臺北科技大學暨北京工業大學
學術合作專題研究計畫成果發表

Research on Ophthalmic Image Fusion Analysis Technology for Auxiliary Diagnosis of Various Diseases

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Abstract:

We propose an anatomy-guided, multi-task framework for automated ROP (Retinopathy of Prematurity) analysis that enforces zone-consistent evaluation and integrates vessel-level characterization within a unified pipeline. The framework combines optic disc and macula detection for zone delineation, curvature-based tortuosity quantification (CVTI) for interpretable and continuous measurement of vascular abnormality with a zero-shot vascular severity score (VSS) for label-efficient categorical severity estimation. Experiments on multi-center datasets demonstrate that the proposed modules robust detection of clinically relevant features. Optic disc localization achieved mAP@50-95 of 0.889 (bbox) and 0.836 (mask). Artery-vein segmentation achieved IoU/Dice of 0.809/0.894 for arteries and 0.830/0.907 for veins. This study supports objective, reproducible ROP assessment and establishes a computational foundation for quantitative clinical decision support in screening and monitoring.

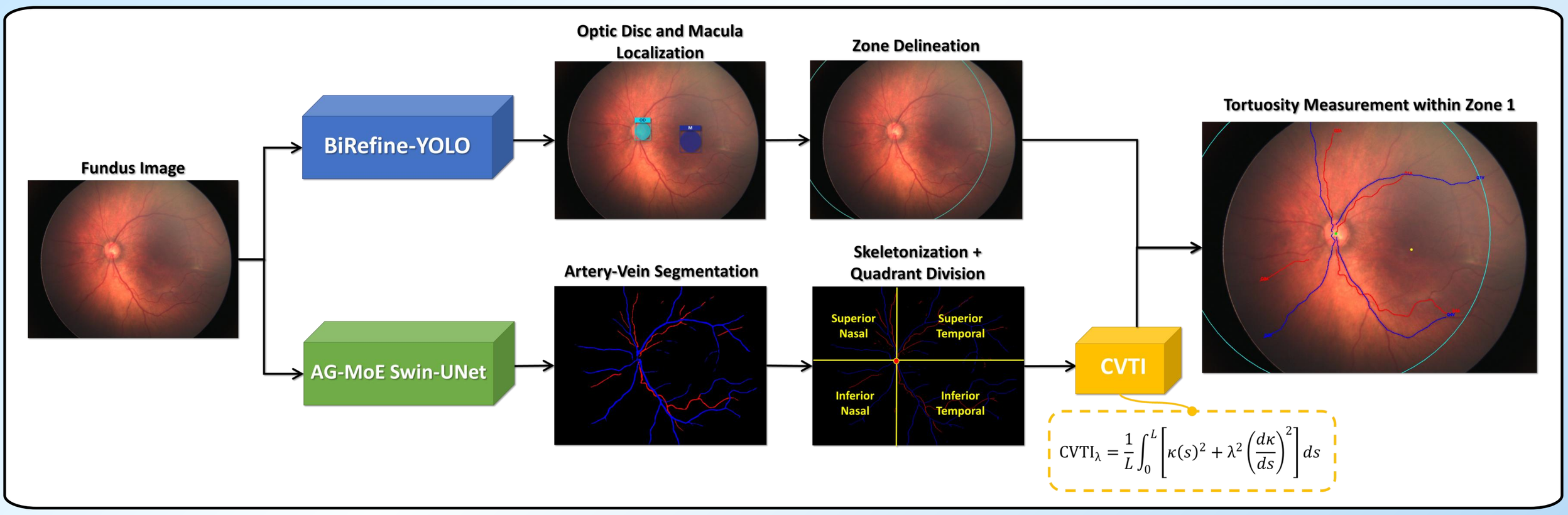

Fig. 1. Vessel tortuosity measurement pipeline for quantitative evaluation of ROP severity.

