Challenges in Segmenting Lesions in Breast Ultrasound Images

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Introduction

Motivation:

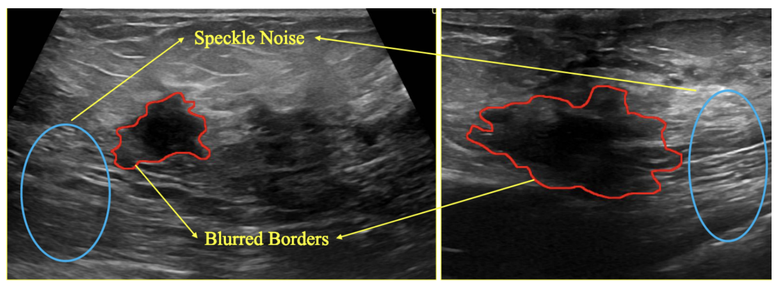
- Breast ultrasound is widely used for early breast lesion detection.
- Precise segmentation aids radiologists and minimizes misdiagnosis.

Challenges:

- Speckle noise and blurry lesion boundaries.
- High variability in image quality.

Objective:

- Evaluate four state-of-the-art deep learning models on two public datasets for breast lesion segmentation.



* Red lines show blurred lesion edges; blue circles highlight speckle noise [1].

Related Work

Breast Ultrasound Segmentation:

- Traditional/classical methods suffer from noise sensitivity and poor generalization [2].
- Deep learning methods outperform classical approaches in accuracy and robustness [3].

SOTA Models:

- **U-Net** [4]: Strong baseline for biomedical segmentation with limited data.
- **FPN** [5]: Combines multi-scale features for better localization.
- **DeepLabV3+** [6]: Uses dilated convolutions for detailed boundary detection.
- **U-Net++** [7]: Enhanced feature fusion via nested skip connections.

Methods

Datasets:
BUSIS [8]: 562 images, avg. size 550×457
UDAIT [9]:163 images, 344×233 to 753×617.

Data Augmentation: resizing (512×512), additive Gaussian noise, box & motion blur, and random changes in: brightness, contrast, hue & saturation.

Experimental Setup:

- **Training/Validation split** 70% / 30%
- **Epochs:** 15, **Batch size:** 4
- **Learning Rate:** 2e-4, **Optimizer:** Adam
- **Encoder:** ResNet18 pretrained on ImageNet
- **Loss:** Dice Loss

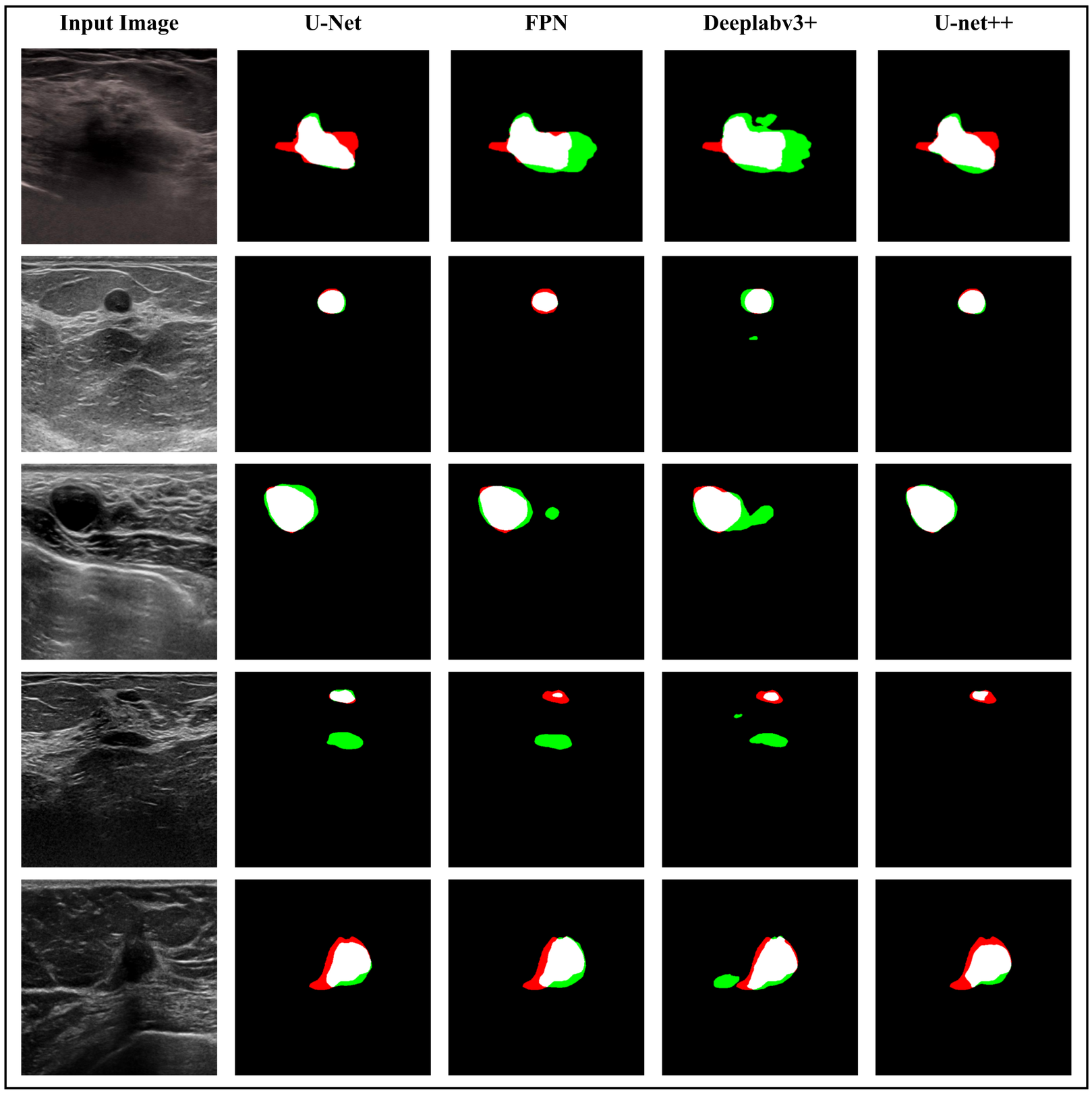
Quantitative Results

Best results are highlighted in bold

	Dice	Jaccard	Recall	Precision
UNet	**0.919** / **0.768**	0.858 / **0.665**	0.905 / **0.822**	0.946 /0.820
FPN	0.910 / 0.760	0.844 / 0.649	0.908 / 0.752	0.927 / 0.804
DeepLabv3+	0.907 / 0.735	0.841 / 0.623	**0.928** / 0.765	0.900 / 0.751
UNet++	**0.919** / 0.755	**0.860** / **0.665**	0.904 / 0.755	**0.949** / **0.890**

Qualitative Results

- **Green:** False Positives (healthy tissue misclassified as lesion)
- **Red:** False Negatives (missed lesion regions)
- **Black:** True Negatives (background)
- **White:** True Positives (lesion)



Discussion

- **UNet++** has the best overall results, especially in precision.
- **UNet** also performed well, with high Dice and Jaccard scores.
- **DeepLabv3+** had the highest recall but more false positives.
- **FPN** was stable but less accurate in the **UDIAT** data set.
- **UNet++** is a good balance between accuracy and fewer errors.

QR Code

References

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