

Artificial Intelligence to Aid 3VT View Screening in Fetal Echocardiography

A Study on Improving Diagnosis of Congenital Heart Disease

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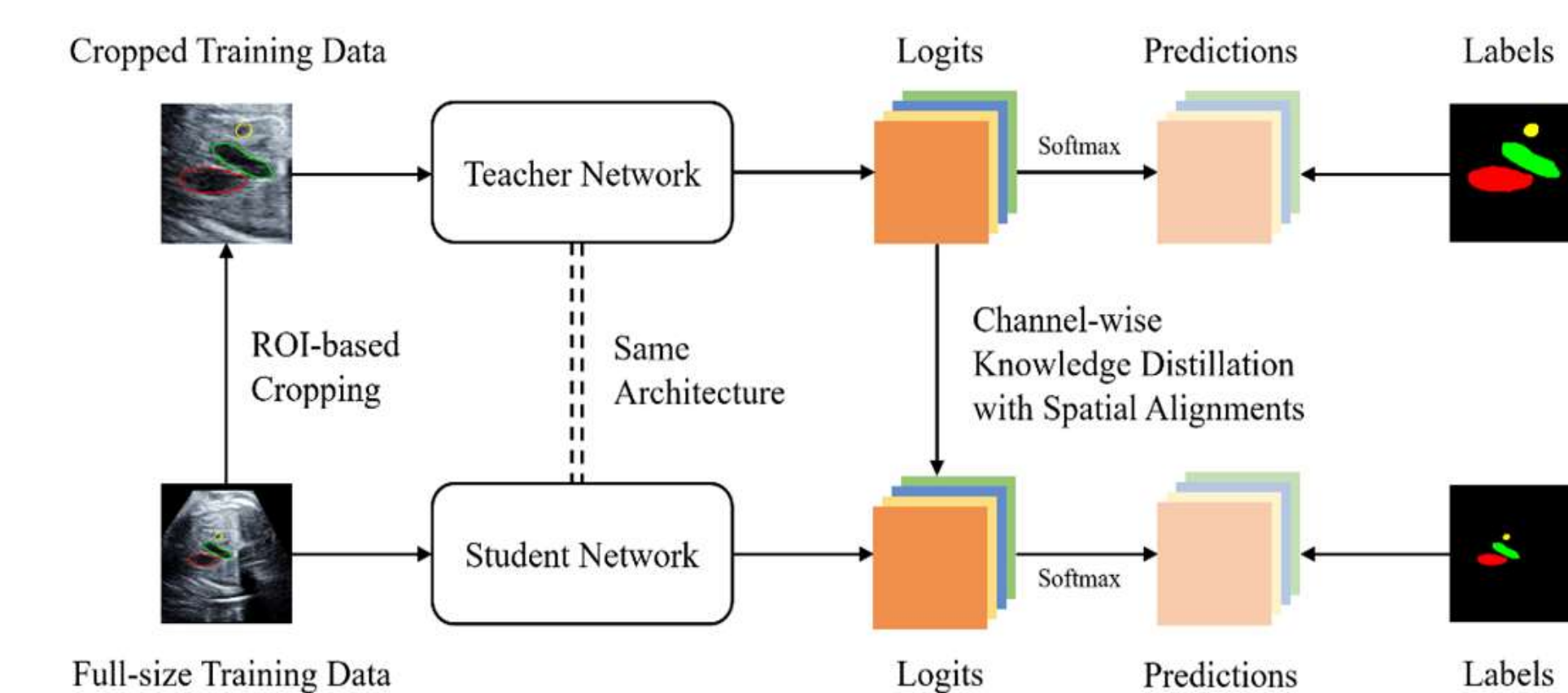
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Introduction

