

Classifying Diabetic Retinopathy Based On Medical Fundus Imaging

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Abstract. Diabetic retinopathy (DR) is an eye disease caused by disease, diabetes. Diabetic retinopathy (DR) is a microvascular complication that occurs in people with diabetes that causes abnormalities in the retina and can both cause blindness. This study was conducted to build an application that can automatically classify Diabetic Retinopathy in accordance with level, ie normal, non-proliferate diabetic retinopathy (NPDR) and proliferate diabetic retinopathy (PDR). This study uses naïve Bayesian. The test results showed that the application of the method accuracy rate in classifying DR naïve Bayesian based levels, normal, NPDR and PDR reached 97%.

Key-Words: *diabetic retinopathy, naïve Bayes*

1. Introduction

Diabetes Mellitus is a degenerative disease that occurs in almost all organs. The disease is caused by blood sugar levels higher than normal (60 mg / dl - 145 mg / dl), glucose can not manage cells due to a deficiency or insulin resistance [1].

Diabetic retinopathy (DR) is a disorder of the eye caused by disease, diabetes. Diabetic retinopathy (DR) is a microvascular complication that occurs in people with diabetes that causes abnormalities in the retina. DR typically characterized by small changes in the retinal capillaries, then microaneurysm (MA) as small red spots on the retina. Weak capillary wall, causing bleeding / hemorrhages (HA) on the retina [2].

The clinical symptoms of this disease is the appearance of microaneurysms which is a swelling of the blood vessels are microscopic and can be seen as reddish spots on the retina [3]. Retinopathy is the leading cause of blindness in adults [4]. The risk of suffering from diabetes retinopathy increases with the duration of a person bearing the DM.

Disease diabetic retinopathy is classified into three stages: Normal, Non-Poliferate diabetic retinopathy (NPDR) and Diabetic Retinopathy Poliferate (PDR). In the Non-Poliferate stage diabetic retinopathy (NPDR) is classified into three, namely mild, moderate and severe [5]

In this study, researchers used a naïve method to classify diabetic retinopathy Bayesian based phases.

2. Material and Methode

2.1. Eye Structure

Eyes are organs of vision-related. Eye socket located in the bone or orbit and protected by the eyelid from the outside air.

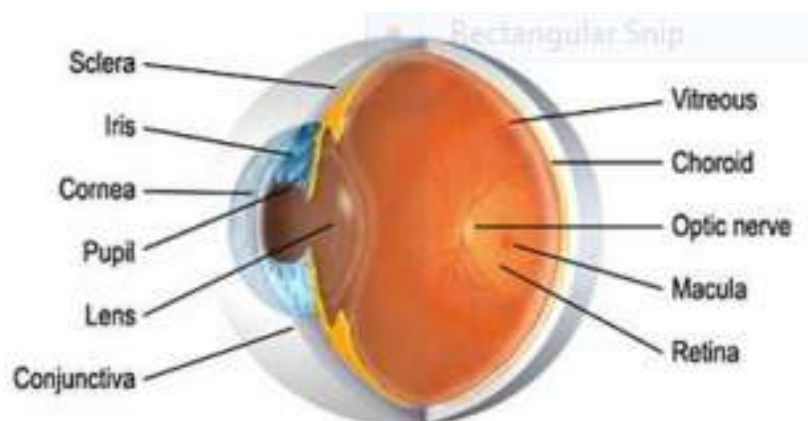


Figure 2.1. Eye Structure

2.2. Diabetes Mellitus

Diabetes mellitus in medical terms is referred to as a disease known as diabetes or diabetes. The term comes from the Greek language. Diabetes means to flow continuously, mellitus means honey or sweet. Thus, this term indicates about the state of the patient's body, that is the sweet liquid that flows continuously.

If the disease is left untreated or is not aware of his illness, the patient years later there will be a variety of chronic complications were fatal. Heart disease, impaired kidney function, blindness, leg decay, which sometimes requires amputation, or the incidence of impotence is very disturbing, are some of the possible complications..

2.3. Diabetic Retinopathy

Diabetic retinopathy (DR) is a microvascular complication that occurs in people with diabetes that causes abnormalities in the retina. DR typically characterized by small changes in the retinal capillaries, then microaneurysm (MA) as small red spots on the retina. Weak capillary wall, causing bleeding / hemorrhages (HA) on the retina [2].

The variety of features consist of Microaneurysm retinopathy (Figure 2.2) is a dark red spots or minor bleeding usually looks like in the retina. Microaneurysm size ranges 10-100 μ or less than 1 / 2th optic disc diameter, and the average shape of a circle.

