Novel neural representations for ultrasound imaging

Ultrasound imaging is one of the most widely used medical imaging modalities for tissue characterization and disease diagnosis. Compared to other techniques, it is non-invasive, widely accessible, and relatively low-cost, making it particularly suitable for routine examinations and point-of-care diagnostics.

Despite its broad clinical adoption, the full potential of ultrasound remains underutilized. Image reconstruction in ultrasound typically relies on simplified physical models that assume constant properties of the medium. These assumptions lead to various imaging artifacts — especially in the presence of pathological tissues — that have become so common they are now embedded in standard radiological terminology.

The primary scientific goal of this project is to revisit the foundations of ultrasound imaging and substantially improve its capabilities by leveraging implicit neural representations, also known as implicit neural networks (INRs).

The project focuses on two key objectives. First, we aim to develop an advanced method for estimating critical quantitative ultrasound parameters, such as the local speed of sound in different tissue types. This will enable the reconstruction of higher-quality images and support more accurate identification of pathological changes. Second, we will explore the application of INRs for more effective analysis of medical images, potentially offering clinicians new AI-powered tools for improved disease detection and decision support.

A particularly innovative aspect of this research is its potential to personalize the imaging process. Unlike conventional reconstruction methods, which are designed to work reasonably well across the general population, the proposed approach can adapt the imaging model to the individual patient and the specific anatomical region being scanned.

In the long term, the proposed research could transform how ultrasound is applied in clinical practice, making it a more precise, efficient, and personalized diagnostic modality. To support this, the project will also involve the development of realistic datasets — both simulated and acquired in vivo — to validate and refine the proposed methods.