# **3D Breast Ultrasound Object detection**

# **Project Leaders**

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Breast cancer is one of the most prevalent malignancies among women worldwide, and early accurate diagnosis is critical for improving survival rates. Breast ultrasound (BUS) is a key screening tool due to its radiation-free nature, low cost, and high sensitivity, especially for dense breasts or younger women. However, conventional 2D ultrasound suffers from **operator dependency, high noise, and ambiguous lesion boundaries**, limiting the accuracy of benign-malignant differentiation.

3D breast ultrasound provides **volumetric imaging** with comprehensive lesion information (e.g., morphology, margins, internal echogenicity). Yet, automating lesion detection and classification in 3D data faces challenges:

* **Data scarcity**: Lack of high-quality public 3D BUS datasets.
* **Lesion heterogeneity**: Subtle differences in shape, texture, and spatial distribution between benign and malignant lesions.
* **3D detection efficiency**: Traditional 2D detection algorithms cannot be directly applied to volumetric data.

**2. Research Directions**

This study aims to develop a **deep learning-based 3D object detection framework** for BUS with the following goals:

1. **Accurate lesion localization**: Employ 3D CNNs (e.g., 3D U-Net, Voxel-RCNN) to detect lesions in volumetric data.
2. **Benign-malignant classification**: Integrate morphological features (e.g., spiculation, aspect ratio) and dynamic enhancement features (e.g., vascularity) for multimodal classification.
3. **Few-shot learning**: Address data scarcity via transfer learning or generative adversarial networks (GANs).

**3. Innovations**

* **Multi-scale 3D feature fusion**: A lightweight network to aggregate features at different resolutions for detecting small lesions.
* **Dynamic enhancement modeling**: Leverage temporal 3D ultrasound (e.g., elastography) to improve classification robustness.
* **Interpretability**: Use Grad-CAM to visualize model decisions, enhancing clinical trust.