Hemorrhage (Figure 2.2) is a form of damage caused by DR red blotches of blood due to rupture of microaneurysm, this damage continues and more widespread if not treated properly can lead to exudates.

Exudates are small dots that are formed from lipids and proteins out of the blood vessels due to vascular leakage. There are two characteristics of exudates, namely hard and soft exudates exudates.

Hard exudates (Figure 2.3) is the damage caused by DR, this exudate stretched and enlarged, if not treated properly can lead to more severe eye conditions and could result in white patches appear like cotton is called as cotton wool. Soft exudates (Figure 2.4) look like a speck - a small white spot yellowish, if not addressed promptly can lead to hard exudates. Cotton-wool (Figure 2.5) looks like white patches like cotton, if not handled well and could result in more severe conditions of the eye and can lead to blindness.

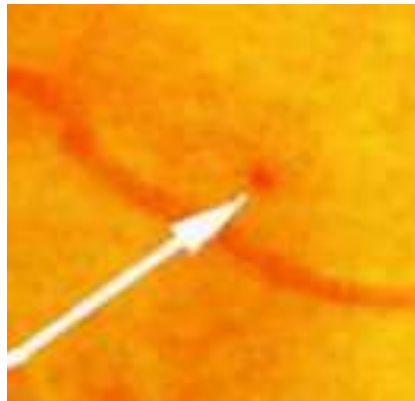


Figure 2.2 Microaneurysms

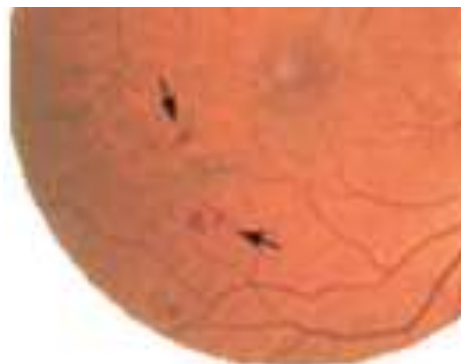


Figure 2.3 Haemorrhages



Figure 2.4 *Hard Exudates*



Figure 2.5 *Soft Exudates*

2.4 Classifying of Diabetic Retinopathy

Diabetic Retinopathy classified by 3 grades:

1. Normal
2. Non-Proliferate diabetic retinopathy (NPDR)
NPDR stages depend on the appearance and size of the features, such as hard exudate, microaneurisms, and cotton wool. NPDR is divided into three, namely:
3. Proliferate diabetic retinopathy (PDR) PDR phase is an advanced stage of NPDR, where the retina is deprived of blood and oxygen, leading to the presence of abnormal new blood vessels and fragile. When new blood vessels leak, it can cause vision loss and even permanent blindness can occur.

2.5. Digital Image Processing

Digital image processing is a discipline that studies matters relating to the improvement of image quality (contrast enhancement, transformation, color, image restoration), image transformation (rotation, translation, scale, geometric transformation), perform image selection trait (feature images), the process of withdrawal of the information or description of the object or object recognition, do compressed or data reduction for data storage purposes, and the data processing time. Input from image processing is the image, and the output is characteristic results processing [6]

2.5.1. Image Processing Stages

Stages of image processing consists of:

- 1 Image Acquisition
- 2 Preprocessing
- 3 Segmentation
- 4 Representation and description
5. Introduction and interpretation

[7] In a study of preprocessing is done by converting RGB to HIS image, then using median filtering on the first channel to reduce the noise and then use the Contrast-Adaptive Histogram Equalization Limited (CLAHE) to increase the contrast.

In another study of [8], optical disks easily distinguished from other features of the retina because the texture is smooth. To determine the entropy computed by calculating the probability mass function for the intensity of the pixels in the local area. Furthermore, the most widely selected connected component and circular.

2.5.2. Morphology

Morphological operations are a set of image processing operations which analyzes the shape of the image. The most basic morphological operations are dilation and erosion are used. Erosion removes pixels on object boundaries in an image by changing the pixel in the background, the object shrinks and break the object. Widening on the other hand, adding pixels to the boundaries of the object by changing background pixels around it. This will enlarge the object and multiple objects can be merged into one.

2.5.3. Canny Edge Detector

This detection is used to find the edge by finding the local maximum of the gradient $f(x, y)$. The gradient is calculated using the derivative of a Gaussian filter. This method uses two thresholds to detect strong and weak edges, and incorporate weak edges in the output only if the edge is connected to strong edges. Thus, this method is more likely to detect true weak edges.

