

“Key to Diagnosis 2” Platform with the Function of Vector Analysis of Anatomical Structures and Pathological Objects in Fundus Images, and the 3D Images Construction Based on the use of AI

Maria Kovalevskaya MD

Professor, Head of the Department of Ophthalmology, Voronezh State Medical University Named After N.N. Burdenko, Russia

Oksana Evdokimova

PhD Student, Ophthalmologist, Voronezh State Medical University Named After N.N. Burdenko, Russia

Abstract:

Object: This study aimed to develop a method for assessing macular pathology parameters using stereophotogrammetry to improve diagnostics and treatment planning.

Material and Methods: The analysis included 16,000 pediatric retinal images (RetCamShuttle), 3D surgical stereo-recordings (NGENUITY), and 589 adult fundus images (Topcon TRS-NW200). Patients were grouped by pathology: diabetic retinopathy, age-related macular degeneration, retinopathy of prematurity, macular hole.

Result: A technology was developed to create a 3D photogrammetric model of the eyeball fragment using the Structure-from-Motion and Multi-View Stereo algorithms. The process included extracting and selecting the sharpest video frames, image preprocessing, and building a dense 3D model in Agisoft Metashape. For automated analysis, a U-Net neural network with a ResNet-50 encoder was trained on a dataset of over 20,000 image patches, achieving a segmentation accuracy of over 94.5% for structures like the optic disc and macular holes. The constructed 3D models (accuracy~0.025 mm) underwent vector analysis. The contours of pathologies were vectorized, and key metrics (perimeter, area) were calculated. Volume was precisely determined using Delaunay triangulation, automated via Python.

Conclusion: This technology allows for objective quantitative assessment of the shape, depth, area, and volume of retinal pathologies proving to be a valuable tool for planning surgical interventions.

Keywords:

Diabetic retinopathy, age-related macular degeneration, retinopathy of prematurity, macular hole, retina, 3D model, vector analysis, AI.