Classification of Axillary Lymph Nodes Metastasised by Breast Cancer using Microwave Imaging Signals

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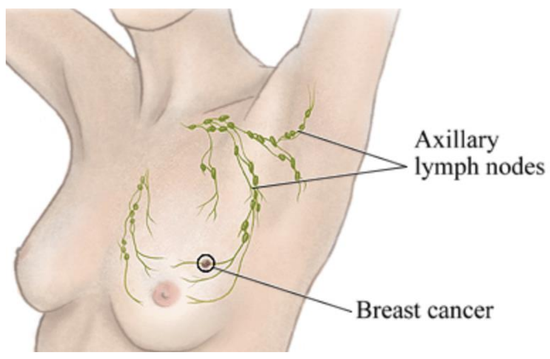
ABSTRACT

We present preliminary results of the classification of healthy and metastasised Axillary Lymph Nodes (ALN) using Microwave Imaging (MWI) signals. We created 60 models of ALNs based on characteristics reported in the literature. Those models were then placed inside simplified models of the axillary region and the reflected signals were measured with one Ultra Wide-Band (UWB) antenna. Then, we tested several Feature Extraction Methods (FEM) and classification algorithms and evaluated their performance in distinguishing healthy from metastasised ALNs.

INTRODUCTION

Breast cancer is the most common cancer worldwide [1]

Cancer cells can metastasise to surrounding lymph nodes, such as Axillary Lymph Nodes (ALNs).



Correct diagnosis of ALNs
↓
More accurate breast cancer staging

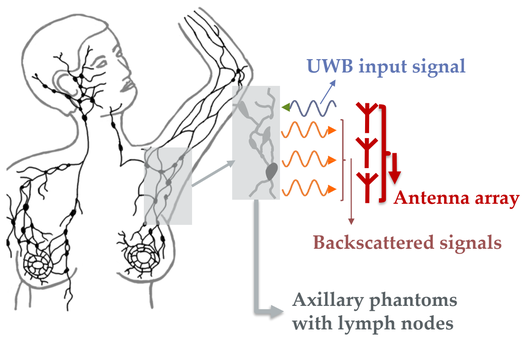
Imaging techniques:
- Ultrasound-Guided Biopsy;
- Computed Tomography (CT);
- Magnetic Resonance Imaging (MRI);
- Positron Emission Tomography (PET).

\+ Axillary Lymph Node Dissection (ALND)

\+ Sentinel Lymph Node Biopsy (SLNB) -

The removal of **too many healthy lymph nodes** can lead to:
- Slower physical recovery;
- Higher risk of infection [2];
- Lymphedema [3];
- Paraesthesia [2].

Main goal:
Design and build a full Microwave Imaging (MWI) system to detect and diagnose ALNs.
↓
Machine Learning may help to identify whether an axillary region has metastasised ALNs or not



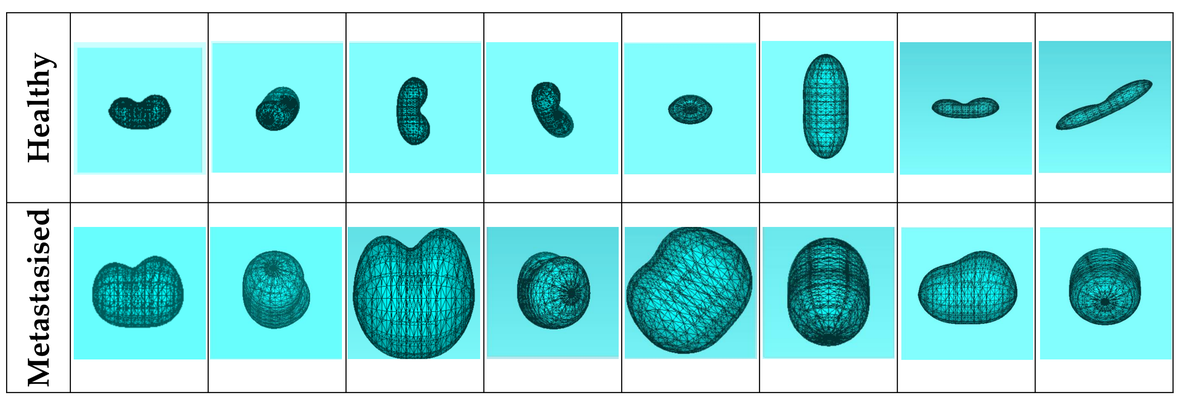
AXILLARY LYMPH NODES MODELS

ALN numerical models were created based on morphology characteristics [4]

Healthy:
- Ratio between longest-axis (L) and the shortest-axis (S) - L/S >= 1.7
- S < 9 mm
- Large concavity to represent hilum

Metastasised, otherwise

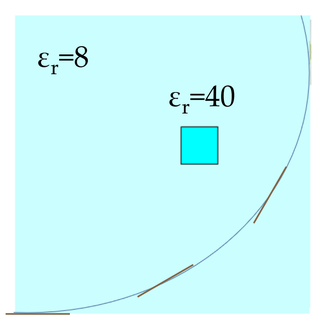
60 models in total:
- **30 healthy**
- **30 metastasised**



