Toufiq Musah

toufiqmusah.github.io

Education …

KNUST
KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

BSc. Biomedical Engineering (2021-2024)

Penn
UNIVERSITY of PENNSYLVANIA

MSE. Data Science (2025-2026)

Research …

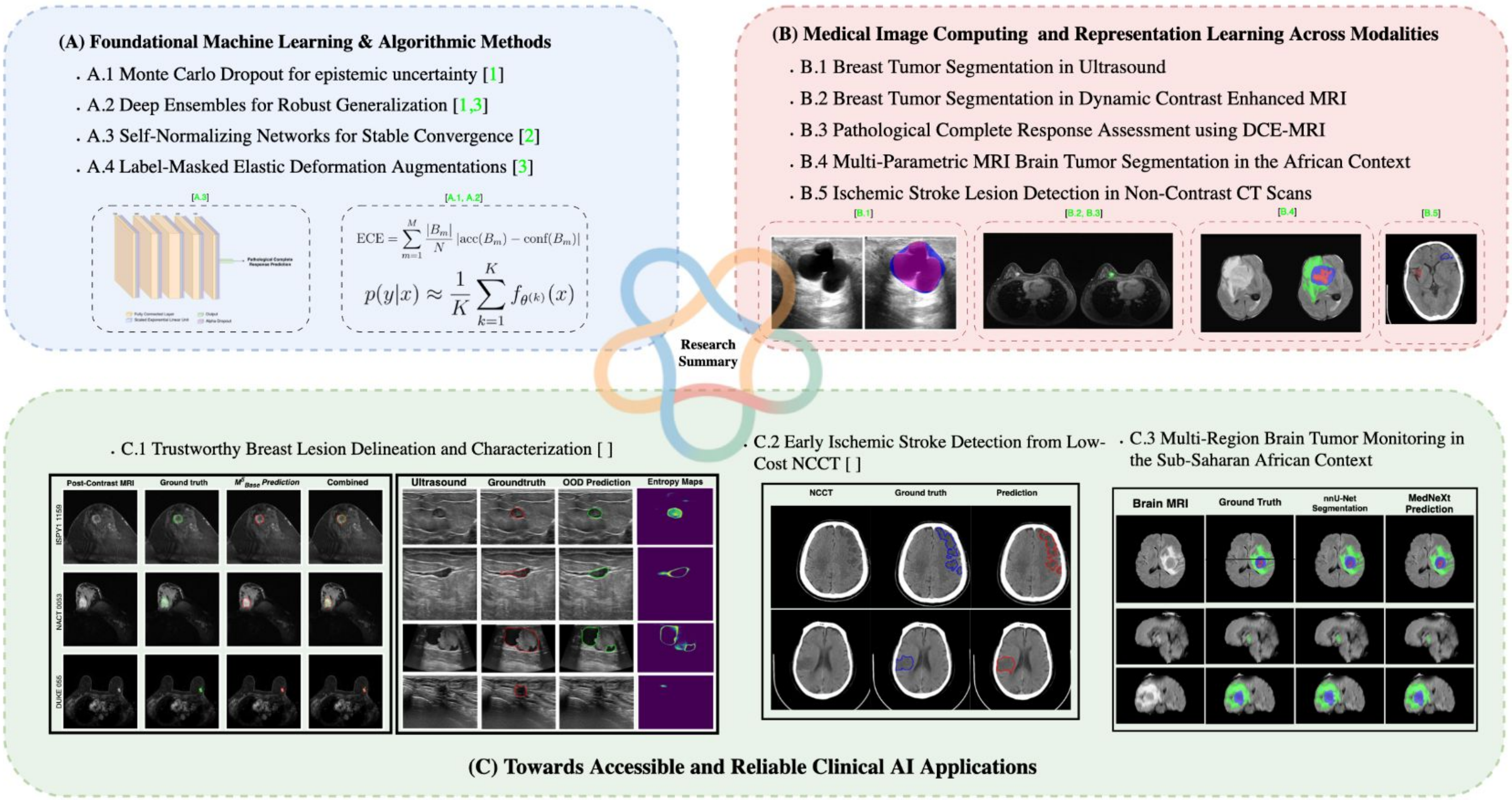
KCCR
Global Health and Infectious Diseases Research Group

KCCR - Centre for Collaborative Research in Tropical Medicine (2024-2025)

RESPONSIBLE ARTIFICIAL INTELLIGENCE LAB

Responsible Artificial Intelligence Lab (2024-2025)

Research Summary



Automated Segmentation of Ischemic Stroke Lesions in Non-Contrast Computed Tomography Scans

MICCAI'24 – Workshop Paper

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Automated Segmentation of Ischemic Stroke Lesions in Non-contrast Computed Tomography Images for Enhanced Treatment and Prognosis

