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FACE IMAGE RETRIEVAL SYSTEM USING COMBINATION METHOD OF SELF ORGANIZING MAP AND NORMALIZED CROSS CORRELATION

Amir Saleh[1], Diky Suryandy[2], Jesron Nainggolan[3]
[1,2,3] Universitas Prima Indonesia
[1]amirsalehnst1990@gmail.com , [2]dikysuryandi09@gmail.com , [3]jesron12nainggolan@gmail.com

Abstract

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Content based image retrieval (CBIR) is one method in computer vision that is widely applied in various fields of life. In this study, two algorithms will be combined, namely self organizing map (SOM) and normalized cross correlation (NCC) to test the method in the face image retrieval system. The SOM algorithm is used to perform learning on the system created and the NCC method is used to calculate the proximity value between the input image and the image contained in the database to be displayed as the result of image retrieval. The test results in the proposed research show good results with an accuracy rate of face image retrieval of 93.62%. This percentage is higher than using the usual SOM method with an accuracy rate of face image retrieval of 91.62%.

Keywords: CBIR, SOM, NCC, Face Image

1. Introduction

Digital images can be used for various activities in various fields of life, such as: trade, government, education, health and security with the number increasing day by day. A common problem found in digital images is in the process of storing large amounts of image files and searching for information on one of the image files. One solution to this problem is to use a database as a data storage medium and display information based on the input image provided [1]. Search engines typically use text that is typed in and linked to the name of an image. However, if most of the image names in the database do not represent the image, then the search will be difficult. One way to search for images in the database can be done with the image retrieval system method. This method is used to find an image from a set of image data or databases by matching the attributes contained in the image. Some of the image attributes that can be used for the image retrieval system method are based on color and texture [2].

The image retrieval system (CBIR) method is a technique for image search based on a given query image and automatically displays similar images as a result based on the similarity of attributes contained in the image database [3]. The way CBIR works is different from the image search method using keywords [4]. The main advantage of this method is its ability to support visual queries. CBIR is an image search method by comparing the query image with the image in the database (training image).

A person can generally be recognized or identified by others based on his face. The face is the central organ for human expression, recognition and communication. Every human face has unique criteria (not the same), so it can be easily distinguished from one another even with images. Face images are also often used to search for data or identify a person for various purposes, such as: attendance and security systems [5]. One of the methods in data search or face identification with face images can be done using the image retrieval system method [6].

Research on image retrieval systems has been carried out by [7] entitled face retrieval and recognition using the CBIR method and a combination of features. In this study, the resulting face recognition displays a very good performance with a data accuracy of 99.9%. Another study conducted by [8] entitled medical image retrieval using self organizing map on texture features. Tests in this study resulted in very good accuracy with a percentage of 93.33%.

The self-organizing map (SOM) artificial neural network requires an initial weight in its learning that is randomly selected. However, several studies show less than optimal results when the initial weight selection is not properly carried out, so that it will reduce the level of accuracy. Determination of initial weights on the SOM network has a major impact on the convergence of the learning methods being trained [9]. The equation used in self organizing map (SOM) learning in measuring the distance between the input and output nodes uses the Euclidean distance equation. This equation has good results in doing its job to see the similarity of the data so that it can be classified in the same class. However, the use of these equations can also cause overlapping cluster problems. Data with similar features will be collected into one cluster even though they are not in the same category. This will also lead to inefficient results where all scattered objects are mapped to a two-dimensional topology that forms a cluster that is not compatible [10].

Based on several studies that have been mentioned, this research will conduct research on the face image retrieval system using the Self Organizing Map (SOM) and Normalized Cross Correlation (NCC) methods. The use of the NCC method was chosen as a method of measuring the level of similarity because of the acquisition of good accuracy in the test. This can be seen from the research that has been done by [11] explaining that face matching using the NCC method is one of the best approaches that provides perfect face matching according to the target. The SOM method is used for the formation of image data clusters and the system learning process. Furthermore, by using the NCC method, it is possible to measure the similarity of the image so that validation can be carried out on the face image meeting point.

