#Sustainable Medical Technologies (SMT)

Early Diagnosis of Retinal Diseases

Monika Aggarwal*, Ambika Sharma, Kamini Upadhyay

Abstract

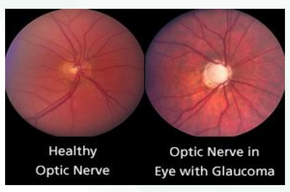
Eye diseases which progress silently in eyes and cause irreversible blindness are major concern issues nowadays, e.g. Glaucoma and Diabetic Retinopathy (DR). These diseases, if detected at an early stage, can be cured. Our work deals with early detection of these eye diseases using techniques of image processing and machine learning on fundus images of eye.

Introduction

- WHO approximates that 42 million people are currently blind in the world, 80% of which could have been cured by early detection [1]
- The number of patients per ophthalmologist is around 2-3 lakhs in India. Apart from the lack of manpower, cost and time pose a major challenge in such scenarios [2].
- The topmost causes of blindness are, Cataract (47.8%), Glaucoma (12.3%), AMD (8.7%) , Diabetic Retinopathy(4.8%)
- Fundus camera captures the 2-D image of back of eye and by analyzing its features such as optic disc, cup and blood vessels various diseases can be diagnosed.
- We have detected these features using image processing and machine learning algorithms.

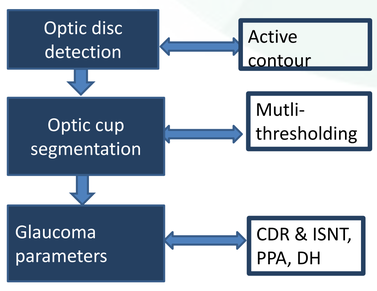
Materials and Methods

For OD detection the blood vessel convergence property along with brightest circular region feature has been used In order to increase the robust-ness, exhaustive set of features has been constructed.



Clinical Features extracted for diagnosis are:

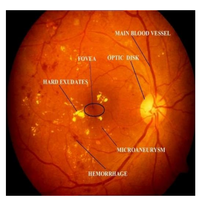
1. Cup-to-disc ratio(CDR) ,
2. ISNT from disc and cup Segmentation
3. Parapapillary atrophy (PPA) classification using Resnet based architecture.
4. Disc Hemorrhage

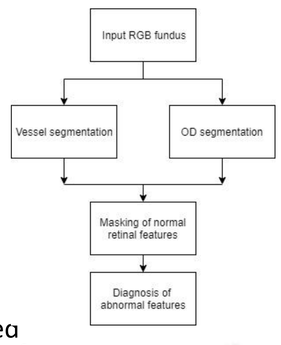


At last, a model has been trained to classify images into healthy and glaucoma.

Symptoms of DR are features like:

1. Micro-aneurysms (MA's),
2. Bright lesions (Hard and Soft Exudates),
3. Haemorrhages,
4. Abnormal growth of retinal blood vessels.

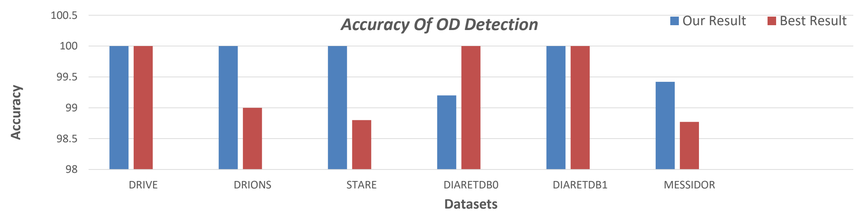


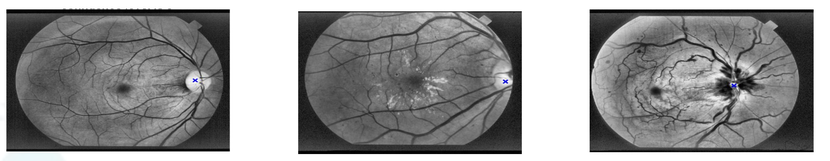


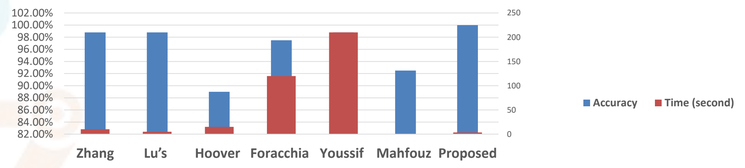
Our approach is to mask out the normal retinal features (blood vessels and OD) to focus on the abnormalities of retina.

