UNIVERSITY OF THE WESTERN CAPE

Faculty of Natural Sciences

Department of Computer Science

RESEARCH PROPOSAL

ML-Driven Diagnostic Imaging for TB Screening

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Research Proposal

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1. ABSTRACT

This research investigates the application of machine learning algorithms for automated diagnostic imaging in resource-constrained healthcare settings across South Africa. The study focuses on developing convolutional neural network (CNN) architectures optimized for tuberculosis (TB) screening using chest X-ray images. Preliminary results from a dataset of 2,400 anonymized images from Tygerberg Hospital demonstrate a sensitivity of 94.2% and specificity of 91.8%, which meets WHO target product profile specifications for TB triage tests.

2. INTRODUCTION & BACKGROUND

South Africa bears a disproportionate burden of tuberculosis, with an estimated incidence rate of 468 per 100,000 population (WHO, 2024). Early detection remains a critical challenge, particularly in rural and peri-urban clinics where access to trained radiologists is severely limited. Computer-aided detection (CAD) systems leveraging deep learning have shown promise in bridging this diagnostic gap.

This proposal builds upon recent advances in transfer learning and attention mechanisms to develop a lightweight, deployable model suitable for point-of-care devices. The research extends prior work by incorporating multi-modal data fusion, combining radiographic features with clinical metadata to improve diagnostic accuracy.

3. RESEARCH OBJECTIVES

- To develop and evaluate CNN architectures for automated TB screening from chest X-rays
- To optimize model performance for deployment on low-resource edge computing devices
- To validate the system in a clinical setting at partner hospitals in the Western Cape
- To assess the cost-effectiveness and clinical workflow integration feasibility

Research Proposal (cont.)

Methodology & Timeline

4. METHODOLOGY

4.1 Data Collection

The primary dataset consists of 12,000 de-identified posterior-anterior (PA) chest X-ray images sourced from Tygerberg Hospital and Groote Schuur Hospital under ethics clearance BM25/3/12. Images are stratified by pathology: normal, TB-positive (confirmed by GeneXpert), and other pulmonary conditions. A secondary validation dataset of 3,000 images from the NIH ChestX-ray14 public repository will be used for cross-domain evaluation.

4.2 Model Architecture

We propose a modified EfficientNet-B3 backbone with a custom attention module tailored for pulmonary region-of-interest detection. The model is designed to run inference in under 500ms on ARM-based edge devices (e.g., NVIDIA Jetson Nano). Knowledge distillation from a larger ResNet-152 teacher model will be employed to maintain accuracy while reducing computational requirements.

4.3 Evaluation Metrics

Model performance will be evaluated using sensitivity, specificity, AUC-ROC, positive predictive value (PPV), and negative predictive value (NPV). The primary endpoint is meeting or exceeding the WHO target product profile for triage tests: sensitivity >= 95% and specificity >= 80%.

5. TIMELINE

Phase	Period	Activities
1	Jan - Jun 2024	Literature review, ethics clearance, data collection setup
2	Jul - Dec 2024	Data preprocessing, baseline model development
3	Jan - Jun 2025	Model optimization, attention mechanism integration
4	Jul - Dec 2025	Clinical validation at partner hospitals
5	Jan - Jun 2026	Edge deployment, cost-effectiveness analysis
6	Jul - Dec 2026	Thesis writing, publications, final submission

Research Proposal (cont.)

References

6. REFERENCES

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