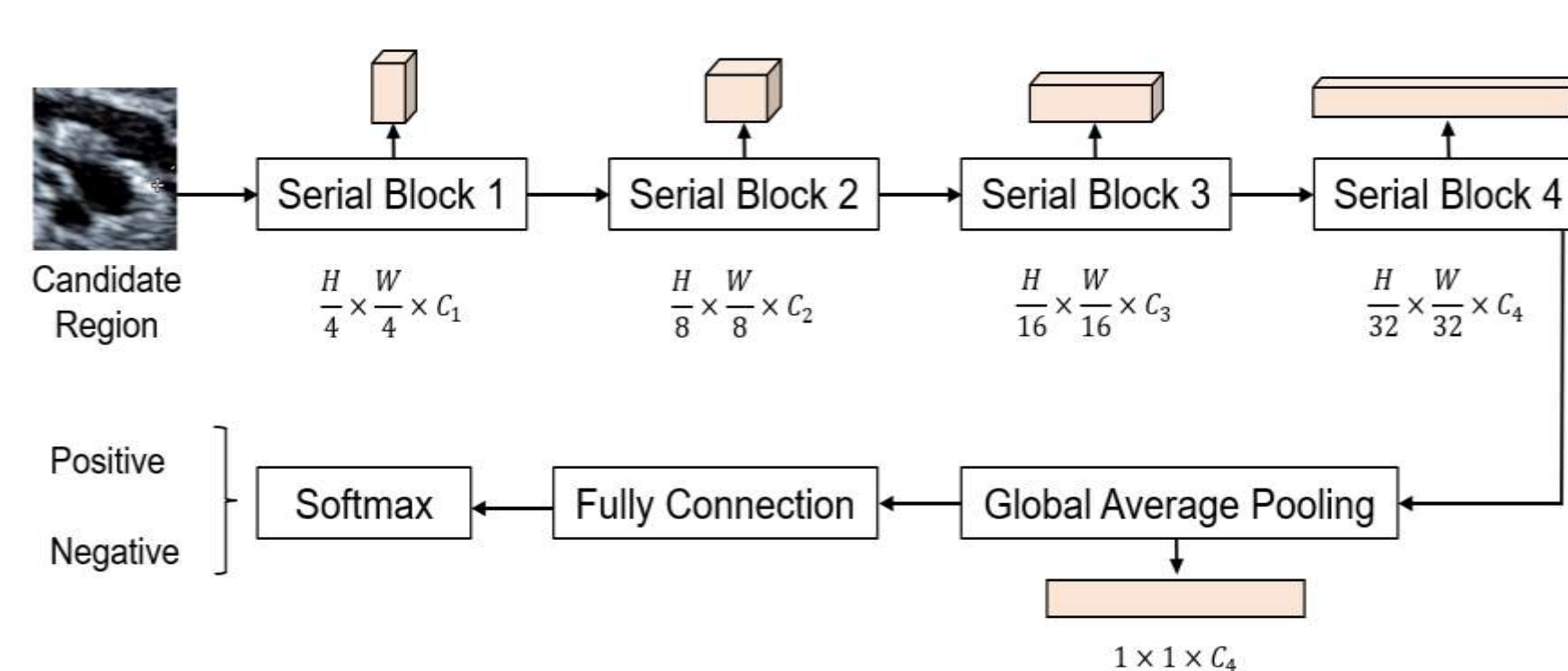
Congenital heart defects are the most prevalent birth abnormalities. The 3VT view is essential for prenatal cardiac screening yet poses challenges for inexperienced sonographers. This AI pipeline is proposed to standardize and improve diagnostic performance.

Methods

We recruited 1,300 pregnant women (1,000 normal, 300 CHD cases) and collected standard fetal 3VT ultrasound scans. A two-stage AI system was constructed. Channel-wise knowledge distillation based on DeepLabv3+ completed precise segmentation of cardiac great vessels, and a Vision Transformer realized automatic normal-abnormal classification. Segmentation and diagnostic metrics were calculated to compare readings from junior sonographers, AI alone and AI-assisted clinicians against expert gold standards.



$$\mathcal{L} = \alpha \cdot \mathcal{L}_{CE}(y_{gt}, y_{pred}) + \beta \cdot \mathcal{L}_{Dice}(y_{gt}, y_{pred}) + \gamma \cdot \mathcal{L}_{KD}(y_{logit}^T, y_{logit}^S)$$