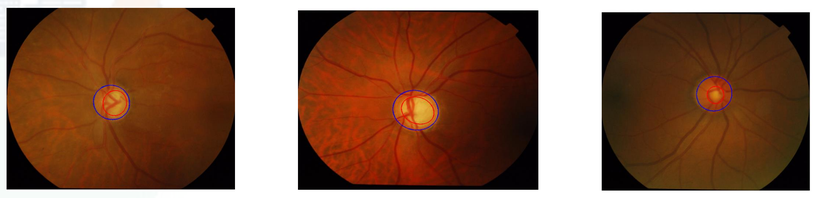
In our work, for vessel segmentation, till now, we have used rule based image processing techniques and have achieved an average accuracy of 95.33% on four different types of datasets. Now, we are trying to improve the segmentation of fine vessel ends by using machine and deep learning techniques. Segmentation of bright lesions is another ongoing work.

Results





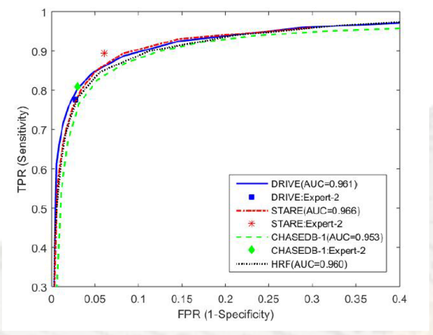




OPTIC DISC		OPTIC CUP		
DICE	BLE	DICE	BLE	CDR Error
0.94±0.03	10.63±5.82	0.724±0.16	33.87±22.11	0.24±0.20

- PPA detection accuracy on 114 (AIIMS dataset) + 165 (public images) : 89.2%

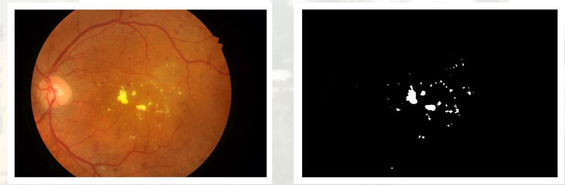
Result of retinal blood vessel segmentation on a '01_test.tif' image of DRIVE database.



Comparison of mean ROC curves of proposed algorithm on different datasets.

Performance of proposed algorithm on four different datasets

S.No.	Dataset	Acc	Sen	Spe	AUC
1	DRIVE	0.9554	0.7994	0.9705	0.9614
2	STARE	0.9420	0.7480	0.9710	0.9596
3	CHASE_DB1	0.9569	0.7679	0.9702	0.9659
4	HRF	0.9588	0.7820	0.9777	0.9670
	Average Performance	**0.9533**	**0.7743**	**0.9723**	**0.9635**



Segmentation results of bright lesions (Exudates)

Conclusions

- There is an urgent need of early detection of eye diseases as they can cause irreversible damage to eyes.
- Use of machine learning algorithms can ease out the diagnostics.
- Our algorithms can do primary shortlisting of glaucoma and DR patients, at an early stage.
- Ophthalmologists will not be needed to use this system, other persons can be trained to use it.

Industrial Significance

- Our algorithm can be made a complete product by collaborating with a camera making company.
- For isolated communities, this work can be a preliminary step for diagnosing eye diseases, thus reducing the load of ophthalmologists.
- Isolated rural areas can be provided affordable healthcare.

References

- "Vision 2020: The Right to Sight," IABP, Global-facts Retrived from http: //www.iapb.org/vision-2020/what-is-avoidable-blindness/glaucoma."
- J. Sivaswamy, S. R. Krishnadas, G. D. Joshi, M. J. Ujjwal, and S. Tabish, "Drishti-GS: Retinal image dataset for optic nerve head(ONH) segmentation," 2014 IEEE 11th Int. Symp. Biomed. Imaging, pp. 53–56, 2014.
- Roychowdhury, S., Koozekanani, D.D. and Parhi, K.K., et al.: 'Iterative vessel segmentation of fundus images', IEEE Trans. Biomed. Eng., 2015, 62, (7), pp. 1738-1749
- Orlando, J.I., Prokofyeva, E. and Blaschko, M.B., et al.: 'A discriminatively trained fully connected conditional random fieldmodel for blood vessel segmentation in fundus images', IEEE Trans. Biomed. Eng., 2017, 64, (1), pp. 16-27.

Acknowledgement

- Public databases - DRIVE, STARE, CHASE_DB-1, HRF, DRISHTI.
- AIIMS.

CARE & BSTTM IIT D