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COMPARATIVE STUDY OF DIABETIC RETINOPATHY USING K-NN AND BAYESIAN CLASSIFIER

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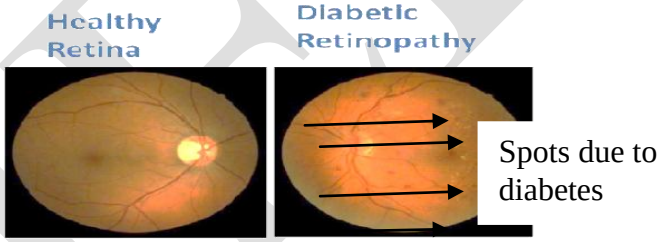
ABSTRACT
Diabetic retinopathy is damage to the retina, specifically blood vessels in the retina, caused by diabetes. It normally starts without any noticeable change in vision. For diagnosis of diabetic retinopathy, ophthalmologists use the retinal image of a patient which is known as fundus image. The blood vessels can be captured directly from retina. This paper presents an automated image processing system which detects the gradation of diabetic retinopathy. Segmentation of blood vessels is performed by using kirsch method. Gray level features of segmented vessels are extracted using moment invariants. The severity of diabetic retinopathy is detected using feed forward neural network along with K-NN and Bayesian classifier.

INTRODUCTION
Diabetic retinopathy (DR) is damage to retina specifically blood vessels in retina. Diabetic Retinopathy is an eye disorder caused by diabetes [12]**.** Diabetic Retinopathy means the effect of diabetes on the eye which may cause partial or even complete loss of vision. It causes the damage of small vessels which results in loss of vision. It is the most common diabetic eye disease leading to blindness.



(a) (b)

Figure: 1Digital retinal images a) Healthy retina, b) Diabetic retina

Fig 1a.shows the healthy retina and fig1b shows retina affected by diabetes, which shows spots on the retina. Diabetes causes high levels blood sugar which causes accumulate in blood vessels, causing damage that hampers or alters blood flow to body's organs including eyes, which affects up to 80 percent of all patients having diabetes for ten years or more. The symptoms of DR are Blurry vision, spots on retina, difficulty to see at night. [2].This effect is shown in following figure.

(a) (b)

Figure: 2Pictures showing vision difference between normal and diabetic retina
a) Normal Vision b)Diabetic Retinopathy Vision[3]

Above two figures gives the difference between normal and the vision affected by diabetic retinopathy. From the above figure it is clear that the person affected by DR cannot see properly.

The extraction of Retinal blood vessel is necessary step for the diagnosis of various eye diseases. Retinal images of humans play an important role in the detection and diagnosis of several eye diseases for the ophthalmologists [9].

In present paper, kirsch algorithm is used for vessel extraction. The kirsch edge detector is one of the most powerful edge detector .It detects edges as well as the direction of edges. It offers very precise segmentation in detecting objects of different sizes [14].

For extraction of blood vessels seven-moment invariants are calculated and are applied separately to K-NN and Bayesian classifier. Finally, the severity of diabetic retinopathy is calculated by using a neural network.

RELATED WORK

Here Anupriyaa Mukherjee, Diksha Rathore, Supriya Shree, Asst Prof. Shaik Jameel[1] described types of diabetic retinopathy and different image processing techniques to show the difference between normal and diabetic retinopathy vision.The advantage of their algorithm is accuracy of result is very high.

Diego Marin et al. [4] have presented a new supervised method for blood vessel detection in digital retinal images. Their method uses a neural network (NN) scheme for pixel classification and computes a 7-D vector composed of gray-level and moment invariants based features for pixel representation. Their method was evaluated on the publicly available DRIVE and STARE databases, widely used for this purpose.

In this paper [5],describes a system for the automatic detection of diabetic retinopathy.This paper also describes the different stages of DR.

In paper [8] the method explained can easily extract efficient retinal blood vessel from retinal image. More than 10 images have been tested and method can extract vessel image successfully. Future work of this method will include improving the presented method and the extraction of other feature such as intensity of image.

M. Reema and R. Pradeepa [9] gives types of diabetic retinopathy .This paper also gives percentage of diabetic retinopathy on different age group.

Nikhil Amrutkar, Yogesh Bandgar, Sharad Chitalkar, Prof. Mr. Sunil Tade[12]explore methods for development of an automated system used for the detection of Diabetic Retinopathy. This work determines the presence of diabetic retinopathy by applying techniques of digital image processing on fundus images.

PROPOSED METHODOLOGY

The present paper, proposed the method to find gradation of the severity of diabetic retinopathy with a neural network using two types of classifiers as K-NN and Bayesian classifier. Figure no.3 shows the block diagram of proposed a methodology.

