

Machine Learning Based Breast Cancer Detection

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Abstract: In this study, a novel ultra-wideband (UWB) radar-based method for early, non-invasive breast cancer diagnosis is presented. The system uses a curved seventh derivative Gaussian UWB pulse that is filtered by a sharp transition bandpass FIR filter in both monostatic and bistatic radar configurations. The pulse shape enhances radiation power, spectrum efficiency, and FCC-compliant safety. Tumors are located and detected using Specific Absorption Rate (SAR) measurement and backscattered signal processing. Results from experiments and simulations confirm that the system can accurately identify cancers.

Keywords: Breast Cancer Detection, Pulse Shaping, Gaussian Derivative Pulse, Monostatic and Bistatic Radar, Specific Absorption Rate (SAR), Breast Phantom, FCC Spectral Mask, FIR Filter, Electromagnetic Imaging

I. Introduction

Since breast cancer is one of the main causes of death for women, early identification is essential to successful treatment. Despite their effectiveness, traditional detection techniques like mammography and MRI have drawbacks such as ionizing radiation and hefty expenses. Ultra-Wideband (UWB) radar systems have become a viable substitute because of their strong penetration ability through biological tissues and non-ionizing characteristics.

UWB systems offer reduced electromagnetic interference and improved spatial resolution, particularly when they use Gaussian derivative pulses. Higher-order derivatives, however, necessitate hardware optimization and add complexity to the system. Because seventh derivative Gaussian pulses are compatible with the FCC spectrum standards for safe body transmission, they have showed potential in this application.

Radar-based detection is possible because malignant tumors have different dielectric characteristics than healthy ones. Analyzing backscattered signals and the energy absorbed by tissues, which is measured by Specific Absorption Rate (SAR), is necessary for precise tumor detection and localization.

In order to maximize the UWB source signal's spectral usage, power efficiency, and tumor detection precision, this study suggests a novel pulse shaping technique. It uses artificial breast phantoms for both experimental validation and simulation.

Motivation

The imaging techniques used today to diagnose breast cancer are frequently costly, intrusive, and infrastructure-intensive. Even in remote or low-resource environments, UWB radar provides an affordable, portable, and non-invasive substitute. Additionally, improving the accuracy of tumor identification can greatly increase early diagnosis and survival rates, particularly for small and deeply entrenched cancers.

II. Literature Review

Umair Rafique, Stefano Pisa, Renato Cicchetti, Orlandino Testa and Marta Cavagnaro :- This research presents a thorough analysis of various UWB antenna designs for near-field microwave imaging. The manufacturing technology is used to categorize the antennas.

Dazzling performances. Additionally, special emphasis is given to the radiation mechanisms and the methods for enhancing the bandwidth and decreasing its size.

Bhushan V. Kadam, Lucy J. Gudino, Ramesha C. K., Joseph X. Rodrigues:- This research presents a unique feeding network for a small, single port, multimode reprogrammable UWB-NB antenna. displayed. A reconfigurable bypass feeding network, a beveled partly defective ground plane with a rectangular slot, and a pentagonal monopole radiator make up the suggested antenna. Four narrow band frequency ranges—5.3 to 6.8 GHz, 6.0 to 7.6 GHz, 7.2 to 8.8 GHz, and 8.4 to 11.4 GHz—as well as a wideband frequency range of 2.4 to 18 GHz are realized by the antenna.

Jesus A. Basurto-Hurtado 1,2, Irving A. Cruz-Albarran 1,2, Manuel Toledano-Ayala 3, Mario Alberto Ibarra-Manzano 4, Luis A. Morales-Hernandez 1,* 1 and Carlos A. Perez-Ramirez:- For this reason, it is critical to diagnose these lesions as soon as possible in order to maximize survival. Although a number of works cover specific subjects in this field, none offer a comprehensive view, that is, from image generation to interpretation. Potential options for image generation and processing are provided and explored in this work, which provides a thorough state-of-the-art evaluation of image generation and processing approaches to detect breast cancer.

Ibtisam Amdaouch 1, Mohamed Saban 1,2 Ana Vazquez Alejos 4, Juan Ruiz Alzola: -

A simulated hemispherical breast model with an embedded tumor is surrounded by a high directional Vivaldi antenna in order to accomplish these goals. By determining the greatest value of SAR within the breast model, the tumor is detected. Along order to reduce the propagation distance during the image-creation process, the antenna position is shifted close to the tumor area and moved to nine positions along a trajectory path.

Deepshikha Bhargava, Phadungsak Rattanadecho:- Breast cancer can be detected more safely, affordably, and effectively with microwave imaging (MI).

