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A Novel Dataset 'Aravind' for Retinal Image Analysis

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ABSTRACT

Introduction: Diabetes is a disorder or a metabolic disease that increases the level of sugar in the blood. Untreated diabetes can cause serious issues to the eye. There are quite a several research works carried out in retina image analysis. For retinal image analysis, there are multifarious datasets available freely for research.

Aim: The objective of the article is to introduce a new dataset namely 'ARAVIND' for retina image analysis for research purposes.

Method: This dataset incorporates 98 images altogether which helps in pinpointing different types of eye defects like haemorrhages, microaneurysms, hard and soft exudates.

Conclusion: The 'ARAVIND' dataset is freely available online that can be used by computer researchers in the field of medical image analysis which bridges the gap between the field of technology and science to a greater extent.

Key Words: Dataset, Exudates, Hemorrhages, Micro aneurysm and Retina

INTRODUCTION

Diabetes leads to various metabolic disorders and physiological abnormalities in the body¹. The rapid growth of diabetes is a key indicator for the prevalence of various microvascular complications². The number of people with diabetes is increasing year by year. Diabetes is increasing more in well-developed countries like the United States than in developing countries. Following the International Diabetes Federation (IDF), the threatening fact about diabetes is that 51% of the world population will likely have diabetes by the year 2045³. The overriding reason for the cause of diabetes is the insalubrious lifestyle. Early detection and proper treatment of diabetes is a life-saving measure. The cost of treatment for diabetes varies from country to country. The consequences of diabetes may cause damage to the indispensable organs like the heart, retina etc.

Prolonged diabetes may affect the retina to a greater extent. Fundus/clinical images of the retina play a vital role after the diagnosis of diabetes. A proper eye examination is mandatory for patients with diabetes. Retinal abnormalities can lead to serious vascular diseases which do not show the ear-

lier symptoms to the patients. In such cases, a high - quality fundus images provide finer details about the retina. The high-quality images help in detecting the abnormalities accurately.

Various datasets for retinal image analysis are available online which can be freely downloaded for detecting the defects in the human eye. Different algorithms were applied by the researchers or by the team of experts to extract the basic and finer details of the retina for the accurate identification of the abnormalities. The accuracy or efficiency of a code depends not only on the algorithm but also on the quality of the image. Hence, high-quality images are imperative for the researchers to prove their contribution to their research.

Diabetic Retinopathy

Diabetes is a metabolic disorder that heightens the level of sugar in the blood. The retina can be affected badly in persons who suffer from diabetes for a quite long period. This may lead to a disease called Diabetic Retinopathy (DR). This particular disease can be treated at the earlier stage whereas, in the advanced stage it might lead to blind-

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ness⁴. There are four different stages of diabetic retinopathy ranging from mild, moderate, severe non-proliferative to proliferative⁵. In the severe stage of this disease, the blood vessels get a leak and thereby leading to blindness. When a person is affected by this disease, ophthalmologists check for the presence of microaneurysms, haemorrhages, hard exudates and soft exudates. Fundus images are those images that are acquired using a high-quality camera in analyzing the retina. This fundus image vividly projects all the components of an eye. For the diagnosis of different retinal defects, fundus images are used. Accurate screening is necessary to identify other abnormalities in diabetic retinopathy patients. Figure 1 represents the internal structure of the human eye.

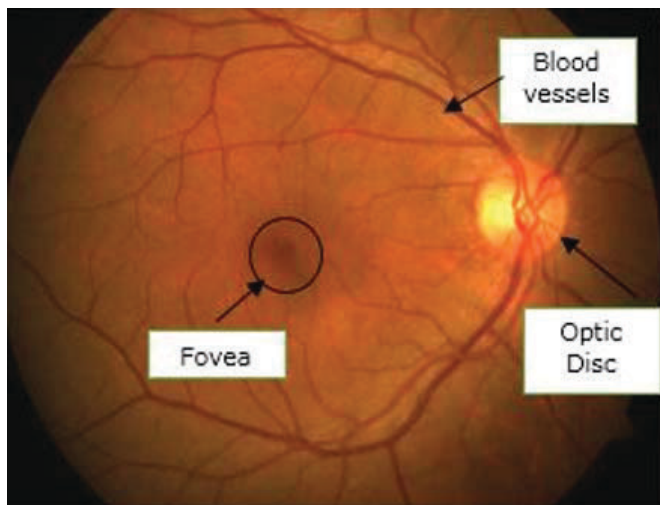


Figure 1: Internal Structure of Human eye

Retinal blood vessels comprise arteries and veins. Arteries of blood vessels bifurcate into branches of vessels. Retinal blood vessels are capable of carrying oxygen to different parts of the eye. The abnormalities of the retina that seems to appear in diabetic patients are elucidated in the following sections.