2.5.4. Analysis Texture

In general, determining the texture of a digital image is to measure the difference in gray level (contrast) by performing windowing. Digital imagery has some basic elements of the following:

- a. Brightness
- b. Contrast
- c. Contour
- d. Color
- e. Shape
- f. Texture

2.6. Naive Bayesian

Bayes decision theory is a fundamental statistical approach in pattern recognition (pattern recognition). This approach is based on quantitative between various classification decisions using probability and the costs incurred in these decisions.

Bayes theorem provides a way to calculate the posterior probability $P(c|x)$, of the class prior probability ($P(c)$), the prior probability characteristics ($P(x)$) and the likelihood probability ($P(x|c)$). naïve Bayes classifier assumes, that the effect of the value of the predictor (x) on a particular class (C) does not depend on the values of other predictors. This assumption is called conditional independence.

$$P(c|x) = \frac{P(x|c) \cdot P(c)}{P(x)} \quad (1)$$

Where,

$P(c|x)$ = probabilities posterior from class target predictor (a tribute)

$P(c)$ = probabilities prior from class

$P(x|c)$ = probabilities likelihood predictor class
 $P(x)$ = probabilities prior from creditors

3. Diabetic Retinopathy Classifying

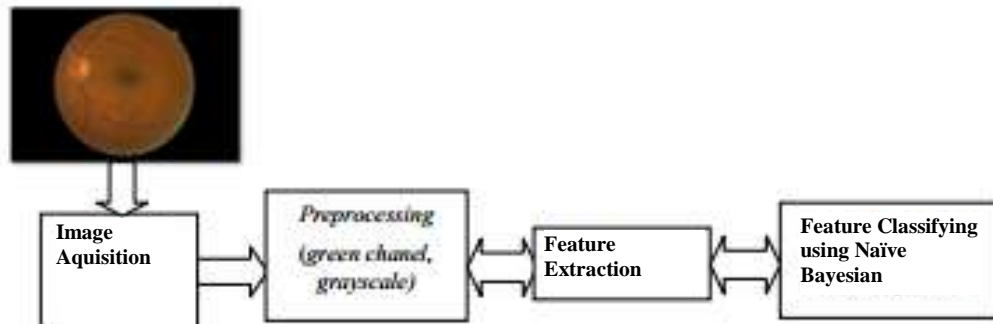


Figure 3.1 Block Diagram Of Diabetic Retinopathy Classifying

3.1. Diabetic Retinopathy Classifying Using Naive Bayesian

The stages of DR Classification using Naive Bayesian are:

- 1 Load Image
- 2 Calculate the mean value and standard deviation of each feature in each class of the data Training
- 3 Taking the value of the image feature extraction that will be tested
- 4 Calculate the prior probability of each class
- 5 Calculating the posterior probability

Here are the training data. This data consists of several features of the extraction results, as for the features used are as follows:

- EX = features of the sum of pixels exudates
- MIC = feature from the sum of pixels microaneurysms
- BV = the sum of the features of blood vessel pixels
- EN = entropy (1) grayscale (2) saturation (3) RGB
- K = Class, consisting of 3 classes, where K1 (Normal), K2 (NPDR), and K3 (PDR)
- Amount of data = 84
- Number of classes 1 = 28
- Number of classes 2 = 28
- Number of classes 3 = 28

