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DETECTION OF DIABATIC RETINOPATHY USING THE MACHINE LEARNING METHOD

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ABSTRACT

Diabetic Retinopathy (DR) is a common complication of diabetes mellitus, which causes lesions on the retina that effect vision. If it is not detected early, it can lead to blindness. Unfortunately, DR is not a reversible process, and treatment only sustains vision. DR early detection and treatment can significantly reduce the risk of vision loss. The manual diagnosis process of DR retina fundus images by ophthalmologists is time-, effort-, and cost-consuming and prone to misdiagnosis unlike computer-aided diagnosis systems. Recently, deep learning has become one of the most common techniques that has achieved better performance in many areas, especially in medical image analysis and classification. Convolutional neural networks (CNNs)are more widely used as a deep learning method in medical image analysis and they are highly effective. The recent state-of-the-art methods of DR color fundus images detection and classification using deep learning techniques have been reviewed and analyzed. Furthermore, the DR available datasets for the color fundus retina have been reviewed.

PROBLEM STATEMENT

World Health Organization (WHO) estimates that, out of the 130 million babies born annually, around 15 million babies are born prematurely, before 37 completed weeks of gestation. Approximately 1 million children die each year due to complications of preterm birth. Many of the survivors face a lifetime disability, both visual and hearing problems, as well as learning disabilities. Among these issues, retinopathy of prematurity (RoP) is a leading and serious cause of disability.

EXISTING SYSTEM

- Ophthalmologists analyze fundus images of eye extensively as a non-invasive diagnosis tool for various internal eye defects. Diabetic retinopathy is an eye complication specially seen in diabetic patients, causing damage to retina which may lead to blindness.
- The major symptoms of this disorder is the presence of exudates, a pus like fluid oozed from damaged blood vessels due to high blood sugar.
- Currently eye check-up and analysis are manual.
- The major symptom of diabetic retinopathy is exudates.
- Exudates can be captured in fundus image of eyes.

PROPOSED SYSTEM

- The proposed system will investigate a case study around Severe Retinopathy of Prematurity (Severe RoP) that leads to full or limited blindness in new born if not treated.
- Stevie Wonders is a well-known musician who suffered from severe RoP. Back in the 1950's, doctors were recently realizing that oxygen could be used to save premature babies. However, it took them additional years to figure out that excess dosage of oxygen would cause vessels in the eye grow irregularly.
- Premature babies with this condition and excess oxygen treatment would suffer from lifelong blindness.

LITERATURE SURVEY

[1] P. Vora and S. Shrestha, "Detecting diabetic retinopathy using embedded computer vision", *Appl. Sci.*, vol. 10, no. 20, pp. 7274, Oct. 2020.

Diabetic retinopathy is one of the leading causes of vision loss in the United States and other countries around the world. People who have diabetic retinopathy may not have symptoms until the condition becomes severe, which may eventually lead to vision loss. Thus, the medically underserved populations are at an increased risk of diabetic retinopathy-related blindness. In this paper, we present development efforts on an embedded vision algorithm that can classify healthy versus diabetic retinopathic images. Convolution neural network and a k-fold cross-validation process were used. We used 88,000 labeled high-resolution retina images obtained from the publicly available Kaggle/EyePacs database. The trained algorithm was able to detect diabetic retinopathy with up to 76% accuracy. Although the accuracy needs to be further improved, the presented results represent a significant step forward in the direction of detecting diabetic retinopathy using embedded computer vision. This technology has the potential of being able to detect diabetic retinopathy without having to see an eye specialist in remote and medically underserved locations, which can have significant implications in reducing diabetes-related vision losses

[2] Y. T. Wong, J. Sun, R. Kawasaki, P. Ruamviboonsuk, N. Gupta, V. C. Lansingh, et al., "Guidelines on diabetic eye care", *Ophthalmology*, vol. 125, no. 10, pp. 1608-1622, Oct. 2018.

Diabetes mellitus (DM) is a global epidemic and affects populations in both developing and developed countries, with differing health care and resource levels. Diabetic retinopathy (DR) is a major complication of DM and a leading cause of vision loss in working middle-aged adults. Vision loss from DR can be prevented with broad-level public health strategies, but these need to be tailored to a countries and population's resource setting. Designing DR screening programs, with appropriate and timely referral to facilities with trained eye care professionals, and using cost-effective treatment for vision-threatening levels of DR can prevent vision loss.