Micro Aneurysm

Micro aneurysms are the tiny blood spots in the capillaries of blood vessels of the retina. The presence of microaneurysm indicates the earlier stage of diabetic retinopathy in diabetic patients⁶. These abnormalities are always seen as groups or clusters. Sometimes it may occur in isolation also. The presence of microaneurysm can be identified by an eye dilation followed by screening, using fundus images. Figure 2 represents the retina image with microaneurysm which appears as white spots in the fundus images.

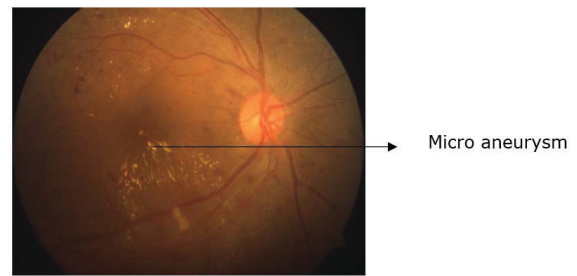


Figure 2: Retina infected with microaneurysm (MA_07).

Hemorrhages

Haemorrhages are serious disorder that causes bleeding in the retina. In the advanced stage of diabetic retinopathy, haemorrhages might transpire which lead to the growth of abnormal new blood vessels. The new abnormal blood vessels may leak and the blood may occupy the central portion of the retina. Excessive blood leakage may cause retinal detachment which leads to the loss of vision. Figure 3 shows a retina image with a haemorrhage or leakage of blood.

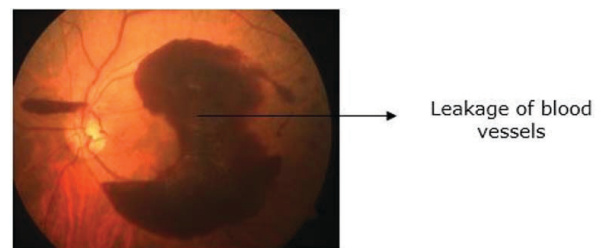


Figure 3: Retina infected with haemorrhage (HM_05).

Hard and Soft Exudates

Hard exudates are lipids in the pale yellowish colour that leaks from the capillaries of abnormal retinal blood vessels. This condition is referred to as chronic leakage in diabetic retinopathy patients⁷. Soft exudates are otherwise called cotton wool spots which appear as a whitish fluffy fibre layer in the abnormal vessels of the retina.⁸ The presence of hard and soft exudates is more common in Diabetic Retinopathy patients. Figure 4 (a) and (b) represents retina with hard exudates and soft exudates respectively.

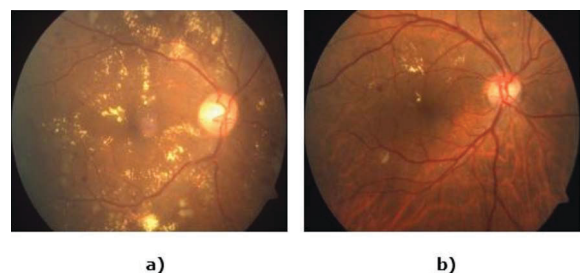


Figure 4: Retina with a) Hard exudates (HE_01), b) Soft exudates (SE_14).

ABOUT THE HOSPITAL

Aravind eye hospital⁹ is the renowned hospital established in the year 1976 in Madurai, Tamil Nadu, India. This hospital works as a network of hospitals in various districts in the state of Tamil Nadu. This hospital has performed phenomenal work in treating millions of people with eye defects including surgeries. Aravind eye hospital also does outreach programs in remote villages by conducting free eye camps.

