Automated Analysis of Retinal Images for Early Diabetes Detection

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Retrieving the right connections between blood vessels in retinal images at key junction points is fundamental for understanding the full retinal vasculature network. However, vessels near branching points might be tortuous, interrupted or have altered bifurcation angles due to disease progression, poor imaging conditions, and limit of the segmentation. Indeed, many quantitative image analysis approaches fail due to these conditions. In this paper/report we tackle these challenges. We propose a novel, robust and fully automatic method for retrieving these vessel connections. The main core of our solution is a five-dimensional connectivity kernel modelling the contextual connections in the primary visual cortex in lifted space of positions, orientations, curvatures and intensity. This kernel is used for creating an affinity matrix, which is further processed in a spectral clustering step. This method detects the challenging vessel connections perfectly [1].

It is shown that there is a close relation between the statistics of edge co-occurrence in natural images and the contour perception problem [5]. We studied the edge co-occurrences in retinal images, its relation to the fundamental solution of the Fokker-Planck equation and its application in vessel connectivity analysis [3]. The probabilistic model is trained from the data via statistics and its best approximation with the symmetrized extension of the probabilistic model on the projective line bundle is found with a least square error smaller than 2%. Apparently, the direction process on the projective line bundle is a good continuation model for vessels in retinal images.

We tested the methods in a clinical application. Several geometrical properties at junction points in retinal images are assumed to be informative in discriminating between healthy and diseased subjects. The main measured biomarkers include branching angles, vessel diameters, bifurcation index, asymmetry, diameter and area ratios, and junctional exponent. These features were measured in a recent project in collaboration with Maastricht hospital after detecting the junction points using the orientation score based junction detection approach [2]. Their association to the diabetes gradings were investigated afterwards. This project is a part of a larger feature analysis framework [4] and helps in establishing the diabetic retinopathy diagnosis system using these features.

References

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