Towards Robust Natural-looking Mammography Lesion Synthesis On Ipsilateral Dual-views Breast Cancer Analysis

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PROBLEMS

1. **Multi-view approaches** in mammogram-based breast cancer classification face conflict between breast sides on cancerous information, impacting **outcome reliability**.

2. **Data insufficiency**.

3. **Mammogram synthesis and augmentation techniques** like MixUp and CutMix can lead to label conflicts and unreliable samples.
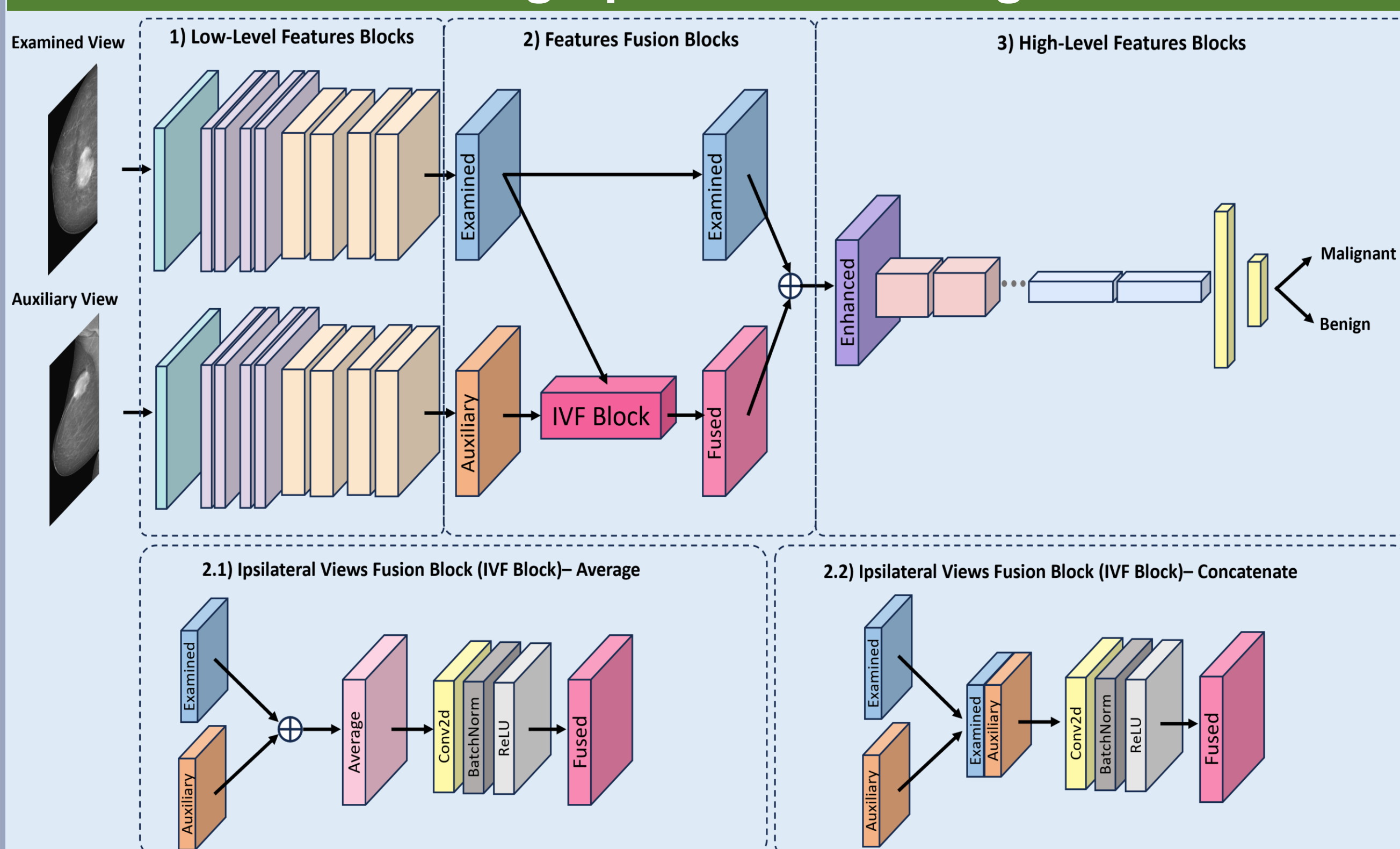
MAIN CONTRIBUTIONS

1. **DIVF-Net:** A multi-view network with **dual fusion operations** leveraging mammogram CC and MLO views for breast cancer classification.