Privacy Policy

For some security and privacy reasons, the information about the patient's details is not divulged anywhere. All images in the dataset are compressed lossless and are stored in a repository in Github¹⁰.

DATA SET

The images in this dataset are procured from a famous hospital in Tirunelveli city, South Tamil Nadu, India. The screening is done on patients between the ages of 30 and 70. This data set is divided into 5 different categories like (i) hard exudates, (ii) soft exudates, (iii) haemorrhages, (iv) microaneurysms and (v) retina with no defect. Each category comprises raw images obtained using the fundus camera. All the images are of high quality which includes colour images and few grayscale images. These images were acquired using an FF450 plus fundus camera with a 50° field of view. The field of view of every image is circular. Each image is compressed in the format of JPEG. This dataset can be used for identifying different retinal diseases like hard, soft exudates, haemorrhages and detecting microaneurysms in diabetic patients. All the images in this dataset are used for clinical diagnosis. These images can be used alone as a standalone image or they can be used with the combination of other retinal images for comparative study. These images in this dataset can be used for testing image processing techniques such as enhancement, segmentation, etc. The number of images in each category is as follows: Table 1 recapitulates the categories of images in the dataset.

Table 1: Categories of images in the dataset.

Category	Number of Images
Micro aneurysms	24
Haemorrhages	20
Hard exudates	28
Soft exudates	16
Normal fundus images	10

The description of the images is given in Table 2, including the name and size of the images in each category.

Table 2: Details of the images in the dataset

Category	File Name	Dimension of the Image (in pixels)
Micro aneurysms	MA_01.jpg	2588 x 1958
	MA_02.jpg	1388 x 1038
	MA_03.jpg	2588 x 1958
	MA_04.jpg	1388 x 1038
	MA_05.jpg	2588 x 1958
	MA_06.jpg	1388 x 1038
	MA_07.jpg	2588 x 1958
	MA_08.jpg	1388 x 1038
	MA_09.jpg	2588 x 1958
	MA_10.jpg	1388 x 1038
	MA_11.jpg	2588 x 1958
	MA_12.jpg	1388 x 1038
	MA_13.jpg	2588 x 1958
	MA_14.jpg	1388 x 1038
	MA_15.jpg	2588 x 1958
	MA_16.jpg	1388 x 1038
	MA_17.jpg	2588 x 1958
	MA_18.jpg	1388 x 1038
	MA_19.jpg	2588 x 1958
	MA_20.jpg	1388 x 1038
	MA_21.jpg	2588 x 1958
	MA_22.jpg	1388 x 1038
	MA_23.jpg	2588 x 1958
	MA_24.jpg	1388 x 1038
HM_01.jpg	2588 x 1958	
HM_02.jpg	2588 x 1958	
HM_03.jpg	2588 x 1958	
HM_04.jpg	2588 x 1958	

Table 2: (Continued)

Category	File Name	Dimension of the Image (in pixels)
Haemorrhages	HM_05. jpg	2588 x 1958
	HM_06. jpg	2584 x 2323
	HM_07. jpg	1138 x 870
	HM_08. jpg	3872 x 3355
	HM_09. jpg	2588 x 1958
	HM_10. jpg	2588 x 1958
	HM_11. jpg	2588 x 1958
	HM_12. jpg	2588 x 1958
	HM_13. jpg	2588 x 1958
	HM_14. jpg	3872 x 3613
	HM_15. jpg	2588 x 1958
	HM_16. jpg	2588 x 1958
	HM_17. jpg	2588 x 1958
	HM_18. jpg	2588 x 1958
	HM_19. jpg	2588 x 1958
	HM_20. jpg	2588 x 1958
	HE_01. jpg	2588 x 1958
	HE_02. jpg	2588 x 1958
	HE_03. jpg	2588 x 1958
	HE_04. jpg	2588 x 1958
HE_05. jpg	2588 x 1958	
HE_06. jpg	2588 x 1958	
HE_07. jpg	2588 x 1958	
HE_08. jpg	2588 x 1958	
HE_09. jpg	2588 x 1958	
HE_10. jpg	2588 x 1958	
HE_11. jpg	2588 x 1958	
HE_12. jpg	2588 x 1958	
HE_13. jpg	2588 x 1958	
Hard Exudates	HE_14. jpg	2588 x 1958
	HE_15. jpg	2588 x 1958
	HE_16. jpg	2588 x 1958
	HE_17. jpg	2588 x 1958
	HE_18. jpg	2588 x 1958
	HE_19. jpg	4249 x 4000
	HE_20. jpg	2588 x 1958
	HE_21. jpg	2588 x 1958
	HE_22. jpg	2588 x 1958
	HE_23. jpg	2588 x 1958
	HE_24. jpg	2588 x 1958
	HE_25. jpg	2588 x 1958
	HE_26. jpg	2588 x 1958
	HE_27. jpg	2588 x 1958
	HE_28. jpg	2588 x 1958