2. Materials and Methods

2.1 Content Based Image Retrieval

Image retrieval system is a method used to search for an image with a comparison between the query image and the image contained in the database based on the information or characteristics that exist in the image [12]. This system is widely used in various areas of life, such as traffic crime information. The image caught on camera and considered a violation will immediately be processed in the program to find information about the violator [13]. The steps used for the image retrieval system can be seen in Figure 1 below.

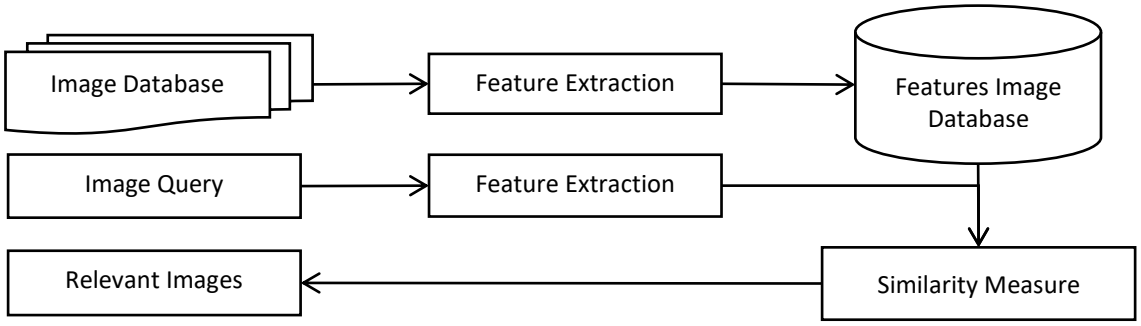


Figure 1. Flowchart Image Retrieval System

2.2 Feature Extraction

Feature extraction is a method for extracting features or characteristics from an image based on color, shape or texture [14]. Feature extraction is one of the important things to do in image processing

because from the results of feature extraction, important information can be obtained about the characteristics of the image.

Texture feature is a digital image representation that you want to analyze based on the texture of an image. In this study, texture characteristics were used using the Gray Level Co-occurance matrix (GLCM) method. These characteristics include [15]:

$$Contrast = \sum_i \sum_j (i-j)^2 P(i,j)$$
$$Correlation = \frac{\sum_i \sum_j i,j\ P[i,j] - \mu_i \mu_j}{\sigma_i \sigma_j}$$
$$Energy = \sum_i \sum_j P[i,j]^2$$
$$Homogeneity = \sum_i \sum_j \frac{P[i,j]}{1+[i-j]}$$

Color characteristics in this study on the image is done by looking for color feature extraction using the HSV method. This method is used to define the RGB color contained in an image that has a value range between 0-255 which will be converted to HSV with a value of 0-1. The formula used is [16]:

$$Hue = \begin{cases} 60^0 \times \left(\frac{G'-B'}{\Delta}\ mod 6\right), Cmax = R' \\ 60^0 \times \left(\frac{B'-R'}{\Delta} + 2\right), Cmax = G' \\ 60^0 \times \left(\frac{R'-G'}{\Delta} + 2\right), Cmax = B' \end{cases}$$
$$S\ (Saturation) = \begin{cases} 0, \Delta = 0 \\ \frac{\Delta}{Cmax}, \Delta <> 0 \end{cases}$$
$$V = Cmax$$

2.3 Self Organizing Map (SOM)

SOM is a technique for analyzing input data with high dimensions which is unsupervised neural network. This model consists of elements, namely units, where each unit is given a weight factor for each cluster [17]. The SOM network architecture consists of two layers, namely the input layer (X) and the output layer (Y). Each neuron in the input layer is connected to every neuron in the output layer. Each neuron in the output layer represents the class of the given input [18]. The SOM network architecture can be seen in Figure 2 below.

