CHAPTER 6

CONCLUSION AND FUTURE SCOPE OF THE WORK

6.1 CONCLUSION

A Computer Aided Decision Support System has been developed and implemented using different types of feature extraction techniques and Artificial Neural Network (ANN) for analyzing and classifying Retinal images. The Acquired image that has been pre-processed using Gabor filter and Adaptive Histogram Equalization is used for denoising and image enhancement of the retinal image. Gabor filter provides better noise reduction and edge detection of original image and visual observation of retinal images. The region of interest has been identified from the preprocessed output. RGB based technique has been used for segmentation.

The multiple features have been extracted from the retinal images. The classification has been obtained using the following techniques: Morphological operations, Binarization, Skeletonization, Thinning and SVM. The computer aided diagnostic system to classify the retinal images using SVM has been developed and validated with various samples and experts. It is concluded from the analysis that the multiple features and the selection of the SVM classifier enhances the classification of retinal image as normal or abnormal. The study reveals that out of various ANN classifiers the computational complexity of SVM does not depend on the dimensionality of the input space. It gives better classification rate of false acceptance rate, false rejection rate and accuracy. The percentage of False Acceptance Rate and False Rejection Rate of the SVM classifier is found less than other classifiers. The accuracy of the proposed system has been verified and found to be
The proposed system can be used as secondary observer in clinical decision making.

In this present work, after classification the grading has been obtained to develop the decision support system for abnormal retinal images. The proposed method is capable of detecting the bright lesions sharply with an average sensitivity and specificity of the tested samples being 96.61% and 98.31% respectively. The mean accuracy value for tested images is 98.18%. Also for detecting the dark lesions sharply, an average sensitivity and specificity of the tested samples are 88.54% and 98.22% respectively. The mean accuracy value for tested images is 97.51%.

The experimental result shows that the proposed method yields better sensitivity, specificity, accuracy and predictive values compared to other methods. The grading results obtained by the proposed method are also comparable to those obtained by other methods. The major strengths of the proposed system are accurate feature extractions and accurate grading of non-proliferative DR lesions. Further if the input image is classified as abnormal, then the image is graded as Mild NPDR, Moderate NPDR, Severe NPDR, Very severe NPDR and Prolific DR.

The objective of implementing the CAD system has been achieved using image, denoising, enhancement, segmentation, and feature extraction and decision making. The implementation would help the clinical experts in classification and decision making of retinal images in an early stage, so that the health care will become more reliable and improved. It is concluded that the soft computing techniques enhance the interpretation for better decision making. When compared with the ophthalmologist, the network has achieved good accuracy for the detection of DR. The proposed criteria for computer classification produced results that are comparable with those provided by
human experts. With additional research, this computer aided diagnosis system could become a useful clinical aid to physicians and a tool for screening, diagnosing, and classifying NPDR. The Support Vector Machine (SVM) is a widely used classifier in bioinformatics due to its high accuracy. Machines not successful in learning and generalization task, with many problems being impossible to solve. SVMs are very effective in a wide range of bioinformatics problems. FAR & FRR value of SVM classifier is relatively lower than other classifiers. Hence SVM is one of the better classifier for classifying the bioinformatics.

6.2 FUTURE SCOPE

In addition to 17 features considered in the present work, more features may be evaluated using various other feature extraction techniques to further improve the classification accuracy. Various Neural Network models may be incorporated to select the best Neural Network. Combined classifier scheme may be implemented for identifying DR. As a future work, with more database images Proliferative DR can be further classified. The classification of PDR is shown below.

**High-Risk Proliferative Retinopathy**

Mild NVD with Haemorrhage (vitreous)

Severe NVD without Haemorrhage

Severe NVD with Haemorrhage

Severe NVE with Haemorrhage

**Non High-Risk Proliferative Retinopathy**

Other than high risk condition
The performance of dark lesions may be improved further by applying different techniques.