Title: Microwave breast imaging classification using machine learning approaches.

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Type

Epos for Radiologists (poster)

Keywords

Microwave, Breast, Machine learning

Purpose / Learning objectives:

To demonstrate the accuracy and robustness of a classification technique developed for microwave breast imaging.

Methods and materials/ Background:

The Micrima MARIA® system is a Radio frequency (3-8GHz) imaging system that measures dielectric contrast within breast tissue. Using a hemispherical array of 60 antennas, 1770 independent channels are measured over 101 frequency points. This data is used to form a 3D focused image of scattered signals from within the breast. High levels of vascularisation within lesions result in high contrast, highlighting their position. To aid in their detection, classification of lesions as suspicious is desirable. It is demonstrated that classification can be achieved by distinguishing between lesion mimicking serum (high contrast), and propanediol (low contrast) targets in an adipose phantom. A classifier was implemented using a non-linear support vector machine. Accuracy and robustness were assessed by means of random repeated sub-sampling (Monte-Carlo simulation) and learning (training and validation) curves.

Results/ Findings and procedure details:

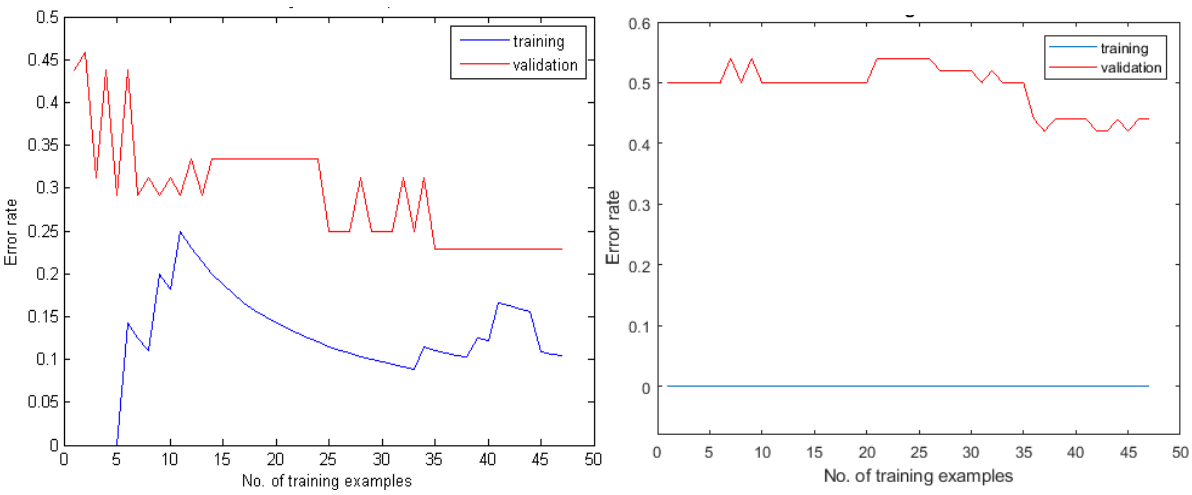
The data set consisted of 96 cases, varying phantom position, size and material. Classification was performed using channel data (178770 features) and the in-image focussed frequency response (101 features). Accuracies of 97% and 81% were achieved over 25 runs of random repeated sampling (75%:25%, training: testing data). This advocates the channel data as the preferred solution. However, learning curve data (Figure 1) demonstrates a lack of robustness on unseen data. So, in practice the focussed frequency response is optimal. Application to a limited clinical data set, and classifying an entire 3D MARIA® image (Figure 2(b) and 3(b)) demonstrates the potential of this technique in a clinical setting.

Conclusion:

Accuracy (81%) and robustness of an RF-based lesion classifier are demonstrated using a adipose/lesion phantom. Application to clinical data demonstrates a tool to aid clinicians in cancer diagnosis.