Conference paper | First Online: 09 February 2025

pp 73–80 | Cite this conference paper

Toufiq Musah, Prince Ebenezer Adjei & Kojo Obed Otoo

Part of the book series: Communications in Computer and Information Science ((CCIS,volume 2240))

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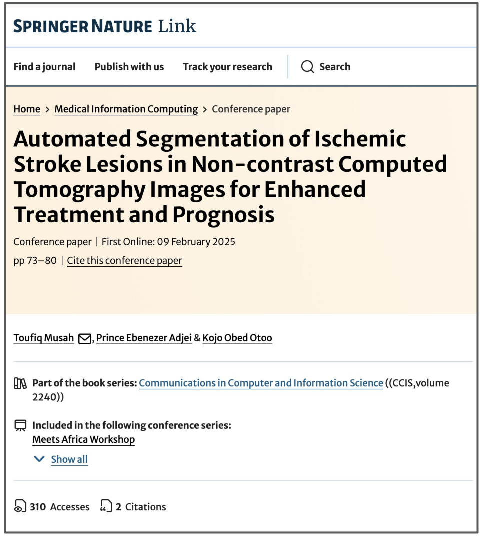

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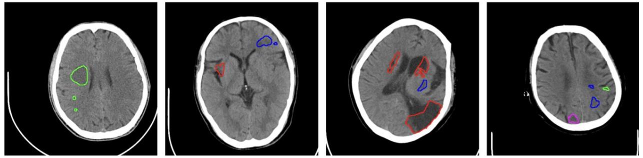
310 Accesses | 2 Citations

Problem:

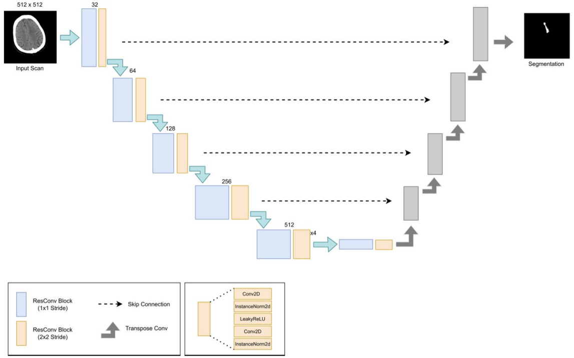
Early Ischemic Stroke detection via neuroimaging is usually done using **DWI MRI**. MRI is not a widely accessible neuroimaging modality in underserved region.

Can we perform IS detection using NCCTs (More widely available and accessible)

1. NCCT Dataset of Different Infarct Types



2. Residual-Encoder U-Net in nnU-Net Framework



Method:

NCCTs are labeled using DWI pairs.
Preprocess NCCTs into relevant slices.

Using a well-validated biomedical image segmentation framework (nnU-Net), with a **Residual-Encoder U-Net**, we perform segmentation of acute infarcts in NCCTs.

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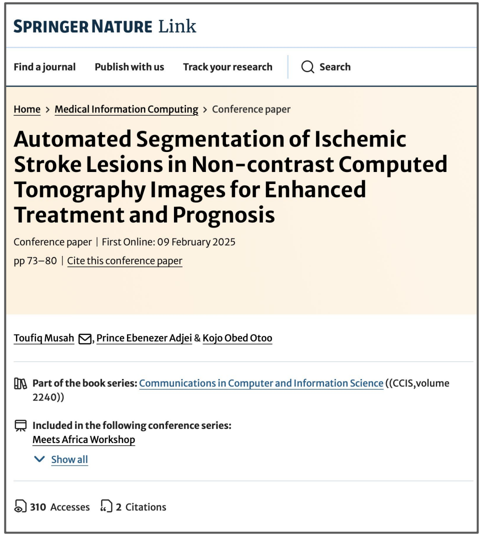

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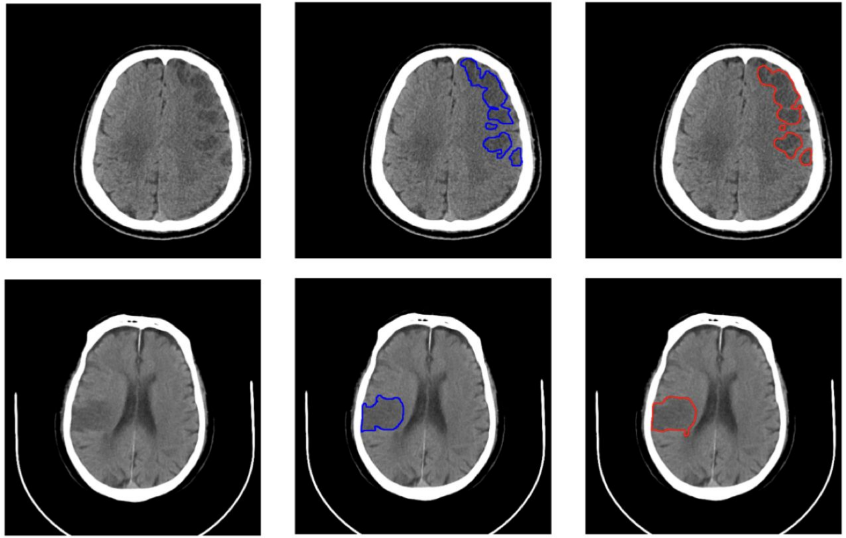
Result:

Achieved 0.752 Dice in the best when adjusting for outliers.

