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Ordinal Plus Disease Grading for Longitudinal Assessment in Retinopathy of Prematurity

Retinopathy of prematurity (ROP) is a retinal disease affecting preterm infants, particularly those with low gestational age (≤ 32 weeks) and low birth weight (≤ 1500 g), leading to visual impairment and permanent blindness when screening and treatment are not provided in time. Among the clinical signs used in ROP evaluation, plus disease is regarded as a major marker of retinal vascular abnormality severity and plays an important role in treatment decision-making. The Third International Classification of Retinopathy of Prematurity further emphasizes regression, reactivation, and the continuous spectrum of vascular abnormality from normal to plus disease, particularly in eyes undergoing laser photocoagulation or anti-vascular endothelial growth factor (anti-VEGF) injection, where longitudinal follow-up is essential before and after treatment. In established clinical grading, however, plus disease continues to be interpreted largely within the three-level annotation of normal, pre-plus, and plus. Although this ternary scheme remains clinically practical, it may not fully capture gradual vascular change, especially in borderline cases and during longitudinal assessment of treatment response. Recent advances in deep learning-based diagnostic tools have expanded the role of automated retinal image assessment in ophthalmology. Despite these developments, it remains challenging to build grading systems that preserve established clinical labels while also reflecting the ordered and continuous nature of vascular severity. This study aims to highlight a finer grading direction for plus disease in ROP by taking advantage of the strong feature representation capability of deep learning models and extending it into a multi-task learning setting. By jointly combining a categorical classification branch optimized with cross-entropy loss and an ordinal prediction branch guided by regression loss (MAE/MSE), the grading output can move beyond rigid class assignment toward a more continuous representation of disease severity. This method holds promise for enabling more clinically meaningful grading and more detailed follow-up of treatment response over time.

Keywords: ROP, fundus imaging, multitask learning, ordinal classification, plus disease

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Biography

Yo-Ping Huang (Fellow, IEEE) received the Ph.D. degree in electrical engineering from Texas Tech University, Lubbock, TX, USA. He is a Chair Professor in the Department of Electrical Engineering, National Taipei University of Technology, Taipei, Taiwan, where he served as the Secretary General. He also serves as the President of Chinese Automatic Control Society. He was the President of National Penghu University of Science and Technology, Penghu, Taiwan. He was a Professor and the Dean of Research and Development, the Dean of the College of Electrical Engineering and Computer Science, and the Department Chair with Tatung University, Taipei. His current research interests include deep learning modeling, intelligent control, machine learning, and AIoT systems design.

Dr. Huang received the FUTEX (Future Tech) Award and the Outstanding Research Award from the National Science and Technology Council, Taiwan. He is Fellows of IET, CACS, TFSA, and AAIA. He serves as the IEEE SMCS VP for Conferences and Meetings, and Chair of the IEEE SMCS Technical Committee on Intelligent Transportation Systems. He was the IEEE SMCS BoG, the President of the Taiwan Association of Systems Science and Engineering, the Chair of the IEEE SMCS Taipei Chapter, the Chair of the IEEE CIS Taipei Chapter, and the CEO of the Joint Commission of Technological and Vocational College Admission Committee, Taiwan.

Thanh Trung Do received the B.S. degree in robotics and artificial intelligence from Ho Chi Minh City University of Technology and Education, Ho Chi Minh City, Vietnam, in 2023, and is currently pursuing the M.S. degree in electrical engineering and computer science with the Department of Electrical Engineering, National Taipei University of Technology, Taipei, Taiwan. His current research focuses on medical image analysis, computer-aided diagnosis, and deep learning applications for ophthalmic diseases, with particular interest in retinal fundus image analysis for retinopathy of prematurity.