Development of Computer-aided Diagnosis System for Fundus Images

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Abstract. The purpose of this study is to develop an automated method for detecting systemic hypertensive and glaucoma on fundus images. In Japan, ophthalmologists usually detect systemic hypertensive changes by identifying arteriolar narrowing and focal arteriolar narrowing, and they usually detect glaucoma by identifying cup-to-disc (C/D) ratio. The blood vessel candidates, the cup and the disk were detected by the density analysis method. Arteriolar narrowing and focal arteriolar narrowing was detected by measuring the diameter of an artery. To evaluate our method for detecting abnormal vessels, we examined 170 fundus images. Abnormal vessels were detected in 75% of the 24 arteriolar narrowing, and 76% of 72 focal arteriolar narrowing. By applying this method to 65 fundus images, the detection sensitivity for glaucoma was found to be 78% when the specificity was 75%. Such an automated detection of abnormalities could help ophthalmologists in diagnosing ocular diseases.

1 Introduction

The number of patients with adult diseases is currently on the increase in our country. To prevent or detect these diseases at an early stage, ophthalmologists rely on fundus images or direct ophthalmoscopy during total health examinations or mass screenings. The frequent use of this technique, however, may impose a heavy burden on ophthalmologists. Therefore, many research groups have made efforts in developing their own computer-aided diagnosis (CAD) systems based on fundus images. We have been developing a CAD system to detect the abnormalities on fundus images [1,2]. In Japan, ophthalmologists usually detect systemic hypertensive changes by identifying arteriolar narrowing and focal arteriolar narrowing, and they usually detect glaucoma by identifying cup-to-disc (C/D) ratio. The purpose of this study is to develop an automated method for detecting systemic hypertensive and glaucoma on fundus images.

2 Method

The scheme of detecting abnormal vessels consists of five-steps. At first, the blood vessel candidates were detected by the density analysis method. In the next step, blood vessels were tracked. The local detection function was used to determine the centerline of the blood vessel. A direction comparison function using three vectors was designed to provide an optimal estimation of the next possible location of a blood vessel. Next, the connectivity of vessel segments was adjusted based on the recognized intersections, the true tree-like structure of the retinal blood vessels was established. In the third step, the blood vessel's diameter was measured based on the distance between the vessel walls from the approximated line. In the forth step, the blood vessels were recognized whether arteries or veins by Hue of HSV color space and their diameters. Finally, the arteriolar narrowing was detected by the rate of diameters (artery-to-vein (A/V) ratio). The focal arteriolar narrowing was detected by change of artery's diameter.

The scheme of calculating C/D ratio consists of four-steps. At first, the candidate region with an optic disk was extracted. In the next step, optic disk was extracted by thresholding technique, and the approximate circle of optic disk was decided. In the third step, cup disk on the approximate circle was extracted, on and the approximate circle of cup disk was decided. In the final step, a C/D ratio was measured by using the diameter of optic disk and cup disk.

3 Results and Conclusion

By applying this method to 100 retinal images, the detection sensitivity for arteriolar narrowing was 76% when the specificity was 91%. Also by applying to 70 another different fundus images, the detection sensitivity for arteriolar narrowing with focal irregularity was 75% with 2.9 false positives per image. Furthermore, to evaluate our system for detecting the caliber different, we examined 65 fundus images including 18 abnormal images. For the existing system, the sensitivity was 78% and the specificity was 75%. In the future, the integrated analysis scheme will be further improved, and more clinical cases will be included in the study to evaluate its accuracy. The techniques employed in our system will help in improving diagnostic accuracy as well as in reducing the workload of ophthalmologists in the future.

References

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