Abstract

Glaucoma is an irreversible ocular pathology, which causes permanent blindness if it is not treated properly. Despite the various technological advances, the reliability of glaucoma tests to diagnose the condition of its progression is remaining unacceptable. Physiologically, glaucoma progression is diagnosed by increased excavation of the optic cup. The objective of the proposed system is to develop a computer aided diagnosis system for early detection of glaucoma using fundus images. In this research work, Local Binary Pattern (LBP) and three unsupervised segmentation approaches; *k*-means clustering, Fuzzy C Means (FCM) clustering and Expectation-Maximization (EM) algorithm based glaucoma detection is proposed through the accurate measurement of Cup-to-Disc Ratio (CDR). It is composed of two main modules; Optic Disc (OD) segmentation and Optic Cup (OC) segmentation.

LBP is a non parametric operator which describes the local spatial structure of an image. This property is utilized for the segmentation of OD region in the given fundus image. It is built by various sequential stages: Region Of Interest (ROI) extraction, OD localization, post processing and OD boundary by elliptical fitting. In the ROI extraction, the approximate OD region is extracted as ROI for further process based on the maximum pixel intensity value. The major intension of ROI extraction is to reduce the computational time as the fundus images are in very high resolution. Then, LBP feature map is created from the ROI image for OD localization. Finally, the appropriate OD region is segmented by performing further sequential operations such as post processing and elliptical fitting. For OC segmentation, three unsupervised segmentation approaches; *k*-means clustering, FCM, and EM algorithm are used.
The performance of the proposed glaucoma detection system is evaluated by using fundus images of normal and glaucomatous images. The automated measurement of CDR provides reliable glaucoma prognosis by performing improved OD and OC segmentation approaches. In this work, CDR is computed from the area of the segmented OD region by LBP and the area of the OC region by the unsupervised segmentation approaches. The quantitative evaluation of the proposed system is performed using the computed CDR with the gold standard CDR. Also, the performance of the system is evaluated using scatter plot and regression analysis. The results show that the proposed glaucoma detection system LBP and EM achieves satisfactory performance with absolute error of below 4%.

*Key words:* Glaucoma detection, Local binary pattern, k-means clustering, Fuzzy C Means clustering and EM algorithm