METHODOLOGY

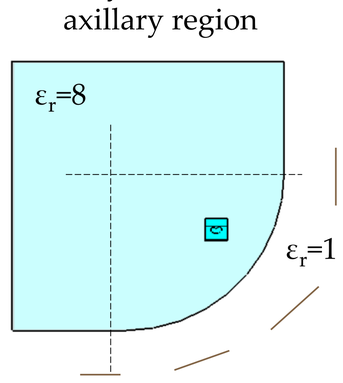
Classification: Healthy vs Metastasised ALNs in three different scenarios
- Relative permittivity of the medium: ε_r=8
- Relative permittivity of the ALN models: ε_r=40

Scenario A: No change in medium



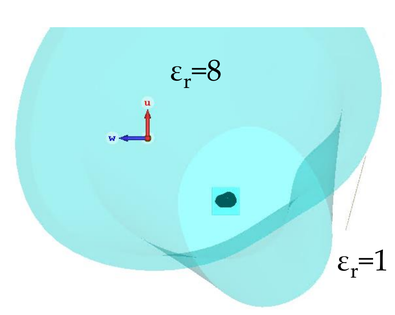
7 antenna signals per ALN

Scenario B: Cylindrical axillary region



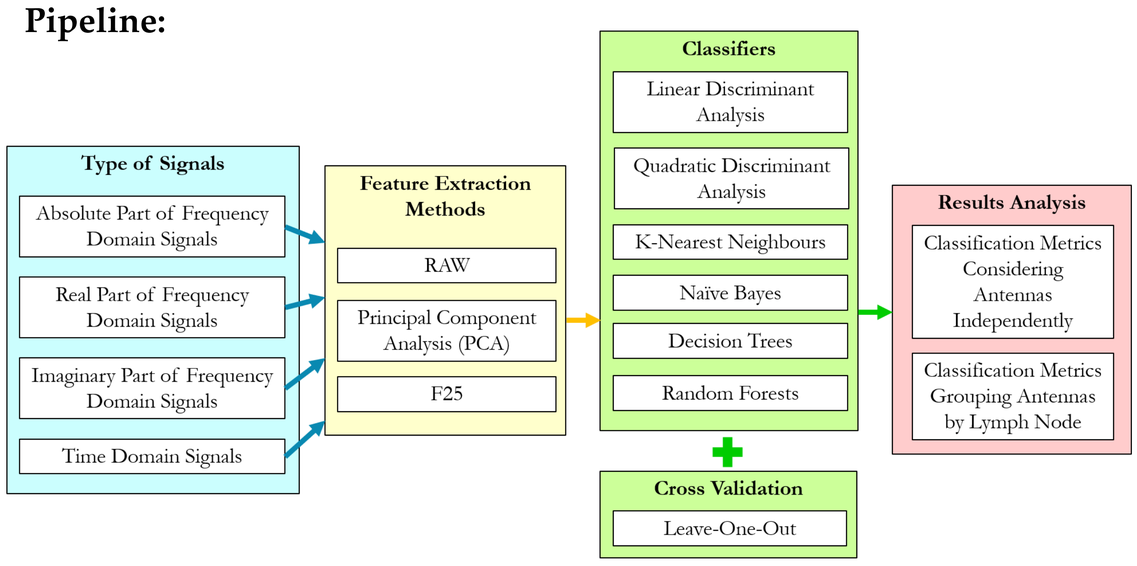
7 antenna signals per ALN

Scenario C: Simplified realistic axillary region



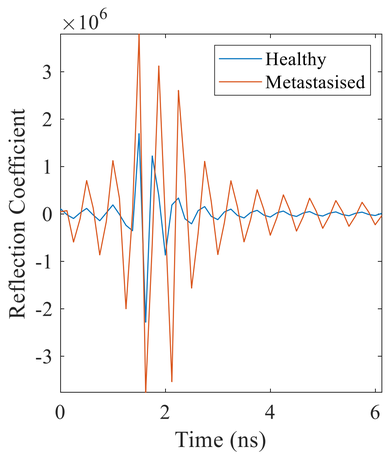
7 antenna signals in 4 different planes per ALN

Pipeline:



RESULTS

Example of microwave signal of healthy and metastasised ALNs:



Best classification results:

	Accuracy Values Using Independent Signals	Accuracy Values Grouping Antenna Signals per ALN	Parameters
Scenario A	93.8%	98.3% (1 FP)	kNN, 19 PCs
Scenario B	96.7%	98.3% (1 FP)	kNN, 18 PCs
Scenario C	96.7%	98.3% (1 FP)	kNN, 20 PCs

PCs: Principal Components (from PCA)

CONCLUSIONS

- We obtained promising results in ALN classification, up to 98.3% considering 60 ALNs models.
- These results are limited to macro-changes in ALNs, since the ALNs are only classified based on their shape and size.
- In future work, we intend to evaluate this methodology using new scenarios with multiple ALNs and muscles, which correspond to more realistic scenarios.

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