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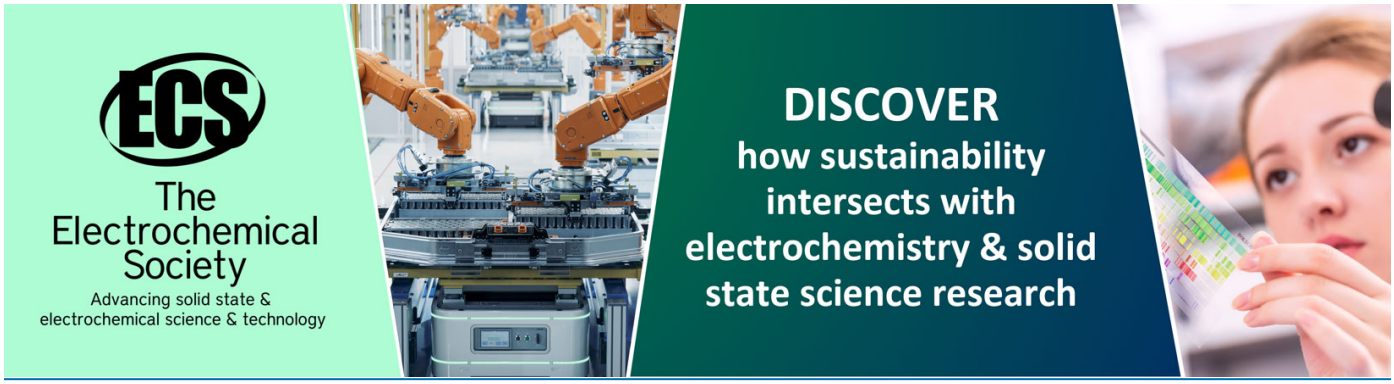

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Identification of Retinoblastoma Using Backpropagation Neural Network

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Abstract. Retinoblastoma (eye cancer) is an eye disease that is usually suffered by children that attack the thin nerve tissue behind the eyes (the part which is sensitive to light). Retinoblastoma can attack one or both eyes and it is a type of disease that can be caused by a genetic mutation called Retinoblastoma1 (RB1). On manual physical examination using ophthalmoscopy by a doctor or an expert there is a yellowish white / white cancer on the fundus that is often caused by the vascularization. That is why it needs a method that can be done to identify retinoblastoma disease through retinal fundus images automatically. In this research the method used is Backpropagation Neural Network using input of retinal fundus image. The stages which is done to identify retinoblastoma disease are image processing (resize, grey scaling, morphological close operation, and optic disk elimination), feature extraction using Grey Level Co-occurrence Matrix method and then classification using backpropagation neural network. After testing on the system in this research, it was concluded that the method used is able to identify retinoblastoma disease with accuracy 90%.

1. Introduction

Retinoblastoma (eye cancer) is a cancer of the eye that usually affects children. It attacks the thin nerve tissue behind the eyes (the part which is sensitive to light). Retinoblastoma can attack one or both eyes and it is a type of disease that can be caused by a genetic mutation called Retinoblastoma1 (RB1). This disease can cause blindness, even cause death.

RB disease ranks as the third largest patient case of cancer in the world after blood cancer (Leukemia) and brain cancer. Based on data from RSCM Jakarta, retinoblastoma became the second largest patient case in Indonesia until the first quarter of 2017. Retinoblastoma patients ranged from 25-30 cases per year in 1997. Since 2006, the number continues to increase to 40 cases per year.

There are several symptoms that appear in patients with retinoblastoma disease. The most common symptom of this disease is the presence of leukocoria that appears in the middle of the eye (pupil). Other symptoms that occur in retinoblastoma are strabismus, the appearance of a lump in the eye, protruding eyes, red eyes, and visual impairment.

Retinoblastoma is usually curable if detected early. Early diagnosis Retinoblastoma can maximize visual prognosis and patient survival rates. If not treated immediately, the disease can develop and attack other parts of the body and endanger the lives of sufferers. Diagnosis of this disease can be done based

on physical examination and investigation such as orbital ultrasound, CT-Orbita-Scan, CT-Scan head, chest X-ray, and bone scan. Physical examination can be done manually through ophthalmoscopy by a doctor while seeing a yellowish white / white cancer lesion on the fundus that is often associated with the increased of vascularization. In this study the authors propose method of retinoblastoma identification through retinal fundus by using backpropagation neural network. Research by utilizing the fundus retina had previously been done by Balasundari et al. 2016 by using a Gaussian filter, Fast Fourier Transform, then log Transform to compress light pixels of the image [1].

In addition, research has also been carried through the image of the iris by Gupta et al. 2015 by using wavelet transform after the previous image enhancement, pre-processing median filtering. Furthermore, the histogram equalization and thresholding is used to distinguish eye cancer and the normal one [2].

The next study is research by Henning et al. in 2014 to detect leukocoria through several pictures taken by camera phone. The detection was made through the iris using convolutional neural network without any pre-processing of the digital image of the eye (except rescaling). This study gives a accurate result by using only the learning process [3].