Comparative works achieved 0.578 Dice.

3. Results from Segmenting Acute Infarcts (0.75 Dice – Benchmark 0.57)



Tumor Segmentation in Dynamic Contrast MRI | Radiomics-Based Pathological Complete Response Assessment

MICCAI'25 – Deep-Breath

Large Kernel MedNeXt for Breast Tumor Segmentation and Self-normalizing Network for pCR Classification in Magnetic Resonance Images

Conference paper | First Online: 21 September 2025
pp 72–80 | Cite this conference paper

Toufiq Musah

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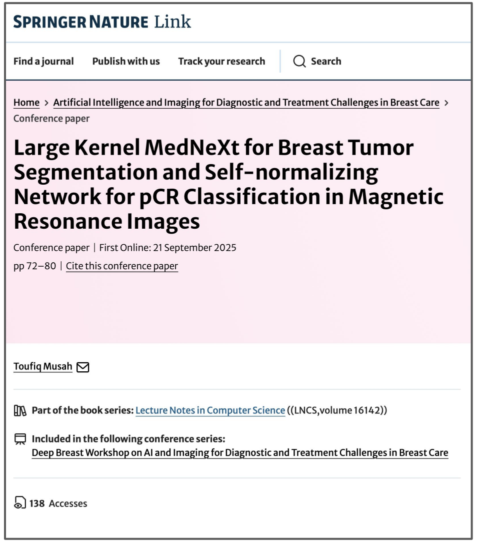
MICCAI'25 – Deep-Breath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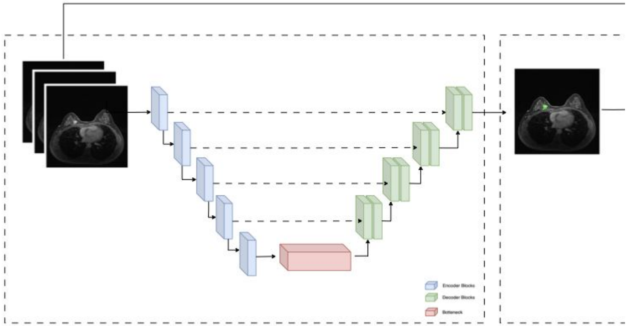
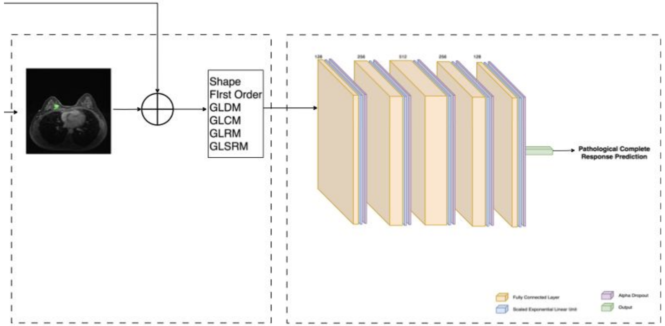
Problem:
Accurate breast tumor segmentation in DCE-MRI is important for downstream tasks.

There is a need to capture both the subtle enhancement patterns of tumors across contrast time points and the broader breast tissue context, which larger receptive fields naturally accommodate.

1. Segmenting Tumors w/ Large Kernel Network



2. Assessing pCR w/ Radiomics-Based SNN



Method:
A large-kernel MedNeXt architecture with a two-stage training strategy that expands the receptive field from 3^3 to 5^3 kernel sizes using the UpKern algorithm.

This allowed for stable transfer of learned features to larger kernels, improving segmentation performance

