

Chapter 3

A Hybrid Genetic Algorithm based Fuzzy Approach for Abnormal Retinal Image Classification

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ABSTRACT

Fuzzy approaches are one of the widely used artificial intelligence techniques in the field of ophthalmology. These techniques are used for classifying the abnormal retinal images into different categories that assist in treatment planning. The main characteristic feature that makes the fuzzy techniques highly popular is their accuracy. But, the accuracy of these fuzzy logic techniques depends on the expertise knowledge, which indirectly relies on the input samples. Insignificant input samples may reduce the accuracy that further reduces the efficiency of the fuzzy technique. In this work, the application of Genetic Algorithm (GA) for optimizing the input samples is explored in the context of abnormal retinal image classification. Abnormal retinal images from four different classes are used in this work and a comprehensive feature set is extracted from these images as classification is performed with the fuzzy classifier and also with the GA optimized fuzzy classifier. Experimental results suggest highly accurate results for the GA based classifier than the conventional fuzzy classifier.

INTRODUCTION

Abnormal retinal image classification system is highly essential in the field of ophthalmology. Classification is a type of pattern recognition system which categorizes the different types of diseases. The effects of the eye abnormalities are mostly gradual in nature which shows the necessity for an accurate abnormality identification system. Most of the ophthalmologists depend on the visual interpretation for the identification of the types of diseases. But, inaccurate diagnosis will change the course of treatment planning which leads to fatal results. Hence, there is a requirement for a bias free automated system which yields highly accurate results. Besides being accurate, the system should be effective in terms of convergence rate which is highly essential for real time applications.

Automating the classification process is a challenging task. Besides being automated, the technique should be accurate and robust. Several computer assisted methods have been proposed for the classification and quantification of brain tumors. Vector fields based pathology identification in retinal images is available in the literature (Benson, 2008). But this technique yields superior results only if the abnormality is highly visible. Contrast enhancement based abnormality detection in retinal images has been implemented (Alan et al., 2006). The drawback of this system is the over estimation of the contrast in the image. Literature survey also reveals the application of wavelet transform for abnormality detection in retinal images (Quellec et al., 2008). The availability of other superior transforms shows the scope for improvement of this technique. Image processing based techniques are also used for retinal exudates detection (Osareh et al., 2003). Diabetic retinopathy detection is also successfully implemented using machine learning techniques (Niemeijer et al., 2007). Though these techniques are highly impressive, they fail to incorporate the intelligence techniques which

have proved to be much better than the image processing techniques.

The intelligence techniques form the subset of cognitive informatics which is the emerging trend in the area of engineering. The theoretical framework of cognitive informatics is proposed by (Wang, 2007). The concept of intelligence techniques is analyzed in detail in this report. The difference between the natural intelligence techniques and the artificial intelligence techniques is explained with the mathematical theorems. The foundation of autonomic computing is also explained by (Wang, 2007). Autonomic computing is the branch of artificial intelligence techniques which mainly deals with automation. The work proposed in this paper is also an automated system and hence it is closely related to cognitive informatics. The recent advances in the area of cognitive informatics is demonstrated by (Wang, 2007; Kisner, 2007). These artificial intelligence techniques which comprise the concepts of cognitive informatics can be used for various applications including the medical field. In this work, the application of intelligence techniques for eye disease identification is explored.

Artificial intelligence techniques generally yield highly accurate results and it includes neural networks, fuzzy theory, etc. Neural network based diabetic retinopathy identification system is reported in the literature (Yun, 2007). Exudate classification based on Support Vector Machine has been successfully implemented (Osareh, 2002). The application of perceptron neural network for retinal disease identification is explored (Treigys, 2007). Radial Basis Function neural networks based abnormality identification system is reported in the literature (Acharya, 2007). Multi layer neural networks are successfully used for keratoconus detection in retinal images (Accardo, 2003). Fuzzy logic techniques based disease identification techniques are also proposed in the literature (Sopharak, 2007). These artificial intelligence based techniques are highly efficient in terms of accuracy. But,

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