CHAPTER 5

Conclusion

In this thesis, methods for an automatic eye gaze tracking system by using three-dimensional eye model with a single camera were proposed. The three-dimensional eye was modeled by using information of the distance between the participant's head and the screen. Then, the 3-D eye model was used to compute the visual eye angle. Near-infrared light sources were attached on the screen frame and used for illuminating the participant's cornea. The eye gaze displacements were then computed by using information of the eye model in order to map the point of the gaze on the screen position. The eye gaze distance estimation was derived by using a single camera. Three novel methods for eye gaze distance estimation were proposed: by using the principle of the summation of gray-level intensity of image patch; using the principle of the eigenvalues; and using the principle of the iris area.

The proposed methods were verified by testing with 51 volunteers under 3 different conditions of head positions: the participant's head was placed in the middle of the screen; the participant's head was tilted to the right of the screen; and the participant's head was tilted to the left of the screen. The results for eye gaze distance estimation showed that the method of using the principle of the iris area achieved 97.43% accuracy. The performance of the proposed method was tested by using the principle of gray-level intensity of image patches and using the principle of the iris area for eye gaze distance estimation. The results of eye gaze on the screen estimation when the participant's head was placed in the center direction of the screen showed that the principle of iris area is preferable to the principle of gray-level intensity of image patch. The former approach yielded a better value of *RMSE*, which is 2.44 cm *RMSE*, while the latter approach yielded 2.55 cm *RMSE*.

Under conditions of the participant's head movements, the results of eye gaze tracking on the screen estimation using the principle of iris area showed the *RMSE* values, which are 2.50 and 2.53 cm, when the head was tilted to the right and left of the screen.

The efficiency of the proposed method was also verified by using the confidence interval computation. For the case where the head was positioned in the middle of the screen, both methods (i.e. the principle of iris area and the principle of gray-level intensity of image patch) provided the same confidence interval values. For the case of the participant's head movements, the results obtained by using the iris area are more accurate than those obtained by using the gray-level intensity. The proposed method showed that an automatic eye gaze tracking which uses three-dimensional eye model system can be designed with a single camera and can operated with the participant's head movements.

For further development, an improved method requiring less computing time is another challenging problem. Moreover, in order to improve the accuracy of the eye gaze tracking system, a screen larger than 17 inches can also be selected.