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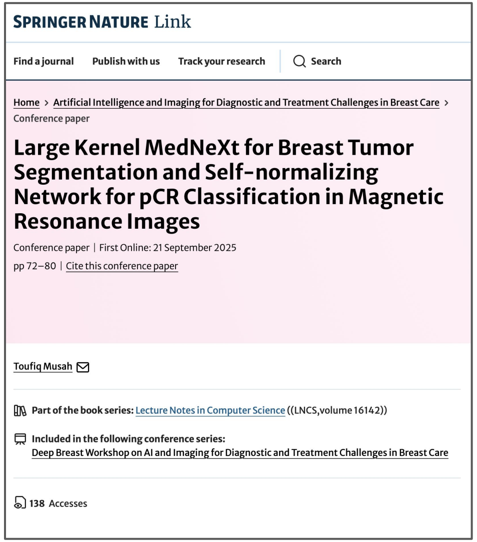
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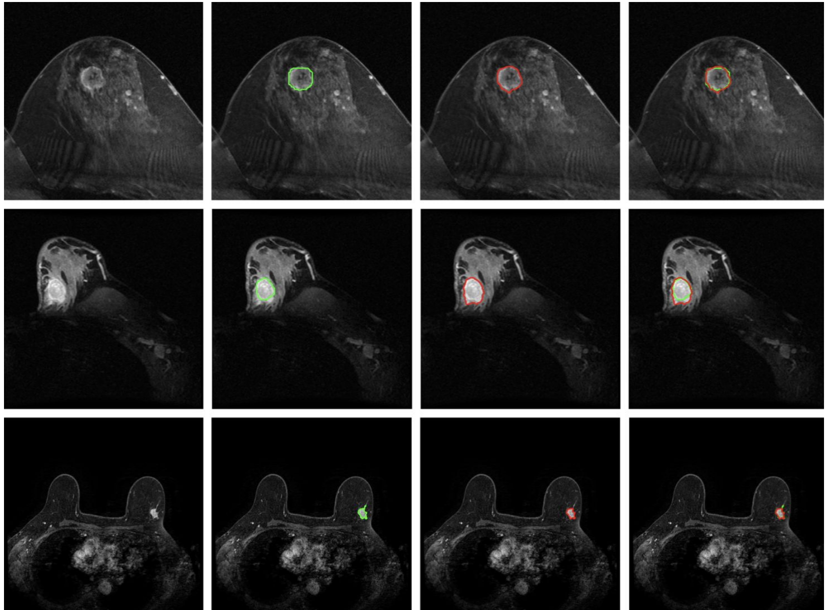
Result:

Ensemble of large-kernel networks achieved a **Dice of 0.67** and a **NormHD of 0.24**.
For pCR classification, a self-normalizing network (SNN) on radiomic features achieved an accuracy of **57%**, and up to **75%** in some subgroups.

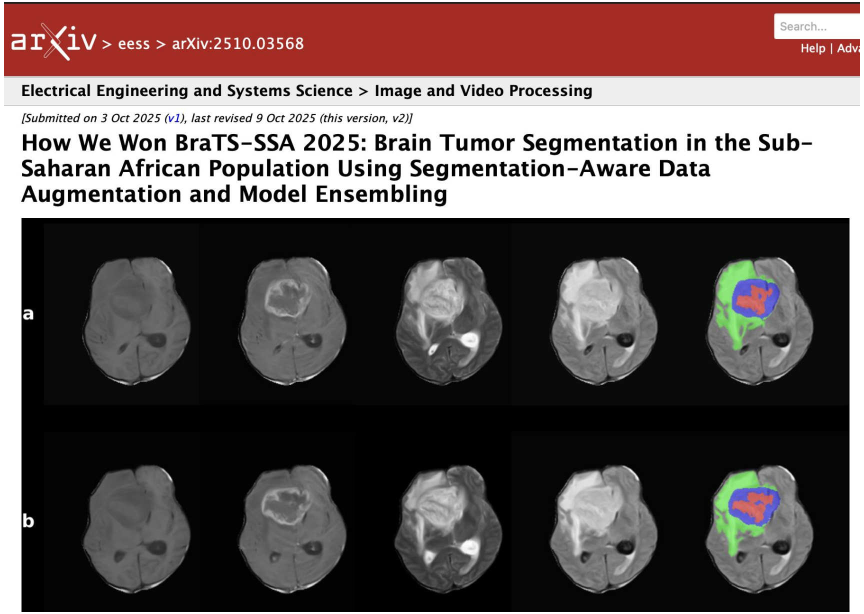
3. 0.67 Dice | 64M Parameters – vs – 0.65 | 700M Benchmark



Other Works

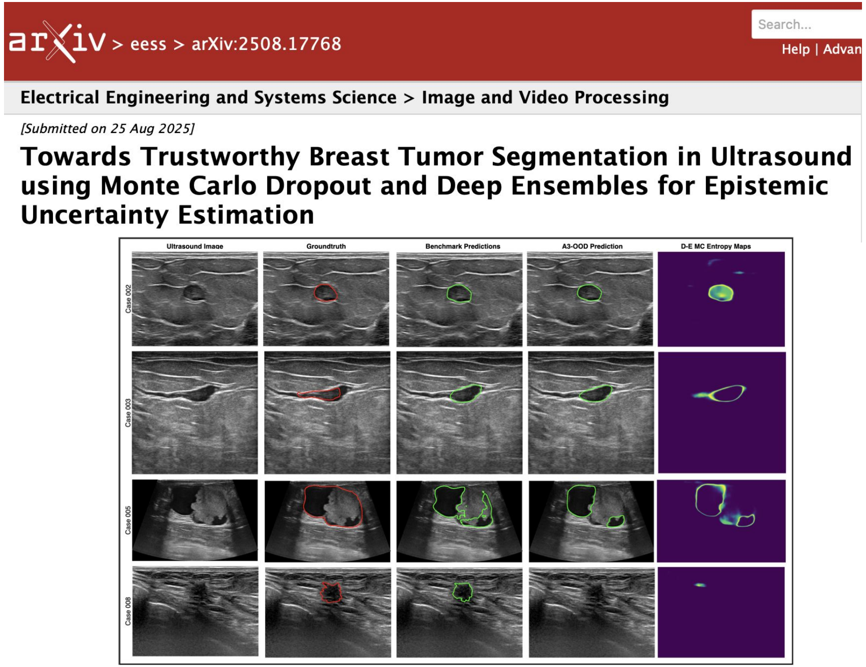
First Place Submission: Brain Tumor Segmentation Challenge (2025)

