

IDENTIFICATION OF GLAUCOMA THROUGH RETINA IMAGES USING THE LEARNING VECTOR QUANTIZATION (LVQ) METHOD

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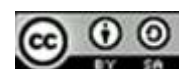
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Abstract: Glaucoma is the second leading eye disease of blindness after cataracts. An ophthalmologist does a glaucoma examination with an eye screening that will produce a retinal image. The diagnosis's result of the retinal image is subjective because each doctor has dissent and a condition experienced. This research builds a system to identify retinal images in the category of glaucoma or normal patients. The purpose of this system as a tool is to help ophthalmologists diagnose glaucoma. This process begins by changing the colour of an image to validity. The image is extracted using the Gray Level Co-occurrence Matrix (GLCM) and produces five features than the result of the five features used as input to neural network Learning Vector Quantization (LVQ). The amount of retinal image data used 60 data for learning and 20 for testing. And the number of neurons used is 12, and the epoch of as many as 1000 was obtained based on the results comparison of variations against 8, 10, 12, 18, and 20 neurons with 500, 900, 1000, and 1100 epochs. The learning process results from the value of weights that will be used in the testing process. The results of this study obtained an accuracy rate of 85%, a precision of 89%, and a recall of 80%.

Keywords: glaucoma; LVQ; GLCM

Abstrak: Glaukoma merupakan penyakit mata penyebab kebutaan nomor dua setelah katarak. Pemeriksaan penyakit glaukoma dilakukan oleh dokter spesialis mata dengan cara skrining mata yang akan menghasilkan citra retina. Hasil diagnosa citra retina oleh dokter bersifat subjektif karena setiap dokter memiliki pendapat yang berbeda serta kondisi yang dialami. Penelitian ini membangun sistem untuk mengidentifikasi citra retina mata kedalam kategori penderita glaukoma atau normal. Tujuan pembuatan sistem ini sebagai alat bantu bagi dokter mata dalam mendiagnosa glukoma. Proses ini diawali dengan mengubah warna citra menjadi keabuan, kemudian citra tersebut diekstraksi menggunakan Gray Level Co-occurrence Matrix (GLCM) dan menghasilkan lima nilai fitur yang kemudian hasil dari kelima fitur tersebut digunakan sebagai masukan jaringan syaraf tiruan Learning Vector Quantization (LVQ). Jumlah data citra retina yang digunakan sebanyak 60 data untuk learning dan 20 data untuk testing. Dan untuk jumlah neuron yang digunakan yaitu 12 dan epoch sebanyak 1000 yang didapat berdasarkan hasil perbandingan variasi terhadap neuron sejumlah 8, 10, 12, 18, 20 dengan jumlah epoch sejumlah 500, 900, 1000 dan 1100. Hasil dari proses learning yaitu nilai bobot yang akan digunakan sebagai bobot di proses testing. Hasil penelitian ini diperoleh tingkat akurasi sebesar 85%, presisi sebesar 89% dan recall sebesar 80%.

Kata kunci: glaukoma; LVQ; GLCM



INTRODUCTION

Glaucoma is the disease that causes blindness, second only to cataracts worldwide. In Indonesia, the percentage of glaucoma sufferers is 0.46%, equivalent to five people with glaucoma out of 1,000 Indonesians. This can be seen from the number of hospital patient visits in 2016 – 2017 who underwent treatment due to glaucoma; there was an increase of 167,794 cases [1]. Glaucoma can be detected by screening the eye, taking pictures of the retina using a fundus camera, and then the retinal fundus image is analysed by a doctor. The screening process has weaknesses, namely in manual retinal image analysis. So that a tool is needed, that can identify glaucoma so that it can help the doctor in considering the results of retinal photos.

Previous studies have been conducted to identify glaucoma disease from retinal image processing results, but the number of studies is still minimal. One is research using the GLCM and KNN methods that can provide correct percentage results of 83.33% at the value of $K = 9$ [2]. Then several studies use the LVQ method in classifying data from retinal images, including research in identifying diabetic retinopathy, which can provide an accuracy of 85%. [3].

