Experimental Validation of an Axillary Microwave Imaging Prototype

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Breast Cancer

2.09 million new cancer cases in 2018

Second most common cancer worldwide
Breast Cancer and Metastases

80% of breast cancer cases are invasive

30% of these can metastasise to surrounding lymph nodes

Breast Cancer Staging

- TNM staging
  - T: tumour size
  - N: metastasised lymph nodes
  - M: metastases in distant organs

- The correct diagnosis of metastasised axillary lymph nodes aids to a more accurate breast cancer staging and treatment decisions.

Source: https://www.boardvitals.com/blog/mammogram/
Axillary Lymph Nodes Diagnosis

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

Positive results can lead to **Axillary Lymph Node Dissection (ALND)**

Negative results needs **Biopsy to confirm the result**
Axillary Lymph Nodes Diagnosis

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

- Risk of infection
- Lymphedema
- Paraesthesia

- Incorrect breast cancer staging
- Impact on therapeutic decisions

Wrong positive results can lead to
Wrong negative results can lead to

Unsatisfactory sensitivity and specificity
Axillary Lymph Nodes (ALN) Microwave Imaging (MWI)

- Our goal is to design and build a full Microwave Imaging (MWI) system to detect and diagnose ALNs.
Microwave Imaging (MWI)

- Microwave Imaging is based on the tissues dielectric properties differences at microwave frequencies (~500MHz-8GHz)
  - ✓ Non-ionising radiation
  - ✓ Low-cost
  - ✓ Low-power
  - ✓ Non-invasive
Axillary Lymph Nodes (ALN) Microwave Imaging (MWI)

Axillary phantoms with lymph nodes

UWB input signal

Antenna array

Backscattered signals

UWB Pulse Generator and Receiver

Skin Artefact Removal

Beamformer

Diagnosis Algorithms

Imaging Algorithms
Experimental MWI system

- 3D-printed axillary region model
- 3D-printed axillary lymph node model
- Cylindrical sweep with 1 antenna (2 to 7 GHz)
Conclusions and future work

• Promising experimental results in ALN detection will be available soon:

• Future work includes:
  • Evaluating the detection of multiple ALNs and contrast between healthy and metastasised ALNs;
  • Adding muscle mimicking materials.
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