Performed segmentation-aware data augmentation with controlled rigorous elastic deformations, and model deep-ensembling for **SOTA** segmentation performance ..



Oral presentation at MICCAI MIRASOL Workshop on trustworthy segmentation in ultrasound.

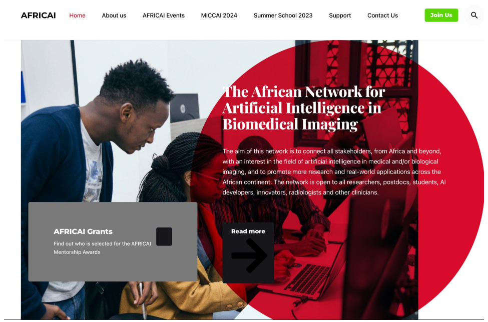
Performed epistemic uncertainty estimation in segmentation using Deep Ensembling and Monte Carlo dropout .



Current Work – ULF-BrainGen: Physics-Guided Generative Synthesis and Super-Resolution of Ultra Low-Field MRI

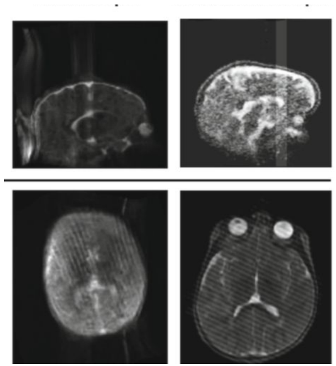
Funded By:

The African Network for Artificial Intelligence in Biomedical Imaging



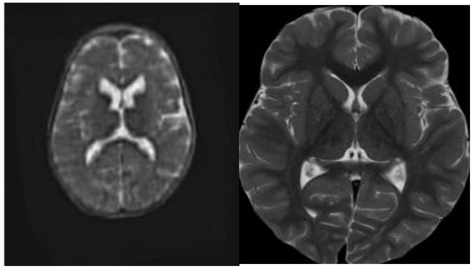
Problem:
Ultra low-field MRI presents a great opportunity for expanding access to MRI procedures in underserved regions of the world.

The imaging quality due to inherent noise and low magnetic strength sometimes leads to poor imaging quality.



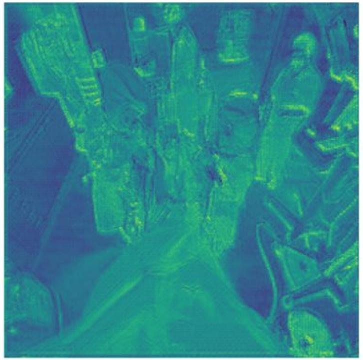
Proposal:
ULF-BrainGEN is a physics-guided generative modeling framework designed to synthesize ULF-MRI scans into diagnostically faithful, high-quality images comparable to conventional 1.5 T MRI systems.

By quantifying ULF degradation patterns and making use of state-of-the-art generative architectures explicitly guided by MRI physics.



