Indian Diabetic Retinopathy Image Dataset (IDRiD): A Resource for Research on Diabetic Retinopathy Screening

A. LAKSHMANNATH[1], DR. DILSHAD BEGUM[2]
[1]3rd Semester M.Tech Student, Department of Computer Science and Engineering, Ghousia College of Engineering, Ramanagara, Karnataka, India
[2]Professor and Head, Department of Computer Science and Engineering, Ghousia College of Engineering, Ramanagara, Karnataka, India

Abstract- ***Diabetic retinopathy remains the leading cause of preventable vision loss, primarily affecting the working-age demographic globally. Contemporary studies have enhanced our understanding of the clinical need for more efficient and cost-effective methods for detecting, diagnosing, managing, and treating retinal disorders. The growing emphasis on screening initiatives and the challenge of ensuring affordable, early-stage detection of diabetic retinopathy highlight the necessity for computer-aided diagnostic systems. Such automated tools in retinal image assessment can streamline large-scale screening for individuals with diabetes mellitus and allow healthcare professionals to allocate their time more productively. Advancements in computing technology, data transmission infrastructure, and machine learning have created significant opportunities for biomedical engineers and computer scientists to support clinical demands. The development and validation of digital screening platforms and their core automated techniques require diverse and representative retinal image collections. To our knowledge, the Indian Diabetic Retinopathy Image Dataset (IDRiD) is the first publicly available dataset that accurately reflects the Indian population. It includes annotations at the pixel level for both typical diabetic retinopathy lesions and healthy retinal features. Each image in the dataset also includes associated information regarding the severity of diabetic retinopathy and the presence of diabetic macular edema. This makes the dataset highly suitable for creating and assessing image analysis methods aimed at early diabetic retinopathy detection.***

I. INTRODUCTION

Diabetic Retinopathy (DR) arises from microvascular changes in the retina caused by diabetes and is recognized as the most common preventable cause of blindness among the working-age population worldwide. Diabetic Macular Edema (DME), a complication related to DR, involves the buildup of fluid or thickening of the retina and can develop at any stage of DR. Reports indicate that one in three individuals with diabetes shows some form of DR, and one in ten develops a vision-threatening condition. In India, DR ranks as the sixth leading cause of blindness. DR is considered a clinical diagnosis, typically identified by the appearance of one or more retinal abnormalities such as microaneurysms, hemorrhages, hard exudates, and soft exudates, as shown in Figure 1.

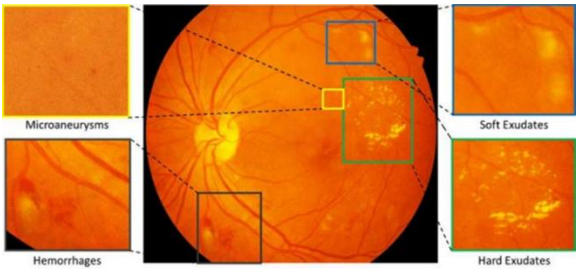

Figure 1. Color fundus image showing various retinal abnormalities linked to diabetic retinopathy. Enlarged sections highlight the presence of microaneurysms, soft exudates, hemorrhages, and hard exudates.

This dataset was released as part of the "Diabetic Retinopathy: Segmentation and Grading Challenge" (http://biomedicalimaging.org/2018/challenges/), held in conjunction with the IEEE International Symposium on Biomedical Imaging (ISBI-2018) in Washington D.C. The challenge was hosted on the Grand Challenges in Biomedical Imaging Platform.

Details about the dataset's structure and availability are summarized in Table 1.

Table 1. Specifications Overview

Subject Area	Biomedical Imaging, Ophthalmology
Specific Focus	Retinal image analysis for identifying DR and DME
Data Type	Image files, CSV files
Acquisition Method	Retinal fundus images captured using Kowa VX-10α camera
Data Format	Raw images with corresponding manual annotations
Experimental Protocol	Mydriasis induced using 0.5% tropicamide eye drops
Imaging Details	Images taken from diabetic patients using a non-invasive fundus camera with a xenon flash and a 39 mm lens-to- eye distance
Collection Site	Eye Clinic, Sushrusha Hospital Building, Nanded, Maharashtra, India
Data Availability	Indian Diabetic Retinopathy Image Dataset (IDRiD)

II. DATA DESCRIPTION

The IDRiD dataset is a newly introduced publicly accessible collection of retinal fundus images, consisting of 516 images divided into two groups: those displaying signs of Diabetic Retinopathy (DR) and/or Diabetic Macular Edema (DME), and normal images without any indications of these conditions. The dataset includes detailed ground truth information related to both pathological features and normal anatomical structures. Specifically, it provides pixel-level annotations of common DR lesions along with the optic disc, image-level grading to represent the severity of DR and DME, and coordinates marking the centers of the optic disc and the fovea. These features make the dataset a valuable resource for the development and assessment of automated image analysis techniques in retinal diagnostics.