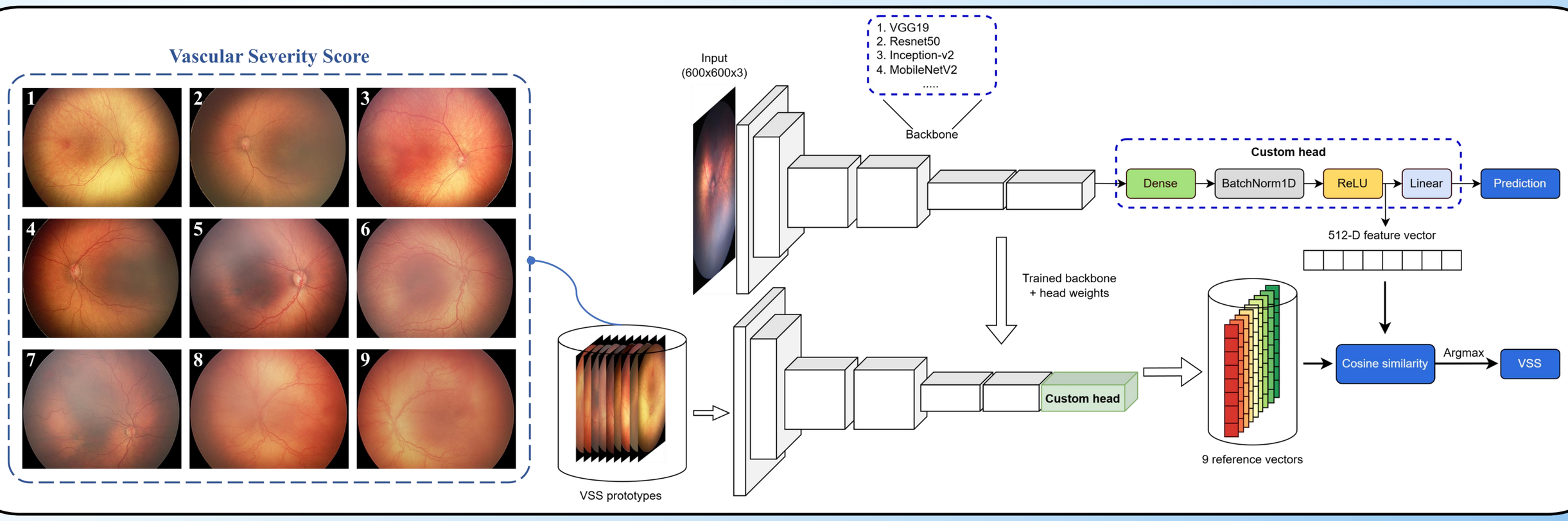

Fig. 2. Zero-shot VSS estimation framework as a complementary categorical evaluation of ROP severity.

Conclusion:

This study presents an automated ROP assessment framework that replaces subjective screening with objective and standardized evaluation. By combining quantitative CVTI analysis with label-efficient VSS estimation, the proposed framework enables reliable evaluation that is both clinically meaningful and scalable. Its strong performance across multi-center datasets demonstrates robustness under diverse conditions. This work establishes a step toward reliable and scalable ROP screening to reduce variability and support earlier intervention for at-risk infants.

Publications and Achievements:

- H. Peng, J. Li, W. Cheng, L. Zhao, Y. Guan, Z. Li, L. Li, X. Xu, and Y.-P. Huang, “Learn to learn: a mirror meta-learning method for retinal disease diagnosis on fundus images,” *IEEE Trans. on Artificial Intelligence*, pp.1-15, May 2025. DOI: 10.1109/TAI.2025.3566082.
- Y.-P. Huang*, R.A.F. Chaniago, W.-C. Wu, F.E. Sandnes, and J. Li, “An anatomically guided deep learning framework for quantitative vascular analysis in retinopathy of prematurity,” *IEEE Journal of Biomedical and Health Informatics*, Dec. 8, 2025. (under review)
- Best Paper Award, *Int. Conf. on Electronic Communications, Internet of Things and Big Data*, New Taipei City, Taiwan, Apr. 25-27, 2025.