This study examines the use of a wide-band microstrip patch antenna operating in the 3.6–9.2 GHz frequency range in a monostatic MI system for the detection of breast cancer. The antenna radiation is applied to a breast model composed of skin, fat, and malignancy. The antenna gathers the reflection coefficients from each scan after scanning the breast model at 77 different points.

Rahul Krishnan^{1,*} and Jobin Christ M.C:-The major dielectrical difference between cancerous breast tissues and normal tissues in this technique is the microwave frequency range. The term Specific Absorption Rate (SAR) describes the amount of energy which is absorbed (W/kg) in the breast tissue. This segment illustrates the usefulness to diagnose the tumor position in the breast by means of maximum SAR value coordinates. Changes in breast and tumor size are important for the risk of diagnosis. The power absorbed in connecting with a normal breast and a tumor breast is measured and equivalent for different breast masses. The maximum SAR is also analyzed at distinct tumor locations at various frequency ranges.

Dilber Uzun Ozsahin^{1,2,*}, Declan Ikechukwu Emegano², Berna Uzun^{2,3,4} and Ilker Ozsahin:-The usefulness of artificial intelligence (AI) applications in the diagnosis of breast cancer has been shown in numerous research. Numerous papers that compare AI and breast cancer diagnosis are included in the systematic review of AI applications in breast cancer diagnosis. They are not organized, though, and it seems like every study is carried out differently.

Fawzy Alsharif¹, and Çetin Kurnaz:-This paper illustrates a novel design for a wearable microstrip patch ultra-wide band (UWB) antenna with improved bandwidth design to be used in breast cancer detection. The operating frequency of the proposed antenna ranges from 1.6 GHz to 11.2 GHz. The antenna consists of a rectangular radiating patch fed by a rectangular feed line. This antenna design will be part of a wearable device for women to detect breast cancer early.

Proposed System

Classifying breast cancer histopathological dataset automatically is an important task in computer assisted pathology analysis.

However, extracting informative and non-redundant features for histopathological image classification is challenging. In our proposed work using numeric dataset, firstly we will apply image pre-processing technique to remove the noise of a dataset. After that we will apply the feature extraction process. The feature-based approaches consist of the features extraction phase and then classification phase. This approach focuses on extracting the feature of image and classify them using machine learning classification technique. The extracted features are trained using

Classification technique. Finally, we compared the performance using the existing classification method.

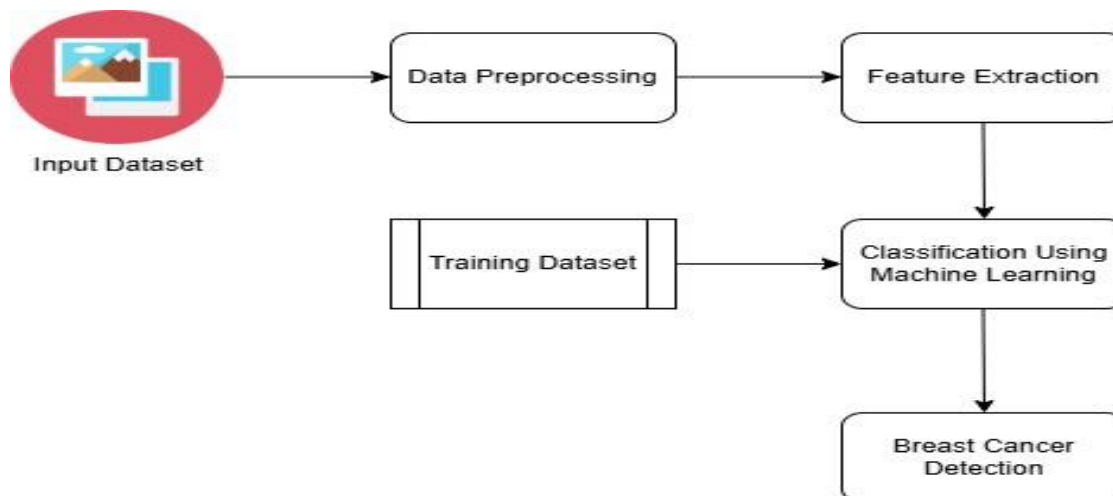


Figure 1. System Architecture

Algorithm

XG Boost Algorithm

It builds decision trees sequentially with each tree attempting to correct the mistakes made by the previous one. The process can be broken down as follows:

Start with a base learner: The first model decision tree is trained on the data. In regression tasks this base model simply predicts the average of the target variable.