Eye Disease Identification Research shows accurate results of 92% of 9 types of diseases with 21 symptoms in the eyes [4]. Then there was a study using LVQ in identifying the condition of kidney organ function from the iris image by producing an accuracy rate of 93.75% [5]. The following research is the use of the GLCM method with five

types of features to extract texture on the iris image using the LVQ method to detect the degree of spinal bending based on digital medical images and managed to get an accuracy rate of 100% with 100 hidden layers and a max epoch of 22 [6].

Research on identifying lip fingerprint patterns in men and women as forensic field applications using the LVQ method managed to obtain an accuracy rate of 93.3% with a computational time of 22.27 seconds [7]. Research on the identification of diabetic retinopathy disease using the LVQ method managed to obtain an accuracy of 82% using data of 250 data [8]. Analyzing pneumonia on X-Rays of the lungs using the LVQ method resulted in an accuracy rate of 89.71% [9].

Currently, no one has been found that focuses on identifying glaucoma disease using the LVQ method, even though the use of the LVQ method can classify images with reasonably high accuracy. Therefore, this study aims to build a system capable of identifying glaucoma diseases using the LVQ method.

METHOD

The research methods used are,

1. Data Collection

The data comprised 80 retinal images consisting of retinal glaucoma and normal retinas. The data is secondary data obtained from data providers, namely www.kaggle.com. Converting Imagery to Grayness

Table 1. Confusion Matrix

		True Class	
		Normal	Glaucoma
Predicted Class	Normal	True Positif (TP)	False Positive (FP)
	Glaucoma	False Negative (FN)	True Negative (TN)

The data obtained will be converted into slavery using the help of the toolbox from the MatLab application with coding 'rgb2gray(img)'.

2. Calculation Using GLCM

Then the grey image is calculated using the GLCM method with the help of the toolbox from the MATLAB application. Five image extraction features are used: contrast, correlation, energy, homogeneity, and entropy. The GLCM coding used in MATLAB is "graycomatrix(img)".

3. Classifying Using LVQ

Classify GLCM data using the LVQ method with the MATLAB toolbox.

4. System Accuracy Calculation

Then from the classification results using LVQ, the amount obtained will be calculated for accuracy, precision, and recall values using the Confusion Matrix method. Accuracy will represent the actual percentage value, precision will represent the percentage value of true positive, and recall will represent the percentage value of true positive value from actually positive. Confusion Matrix consists of true positive, true negative, false positive, and false negative, which will be described in Table 1.

Calculation of accuracy, precision, and recall can use the following formula,

$$\text{Accuration} = (\text{TP}+\text{TN}) / [1]$$

$$(\text{TP}+\text{FP}+\text{TN}+\text{FN})$$

$$\text{Presition} = \text{TP} / (\text{TP}+\text{FP})$$

$$\text{Recall} = \text{TP} / (\text{TP}+\text{FN})$$

5. Implementation into an application
The coding process is carried out to produce applications on MATLAB.

There are two stages of the LVQ method, namely:

1. Data Training Stage

The training stage was carried out using 60 retinal image data consisting of 30 retina glaucoma retinal image data and 30 normal retinal image data. Then the image is trained using the toolbox on Matlab with lvqnet coding. The output of the training stage is the final weight value that will be used in the testing stage.

2. Data Testing Stage

The testing stage was performed using 20 retinal image data consisting of 10 retina glaucoma and 10 normal retinal images. Then the image is classified using the final weight value assisted by the Matlab toolbox. The output of the testing stage is information from each testing data included in glaucoma or normal class.

RESULTS AND DISCUSSION

The following are the results and discussions that will be explained according to the order of research methods.

1. Data Collecting

The data used are retinal glaucoma and normal images. An example of the retinal image used can be seen in Image 1.



Image 1. Retina Image

2. Converting Imagery to Greyness

The data obtained will be converted into gray using the Matlab toolbox with *rgb2gray(img)* coding. The result of the conversion of gray imagery can be seen in Image 2.



Image 2. Gray Imagery Retina

3. Calculation Using GLCM

The gray imagery from the results of image color conversion will be calculated by five image extraction features, namely entropy, correlation, contrast, energy and homogeneity using the GLCM method with the help of a toolbox on Matlab. An example of one of the image extraction calculations, namely contrast, can be seen in Table 2.

4. Classifying Using LVQ

There are two stages in classifying using the LVQ method, namely the learning stage and the testing stage.