[3] O. M. Al Hazaimeh, K. M. O. Nahar, B. Al Naami and N. Gharaibeh, "An effective image processing method for detection of diabetic retinopathy diseases from retinal fundus images", *Int. J. Signal Imag. Syst. Eng.*, vol. 11, no. 4, pp. 206, 2018.

Diabetic retinopathy (i.e., DR), is an eye disorder caused by diabetes, diabetic retinopathy detection is an important task in retinal fundus images due the early detection and treatment can potentially reduce the risk of blindness. Retinal fundus images play an important role in diabetic retinopathy through disease diagnosis, disease recognition (i.e., by ophthalmologists), and treatment. The current state-of-the-art techniques are not satisfied with sensitivity and specificity. In fact, there are still other issues to be resolved in state-of-the-art techniques such as performances, accuracy, and easily identify the DR disease effectively. Therefore, this paper proposes an effective image processing method for detection of diabetic retinopathy diseases from retinal fundus images that will satisfy the performance metrics (i.e., sensitivity, specificity, accuracy). The proposed automatic screening system for diabetic retinopathy was conducted in several steps: Pre-processing, optic disc detection and removal, blood vessel segmentation and removal, elimination of fovea, feature extraction (i.e., Micro-aneurysm, retinal hemorrhage, and exudates), feature selection and classification. Finally, a software-based simulation using MATLAB was performed using DIARETDB1 dataset and the obtained results are validated by comparing with expert ophthalmologists. The results of the conducted experiments showed an efficient and effective in sensitivity, specificity and accuracy.

[4] A. Attia, Z. Akhtar, S. Akrouf and S. Maza, "A survey on machine and deep learning for detection of diabetic Retinopathy", *ICTACT J. Image Video Process.*, vol. 11, no. 2, pp. 2337-2344, Dec. 2020.

Diabetic Retinopathy (DR) is one of the mainly causes of visual loss worldwide. In fact, DR is leading source of impaired vision in people between 25 and 74 years old. DR exists in wide ranged and its detection is a challenging problem. The gradual deterioration of retina leads to DR with several types of lesions, including haemorrhages, exudates, micro aneurysms, etc. Early detection and diagnosis can prevent and save the vision of diabetic patients or at least the progression of DR can be slowed down. The manual diagnosis and analysis of fundus images to substantiate morphological changes in micro aneurysms, exudates, blood vessels, hemorrhages, and macula are usually time-consuming and monotonous task. It can be made easy and fast with the help of computer-aided system based on advanced machine learning techniques that can greatly help doctors and medical practitioners. Thus, the main focus of this paper is to provide a summary of the numerous methods designed for discovering hemorrhages, microaneurysms and exudates are discussed for eventual recognition of non-proliferative diabetic retinopathy. This survey will help the budding researchers, scientists, and practitioners in the field.

[5] A. Gupta and R. Chhikara, "Diabetic retinopathy: Present and past", *Proc. Comput. Sci.*, vol. 132, pp. 1432-1440, Jan. 2018.

Diabetes, a chronic disease affects various organs of human body including the retina. Diabetic Retinopathy (DR) results from the Diabetes Mellitus (DM). In literature various machine learning algorithms have been applied in detection of DR. This involves two steps; Feature extraction and Classification. This paper reviews the various techniques used for detecting DR based on the features like blood vessels, microaneurysms, hemorrhages etc. In most of the experiments retinal fundus images were used in which images of retina were captured by fundus camera. This review bifurcates the detection of DR into two approaches; Blood vessels segmentation and Identification of lesions. This paper compares the experimental results of various machine learning techniques based on parameters like sensitivity, specificity, Area Under Curve (AUC), Accuracy. The results are also compared with the deep neural networks and analysis of best technique has been provided.

[6] W. L. Alyoubi, W. M. Shalash and M. F. Abulkhair, "Diabetic retinopathy detection through deep learning techniques: A review", *Informat. Med. Unlocked*, vol. 20, Jan. 2020.

Diabetic Retinopathy (DR) is a common complication of diabetes mellitus, which causes lesions on the retina that effect vision. If it is not detected early, it can lead to blindness. Unfortunately, DR is not a reversible process, and treatment only sustains vision. DR early detection and treatment can significantly reduce the risk of vision loss. The manual diagnosis process of DR retina fundus images by ophthalmologists is time-, effort-, and cost-consuming and prone to misdiagnosis unlike computer-aided diagnosis systems. Recently, deep learning has become one of the most common techniques that has achieved better performance in many areas, especially in medical image analysis and classification. Convolutional neural networks are more widely used as a deep learning method in medical image analysis and they are highly effective. For this article, the recent state-of-the-art methods of DR colour fundus images detection and classification using deep learning techniques have been reviewed and analysed. Furthermore, the DR available datasets for the colour fundus retina have been reviewed.

