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Cross-View Relation Networks for Mammogram Mass Detection

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Background

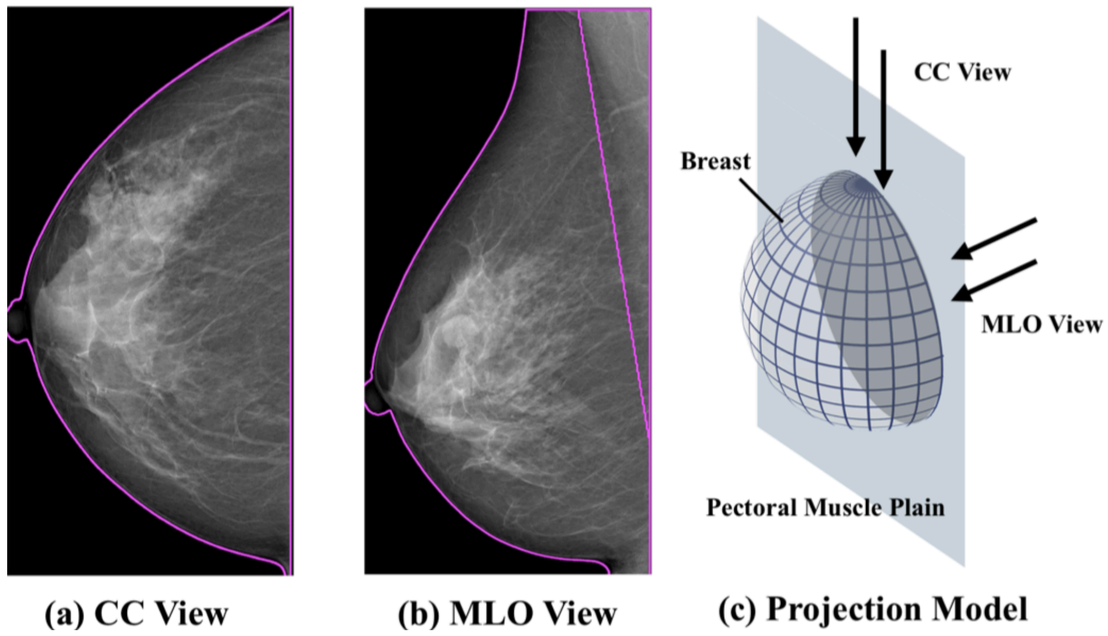

Figure 1. Relations between CC view and MLO view [1].

Motivation

- Radiologists relation reasoning procedure:
  - Extract suspicious regions in the target view;
  - Search the corresponding features in the other view;
  - Combine information and make diagnosis decision under cross-view.

How to model clinical experience ?

- The **Two-branch Faster RCNNs** represent Extract regions in two views of breasts.
- The **Cross-view Relation Networks** represent Search regions in breasts, enables relational reasoning via iterated, message-passing-like modes of processing.
- The **Channel-wise attention module** represent Combine cross-view information to re-weight the feature maps of different views.