Projects

Surgical Video Scene Understanding & Panoptic Segmentation

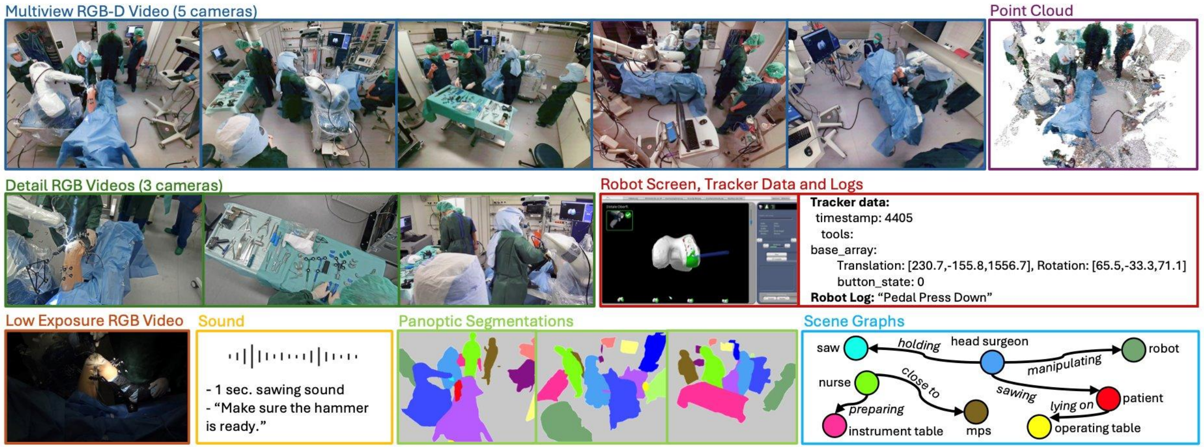


Problem:
Surgical Operating Rooms are a complex, high-risk environment …

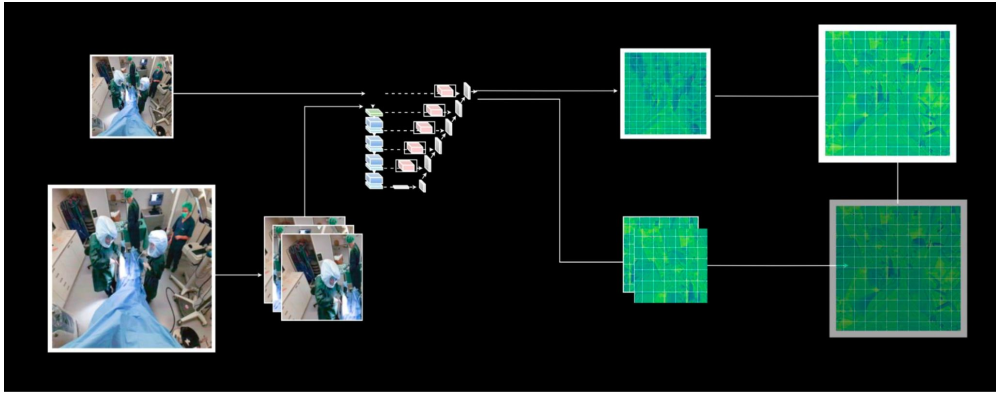
Precise understanding of interactions among staff, tools, and equipment can enhance surgical assistance and situational awareness

Dataset:
MM-OR dataset including a rich set of synchronized data sources:

- Multi-view RGB-D Video
- Detail RGB Cameras (3 cameras)
- Low-exposure RGB Video
- Audio + Speech Transcripts



Surgical Video Scene Understanding & Panoptic Segmentation



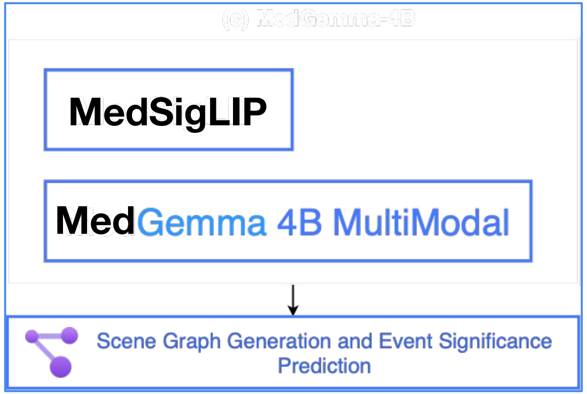
Methods – Panoptic Scene Segmentation:
Applied S2-Scaling to SwinUNETR to enable better feature extraction for high precision segmentation.