[7] S. Stolte and R. Fang, "A survey on medical image analysis in diabetic retinopathy", *Med. Image Anal.*, vol. 64, Aug. 2020.

Diabetic Retinopathy (DR) represents a highly-prevalent complication of diabetes in which individuals suffer from damage to the blood vessels in the retina. The disease manifests itself through lesion presence, starting with microaneurysms, at the no proliferative stage before being characterized by neovascularization in the proliferative stage. Retinal specialists strive to detect DR early so that the disease can be treated before substantial, irreversible vision loss occurs. The level of DR severity indicates the extent of treatment necessary - vision loss

may be preventable by effective diabetes management in mild (early) stages, rather than subjecting the patient to invasive laser surgery. Using artificial intelligence (AI), highly accurate and efficient systems can be developed to help assist medical professionals in screening and diagnosing DR earlier and without the full resources that are available in specialty clinics. In particular, deep learning facilitates diagnosis earlier and with higher sensitivity and specificity. Such systems make decisions based on minimally handcrafted features and pave the way for personalized therapies.

[8] S. Valarmathi and R. Vijayabhanu, "A survey on diabetic retinopathy disease detection and classification using deep learning techniques", *Proc. 7th Int. Conf. Bio Signals Images Instrum. (ICBSII)*, pp. 1-4, Mar. 2021.

Diabetes is the most commonly found chronic disease seen in many people of different age groups with poor insulin production, which causes high blood sugar. Diabetes, when left untreated, can lead to the development of several diseases across the body. Diabetic Retinopathy (DR) is an asymptomatic eye disease induced by diabetes that results in damaged retinal vessels. Many automatic diagnostic systems have been developed in the literature in which conventional handcrafted features were used. With the development of Deep Learning (DL), particularly in medical imaging, more accurate and potential results are produced, as it performs automatic feature extraction. Convolutional Neural Networks (CNNs) are the most widely used deep learning method in medical image analysis. In this paper, several Deep Learning-based diabetic retinopathy disease detection and classification techniques are analyzed and reviewed for better understanding.

[9] F. Shamshad, S. Khan, S. W. Zamir, M. H. Khan, M. Hayat, S. Khan, et al., "Transformers in medical imaging: A survey", *arXiv:2201.09873*, 2022.

Following unprecedented success on the natural language tasks, Transformers have been successfully applied to several computer vision problems, achieving state-of-the-art results and prompting researchers to reconsider the supremacy of convolutional neural networks (CNNs) as {de facto} operators. Capitalizing on these advances in computer vision, the medical imaging field has also witnessed growing interest for Transformers that can capture global context compared to CNNs with local receptive fields. Inspired from this transition, in this survey, we attempt to provide a comprehensive review of the applications of Transformers in medical imaging covering various aspects, ranging from recently proposed architectural designs to unsolved issues. Specifically, we survey the use of Transformers in medical image segmentation, detection, classification, reconstruction, synthesis, registration, clinical report generation, and other tasks. In particular, for each of these applications, we develop

taxonomy, identify application-specific challenges as well as provide insights to solve them, and highlight recent trends. Further, we provide a critical discussion of the field's current state as a whole, including the identification of key challenges, open problems, and outlining promising future directions.

[10] R. J. Chalakkal, W. H. Abdulla and S. S. Thulaseedharan, "Automatic detection and segmentation of optic disc and fovea in retinal images", *IET Image Processing*, 2018.

Feature extraction from retinal images is gaining popularity worldwide as many pathologies are proved having connections with these features. Automatic detection of these features makes it easier for the specialist ophthalmologists to analyse them without spending exhaustive time to segment them manually. The proposed method automatically detects the optic disc (OD) using histogram-based template matching combined with the maximum sum of vessel information in the retinal image. The OD region is segmented by using the circular Hough transform. For detecting fovea, the retinal image is uniformly divided into three horizontal strips and the strip including the detected OD is selected. Contrast of the horizontal strip containing the OD region is then enhanced using a series of image processing steps. The macula region is first detected in the OD strip using various morphological operations and connected component analysis. The fovea is located inside this detected macular region. The proposed method achieves an OD detection accuracy over 95% upon testing on seven public databases and on our locally developed database, University of Auckland Diabetic Retinopathy database (UoA-DR). The average OD boundary segmentation overlap score, sensitivity and fovea detection accuracy achieved are 0.86, 0.968 and 97.26% respectively.

