Medical Imaging and Applications (EE-XXX)

Case Study Report

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Submitted to:

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Title: Breast Cancer Detection.

Objective

The objective of this task is to develop a Computer-Aided Diagnosis (CAD) system for classifying images from the BUSI (Breast Ultrasound Images) dataset. The system have graphical user interface (GUI) built with Tkinter, deep learning models (ResNet18, GoogleNet, CNN+Transformer), and machine learning models (Random Forest, AdaBoost, SVM) for classifying images into benign, malignant, or normal categories. The preprocessing pipeline applies **median filtering**, **high-pass and edge enhancement**, and resizing to prepare images for classification.

Overview

Dataset:

Classes	**# images**
Malignant	**210**
Benign	**437**
Normal	**133**

Preprocessing Pipeline:

- Prepare images for classification by enhancing quality and standardizing format.
- **Steps**:
    - Convert images to grayscale and then to RGB.
    - Apply median filtering to reduce noise.
    - Perform high-pass and edge enhancement using Gaussian filtering.
    - Resize images to 224x224 pixels.

Classification Models:

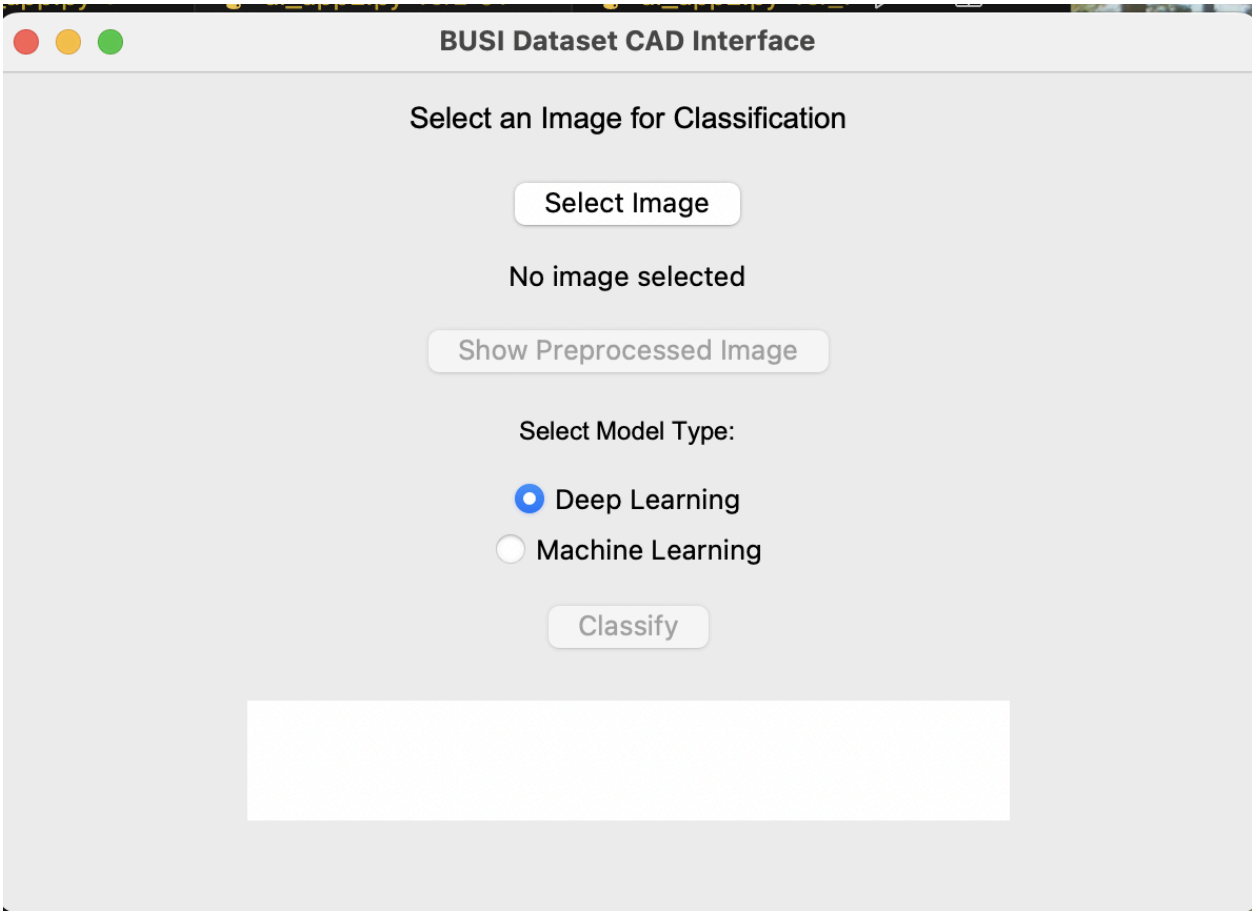
- **Deep Learning Models**:
    - **ResNet18**: A convolutional neural network (CNN) with a modified fully connected layer for 3-class output.
    - **GoogleNet**: A deep CNN with an Inception architecture, adapted for 3-class classification.
    - **CNN+Transformer**: A hybrid model combining ResNet18's feature extraction with a Transformer encoder for enhanced feature processing.
    - **Ensemble**: Combines predictions by selecting the class with the