Our Overall Framework

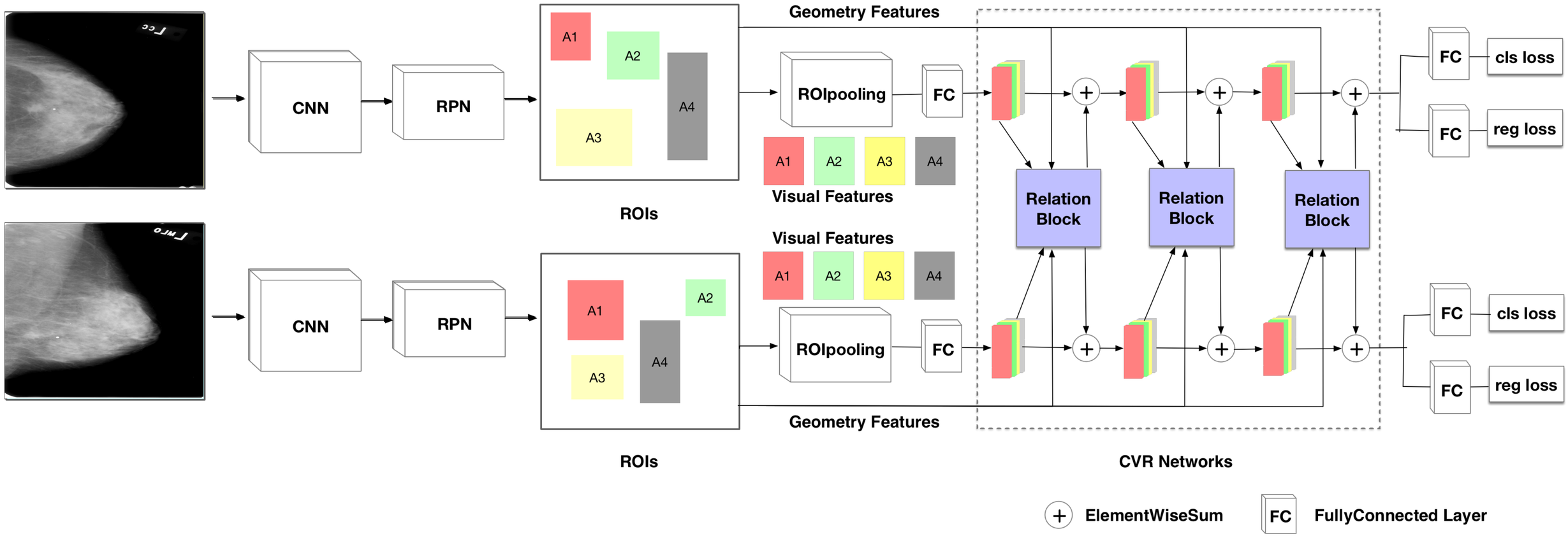

Figure 2. The architecture of the proposed cross-view relation networks.

Quantitative Results

Comparison with state-of-the-art methods:

Table 1. Comparisons with state-of-the-art methods with true positive rate (TPR) versus FPI on the public DDSM dataset.

Methods	F_1 score	TPR@FPI
Campanini et al. [25]	-	0.80@1.1
Eltonsy et al. [26]	-	0.92@5.4, 0.88@2.4, 0.81@0.6
Sampat et al. [27]	-	0.88@2.7, 0.85@1.5, 0.80@1.0
Li et al. [29]	-	0.90@3.4, 0.87@2.0, 0.84@1.0
Min et al. [3]	-	0.89@2.5, 0.86@1.7, 0.84@1.2
Yan et al. [4]	-	0.87@2.3, 0.76@1.7, 0.73@1.1
Faster RCNN [22]	0.52	0.85@2.1, 0.75@,1.8, 0.73@1.2
two-branch Faster RCNNs	0.57	0.75@1.0, 0.73@0.9
CVR-RCNN	**0.75**	**0.92@2.2, 0.88@1.9, 0.85@1.2**

Ablation Study

Table 2. Effect of relation block(s) in the cross-view relation network on the private dataset. $N = 0$ corresponds to the two-branch faster rcnns without relation blocks.

Relation Block (N)	Precision (%)	Recall (%)	F_1 Score	FPI
N=0	65.27	71.93	0.69	0.42
N=1	69.66	71.70	0.71	0.35
N=2	70.10	72.13	0.71	0.33
N=3	71.12	**75.33**	**0.73**	0.30
N=4	**76.56**	70.39	**0.73**	**0.27**

Table 3. Effect of design loss in the cross-view relation network.

$\frac{CCLoss}{MLOLoss}$	$\frac{Reg.Loss}{Cls.Loss}$	Precision(%)	Recall(%)	F1-Score	FPI
2:1	2:1	68.18	72.13	0.49	0.40
	1:1	70.69	70.83	0.50	0.36
	1:2	68.94	72.86	0.50	0.37
1:1	2:1	**71.72**	**75.33**	**0.73**	**0.30**
	1:1	70.23	74.46	0.52	0.35
	1:2	71.53	72.71	0.52	0.33
1:2	2:1	72.20	71.26	0.51	0.31
	1:1	69.37	71.26	0.49	0.35
	1:2	69.76	71.99	0.50	0.36

Table 4. Comparisons with different detection models in the cross-view relation network.