METHODOLOGY

- "Support Vector Machine" (SVM) is a supervised machine learning algorithm which can be used for both classification or regression challenges. However, it is mostly used in classification problems.
- In this algorithm, we plot each data item as a point in n-dimensional space (where n is number of features you have) with the value of each feature being the value of a particular coordinate.
- Then, we perform classification by finding the hyper-plane that differentiate the two classes very well. Support Vectors are simply the coordinates of individual observation. Support Vector Machine is a frontier which best segregates the two classes.
- Microaneurysms and Hemorrhages commonly appear as red lesions, while the two types of exudates appear as bright lesions.

- Diabetic Retinopathy detection involves identifying 5 stages which are no DR, mild DR, moderate DR, severe DR and proliferative DR.

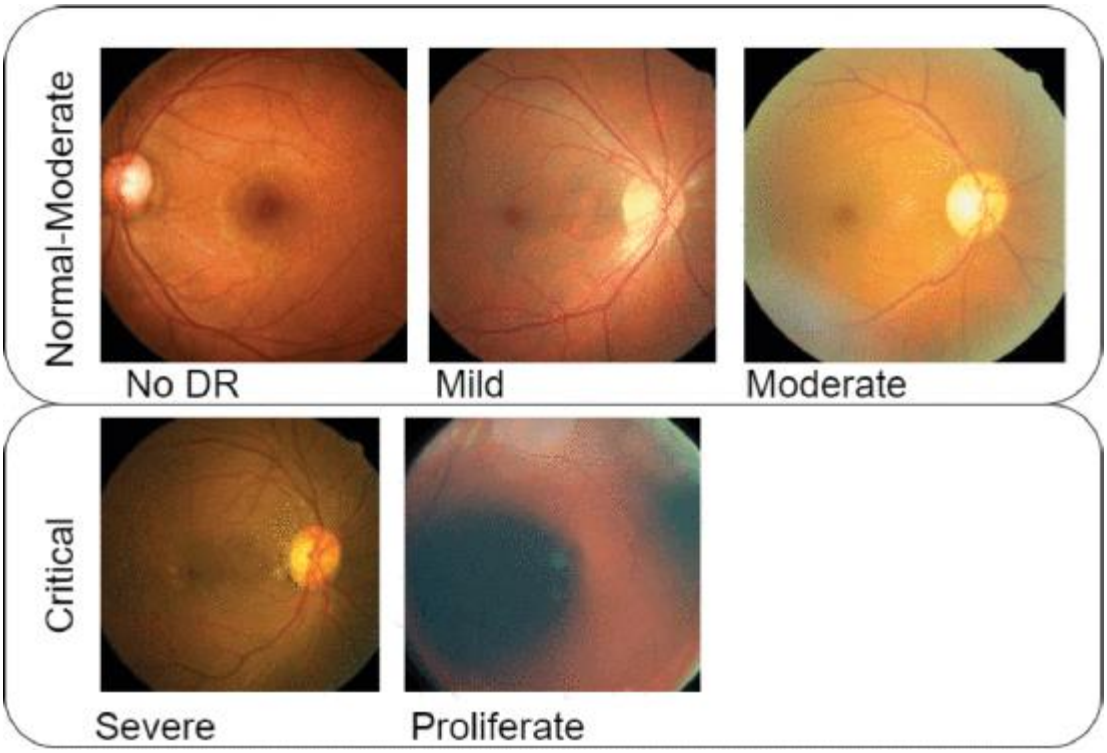


Fig. 1 Illustrates the five possible stages of DR development.

Working of SVM

An SVM model is basically a representation of different classes in a hyperplane in multidimensional space. The hyperplane will be generated in an iterative manner by SVM so that the error can be minimized. The goal of SVM is to divide the datasets into classes to find a maximum marginal hyperplane (MMH).