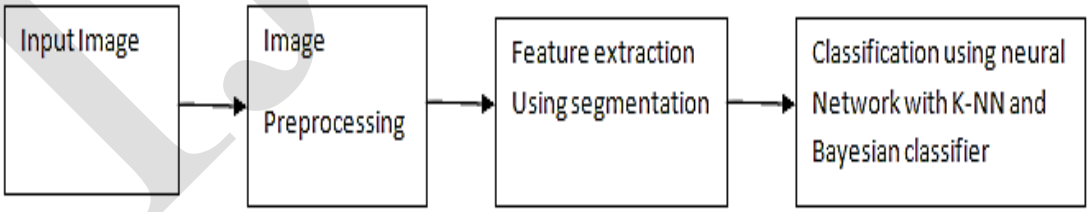


Figure:3 Block diagram of proposed method

Following steps are performed for finding severity of diabetic retinopathy.

A.INPUT IMAGE

In this paper, the retinal images of diabetic patients are taken for testing which are real and provided by an ophthalmologist. The database of hundred retinal images of diabetic patients along with normal retina is taken from the internet [16] for training purpose.

B.IMAGE PRE-PROCESSING

The image pre-processed to remove noise and correct the non-uniform illumination. In proposed method, the input color image is converted to gray level image.

C.FEATURE EXTRACTION USING SEGMENTATION

The features are extracted to help next stage for easy classification. In proposed method, blood vessels are segmented by using Kirsch method. Segmentation is performed by using Kirsch method. Kirsch Edge-detection method finds maximum edge strength in a few pre-determined directions. The operator takes a single kernel mask and rotates in 451 degrees increments through all 8 compass directions North, South, East, West, North West, South West, North East, and South East. The edge magnitude is calculated as the maximum magnitude across all directions. [8]. Blood vessels are extracted and seven invariant moments are calculated.

$$\sum_i \sum_j i^p j^q I_{V_E^{x,y}}^{S^{17}}(i,j)\ p,q = 0,1,2,\ldots \quad (1)$$

where summing are the values of the spatial coordinates where summations are over the and $I_{V_E^{x,y}}^{S^{17}}(i,j)$ is the gray level at point(i,j).In particular, Hu(1962),defines seven values, computed by normalizing central moments through order three, that are invariant to object scale, position, and orientation. The seven moment invariants are calculated as following [4].

$$M1 = (\eta 20 + \eta 02), \quad (2)$$
$$M2 = (\eta 20 - \eta 02)2 + 4\eta 211, \quad (3)$$
$$M3 = (\eta 30 - 3\eta 12)2 + (3\eta 21 - \eta 03)2, \quad (4)$$
$$M4 = (\eta 30 + \eta 12)2 + (\eta 21 + \eta 03)2, \quad (5)$$
$$M5 = (\eta 30 - 3\eta 12)(\eta 30 + \eta 12)[(\eta 30 + \eta 12)2 - 3(\eta 21 + \eta 03)2] + (3\eta 21 - \eta 03)(\eta 21 + \eta 03)[3(\eta 30 + \eta 12)2 - (\eta 21 + \eta 03)2], \quad (6)$$
$$M6 = (\eta 20 - \eta 02)[(\eta 30 + \eta 12)2 - (\eta 21 + \eta 03)2] + 4\eta 11(\eta 30 + \eta 12)(\eta 21 + \eta 03), \quad (7)$$
$$M7 = (3\eta 21 - \eta 03)(\eta 30 + \eta 12 \quad (8)$$

D. K-NN CLASSIFIER

The seven-moment invariants are then applied to two types of classifiers as K-NN and Bayesian classifier. The k-nearest neighbor algorithm is amongst the simplest of all machine learning algorithms. K-nearest neighbor classification was developed from the need to perform discriminate analysis when reliable parametric estimates of probability densities are unknown or difficult to determine [9].

E. BAYESIAN CLASSIFIER

The Bayesian classifier classifies each pixel into lesion or non-lesion classes. It represents a supervised learning method as well as a statistical method for classification. It is simpler and computationally fast for making decisions [13].