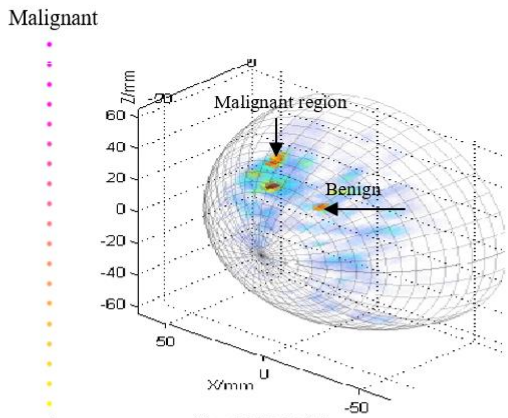
Limitations:

- Small dataset.

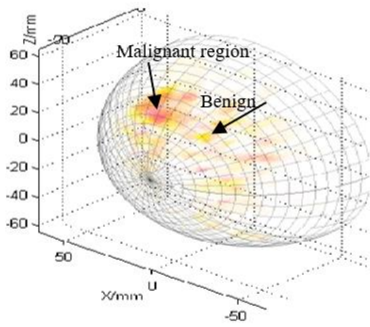


(a) Phantom data: Focussed data (b) Phantom data: Channel data (training error – zero)

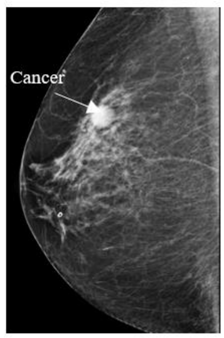
Figure 1: Learning curves for (a) focussed and (b) channel data (48 cases were used for training and remaining 48 cases were used for validation). Smaller differences in the error between training and validation curves indicate higher confidence in the model's robustness towards unseen data, demonstrating that the model trained on channel data exhibits signs of overfitting compared to the focussed model.



(a) MARIA® image

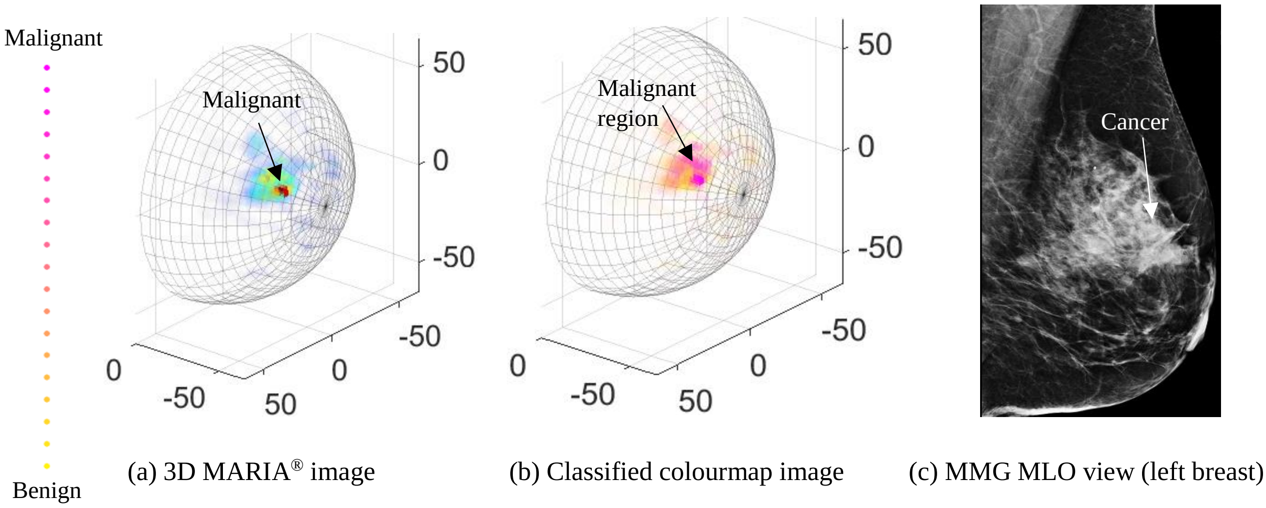


(b) Classified colourmap image



(c) MMG (Mammogram) MLO view of right breast

Figure 2: (a) MARIA® image (red blobs showing lesion location) along with (b) classification results (pink: malignant, yellow: benign) (M5 - P064R).



(a) 3D MARIA® image (b) Classified colourmap image (c) MMG MLO view (left breast)

Figure 3: (a) A MARIA® image (red blob showing lesion) along with (b) classification results (pink: malignant, yellow: benign) (M5: P235L).