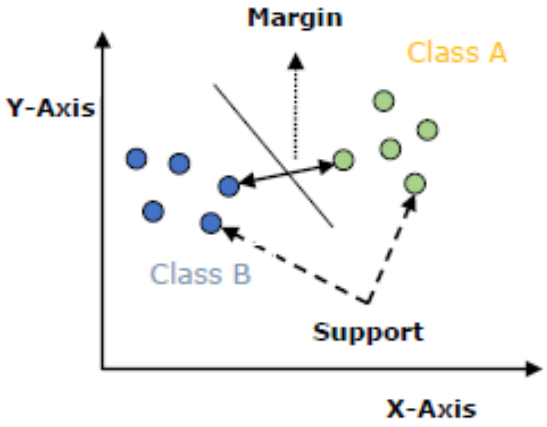


Fig.2 Graph using SVM Technique

The followings are important concepts in SVM:

- **Support Vectors** − Datapoints that are closest to the hyperplane is called support vectors. Separating line will be defined with the help of these data points.
- **Hyperplane** − As we can see in the above diagram, it is a decision plane or space which is divided between a set of objects having different classes.
- **Margin** − It may be defined as the gap between two lines on the closet data points of different classes. It can be calculated as the perpendicular distance from the line to the support vectors. Large margin is considered as a good margin and small margin is considered as a bad margin.

The main goal of SVM is to divide the datasets into classes to find a maximum marginal hyperplane (MMH) and it can be done in the following two steps −

I. First, SVM will generate hyperplanes iteratively that segregates the classes in best way.

II. Then, it will choose the hyperplane that separates the classes correctly.

Modules-Implementation

A. Data Augmentation

The fundus images are obtained from the different datasets are taken under different camera with varying field of view, non-clarity, blurring, contrast and sizes of images different. In data augmentation, contrast adjustment, flipping images, brightness adjustments are made.

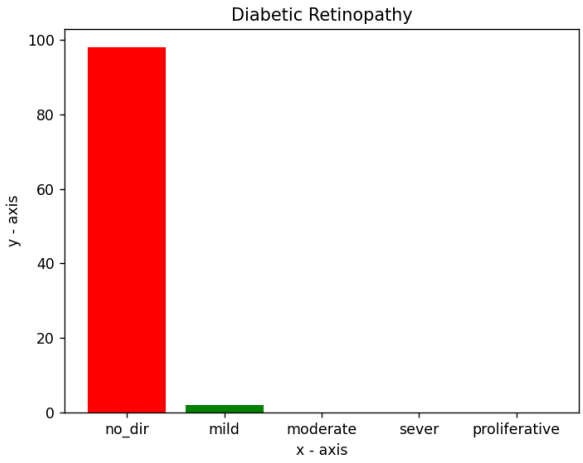
B. Pre-Processing

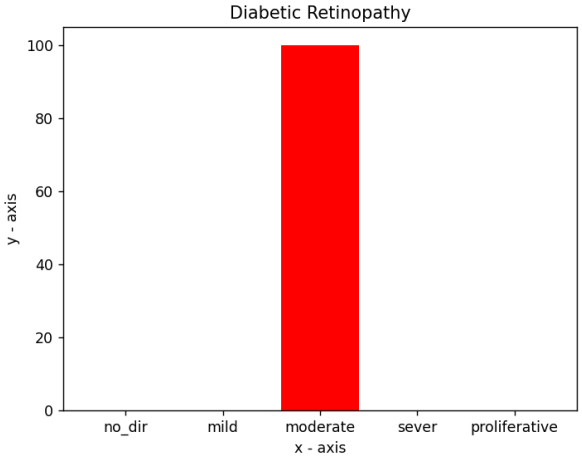
For Deep convolutional neural network worked on spatial data of the fundus images. A primary step involved in the preprocessing is resizing the images. Before feeding into the architecture for classification, convert the images in to gray scale. And then, convert in to the L model. It is a monochrome image which is used to highlights the microaneurysms, and vessels in the fundus images. And flatten the images in single dimensional for processing further.

C. CNN Classification

In Image recognition, a Convolutional Neural Network (CNN) is a type of feed-forward artificial neural network in which the connectivity pattern between its neurons is inspired by the organization of animal visual cortex, whose individual neurons are arranged in such a way that respond to overlapping regions tiling the visual field. In deep learning the convolutional neural network uses a complex architecture composed of stacked layers in which is particularly well-adapted to classify the images. For multi-class classification, this architecture robust and sensitive to each feature present in the images.