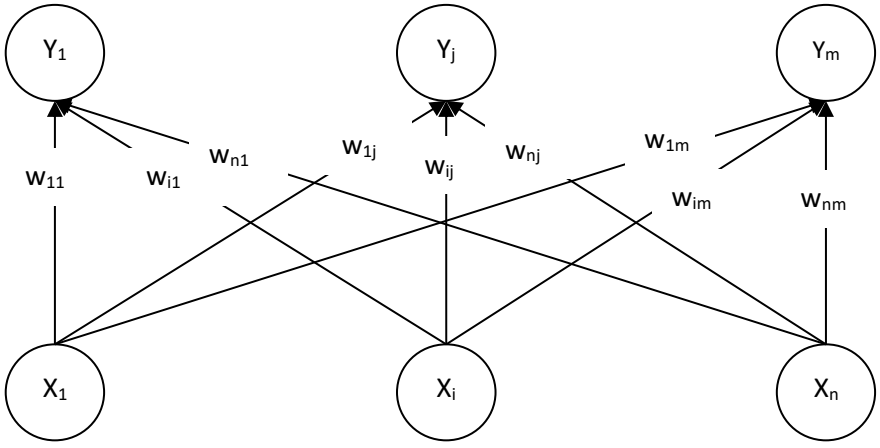


Figure 2. SOM Network Architecture

The steps used to perform SOM calculations can be done as follows [19]:

1. Initialization
   - Determine the weight with a random value
   - Setting the learning rate parameter (α)
   - Determine the number of epochs
2. Calculating Euclidean distance between data and weight
3. Find the index with the closest distance D (minimum)
4. Make improvements to the weight value with the following equation
   wij(new) = wij(old) + [xi – wij(old)]
5. Update the learning rate with the following equation
   (t+1) = 0.5 t
6. Repeat steps 2 to 5, congratulations the epoch has not been reached.

2.4 Normalized Cross Correlation (NCC)

The method for measuring image similarity based on the correlation function is called the normalized cross correlation (NCC). This method is often used to determine the similarity of two images based on the value of feature extraction that has been processed previously. The equation used to find the similarity value can be stated as follows [20].

$$NCC = \frac{\sum_{x=1}^{N}\sum_{y=1}^{M}[a(x,y).b(x,y)]}{\sqrt{(\sum_{x}^{N}\sum_{y}^{M}[a(x,y)]^2)}.\sqrt{(\sum_{x}^{N}\sum_{y}^{M}[b(x,y)]^2)}}$$

2.5 Research Method

In this study, in determining the initial weight of the SOM network, it will be obtained by calculating the level of similarity or proximity of image data using the NCC equation. The initial weight value is very influential on the image retrieval results and the NCC method will be combined for network training needs. This level of similarity is the basis for the system to find images in the database that match the query image.

Database images that have close proximity to the query image will be displayed in the order as the result of the image retrieval. Each query image will be inputted and its distance compared to the database image and seen accuracy for image retrieval. In the testing process, as many as 10 images are displayed on the database image according to the query image entered. In addition, as a comparison for the testing process, the ordinary SOM method using random weights is also used. This is done to see the performance of the proposed method. Each image tested will calculate the accuracy of the image retrieval accuracy using the two methods as much as the previously mentioned image, so that it can be seen which method is better in this study.