2. **A new robust mammogram synthesis framework** replacing benign to malignant regions with smoothed informative patches, employing Fourier Domain Adaptation.
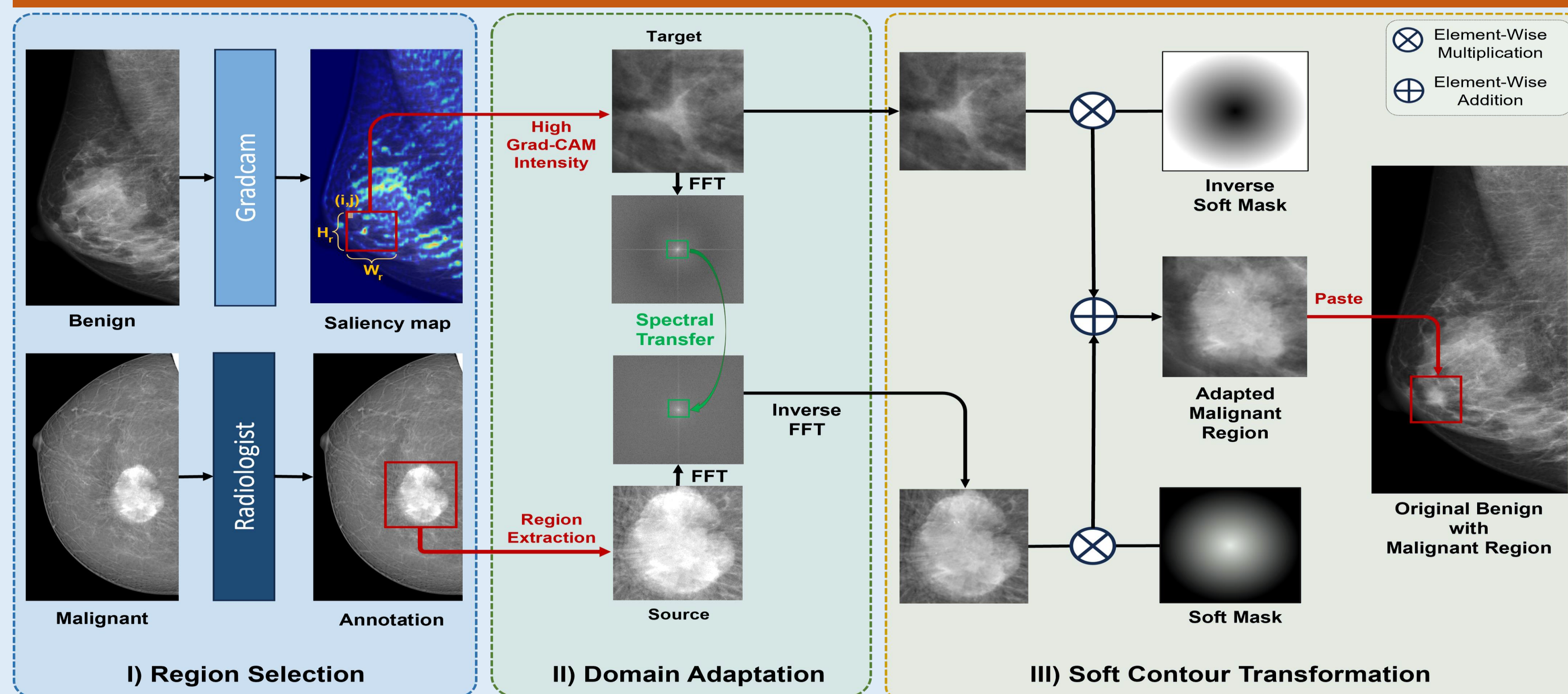
FUTURE DIRECTIONS

- Breast density classification.
- BI-RADS classification.
- Lesion detection.

METHODOLOGY AND EXPERIMENTAL RESULTS

Dual Ipsilateral Views Fusion Network (DIVF-Net) for Mammographic Cancer Diagnosis.

Proposed Soft-Adapted Malignancy Synthesis Framework

I) Region Selection   II) Domain Adaptation   III) Soft Contour Transformation

Data Acquisition

Datasets	Samples	Training Set		Testing Set	
CMMD	5,202 mammograms	498	benign	88	benign
	(1,775 studies)	1,157	malignant	205	malignant
VinDr-Mammo	20,000 mammograms	1,870	benign	467	benign
	(5,000 studies)	395	malignant	99	malignant

Quantitative results (%) among our proposed DIVF-Net and other approaches.