highest probability across the three models.

- **Machine Learning Models**:
  - **Random Forest**, **AdaBoost**, and **SVM**: Trained on features extracted by a ResNet18-based feature extractor.
  - **Ensemble**: Uses the maximum probability across these models for final classification.

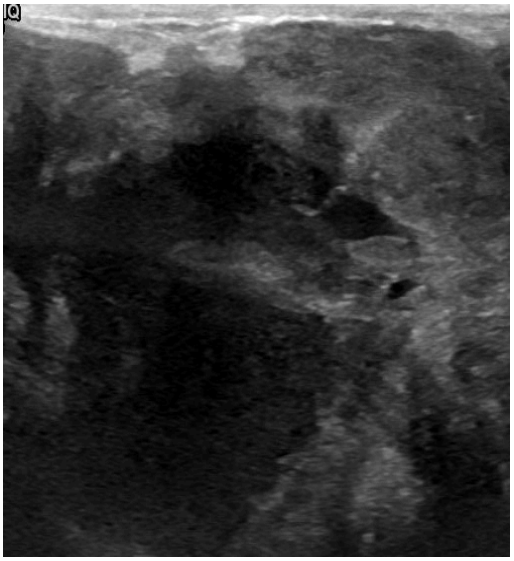
Graphical User Interface (GUI):

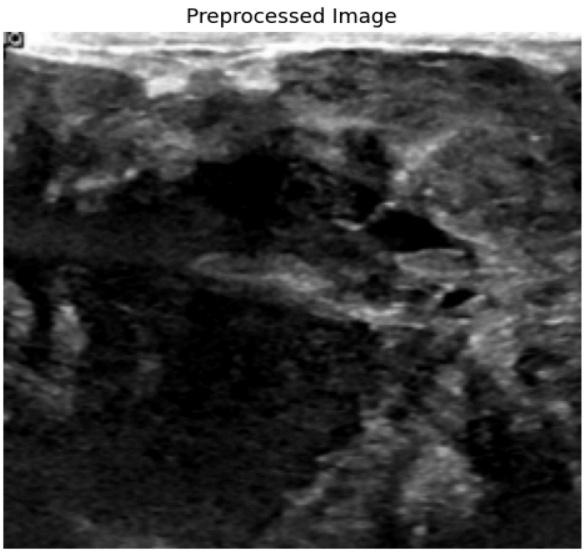
- **Framework**: Built using Tkinter.
- **Features**:
  - **Image Selection**: Users can select an image (PNG, JPG, JPEG) via a file dialog.
  - **Model Type Selection**: Choose between deep learning or machine learning ensembles.
  - **Classification**: A "Classify" button triggers classification and displays results (predicted class and probabilities) in a text area.
  - **Preprocessed Image Display**: A "Show Preprocessed Image" button displays the preprocessed image in a Matplotlib window.
- **Functionality**: Displays the selected image path, classification results.



