

AI-Assisted Medical Microwave Radiometry (MWR) for Point-of-Care Breast Cancer Screening

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Introduction

- Breast cancer remains a leading cause of mortality, making early detection critical.
- Traditional imaging techniques (e.g., mammography) have limitations such as radiation exposure, high costs, and accessibility issues.



MWR2020 microwave radiometer device developed by MMWR Ltd.

- Microwave Radiometry (MWR)** is a promising, non-invasive imaging modality that measures internal tissue temperatures to detect abnormalities¹.



Details on MWR can be found at¹:

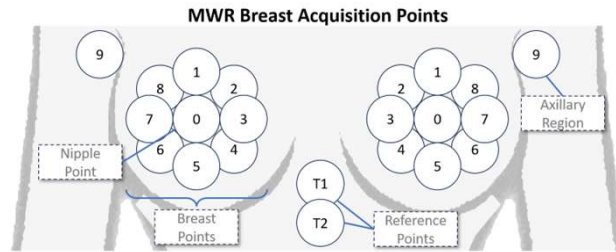
- However, MWR data interpretation is complex, requiring advanced AI-driven methods for accurate diagnosis.

Aim: To introduce an innovative MWR AI system that improves the automation of breast cancer diagnosis by integrating both knowledge-based and data-driven methods, ensuring its effective application in point-of-care settings.

Methodology

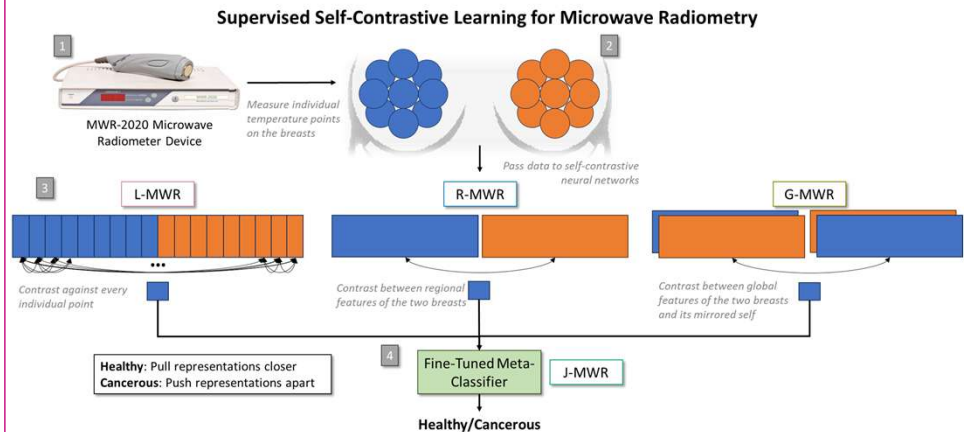
Data collection:

- 4,932 patient cases collected using the MWR2020 device, capturing both skin and internal tissue temperatures, of which 548 had breast cancer.
- 22 measurement points per breast, leading to a total of 44 temperature readings per patient.



Model Architecture²:

- Supervised self-contrastive learning to refine intra-patient feature extraction using three hierarchical models:
 - Local-MWR (L-MWR)**: Compares individual temperature points.
 - Region-MWR (R-MWR)**: Compares regional temperature features between left and right breasts.
 - Global-MWR (G-MWR)**: Swaps and compares entire breast temperature features.
- Joint-MWR (J-MWR)**: Meta-classifier integrating information from all levels.



Results

The proposed J-MWR model shows substantial improvement in predictive performance²:

- J-MWR outperformed baseline models with a **Matthew's Correlation Coefficient of 0.74 ± 0.018 , accuracy of 0.95 ± 0.003 , and ROC AUC of 0.96 ± 0.001 .**
- The hierarchical self-contrastive approach improved detection of subtle thermal asymmetries.
- Demonstrated strong generalisability even under limited training data and noisy conditions.

Detailed analysis of the results can be viewed at²:



Conclusions

- J-MWR improves MWR-based breast cancer detection by embedding domain knowledge into AI-driven methodologies.
- Potential for real-world clinical application in point-of-care diagnostics.
- Future work includes integrating multi-modal data, automation of model selection, and real-world deployment.

References:

- Goryanin, I., Karbainov, S., Shevelev, O., Tarakanov, A., Redpath, K., Vesnin, S. and Ivanov, Y., 2020. Passive microwave radiometry in biomedical studies. *Drug Discovery Today*, 25(4), pp.757-763.
- Galazis, C., Wu, H. and Goryanin, I., 2024. Multi-Tiered Self-Contrastive Learning for Medical Microwave Radiometry (MWR) Breast Cancer Detection. *arXiv preprint arXiv:2410.04636*.