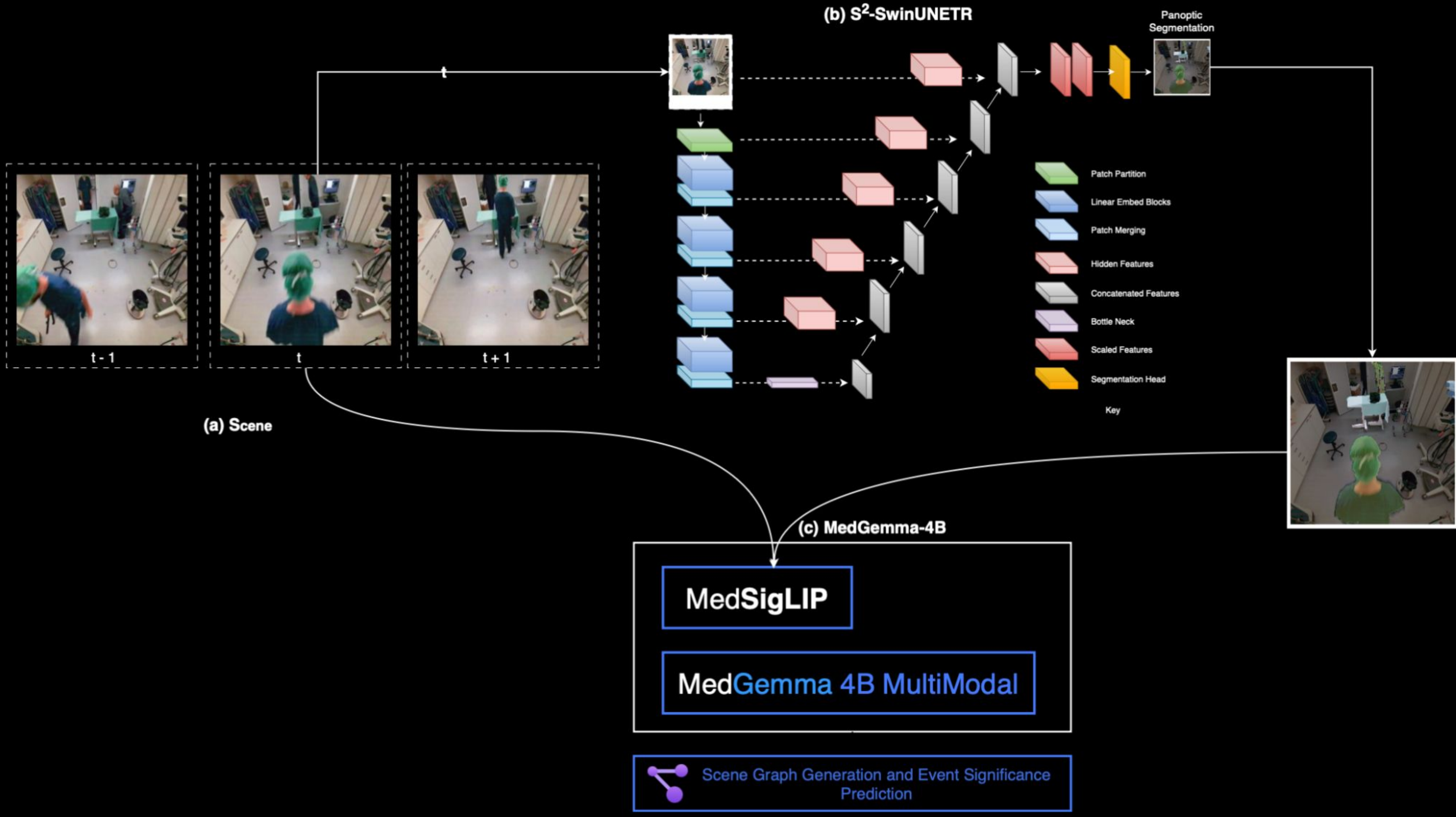
Segmented for 21 classes, including personnel and tools.

Method – Vision Language Finetuning:
MedGemma Vision Language model for Scene Graph Generation and Event Significance Classification.

Model trained on 3 FPS surgical video + panoptic segmentations.

Trained with Quantized Low-Rank Adaptation.



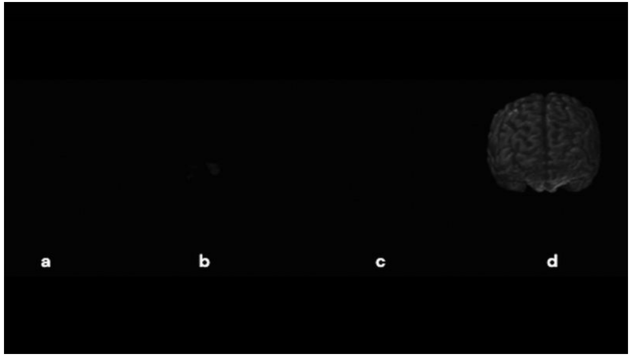


(b) S^2-SwinUNETR
Panoptic Segmentation
t
Patch Partition
Linear Embed Blocks
Patch Merging
Hidden Features
Concatenated Features
Bottle Neck
Scaled Features
Segmentation Head
Key
t - 1
t
t + 1
(a) Scene
(c) MedGemma-4B
MedSigLIP
MedGemma 4B MultiModal
Scene Graph Generation and Event Significance Prediction

Tutorial Articles on 3D Medical Image Computing

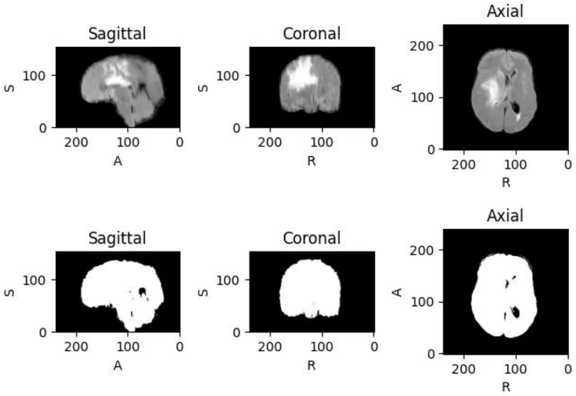
A Hitchhiker's Guide to 3D Medical Image Processing (Preprocessing, Augmentations & DataLoaders)