Results:

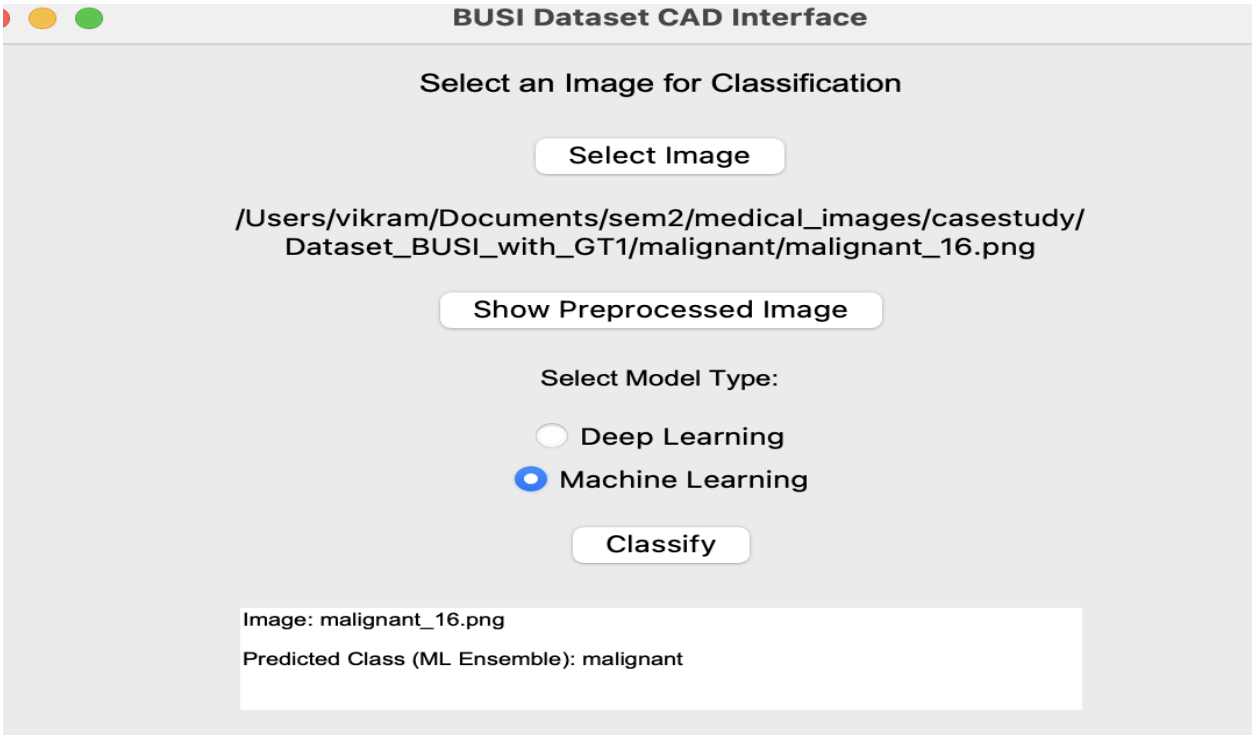
Preprocessed image





Model	Class	Probability
ResNet18	Benign	0.0028
	Malignant	0.8965
	Normal	0.1006
GoogleNet	Benign	0.6410
	Malignant	0.2661
	Normal	0.0929
CNN+Transformer	Benign	0.4843
	Malignant	0.4945
	Normal	0.0212
Random Forest	Benign	0.2200
	Malignant	0.4600
	Normal	0.3200
AdaBoost	Benign	0.3157
	Malignant	0.3407
	Normal	0.3436

SVM	Benign	0.0326
	Malignant	0.6623
	Normal	0.3052
Result	**Malignant**	



Conclusion

The development of the new Computer-Aided Diagnosis (CAD) system for the BUSI dataset successfully achieves its objective of providing a robust and user-friendly platform for classifying breast ultrasound images into benign, malignant, or normal categories. By integrating a sophisticated preprocessing pipeline, a combination of deep learning and machine learning ensemble models, and a Tkinter-based graphical user interface (GUI), the system ensures accurate classification and seamless user interaction.