A. Data Learning Stage

In the learning stage using input, namely the value of the five features of 60 retinal image data. Then the data is carried out variations in the number of epochs to neurons to determine the best epoch and neurons that will later be used. In Image 3, it is known that the variation of epoch 1000 with neuron 12 produces a performance of 0.2 where the lower the performance is equal to the lower the error rate so that the lower the performance the better.

Table 2. Values of GLCM Contrast

Data	Kontras							
	Normal				Glaukoma			
	0	45	90	135	0	45	90	135
Ke 1	0.024513	0.03034	0.025186	0.029837	0.02531	0.03047	0.02488	0.03055
2	0.025932	0.032471	0.026628	0.032256	0.02530	0.03179	0.02567	0.03262
3	0.028146	0.033676	0.028231	0.033509	0.01587	0.01918	0.01559	0.01870
4	0.029523	0.034771	0.029694	0.035703	0.01551	0.01857	0.01473	0.02039
5	0.016638	0.021398	0.016806	0.021443	0.01794	0.02134	0.01757	0.02121

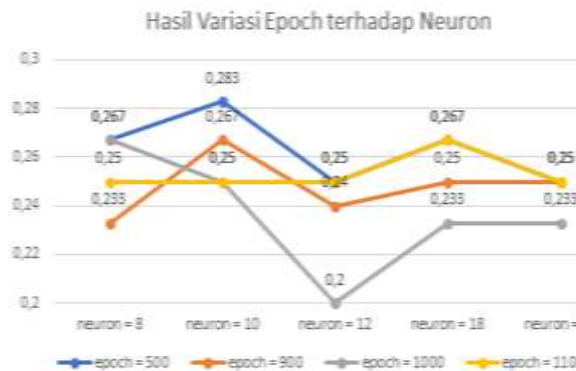


Image 3. Epoch Variation Result on Neuron

at the testing stage. The results of epoch variations on neurons will be represented in a graph as shown in Image 3. Based on the results of epoch variations on neurons, at the testing stage, the final weight value of the number of epochs of 1000 and the number of neurons will be used, which is 12.

B. Data Testing Stage

In the testing stage using input, namely the value of the five features of 20 retinal image data. Then the data were tested using the final weight value with the number of epochs 1000 and neurons 12. The results of the testing stage are information from each testing data included in glaucoma or normal class which will be exemplified in Table 3.

5. System Accuracy Calculation

At the calculation stage, the accuracy of the system is obtained from the results of the testing stage in Table 3 with each value of TP = 8, TN = 9, FP = 1, and FN = 2. Then the values are calculated with accuracy, precision, and recall.

$$\text{Accuration} = (TP + TN) / (TP + FP + TN + FN)$$

$$= (8 + 9) / (8 + 1 + 9 + 2)$$

$$= 0.85 \text{ atau } 85 \%$$

$$\text{Presition} = (TP) / (TP + FP)$$

$$= 8 / (8 + 1)$$

$$= 0.89 \text{ atau } 89 \%$$

$$\text{Recall} = (TP) / (TP + FN)$$

$$= 8 / (8+2)$$

$$= 0.8 \text{ atau } 80 \%$$

6. Implementation into an application

The application created has a .mlapp extension which devices can only run with a Matlab application.

This application consists of two displays, namely

a. Main View

the main display on the application contains some information about the origin of the agency and study program of the system maker, the title of the system, the name of the maker and the start button.



Image 4. Main View

b. Second View

The second view contains all processes from the application, from searching for image data and processing image data to classifying image data.



Image 5. Second View

CONCLUSION

Identifying glaucoma disease using artificial neural learning vector quantization (LVQ) begins with remodelling the coloured retina into greyness and then calculating features, namely contrast, correlation, energy, entropy and homogeneity with an angle of degrees 0, 45, 90 and 135. From the values of the five features, 60 data were used for the learning process with LVQ using the number of neurons 12 and epoch 1000 obtained from the results of neuron variations of 8, 10, 12, 18, 20 with epochs of 500, 1000, 1100. The output of the learning process will be in the form of the final weight value, which is used as input in the testing process with data amounting to 20 images data producing the output of normal image information or glaucoma. The results processed in this study were an accuracy value of 85%, precision of 89% and recall of 80%.

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