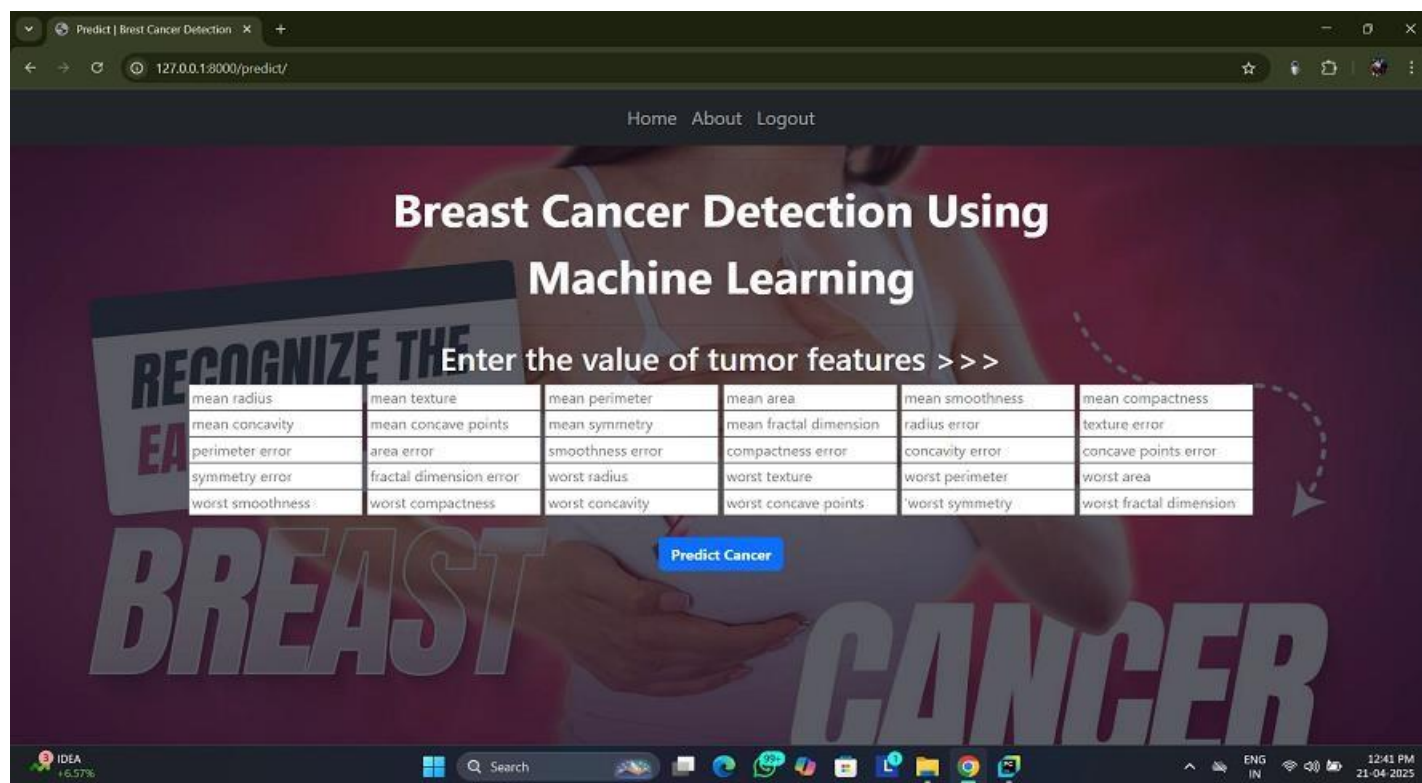
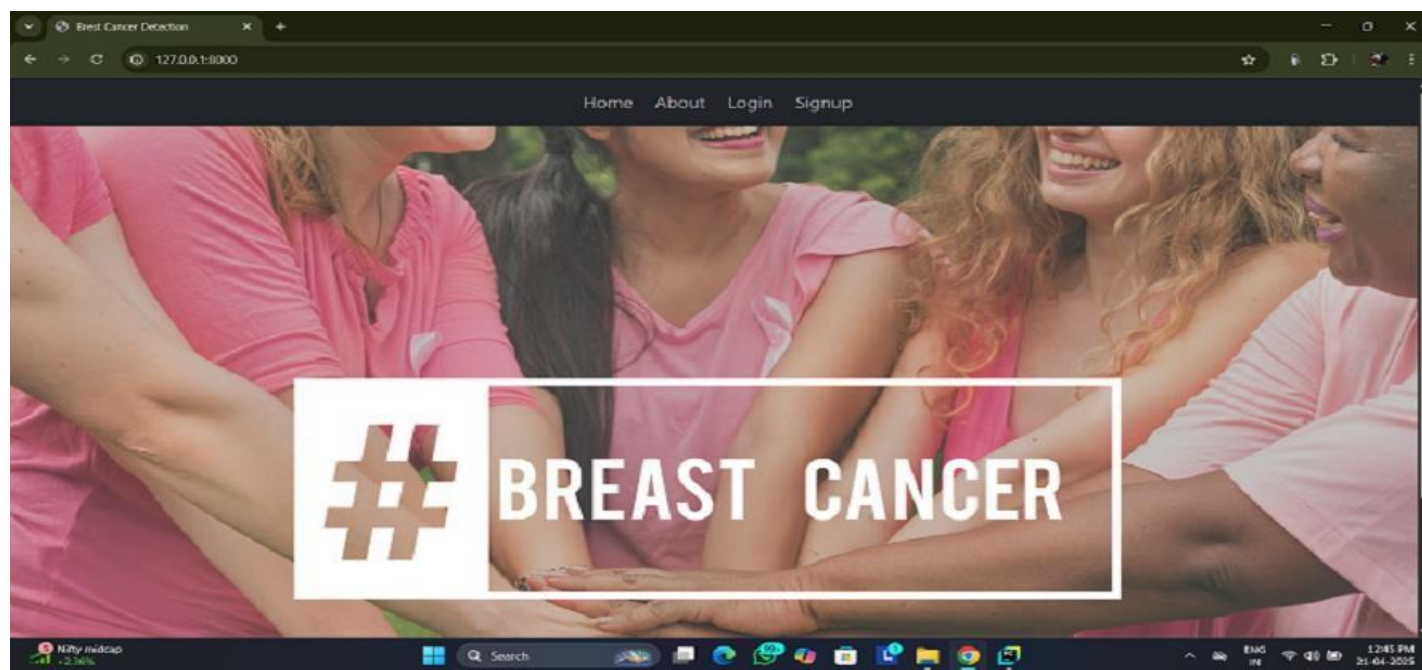
Calculate the errors: After training the first tree the errors between the predicted and actual values are calculated.