Methods	Precision	Recall	F_1 Score	FPI
Faster RCNN [22]	64.01%	70.53%	0.67	0.45
two-branch Faster RCNNs	65.27%	71.93%	0.69	0.42
SSD [28]	65.75%	66.91%	0.66	0.42
two-branch SSDs	66.40%	68.30%	0.67	0.41
CVR-RCNN	**71.12%**	**75.33%**	**0.73**	**0.30**

Table 5. Comparisons with different modify models in the cross-view relation network.

Methods	Precision	Recall	F_1	FPI
Early Fusion with RNN [20]	66.77%	67.83%	0.70	0.39
Later Fusion with FC-layer [19]	66.77%	71.86%	0.69	0.40
Individual-similar-param	67.37%	71.73%	0.69	0.40
CVR-RCNN	**71.12%**	**75.33%**	**0.73**	**0.30**

Visualization

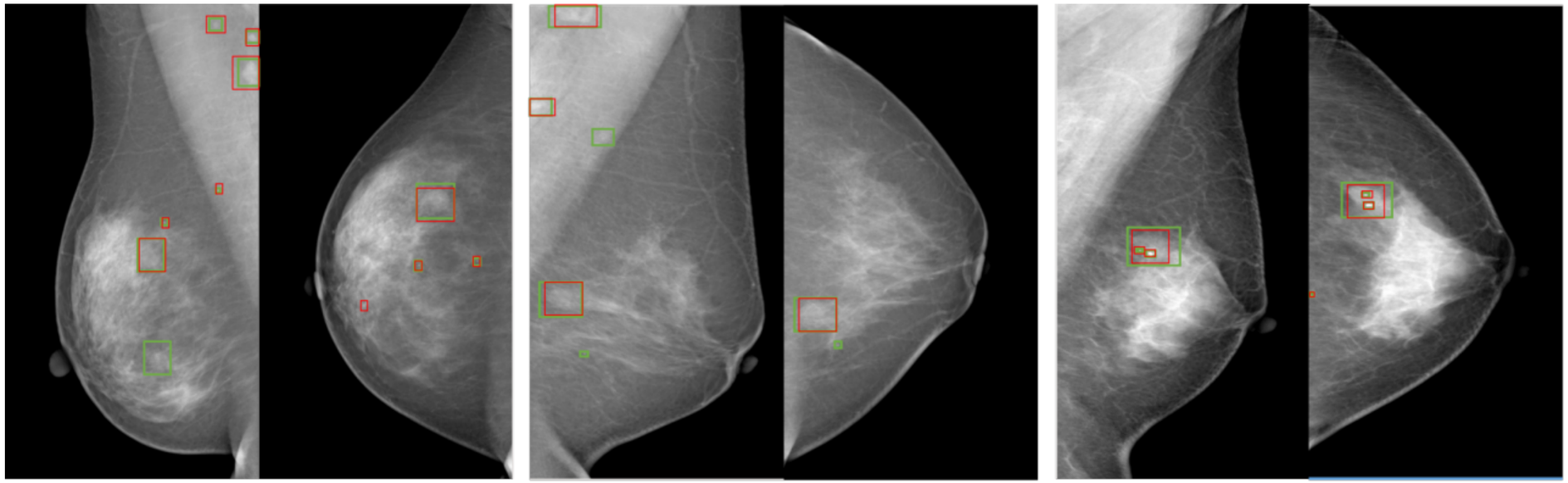

Fig.3. Exemplar mass detection results by the proposed method. First pair: MLO and CC view of a right breast. Second and third pairs: MLO and CC view of two left breasts. Green boxes represent detection results, while red boxes for ground-truths.

Thank you!