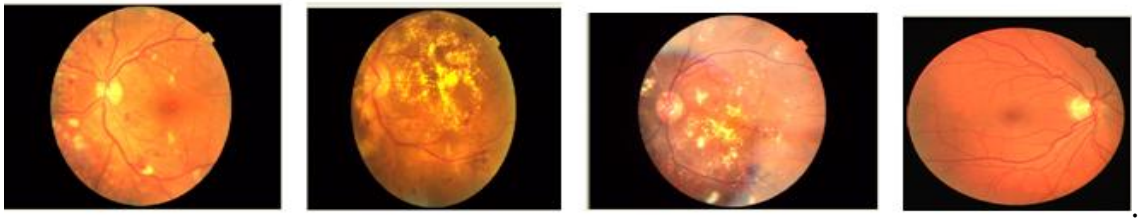
F. NEURAL NETWORK

In proposed method a multilayer feed forward neural network consisting of an input layer, three hidden layers and an the output layer is used at the final stage to detect the severity of diabetic retinopathy [9].

RESULTS AND DISCUSSION

A. INPUT IMAGE

Input images are color retinal images of real diabetic patients and are provided by an ophthalmologist. These are taken for testing purpose while hundred images are normal as well as diabetic patients retinal images taking for training and are taken from the internet on [16] site.



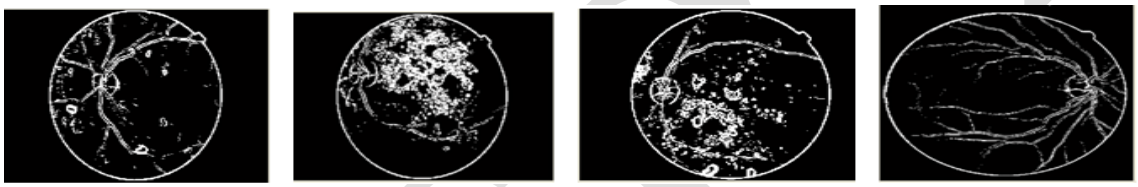
(a) (b) (c) (d)

Figure: 3 Digital Retinal images a) Less b) Medium c) More affected d) Normal retina

Figures 3(a), (b),(c),(d)shows four testing images of the diabetic patient with different grading of severity of diabetic retinopathy. As the severity of diabetic retinopathy increases spots on retina goes on increasing and causes blurry vision.

B.VESSEL EXTRACTION

In color image, it is difficult to find severity of diabetic retinopathy so color image is converted to gray level image. The blood vessels are extracted. The blood vessels become broader with increased severity of diabetic retinopathy.



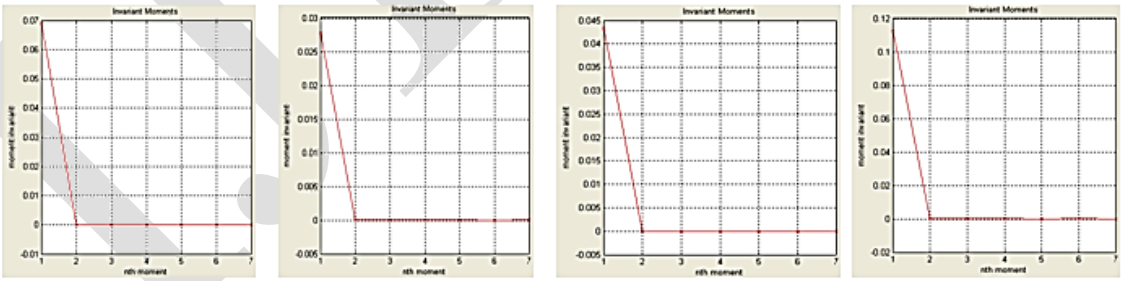
(a) (b) (c) (d)

Figure:4 Vessel extracted of retinal images a) Less b)Medium c) More affected retina d) Normal retina.

This effect is shown on following above images Figures 4(a) to 4(d) which are vessel extracted images of figures 3(a) to 3(d) of corresponding color images.

C.MOMENT INVARIANTS

The moment invariants are used to describe the shape of an image. So it is a tool which will help for deciding damage of vessels due to retinopathy. In proposed method blood vessels are extracted using seven-moment -*invariants [9].



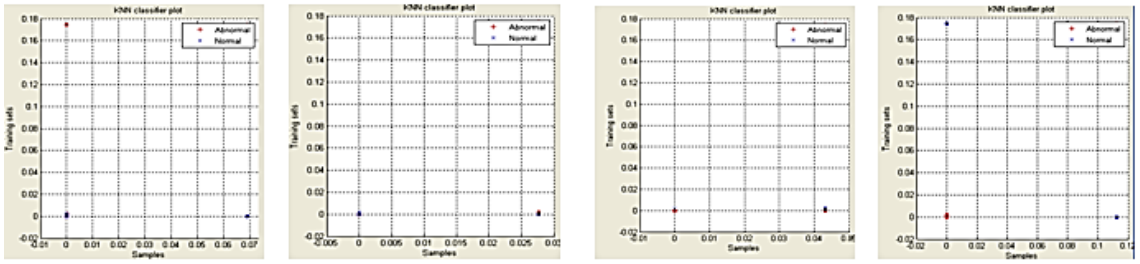
(a) (b) (c) (d)

Figure: 5 Moment invariants plot for a) less b) Medium c) More affected d) Normal retina

The seven-moment invariants are calculated using equations (2) to (8).The corresponding plot is drawn as shown in figures 5(a) to (d). This plot is moment invariant values Vs n^{th} moment. These moment invariants are further applied to K-NN and Bayesian classifiers.