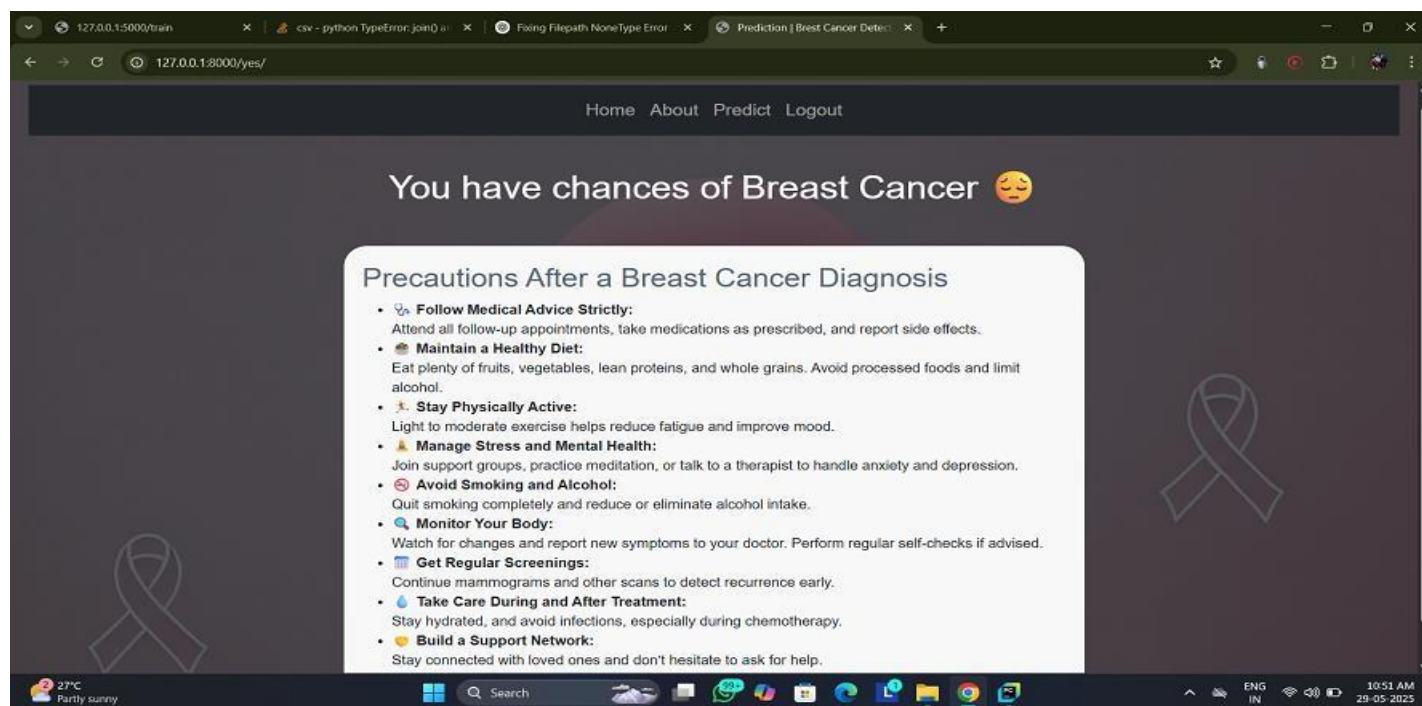
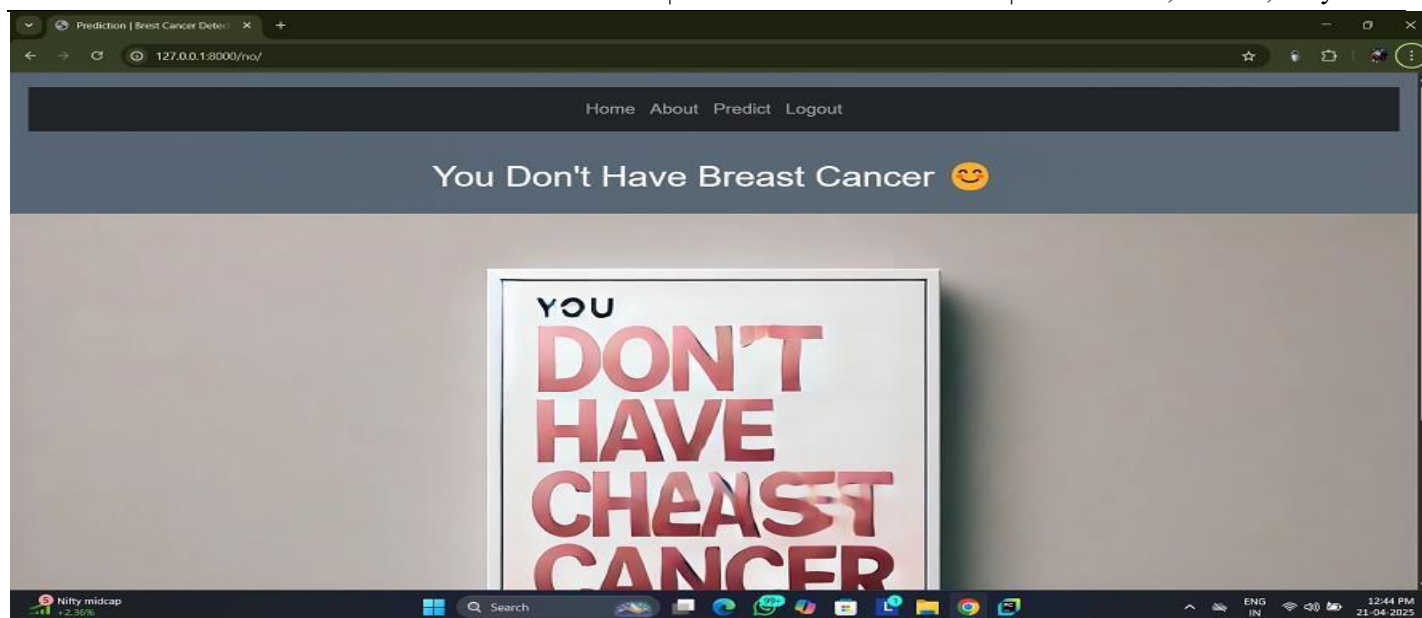
Train the next tree: The next tree is trained on the errors of the previous tree. This step attempts to correct the errors made by the first tree.

Repeat the process: This process continues with each new tree trying to correct the errors of the previous trees until a stopping criterion is met.

Combine the predictions: The final prediction is the sum of the predictions from all the trees.

III. Results and Discussion





IV. Conclusion

Small breast tumor detection accuracy, safety, and spectral efficiency are all enhanced by the suggested UWB radar system using shaped Gaussian pulses. It improves signal penetration and radiation properties, making it a useful tool for early breast cancer detection. The system's practical usefulness is confirmed by experimental validation utilizing a realistic breast phantom.

V. Acknowledgment

It is optional. The preferred spelling of the word “acknowledgment” in American English is without an “e” after the “g.” Use the singular heading even if you have many acknowledgments. Avoid expressions such as “One of us (S.B.A.) would like to thank ...” Instead, write “F. A. Author thanks” Sponsor and financial support acknowledgments are placed in the unnumbered footnote on the first page.

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