Table 1. Feature Extraction of Data Training

NO	EX	MBC	BV	EN1	EN2	EN3	EN4	NO	EX	MBC	BV	EN1	EN2	EN3	EN4	NO	EX	MBC	BV	EN1	EN2	EN3	EN4
1	3	99	20815	4	7	7	5	29	44	78	27131	4	7	8	7	57	0	13	16436	4	7	6	5
2	67	98	11578	4	7	6	6	30	107	23	27237	4	7	8	6	58	129	0	7844	4	7	6	6
3	9	64	9546	4	7	6	6	31	0	0	24460	4	7	8	6	59	480	133	11514	4	7	6	6
4	8	10	17503	4	7	7	6	32	8	0	24154	4	7	8	6	60	0	0	19327	4	7	8	5
5	0	120	24490	4	8	8	6	33	4	187	11413	4	7	6	6	61	0	0	28996	4	7	6	5
6	0	99	22973	4	7	8	6	34	0	36	20750	4	7	6	5	62	0	0	16446	4	7	7	5
7	8	18	19280	4	7	6	6	35	0	78	18213	4	7	6	5	63	6	0	20670	4	7	7	6
8	5	7	31552	4	7	7	6	36	0	77	20700	4	7	6	6	64	240	10	18150	4	7	8	6
9	8	33	28879	4	7	7	6	37	15	57	18007	4	7	7	5	65	0	0	15202	4	8	8	6
10	66	14	21546	4	7	7	6	38	0	0	15188	4	7	7	6	66	0	0	15047	4	7	8	5
11	541	212	19808	4	7	7	6	39	0	27	14173	4	7	7	6	67	0	0	19794	4	7	6	5
12	277	77	21760	4	7	7	5	40	4	0	18164	5	7	7	6	68	0	21	14865	4	7	7	5
13	50	157	20026	4	7	6	6	41	17	316	28793	4	7	6	6	69	0	0	8200	4	7	7	5
14	801	155	18806	4	7	6	6	42	19	0	24316	4	7	6	6	70	0	0	28910	4	7	8	5
15	208	88	15278	4	7	6	5	43	0	61	20451	4	7	7	5	71	0	0	22919	4	8	8	6
16	245	82	12281	4	7	6	5	44	0	19	19164	4	7	7	6	72	0	0	16540	4	7	7	6
17	0	0	10398	4	7	7	6	45	0	0	23620	4	7	6	6	73	0	26	18125	4	7	8	6
18	0	0	16905	4	7	7	6	46	0	34	21439	4	7	6	6	74	189	4	19404	4	7	7	5
19	0	19	13106	4	6	7	4	47	150	121	19443	4	7	8	6	75	86	11	26266	4	7	6	6
20	0	66	18237	4	7	6	6	48	496	183	21926	4	7	7	6	76	2	57	28631	4	7	6	6
21	2453	243	15197	4	7	8	6	49	514	364	39576	4	7	6	6	77	0	82	5680	4	7	6	6
22	960	116	20903	4	7	8	6	50	672	41	21144	4	7	7	6	78	3	9	22719	4	7	6	6
23	0	35	18958	4	8	8	5	51	18	69	17920	4	7	8	6	79	0	42	18199	4	7	6	6
24	7	0	408	4	7	8	5	52	487	314	16044	4	7	8	5	80	5	10	17636	4	7	6	6
25	152	80	4944	4	7	6	6	53	1249	188	31820	4	7	7	5	81	60	61	21456	4	7	8	6
26	138	25	8635	4	7	6	6	54	0	0	20494	4	7	7	5	82	0	33	16624	4	7	8	6
27	0	0	20386	4	7	8	6	55	0	514	21063	4	7	8	5	83	57	49	27560	4	7	6	6
28	0	27	20181	4	7	8	6	56	1	452	22937	4	7	6	5	84	0	15	18300	4	7	8	6

4. Results and Discussion

Tests using 36 data consisted of 12 normal data, 12 data with the DR rate NPDR, and 12 data with the rank of PDR DR. From the test results are correctly classified the data 32 and 4 the data is classified in other classes. To calculate the percentage of the effectiveness of the system can use the f-measures.

$$TR (\text{True Positif}) = 23$$

$$FN (\text{False Negatif}) = 1$$

$$FP (\text{False Positif}) = 0$$

Following the calculation of the value of the effectiveness of the program with coefficient = 0.5 :

$$TPR = \frac{23}{23 + 1} = 0.95 \quad PR = \frac{23}{23 + 0} = 1$$

$$Efektifitas = \frac{0.95 \times 1}{0.5 \times 0.95 + (1 - 0.5) \times 1} = 0.97$$

Effectiveness NPDR

$$TR (\text{True Positif}) = 12$$

$$FN (\text{False Negatif}) = 0$$

$$FP (\text{False Positif}) = 0$$

$$TPR = \frac{12}{12 + 0} = 1 \quad PR = \frac{12}{12 + 4} = 0.75$$

$$Efektifitas = \frac{1 \times 0.75}{0.5 \times 1 + (1 - 0.5) \times 0.75} = 0.86$$

The value of the effectiveness of the above, the percentage of accuracy of the system in the fundus image classification rate is 100% NPDR and PDR level fundus image classification of 86%. Overall the percentage of the system of classifying the DR of 97%

5. Conclusion

Classification of diabetic retinopathy using a program testing performed three times with a total of 120 training data and test data as many as 36 data. To test was done by comparing the results of identification manually. Based on the discussion and description of the application that was created along with the trials that have been conducted, it can be concluded:

Applications can detect diabetic retinopathy severity level based on the normal, NPDR, and PDR with a success percentage of 97% of the entire image are tested.

6. References

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