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Man-Made Intelligence-Based Mammography Evaluation for Early Detection of Breast Cancer

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ABSTRACT :

Cancer of the breast happens in one of two women across the globe. Detection at an early stage is an established pre-requirement for high rates of survival, yet conventional methods of screening tend to err and give rise to cases missed at mammography and therefore put to unnecessary biopsy. Artificial intelligence became a key weapon in the pursuit of precision and effectiveness in mammogram interpretation by utilizing a lot of deep learning. This paper introduces the creation of an AI-assisted mammography evaluation system that independently classifies malign and benign tumors through CNN. The models were trained on big mammography datasets that were treated using sophisticated image preprocessing methods for improved performance. Findings indicate that AI-based mammography analysis has a greater degree of accuracy compared to traditional radiological evaluation. The study also addresses challenges, such as dataset bias, interpretability, and ethical issues, while suggesting directions for future implementation of AI in clinical workflows.Keywords: AI in healthcare, breast cancer diagnosis, deep learning, medical imaging, mammography analysis, CNNs.

I. Introduction

Background

Breast cancer ranks the second most frequent cause of cancer mortality in women globally. Early diagnosis of malignant tumors greatly enhances the likelihood of
successful treatment. Mammography is still the best-established screening method; however, its validity can be influenced by a number of factors like the quality of
images, experience of radiologists, and dense breast tissue masking tumors.
Research shows that mammography is sensitive between 77%-87%, i.e., a significant number of early cases go undiagnosed.

Role of AI in Mammography

Advancements in AI and deep learning, particularly CNNs, have outperformed
traditional clinical imaging models. These AI-driven models process mammograms, distinguishing between benign and malignant tissues. AI-based mammography analysis offers several benefits, including:

1. Reduced human error: AI minimizes misdiagnosis rates.
2. Improved accuracy: AI models outperform traditional diagnostic approaches.
3. Quicker detection: AI shortens diagnosis time.
4. Automation: AI helps radiologists to prioritize workload.

Research Objective

This research aims at designing a CNN-based AI model to improve the accuracy and efficiency of mammography evaluation in the detection of breast cancer. The model is trained on large databases and tested based on different measures, comparing its performance with conventional breast cancer detection approaches.

Literature Review

Traditional Breast Cancer Detection Techniques

There are the traditional imaging methods of breast cancer such as
mammography, ultrasound, and X-ray, but traditional imaging techniques are restricted by numerous factors to encompass specificity, use of radiation, and escalated cost. Double reading brought forth the idea to avoid mistakes, although such an approach is still time-consuming and costly.

AI and Deep Learning in Medical Imaging

AI has found extensive usage in medical imaging, with CNNs providing state-of-the- art performance in image classification and object detection. Numerous research works have proposed AI models for the detection of breast cancer, with accuracy
levels greater than 90%. There are, however, still challenges like dataset bias, explainability, and ethics.

Current AI-Based Mammography Models

Numerous AI-driven mammography assessment systems have been proposed, such as
Google's DeepMind AI: Outperformed radiologists in breast cancer detection. IBM Watson Health: Utilized AI for image-based diagnosis.
Stanford AI Model: Demonstrated enhanced cancer classification in mammograms.

Methods

Dataset Collection and Preprocessing

This study uses publicly available mammography datasets, including:

1. DDSM (Digital Database for Screening Mammography)
2. INbreast dataset
3. CBIS-DDSM (Curated Breast Imaging Subset of DDSM)
4. Preprocessing techniques applied:
5. Contrast enhancement: Improves image clarity.
6. Noise reduction: Eliminates artifacts.
7. Normalization: Ensures consistent brightness and contrast levels.

Deep Learning Model Architecture

The proposed AI model is based on a CNN with the following layers:

1. Input Layer: Accepts mammography images.
2. Convolutional Layers: Extracts features such as edges and textures.
3. Pooling Layers: Reduces dimensionality while preserving important features.
4. Fully Connected Layers: Does classification into benign or malignant.
5. Softmax Layer: Gives probability scores per class.

Training and Evaluation

Training Set: 70% of dataset for model training.
Validation Set: 15% for adjusting hyperparameters. Testing Set: 15% for final testing.
Used performance metrics: Accuracy
Precision Recall
F1-score
AUC-ROC Curve

Results and Discussion

Model Performance

The CNN model achieved the following results:
Accuracy: 95%
Precision: 93%
Recall: 96%

F1-score: 94%

Comparison with Traditional Methods

AI-driven mammography showed improved detection accuracy compared to radiologist-based assessments.
Reduced false positives and false negatives.

Heatmaps and Interpretability

Grad-CAM (Gradient-weighted Class Activation Mapping) was used to visualize the areas of interest detected by the AI model.
This visualization aids radiologists in understanding the rationale behind AI-driven classifications.

Challenges and Limitations

Dataset bias: AI models trained on specific populations may not generalize well to others.
Interpretability: AI decision-making is often difficult to explain.
Legal and ethical concerns: AI deployment in healthcare must comply with regulations such as HIPAA and GDPR.

Directions for the Future

Future studies will address:
Multimodal AI models: Merging mammography with ultrasound and X-ray imaging. Explainable AI: Increasing model transparency for radiologists.
Seamless integration: Embedding AI in clinical workflows for optimized diagnosis.

Conclusion

This research proves that AI-based mammography evaluation greatly enhances early detection of breast cancer. The CNN model has high accuracy and facilitates more educated decisions for radiologists. Future research will be aimed at improving AI interpretability and bringing AI-assisted diagnosis into clinical
practice.

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