2.1 Pixel Level Annotated Data

This dataset consists of 81 color fundus images with signs of DR and 164 without signs of DR. Precise pixel level annotation as shown in Figure 2 of abnormalities associated with DR like microaneurysms (MA), soft exudates (SE), hard exudates (EX) and hemorrhages (HE) is provided as a binary mask for performance evaluation of individual lesion segmentation techniques. It includes color fundus images (.jpg files) and separate binary masks for each lesion type (.tif files). Along with the lesion masks, it also consist of optic disc (OD) mask for all 81 images (see example in Figure 6).

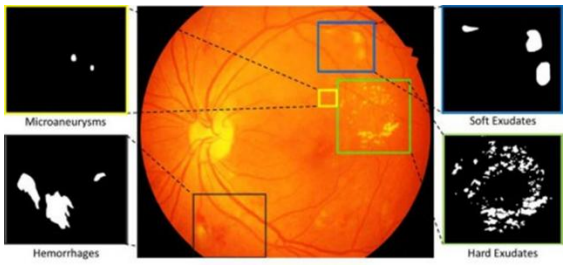

Figure 2 displays a color fundus image that shows various retinal lesions commonly linked with diabetic retinopathy. The figure also includes enlarged sections that highlight example annotations of key lesion types such as microaneurysms, soft exudates, hemorrhages, and hard exudates.

A total of 516 retinal images, each reflecting a range of pathological conditions related to diabetic retinopathy (DR) and diabetic macular edema (DME), were assessed and graded by medical experts. These images were then divided into two sets: a training set consisting of 413 images (80%) and a testing set with 103 images (20%), ensuring balanced representation of various disease severities. The grading details for both DR and DME severity levels are documented in two CSV files named IDRiD_DiseaseGrading_TrainingLabels.csv and IDRiD_DiseaseGrading_TestingLabels.csv. Figure 3 presents a sample view of the structure and contents of these files. Each file includes the following information: the image number, which is a unique identifier for each anonymized patient image; the DR

grade, which ranges from 0 (no signs of DR) to 4 (severe DR); and the DME risk level, which is scored from 0 (no DME) to 2 (severe DME).

	A	B	C
1	Image No	DR Grade	Risk of DME
2	IDRiD_001	3	1
3	IDRiD_002	2	2
4	IDRiD_003	4	2
5	IDRiD_004	2	1
6	IDRiD_005	1	0

Figure 3. Sample DR and DME expert labels in CSV file.

2.3 Optic Disc and Fovea Center Location

In addition to the previously mentioned annotations, the dataset also includes the central pixel coordinates of the optic disc [ODx, ODy] and fovea [Fx, Fy] for all 516 images, as depicted in Figure 4.

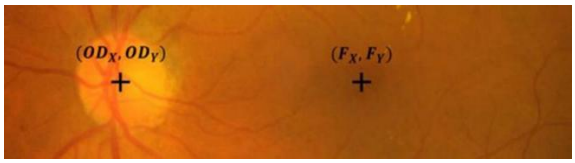

Figure 4. A cropped IDRiD image showing the center coordinates of the optic disc and fovea.

The dataset is categorized into a training set and a testing set, containing 413 (80%) and 103 (20%) images respectively. The central pixel coordinates for the optic disc and fovea are provided in two distinct folders. One folder includes the optic disc center coordinate files named IDRiD_OD_Center_Training Set_Markups.CSV and IDRiD_OD_Center_Testing Set_Markups.CSV; the other folder contains the fovea center coordinate files IDRiD_Fovea_Center_Training Set_Markups.CSV and IDRiD_Fovea_Center_Testing Set_Markups.CSV. Each CSV file holds three columns detailing the image number, X coordinate, and Y coordinate. The X and Y values represent the pixel coordinates of the optic disc or fovea center in each image. Table 2 outlines the dataset, describing the data type, quantity, and file format.

Table 2. Details of the data provided in the compiled dataset.

Data Description	Quantity	Data Type	File Format
Retinal color fundus images	516	Raw image data	JPG
DR and DME severity grading	516	Image-level tabular annotation	CSV
Optic disc and fovea center coordinates	516	Manually recorded tabular data	CSV
Lesion binary masks	81	Detailed pixel-wise annotations	TIF
Optic disc binary masks	81	Manual pixel-level annotations	TIF

III. EXPERIMENTAL DESIGN, MATERIALS AND METHODS

3.1 Ethics Statement

All participants involved in this study gave informed consent prior to their inclusion. Patient confidentiality was upheld in accordance with the regulations prescribed by the institutional ethics committee and the general ethical standards governing clinical research and practice. The dataset utilized in the study received ethical clearance from the research ethics committee of Shri Guru Gobind Singhji Institute of Engineering and Technology, Nanded, Maharashtra, India.