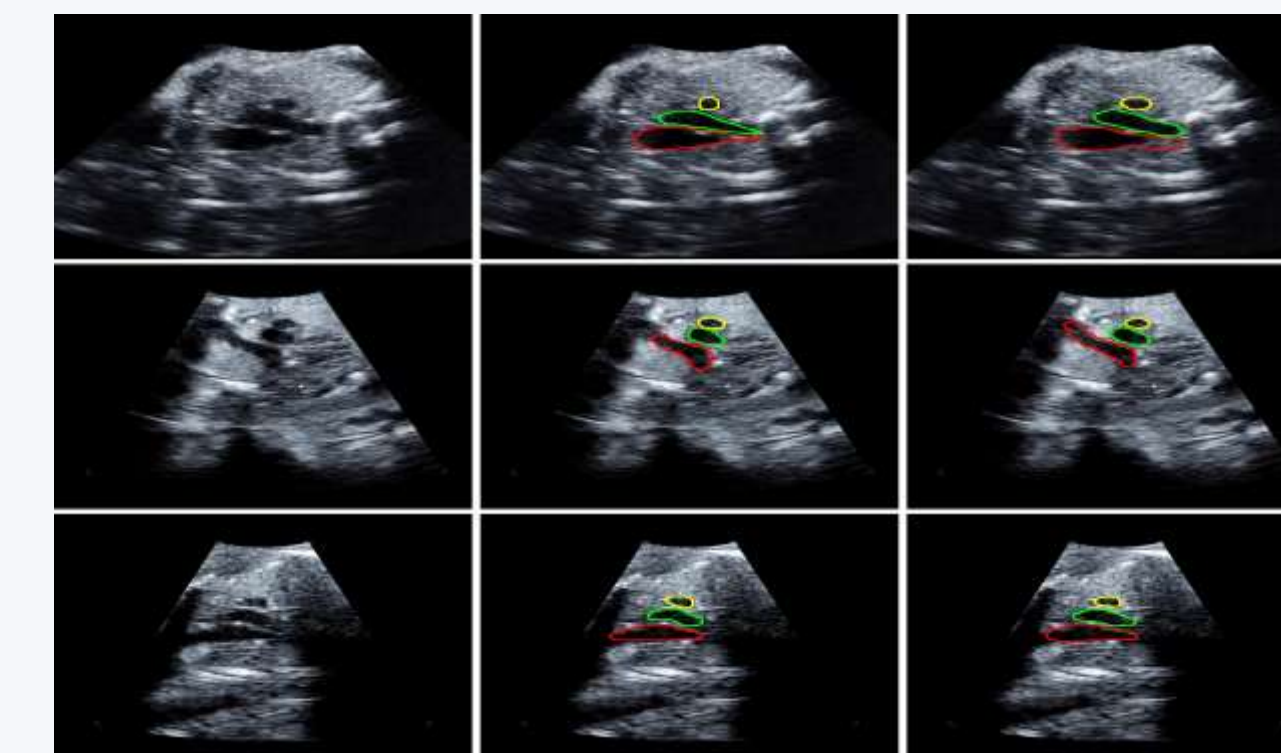


$$ConvAttention(X) = \frac{Q}{\sqrt{C}}(softmax(K)^T V) + \tilde{E}V$$

$$\tilde{E}V = Concat(Q^{img} \odot DepthwiseConv(P, V^{img}), 0)$$

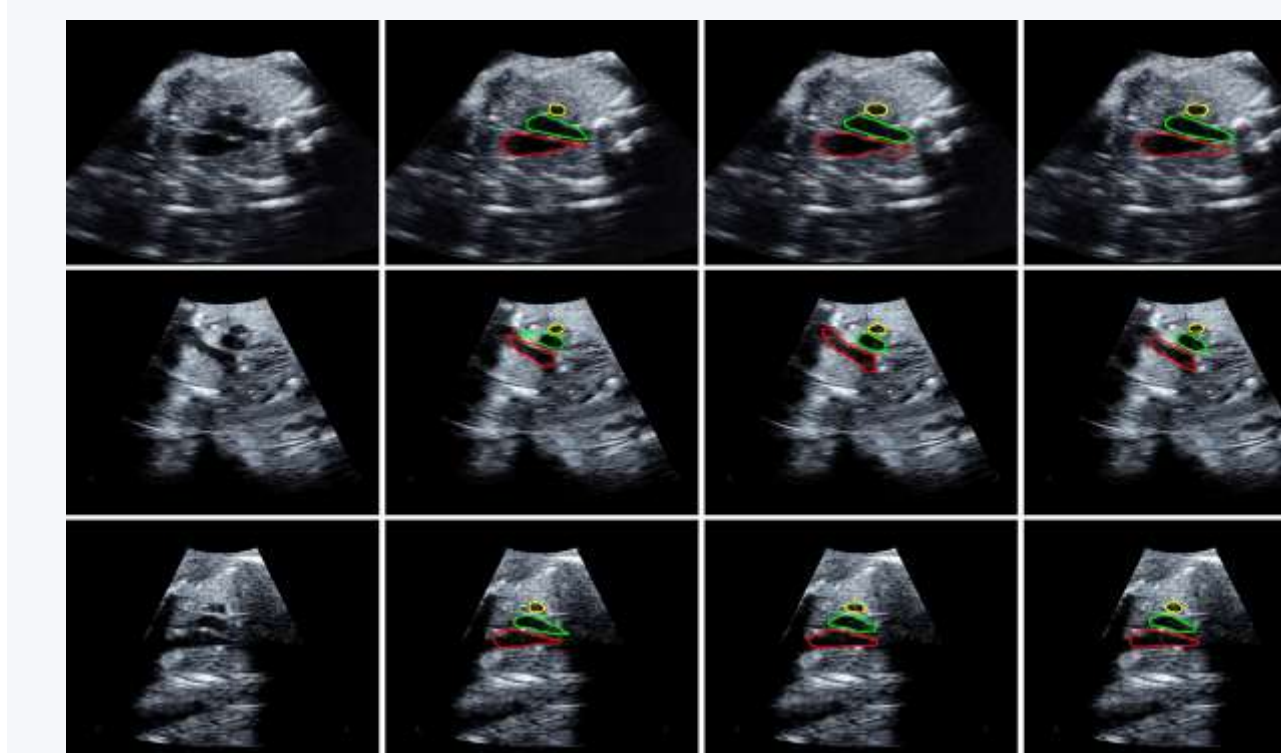
Results

AI Segmentation Performance



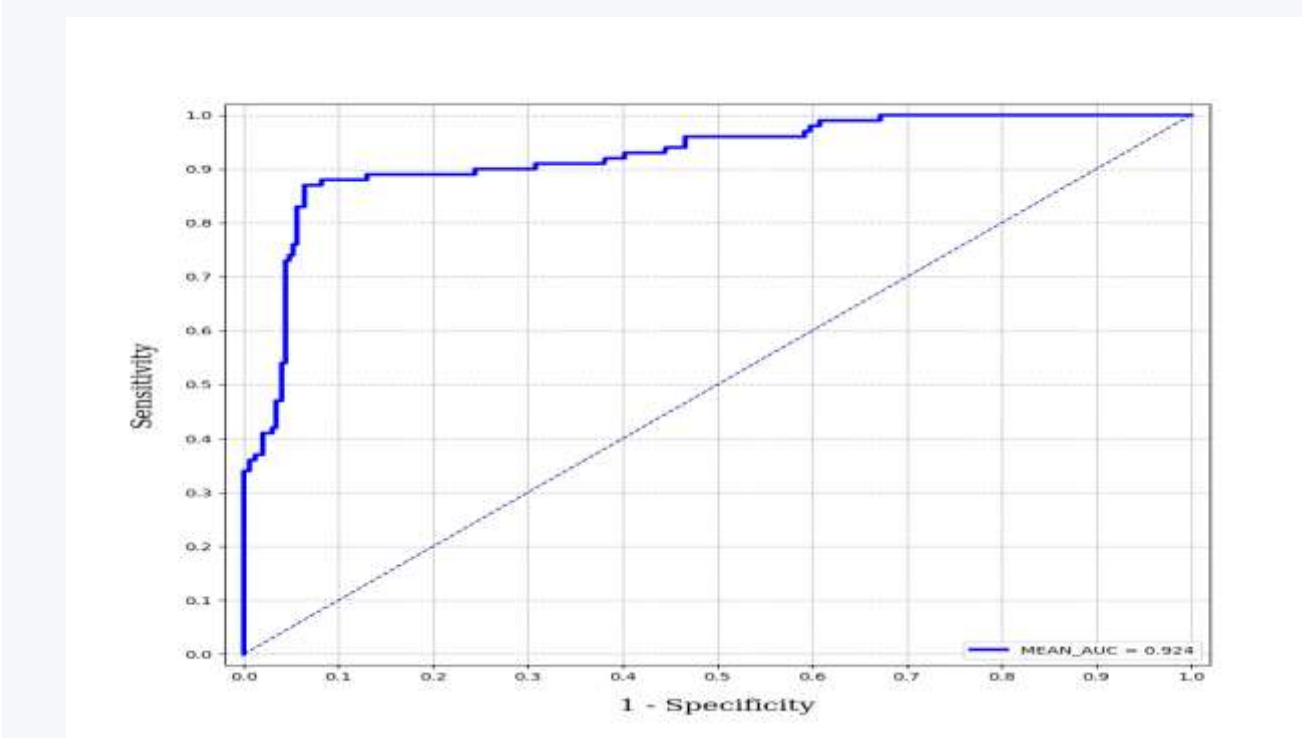
Accurately segmented key vessels with Dice coefficient of 81.3% and IoU of 68.6%, matching expert annotations.

AI Assistance Effect



Improved junior sonographers' accuracy from 94.1% to 97.5% (p<0.05) and segmentation Dice from 71.9% to 82.0% (p<0.01).

Model Diagnostic Performance



ViT classifier achieved AUC of 0.924, accuracy of 90.9%, sensitivity of 88.1%, and specificity of 94.7%.

Conclusion

Our AI pipeline delivers precise automatic segmentation for fetal cardiac 3VT view. It improves diagnostic accuracy of junior sonographers and achieves strong independent performance (AUC=0.924), with great potential to standardize prenatal CHD screening and lower dependence on clinician experience.