding of operating room scenes. Trained an S^2-Scaled SwinUNETR for panoptic segmentation across 21 classes, including personnel, instruments, and tools, enabling precise spatial localization. Fine-tuned MedGemma using QLoRA for scene graph generation and event significance detection.

Collaborative AI Resources for Expectant Mothers (C.A.R.E) Project
Developed an accessible AI assistant built on Large Language Models with Retrieval-Augmented Generation to help expectant mothers with gestational diabetes manage their pregnancies. Deployed through WhatsApp to ensure inclusivity and ease of access to providing personalized health guidance in low-resource settings.

Generative AI for Medical Imaging Enhancement and Data Augmentation
Developed generative models to improve medical imaging quality and data efficiency. Designed a super-resolution and denoising framework for producing high-resolution head CT scans from low-resolution variants, reducing effective radiation exposure in diagnostic procedures. Implemented a Deep Convolutional Generative Adversarial Network to generate synthetic medical image data for self-supervised pre-training and data-efficient finetuning.

Awards and Acknowledgments

- Best Oral Presentation Award - MICCAI Meets Africa Workshop, 2024 [P.2]
- Brain Tumor Segmentation Challenge (BraTS-SSA Task), 2025 – First Place [P.4]
- Best Poster Presentation Award - Ghana Data Science Summit, IndabaX, 2024
- Academic Excellence Award – Provost List 2021, 2022, 2023
- MasterCard Healthcare Entrepreneurship Grant
- MICCAI Education Challenge Finalist, 2024
- MICCAI Travel Award, 2024, 2025

Volunteering and Community Activities

Team Coordinator, Sprint AI Training for Medical Image Knowledge Translation Coordinating, teaching, and developing training materials for the Sprint AI program (2024–2025), focused on building capacity among emerging researchers and clinicians in medical image computing and deep learning applications.

Technical Committee Member & Contributor, Breast Ultrasound Segmentation and Classification Challenge Contributed to the organization of the PRECISE-Abreast Challenge (PRECISE-Abreast Challenge – CodaBench, 2025) as a technical committee member. Designed and implemented validation and evaluation pipelines for participant submissions, ensuring fairness and reproducibility of the assessment process.

Course Facilitator, Women in Engineering - SheCodes Club Teaching Python programming and introductory machine learning classes for the Women in Engineering Society, creating an inclusive learning environment to help members gain tech skills and build their confidence in STEM.

MONAI Ultrasound Working Group Volunteering in the MONAI Ultrasound Working Group, working torwards the development of a foundational model for general structure segmentations in 2D and 3D Ultrasound (Ultrasound-TotalSegmentor)

Volunteer, IndabaX, Ghana Data Science Summit Contributing to the organization of IndabaX GDSS by curating engaging content that raised awareness and sparked interest in the transformative potential of data science.

Blog Posts, Tutorials

A Hitchhiker's Guide to 3D Medical Image Processing - Medium Article
Introduction to TorchIO for 3D MRI Processing: - Preprocessing (Part 1) - Augmentation & Dataloaders (Part 2)
End-to-End Deep Learning Tutorial for Image Classification: Pneumonia Detection - Colab Notebook
How to Make an Image Classification Model: Is it a Pie? - Blog Post

Skills

Languages: Python, LaTeX, C/C++, MATLAB

Libraries: PyTorch, TensorFlow, Keras, Scikit-Learn, Pandas, LangChain

Software: Solidworks, Fusion 360, ANSYS FEA, Unity Game Engine, KiCAD, Electronics Prototyping