Furthermore, there is also research conducted by Perea et al. in 2014 to detect leukocoria through iris analysis using median filtering to remove noise. After denoising then performed equalize histogram for a better angle detection by using wavelet-based filtering and then Hough Transform [4].
Research by applying back propagation algorithm in medical imaging had previously been done on the detection of gastric disorders through the iris of the eye are performed [5][6].

2. Problem Identification

Retinoblastoma (eye cancer) is a cancer of the eye that usually affects children. It attacks the thin nerve tissue behind the eyes (the part which is sensitive to light). On fundus examination of the retina, one of the signs of the disease is the presence of cancer with white or yellowish white. In general, to identify this disease through the fundus retina is still done manually by a specialist (doctor) which is allowing the occurrence of errors in diagnosing the disease. Therefore, we need a method that can help experts (doctors) in the diagnosis of retinoblastoma disease in order to obtain a better examination results than diagnosing manually.

3. Methodology

The method proposed for identifying retinoblastoma in this study consists of several processes. The processes are: pre-processing that consist of resizing, gray scaling, morphological close operation, and optic disc elimination. After pre-processing is done then performed using the image feature extraction, GLCM. Furthermore, the final process after the classification feature extraction is performed by using back propagation neural network. General architecture that describes each methodology in this study is shown in Figure 1.

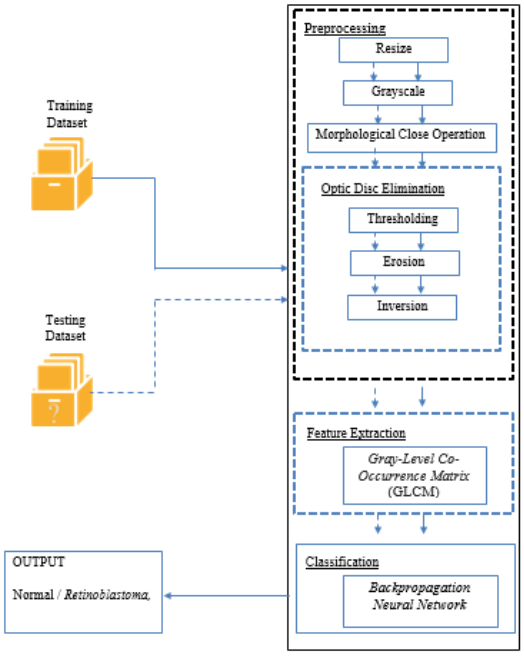

Figure 1. General architecture.

3.1. Pre-processing

In the pre-processing stage, retinal fundus image processed to be extracted by producing a good trait. The steps are resizing, grayscale, morphological close operation, and optic disc elimination that can be seen in figure 2.

- Resizing
  In the early stages of pre-processing is performed resize to change the original size of images in the horizontal direction and / or vertical to 200x200 px. It aims to unify the size of each image which is used for training and testing process.
- Grayscale
  The next stage is performed fundus retinal grayscale to convert color images into gray image in the image with a size of 200x200 pixels.
- Operation Morphological Close
  The next stage is optic disc elimination. Optic disc has the characteristics and shape that like a cancer, that is why it must be eliminated. The stages include thresholding, erosion and inversion.

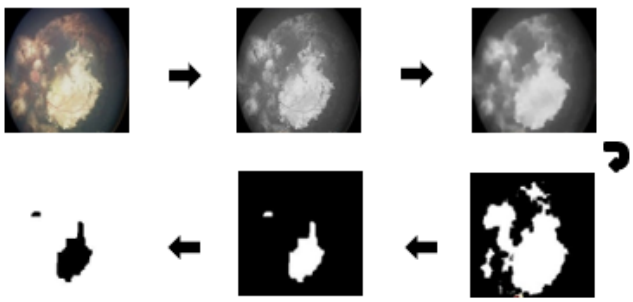

Figure 2. Preprocessing.

3.1.1. Optic Disc elimination

In the early stages of pre-processing is performed resize to change the original size of images in the horizontal direction and / or vertical to 200x200 px. It aims to unify the size of each image which is used for training and testing process.

- Thresholding
  At this early stage in order to eliminate the optical disc that is thresholding, i.e. thresholding segmentation method is simple. With this method produced the segmentation of the optic disc.
- Erosion
  Optic disc is circular, but the results of the previous process does not show the shape of a circle. So, we perform erosion (thinning pixels) to create a circle on the optic disc.
- Inversion
  In the next stage of inversion (negative image formation), black pixels are obtained when converted to white and white to black changed.

3.2. Feature Extraction

The next process is feature extraction. Shape or part that has been represented to be taken distinguish characteristics by using feature extraction GLCM, so that the results obtained from the extraction of features used for the next process called the identification stage.

3.3. Classification

The last stage of retinoblastoma identification through fundus image of retina is classification. Information obtained from the previous process will be classified based on the results of the training process. Classification is done by using the back propagation neural network algorithm.

