Contribute to the development and optimization of a signal processing and AI algorithm for microwave imaging in the early detection of breast cancer

Breast cancer is the most frequently diagnosed cancer in women worldwide, particularly in developed countries, where it accounts for 33% of all female cancer cases and contributes to 14% of cancer-related deaths in women. Early detection significantly improves patient survival rates, while reducing treatment time and associated costs.

The primary objective of this study is to develop innovative methodologies for the direct and indirect detection of breast cancer by exploiting the dielectric properties of tissues. Pathological conditions alter the electrical characteristics of biological tissues when exposed to electromagnetic waves, resulting in distinct "dielectric signatures". The use of microwave (MW) imaging technology, combined with flexible microstrip antennas, offers a cost-effective, non-invasive alternative to traditional diagnostic methods such as X-ray mammography, ultrasound and MRI.

In addition, this research focuses on advanced signal processing techniques and the integration of artificial intelligence (AI) for image reconstruction. Signal processing plays a crucial role in extracting relevant information from microwave signals, reducing noise and improving imaging accuracy. Advanced algorithms promise increased resolution and image quality, enabling precise localization and characterization of breast anomalies.

However, this undertaking is not without its scientific challenges. The project faces several major hurdles, not least the development and refinement of signal processing algorithms specifically designed for microwave imaging systems. These algorithms aim to improve image quality, resolution and accuracy of anomaly detection. In addition, state-of-the-art deep learning techniques and artificial neural networks are being explored to streamline image reconstruction and improve the accuracy of anomaly detection in microwave breast imaging.

Innovative strategies for pre-processing and denoising microwave signals are also being investigated to increase the signal-to-noise ratio and improve overall image fidelity. Efficient algorithms for the localization and characterization of breast tumors using microwave data are being developed, with AI playing a key role in obtaining reliable results.

In addition, the project aims to evaluate algorithmic performance through in-depth simulations and real-life measurements, taking into account parameters such as sensitivity, specificity and computational efficiency.

This research aims to revolutionize breast cancer detection by exploiting the dielectric properties of tissue, advancing signal processing methodologies and integrating AI for image reconstruction. By overcoming scientific challenges, we can expect greater diagnostic accuracy, helping to improve patient outcomes and increase healthcare efficiency.

Supervisor name:
Latifa Fakri-Bouchet Associate Professor (MC-HC-HDR).
Affiliation: Institute of Analytical Sciences (ISA), UMR CNRS 5280, 5 rue de l, rue de la Doua, 69100 Villeurbanne
eMail address for contact: latifa.bouchet@univ-lyon1.fr
Tel.: +33 6 31 84 21 76;

Main ArchiFun theme involved:

- ☐ Host-pathogen interactions;
- ☐ Mechanisms of bacterial resistance and cancer onsets;
- ☐ Neurodegenerative and autoimmune diseases;
- ☑ Translational research in prevalent diseases;
- ☐ Physiology and ecology;
- ☐ Neurosciences and cognition.