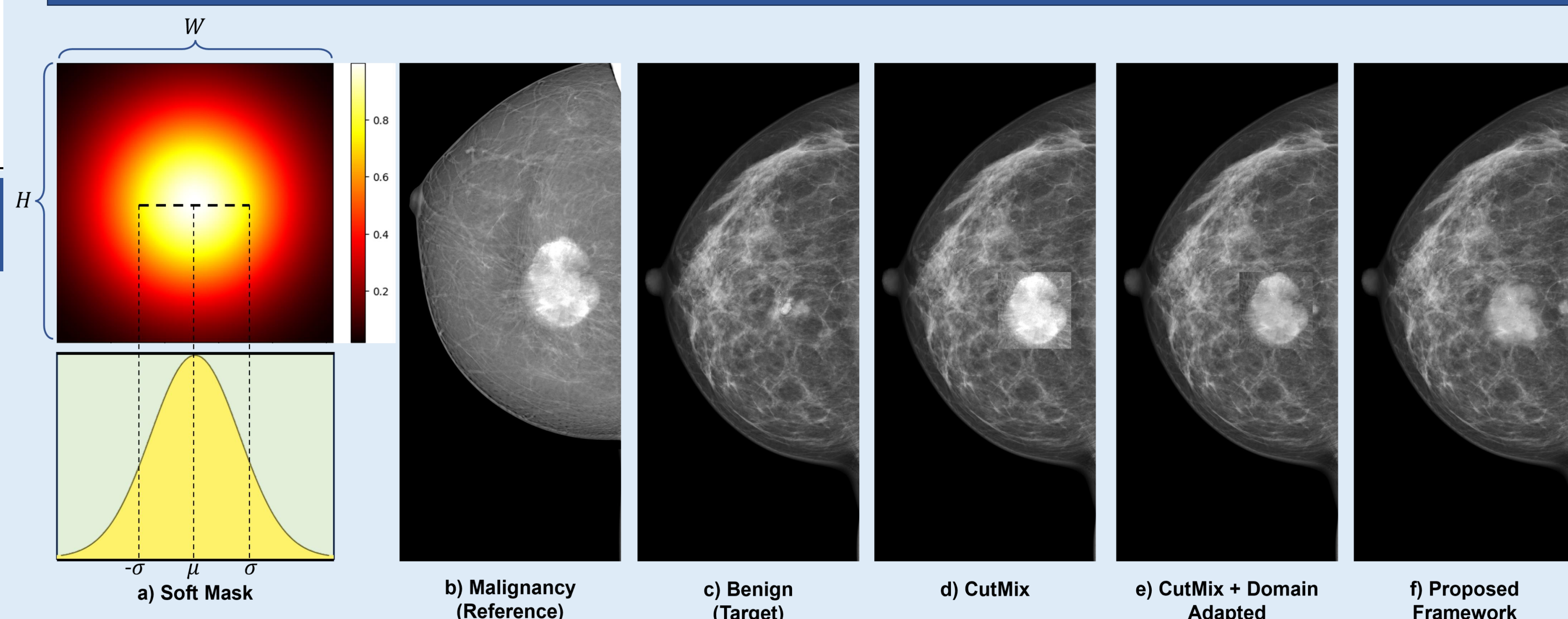| Backbone		ResNet-18		ResNet-34	
Dataset	Method	F1-Score	AUC-ROC	F1-Score	AUC-ROC
VinDr-Mammo	No Fusion	70.12	68.79	71.48	70.22
	Average Fusion	72.54	74.20	73.25	72.88
	Concatenate Fusion	73.22	70.66	74.63	72.18
	DIVF(Average)	74.00	72.15	74.17	71.67
	DIVF(Concatenate)	**75.34**	**74.24**	**75.98**	**74.86**
CMMD	No Fusion	73.26	76.70	75.52	77.18
	Average Fusion	79.22	79.13	79.97	81.80
	Concatenate Fusion	75.86	77.10	78.12	77.67
	DIVF(Average)	**81.45**	**84.14**	**82.44**	80.92
	DIVF(Concatenate)	77.77	80.42	79.51	**81.97**

Ablation studies of the proposed Soft-Adapted Malignancy Synthesis Framework on DIVF Concatenate+ResNet-34 on VinDr-Mammo Dataset

	DIVF	Region Selection & CutMix	Fourier Adaptation	Soft Mask	Macro F1-Score
Baseline	✓				75.98
Proposed Methods	✓	✓			76.54
	✓	✓	✓		76.96
	✓	✓		✓	76.78
	✓	✓	✓	✓	**77.32**

