Chapter 6

Conclusions

This chapter summarizes all research works in this dissertation. The key contributions are listed and some recommendations for future research are also discussed.

6.1 Research Summary

This thesis presented algorithms of automatic detection of optic disk from low-contrast fundus images of ROP Infant. All techniques are implemented in 3 GHz Pentium 4 machine. The first technique is based on Circular Hough Transform and Canny Edge Detection to detect the optic disk. The Circular Hough Transform histogram is reduced from 3D to 2D then in the calculation process, a value in particular point in Hough space is accumulated. After that, it was thresholded to leave only points with high probability of being the centers. The OD position was considered correctly detected if the pixels in the detected image present in the clinician's hand-drawn ground truth. In the finally, we find the best circle to fit the optic disk. The accuracy result of this method is achieved 81.7% from a data set of fifty infant fundus images. The time consuming for 2D Circular Hough Transform technique is 12 seconds for each image. The second method is achieved using PCA and deformable contour model with gradient vector flow as an external force. The first snake is placed at a location very close to the center of the optic disk approximated by PCA based model. The accuracy result is quite successful with 85.34% from a data set of fifty infant fundus images and the rate of convergence for each image is 10 seconds. One visible advantage of this method is that the optic disks are detected even though the boundary of the optic disk is not continuous or blurred. The last method, we use mathematical morphology to detect the optic disk. This method is based on mathematical morphology. We use many techniques to detect the region of optic disk, Histogram equalization and average filtering techniques were used to enhance Red band of the original low-contrast retinal image. The blood vessel was eliminated from the retinal image using the morphology closing. Optic disk localization is then achieved using optimized mathematical morphology and connected labeling. The result of thirty infant's retinal images with ROP condition and thirty images from diabetic retinopathy patients were validated with experts' hand-drawn ground truth. The result is quite successful with the accuracy of 99.9 % for retinal images with ROP and 99.7% for diabetic retinopathy retinal images. The time consuming in morphology technique is 15 seconds for each image. This method is able to identify correct position of all optic disk in ROP Infant as well as in adult's retinal image with diabetic retinopathy. Visible advantages of this algorithm are that it works pretty well on low-contrast retinal image with ROP with fast computation and quite reliable. This algorithm could facilitate clinicians to analyze the area surrounding the optic nerve. For the verification results were compared and validated with experts' hand-drawn ground truth.

In all three algorithms, they work pretty well in low-contrast retinal image with ROP. All three prototypes have been implemented in MATLAB 7.0.4(R14) on a 3.00 GHz PC under Windows XP.

6.2 Key Contributions of the Research

1. To find an efficiency algorithm to detect the optic disk in ROP Infant retinal image
2. Implement an automatic program to detect the optic disk in ROP Infant
3. To help the clinician to diagnose the ROP in the earlier stage that can prevent the infant blindness
4. To protect Thai infant from blindness with ROP

6.3 Future Study

As the future study of detection of optic disk in ROP Infant, we try develop this demo in the package of application software because all of algorithms were implemented in MATLAB. That is not convenient for clinician to handle, if we develop in application software which easy to use, it will be the efficiency tool for medical doctor to diagnosis the ROP disease in the rural area in Thailand.