3.2 Data Acquisition

Fundus photography, a non-invasive and painless diagnostic tool, was used to obtain retinal images for this study. These images were collected from a specialized eye clinic located in Nanded, Maharashtra, and represent patients diagnosed with diabetes. Imaging was carried out using a non-contact fundus camera, positioned 39 mm from the eye and equipped with a xenon flash. Prior to image capture, all subjects underwent pupil dilation (mydriasis), achieved by instilling a single drop of tropicamide at a 0.5% concentration. The images were taken using a Kowa VX-10α digital fundus camera with a 50-degree field of view. Each image was captured at a resolution of 4288 × 2848 pixels, saved in JPEG format, and averaged around 800 KB in size. From a pool of thousands of retinal exams conducted between 2009 and 2017, a total of 516 high-quality images were selected. Expert ophthalmologists verified that all selected images were clinically useful, unduplicated,

and represented a broad range of diabetic retinopathy and diabetic macular edema cases.

3.3 Image Annotation

The dataset includes three types of annotations: pixel-level lesion segmentation, image-level grading for diabetic retinopathy and diabetic macular edema, and coordinates for the center of the optic disc and fovea. Observers were first trained under the supervision of experienced ophthalmologists to accurately identify individual lesions. A subset of 81 images containing soft and hard exudates, microaneurysms, and hemorrhages was chosen by an image processing expert. These were then manually annotated by a master's student using specialized software developed for annotation purposes. The markings were later reviewed by two retina specialists and finalized upon reaching consensus. Figures in the source document illustrate sample annotated images and finalized ground truths, which are comparable to those found in other retinal image datasets. For image-level classification, trained medical professionals assessed all 516 images for signs of diabetic retinopathy and diabetic macular edema. Diabetic retinopathy severity was classified into five categories, ranging from no apparent DR to severe DR, following the International Clinical Diabetic Retinopathy Scale. The severity of diabetic macular edema was graded by assessing the presence of hard exudates near the macula center, based on established criteria. Additionally, the centers of the optic disc and fovea were marked independently by a master's and a PhD student. The final coordinates were derived by averaging the two annotations, which were then verified by a retina specialist to ensure accuracy and reliability.

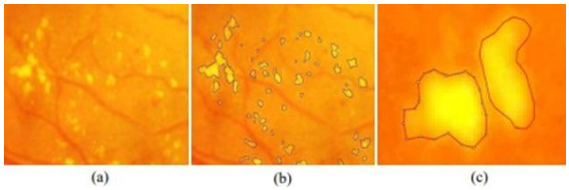

Figure 5. Zoomed-in section of a retinal fundus image from the dataset highlighting hard exudates: (a) the visible presence of hard exudates; (b) manual annotations illustrating the location of hard exudates; and (c) the contour markings as shown on the annotator's interface.

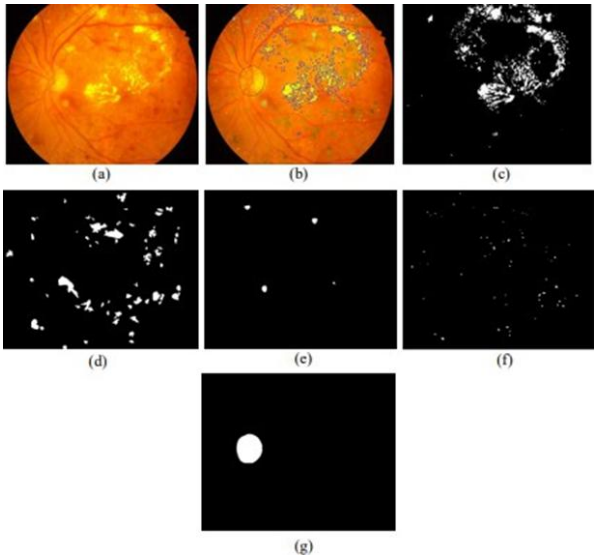

Figure 6. Retinal image and corresponding annotations: (a) a representative fundus image from the dataset; (b) ground truth annotations provided by the annotator; (c–g) individual ground truth masks showing hard exudates, hemorrhages, soft exudates, microaneurysms, and the optic disc, respectively.

Author Contributions:

The research work was conceptualized and executed by A. Lakshmannath, a third-semester M.Tech student at Ghousia College of Engineering, Ramanagara. The project was carried out under the guidance and supervision of Dr. Dilshad Begum, Professor and Head of the Department of Computer Science and Engineering at the same institution. A. Lakshmannath was responsible for data collection, preprocessing, annotation handling, experimental design, and the preparation of the original draft. Dr. Dilshad Begum provided continuous mentorship, critical review, methodological support, and overall project oversight.

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