OUTPUT GRAPH





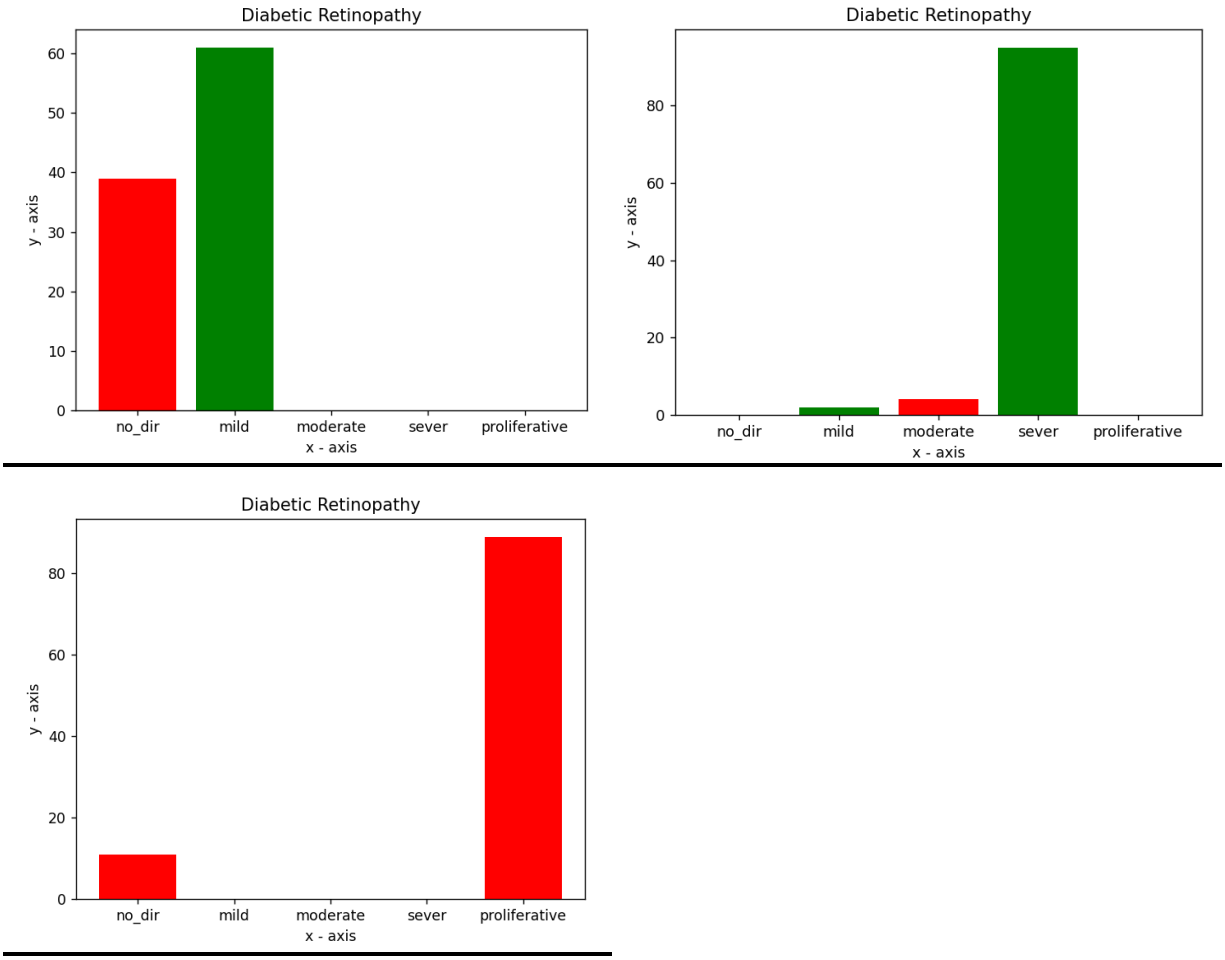


Fig. 3 Output Graph for sample having No DR, Moderate DR, Mild DR, Sever DR, Proliferative DR

CONCLUSION

A new method is proposed for the classification of Diabetic retinopathy using deep learning. Using the proposed method, it is observed that machine learning techniques like neural networks have a very high future scope in disease detection for medical images. Researches have already proved the efficiency of the R-CNN technique in the field of object detection. With this project, it is proved that R-CNN can also use for detecting very tiny features. R-CNN is found to be highly accurate and sensitive for lesion detection. An accuracy of about 93.8% is obtained for R-CNN.

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