Pipeline for Training and Synthesizing Mammographic Images

I) Supervised Learning
II) Mammogram Synthesis
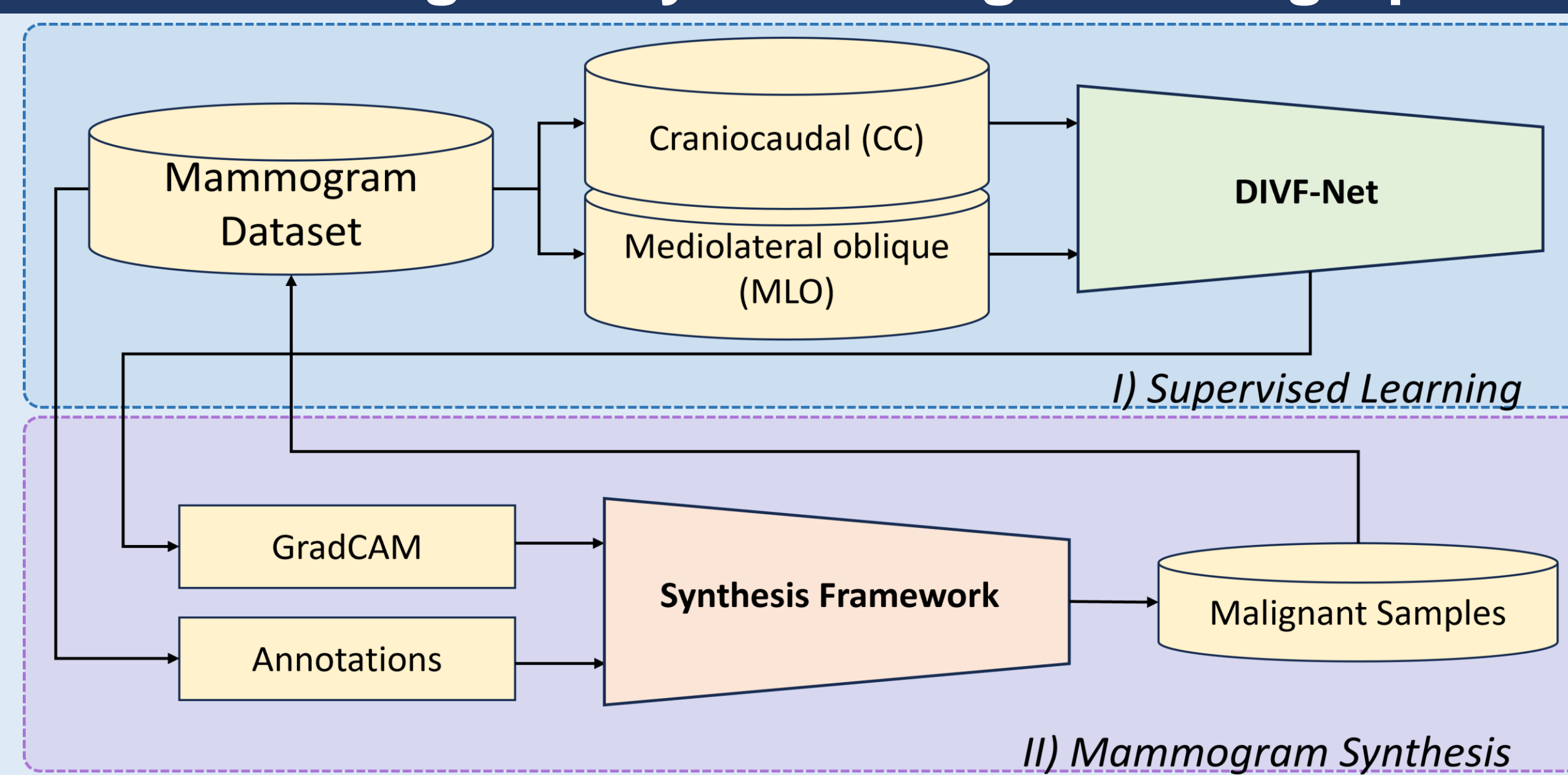
Comparison of mammogram images synthesized using other algorithms with our proposed framework

a) Soft Mask   b) Malignancy (Reference)   c) Benign (Target)   d) CutMix   e) CutMix + Domain Adapted   f) Proposed Framework

REFERENCES

1. Liu et al. (2021) IEEE Transactions on Pattern Analysis and Machine Intelligence. 2021 Jun 1;44(10):5947-61.

2. Yang, Y., & Soatto, S. (2020). Proceedings of the IEEE/CVF conference on computer vision and pattern recognition (pp. 4085-4095).

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