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High-Resolution Retinal Vascular Imaging and Analysis System

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PURPOSE: This study aims to develop and evaluate the High-Resolution Retinal Vascular Imaging and Analysis System (HRVIAS), an advanced diagnostic tool designed to improve the evaluation and monitoring of retinal vascular health.

METHODS: HRVIAS utilizes high-resolution retinal images (2048x2048 pixels) and incorporates deep learning models specifically trained for vascular feature segmentation. The system employs adaptive thresholding methods and fractal dimension analysis to enhance image clarity and provide quantitative measures of retinal vascular complexity. ROC analysis is used to determine cut-off values for fractal dimension assessments, and the system is designed for both high-performance computing systems and more modest specifications to ensure broad accessibility.

RESULTS: The HRVIAS demonstrated superior performance in segmenting and analyzing retinal vascular features compared to traditional methods. The adaptive thresholding technique provided significant improvements in the visibility of vascular structures, and fractal dimension analysis yielded precise quantifications of vascular complexity. ROC curve analysis indicated high diagnostic accuracy for various ocular diseases, including Age-related Macular Degeneration (AMD), Diabetic Retinopathy (DR), and Glaucoma.

CONCLUSION: The HRVIAS represents a significant advancement in ocular health diagnostics by leveraging cutting-edge technology to enhance diagnostic accuracy and early disease detection. Its ability to provide detailed risk assessments and improve the visibility of retinal structures makes it an invaluable tool for practitioners, ultimately leading to better patient outcomes.

Keywords: Retinal imaging, deep learning, vascular segmentation, adaptive thresholding, fractal dimension analysis.