Toufiq Musah 10 min read · Aug 17, 2025



Introduction to TorchIO for 3D MRI Processing: Preprocessing Transforms (Part 1)

Toufiq Musah 7 min read · Feb 2, 2025



Introduction to TorchIO for 3D MRI Processing: Augmentation Transforms & DataLoaders (Part 2)

Toufiq Musah 6 min read · May 11, 2025

SPARK ACADEMY

Train the trainer strategy

SPrint AI Training for African Medical Imaging Knowledge Translation

USE

Practicum
Build SOTA AI models
Scientific communication
Participate in a grand Challenge

TRY

Hybrid Hackathon
Code hack excercises
Interdisciplinary seminars

FROM TRAINEES TO TRAINERS

Transform trainees to trainers

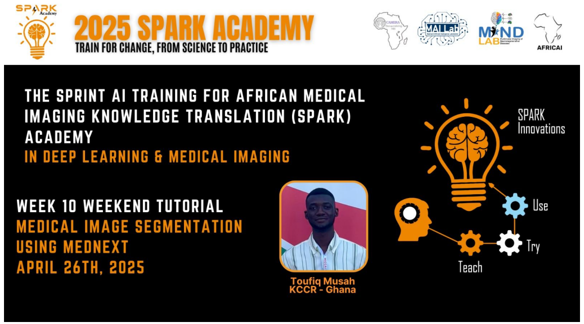
TEACH

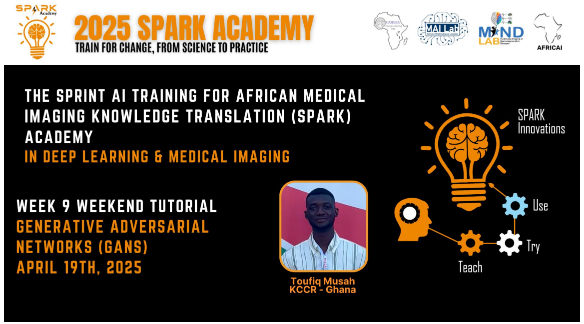
Foundational Course
Fundamentals of AI
and medical imaging.

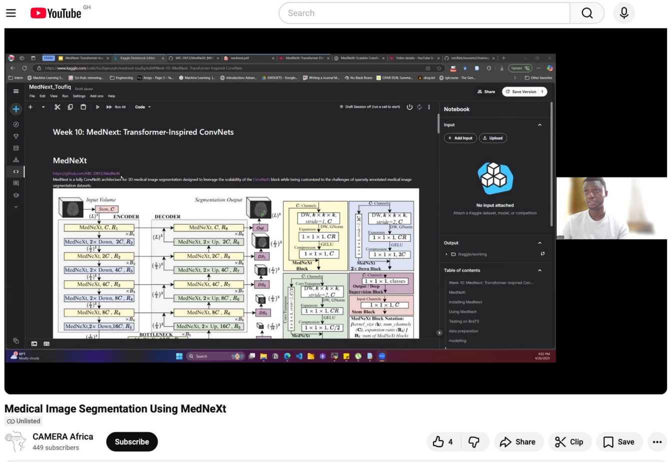
GO

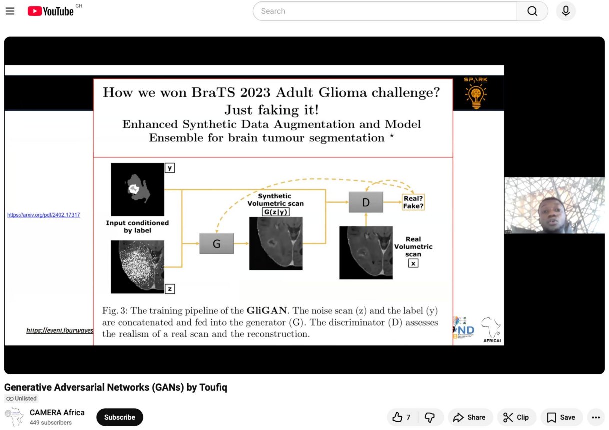
Need Assessment
Identify Knowlledge gaps
Apply Aquired skills to local problems

SPARK ACADEMY – Coordination









Other Ongoing Works …

MedSegMNIST – A Python Library for Easy Access to 2D/3D Medical Image Segmentation Datasets for Benchmarking and Learning Purposes.

MED-RAE – Representational AutoEncoders for Medical Image Synthesis …

SSC-UNet – State-Space ConvNeXt UNet for 3D Biomedical Image Segmentation

Topology-Based Network Optimization for Neuro Tracing/Segmentation

Imaging-Biomarker Based Prediction