Early Detection of Breast Cancer Through Ultrasound Images using Meta Learning

Presented by

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Introduction

- Breast cancer is a leading cause of cancer-related deaths in women worldwide.
- Early and accurate detection improves survival rates and reduces treatment complexity.
- Ultrasound imaging is widely used due to safety, accessibility, and suitability for dense breast tissue.
- Meta-learning enables robust classification with small datasets, ideal for medical imaging constraints.
- This research integrates Prototypical Networks with Segmentation-Guided Attention (SGA) for accurate and explainable breast ultrasound classification using the BUS-BRA dataset.

Problem Statement

- Ultrasound images of the breast are difficult and time consuming to interpret manually and are susceptible to errors.
- Traditional deep learning models require large, balanced datasets, which are scarce in medical imaging.
- There is a lack of explainable AI systems tailored for breast ultrasound classification.
- Existing methods struggle with class imbalance and generalization across varying image quality.

Motivation and Objective

Motivation:

- Improve early breast cancer detection through AI-assisted ultrasound diagnosis.
- Reduce diagnostic variability among radiologists.
- Leverage meta-learning for data-efficient model training.

Objectives:

- Build a few-shot learning classification framework for breast ultrasound images.
- Integrate SGA to enhance interpretability and focus on lesion areas.
- Use BUS-BRA dataset with BI-RADS annotation for training and evaluation.
- Achieve >90% accuracy with limited training data.

Related Works

- Gómez-Flores, (2024): BUS-BRA: a breast ultrasound dataset for assessing computer-aided diagnosis systems.
- Ali, A. (2023): Breast cancer classification through meta-learning ensemble technique using convolution neural networks.
- Dan, (2024): Diagnostic performance of deep learning in ultrasound diagnosis of breast cancer
- Işık, (2024): Few-shot classification of ultrasound breast cancer images using meta-learning algorithms.
- Padmini P, (2024): Breast Cancer Classification through Meta-Learning Ensemble Model based on Deep Neural Networks.

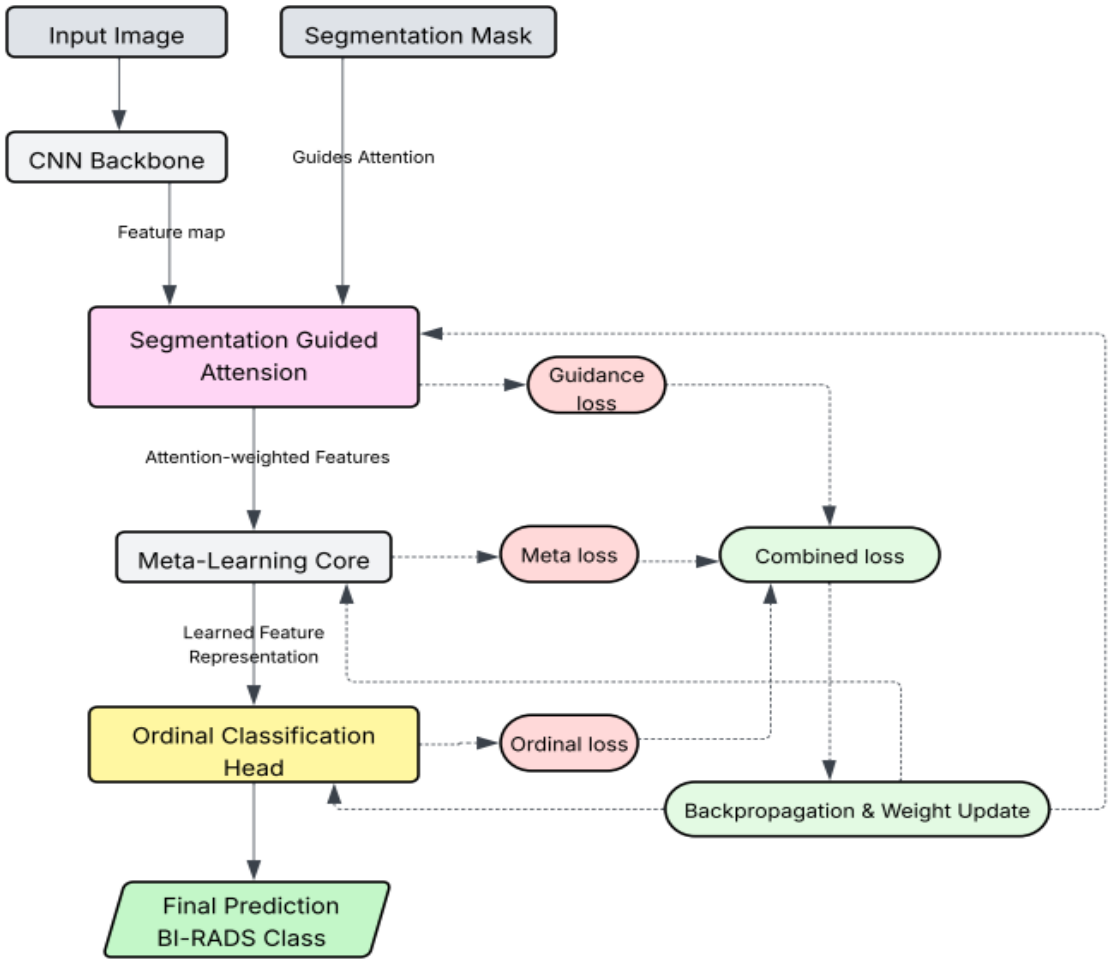
Comparison Between Existing Works

Author(s) & Year	Method Used	Reported Metric	Relevance to My Work
Al-Taie et al. (2024)	Few-Shot Meta-Learning (DenseNet-121)	96.9% Accuracy	Directly applies meta-learning for BUS classification with limited data, similar to my final goal.
Shen et al., 2025	Multi-Task Learning (Segmentation + Classification) with Attention	97.1% Accuracy	Uses an attention module and performs segmentation jointly with classification.
Wang et al., 2024	Single-Task Meta-Learning + Auxiliary Network	+1.85% Accuracy Boost	Proposes a novel meta-learning strategy to improve generalization on diverse breast tumor images.
Sarki et al., 2023)	CNN with a CBAM Attention Module	98.8% Accuracy	Demonstrates the power of a standard attention mechanism to improve feature extraction in BUS images.
Liu et al., 2023	Meta-Learning + Ordinal Classification	89.5% Accuracy	Employs ordinal classification within a meta-learning framework to respect the severity ranking in medical images.

Gap Analysis

- Lack of integrated attention in meta-learning approaches for breast ultrasound.
- Explainability missing in most few-shot classification systems.
- Few studies focus on public datasets like BUS-BRA for reproducibility.
- Limited research on BI-RADS based automated classification using few-shot learning.

Proposed Methodology



The proposed methodology integrates a CNN backbone with a Segmentation-Guided Attention (SGA) module to focus on lesion regions, followed by a meta-learning core and ordinal classification head to predict BI-RADS categories, optimized using combined guidance, meta, and ordinal losses.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A

THANK YOU