An initial stage in the training process is the input of training data. In this research the authors used 40 input data to be trained. Each input data consists of five feature extraction results that will be used directly as an input neuron. Then specify the target output of each data input. Then initialize value of all weights and biases at random in the range of -1 to 1. After that specify the parameter values like learning rate, the maximum epoch, and the minimum error. After initializing, for each data input is done by calculating the feedforward phase output value of each neuron in the hidden layer and output layer. Then do the phase backward to calculate the error factor in the output layer and the hidden layer. The error factor calculation results will be used to calculate the weight change rate in the output layer and the hidden layer. Then count the number of errors of input data by adding together the error of each neuron in the output layer. Then calculate the error value at each epoch by summing the sum of each data input error. If the value of an epoch error is smaller than the minimum value specified error then the iteration will stop, vice versa. After the final iteration stopped the weight value stored in the file "weights.txt" that will be use in the testing phase. Training backpropagation network using network architectures such as five input neurons, two hidden neurons, and two output neurons.

After the training process is done, then do test. In backpropagation network testing phase is done simply by implementing a forward direction (feedforward). The data used in the testing phase is the data that is not used during training. The weights used in the phase of the forward direction is the weight training process results. Then calculate the output value of each node in the hidden layer and output layer. After testing of the output of each node in the output layer, if the output node is greater than 0.5 then the output value will be changed to one that is showing signs of retinoblastoma. Conversely, if the output value of less than 0.5 will be changed into 0 which showed no indication of retinoblastoma (normal).

4. Result

The parameters used in the backpropagation neural network can be shown in Table 1.

Table1. Backpropagation Parameters

No.	Information	Information
1	Total input neurons	5
2	The number of hidden neurons	2
3	Total output neurons	2
4	Function activation	Binary sigmoid
5	Maximum epoch	600
6	Minimum error	0.0
7	Learning rate	0.8

In determining the parameters used in the propagation process, the previous step is conducted experiments on learning parameter rate selection in the training process that can be seen in Figure 3. The experiment was performed using the maximum value of 600 and learning epoch with different values. Based on the experimental result that the learning rate 0.8 provides the results of training with accuracy 100% and actual epoch that is quite a bit compared to the others, so that the learning rate of 0.8 is used as a parameter to backpropagation algorithm.

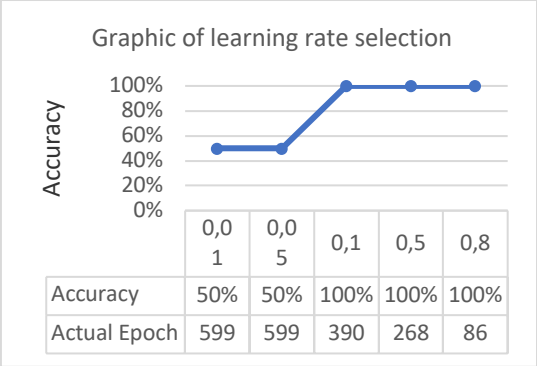

Figure 3. Graphic of learning rate selection.

The result of the testing process in identification of retinoblastoma are based on the final weight training using the parameters in Table 1. Testing images were used for each category amounted to 5 so that the total image is 10. The result of testing can be seen in Table 2.

Table 2. Testing result.

No.	Image's Name	Desired Output	Actual Output
1	21_h.jpg	Normal	Normal
2	22_h.jpg	Normal	Normal
3	23_h.jpg	Normal	Normal
4	24_h.jpg	Normal	Normal
5	25_h.jpg	Normal	Normal
6	rb21.jpg	Retinoblastoma	Retinoblastoma
7	rb22.jpg	Retinoblastoma	Retinoblastoma
8	rb23.jpg	Retinoblastoma	Retinoblastoma
9	rb24.jpg	Retinoblastoma	Retinoblastoma
10	rb25.jpg	Retinoblastoma	Normal

Based on the results in Table 2, the overall accuracy can be calculated. Overall accuracy is obtained by adding the appropriate amount of actual output to the desired output divided by the total number of testing dataset that is used as follows: accuracy = 9/10 x 100.

From the above calculation can be seen that the level of accuracy of backpropagation neural network in identifying the disease of retinoblastoma through fundus image reached 90%.

5. Conclusion

Based on this research in identifying the disease of retinoblastoma using Backpropagation Neural Network can be concluded that the method of Backpropagation Neural Network was able to identify the disease retinoblastoma through fundus image of retina with an accuracy of 90%. However, the shape and size of the cancer that resembles the optic disc on the fundus image become one of the difficulties in the pre-processing stage because the cancer could have been eliminated during the process of optical disc elimination, so that it can reduce the accuracy of the identification of the disease.

Subsequent research can be developed with another machine learning algorithms that have higher accuracy, implement another feature extraction algorithms and methods for the optic disc elimination to improve the accuracy of the identification result of the disease. Furthermore, the dataset used in the research should be more to improve the accuracy of testing.

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