Table 2: (Continued)

Category	File Name	Dimension of the Image (in pixels)
Soft exudates	SE_01. jpg	2588 x 1958
	SE_02. jpg	2588 x 1958
	SE_03. jpg	2588 x 1958
	SE_04. jpg	2588 x 1958
	SE_05. jpg	2588 x 1958
	SE_06. jpg	2588 x 1958
	SE_07. jpg	2588 x 1958
	SE_08. jpg	2588 x 1958
	SE_09. jpg	2588 x 1958
	SE_10. jpg	2588 x 1958
	SE_11. jpg	2588 x 1958
	SE_12. jpg	2588 x 1958
	SE_13. jpg	2588 x 1958
	SE_14. jpg	2588 x 1958
	SE_15. jpg	2588 x 1958
	SE_16. jpg	2588 x 1958
Normal Fundus Images	NORMAL_01. jpg	2588 x 1958
	NORMAL_02. jpg	2588 x 1958
	NORMAL_03. jpg	2588 x 1958
	NORMAL_04. jpg	2588 x 1958
	NORMAL_05. jpg	2588 x 1958
	NORMAL_06. jpg	1388 x 1038
	NORMAL_07. jpg	2588 x 1958
	NORMAL_08. jpg	1388 x 1038
	NORMAL_09. jpg	2480 x 3187
	NORMAL_10. jpg	2588 x 1958

All the images in the dataset are compressed in JPEG format. The dimension of HM_14 (Hemorrhage category) is comparatively high because the retina is highly infected by the leakage of blood vessels. Similarly, an image in the hard exudates (HE_19) category also has a higher dimension due to the presence of a greater number of hard exudates. The images can be downloaded from the following URL:

<https://github.com/ARAVINDDATASET/ARAVIND.git>

SCOPE FOR COMPUTER RESEARCHERS

Using this dataset, the computer researchers can execute their research in the areas such as detection of abnormalities in the

retina, segmentation of the blood vessels, identification of hard and soft exudates, localization of optic disc in the retina, classification, feature extraction, detection of haemorrhages and microaneurysm and grading the level of disease in the case of diabetic retinopathy patients.

DISCUSSION

Retina image analysis is an emerging research area for which many researchers are contributing by proposing new techniques for automatic diagnosis. At present, only very few Indian datasets are available for retina image analysis. There are hundreds of patients visiting the Aravind eye hospital, Tirunelveli every day for eye checkups and eye treatment. We have collected the retina images of various patients from the hospital and created a dataset that contains images of different categories like microaneurysm, haemorrhages, soft exudates, hard exudates and images with no defect. To motivate the research on retina image analysis, we would like to publish the database so that it could be used by the upcoming young researchers in the field of medical imaging. The dataset contains 98 retina images. This dataset is open to researchers for image analysis purposes.

CONCLUSION

The dataset "ARAVIND" is an image database that contains raw images of infected retina and retina with no defect. The images in this dataset can be used for image processing techniques and machine learning techniques to diagnose retinal disease. Using these images, the researchers can propose new algorithms for medical image analysis and thereby the usage of technology can be transferred to the field of medicine.

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Ethical Clearance: There was no direct human intervention involved in this research.

Author's Contribution: The images that are stored in the repository are real-time images that have been collected from Aravind Eye Hospital. Ground truth images are generated with the help of experts which can be used for evaluation purposes.

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