D.K-NN CLASSIFIER-

The *k*-nearest neighbor algorithm is the simplest algorithm. The Kirsch algorithm detects direction of the edge as well as an edge. It calculates magnitude across all directions. It works effectively.



(a) (b) (c) (d)

Figure: 6 K-NN classifier plot for a) Less b) Medium c) More affected d) Normal retina

These plots are the plot of target sets Vs samples. In this plot red clusters indicates abnormal condition, i.e., the area affected by diabetic retinopathy whereas blue cluster indicates normal condition. As the grading of severity of diabetic retinopathy increases red clusters will also be increases.

E.BAYESIAN CLASSIFIER

The seven-moment invariants are applied to the Bayesian classifier to 5(a) to 5(d).The following figures show the result of Bayesian classifier.

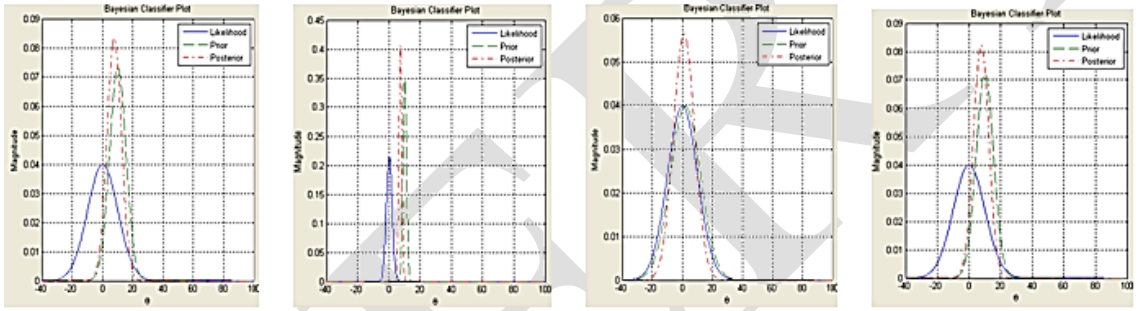


Figure: 7 Bayesian classifier plot for a) Less b) Medium c) More affected d)Normal retina

Figures 7(a) to 7(d) are Bayesian plots of corresponding to figures 3(a) to 3(d) images, as the every plot is of diabetic patients testing image which is in red color it is deviated from theoretical which is in green colour. So from fig 7(a) to (d) as the severity goes on increasing deviation is also more.

Lastly by applying feed forward neural network separately to K-NN and the Bayesian classifier the grading of severity of diabetic retinopathy is calculated. In our work three hidden layer neural network is used for grading severity of diabetic retinopathy. Following table shows the severity of diabetic retinopathy.

Table1. Table showing grading of severity of Diabetic Retinopathy

Sr.No.	Image No.	Gradation of severity of Diabetic Retinopathy		
		K-NN classifier	Bayesian classifier	Expert's opinion
1	1	70	56	50
2	2	83	70	60
3	3	90	77	70
4	4	0	0	0

We have tested four different images of different severity of diabetic retinopathy for K-NN and Bayesian classifier using neural network and these are compared with expert's opinion. Above table shows that the result of Bayesian classifier is near to Bayesian classifier than K-NN classifier.

CONCLUSION

In present paper, retinal blood vessels are extracted by using Kirsch segmentation method. We found that Kirsch method has efficiently segmented blood vessels from retinal images. We found that seven-moment invariants provide sufficient features for K-NN classifier and Bayesian classifier. The severity of diabetic

retinopathy obtained for two different classifiers using a feed forward neural network and it is verified by an ophthalmologist, from which it is clear that the Bayesian classifier gives result near to expert's opinion than the K-NN classifier. In proposed method, the efficiency of the Bayesian classifier is 74% and for K-NN classifier it is 66%.Also K-NN classifier is lazy algorithm where as Bayesian algorithm is fast and accurate. The Bayesian classifier is not sensitive towards the garbage and irrelevant features. In future this methodology will be applied for different and large database and results will be approved by an ophthalmologist.

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