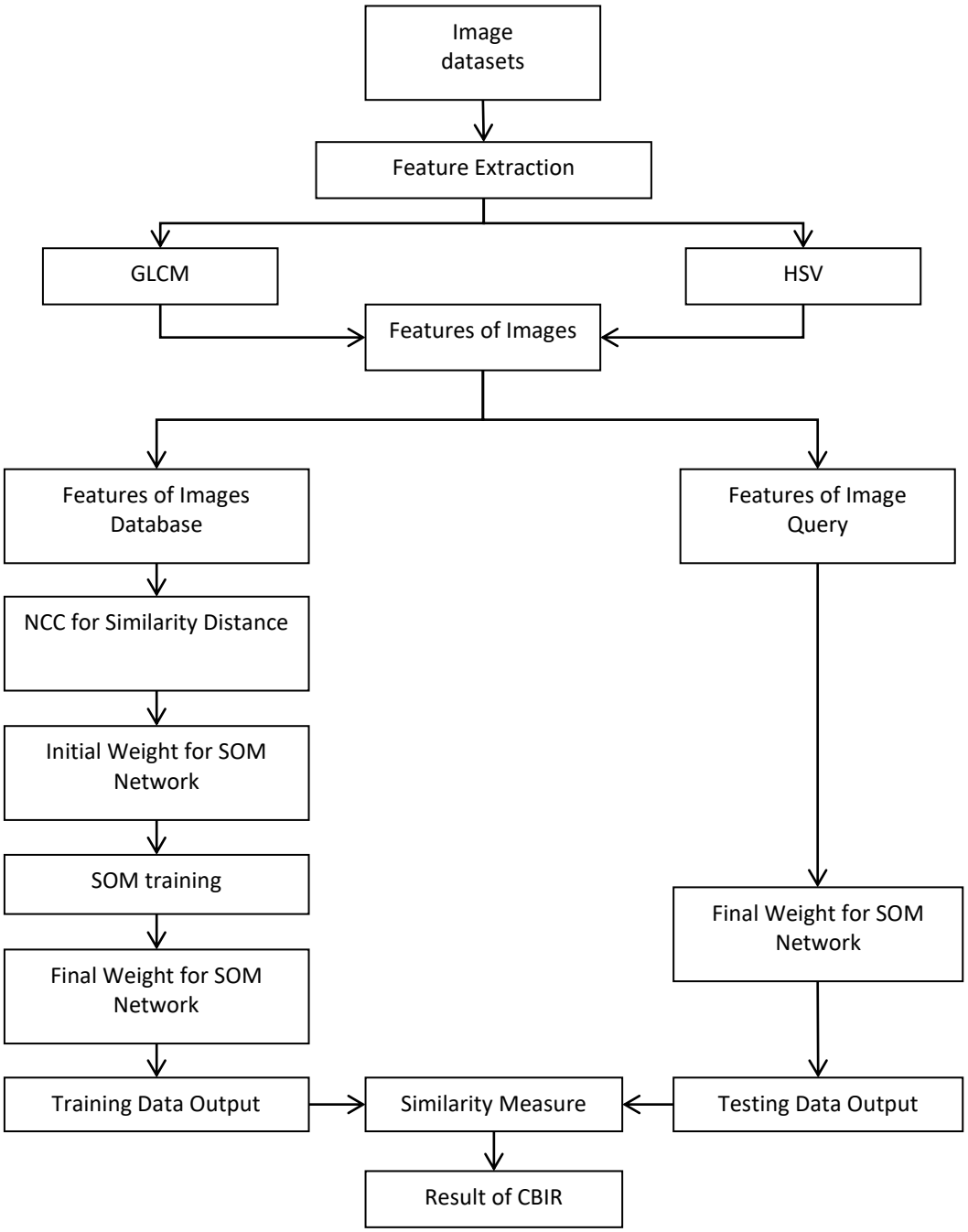


Figure 3. CBIR System using Combination SOM Neural Network and NCC

In Figure 3, the workflow in this study can be divided into 2 parts, namely the image feature extraction stage and the combination of SOM and NCC networks. At the feature extraction stage, the characteristics of each image will be generated based on the texture and color parameters. Extraction results will be collected and used as training data and test data. The training data obtained from the feature extraction results will be searched for the similarity of characteristics using NCC for initial weights on the SOM network. Next, the training process is carried out to find the final weight and network output. The network output in the training data and the test data will be measured for the

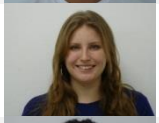
similarity level using the NCC equation. The results of the highest similarity of 10 images will be displayed as a result of the image retrieval system.

3. Results and Discussion

3.1 Data requirements

Face image data for research needs is taken from the internet page with the address https://fei.edu.br/~cet/facedatabase.html. The total images used for training and network testing are 130 images with a total sample class of 10 individuals. Each individual has a sample of 13 face images with various orientation angles which will then be carried out feature extraction based on color and texture. The data used in the implementation combination SOM and NCC of in the following:

Table 1. Face Images

No.	*Name*	*Image*
1	Person 1	
2	Person 2	
3	Person 3	
4	Person 4	
5	Person 5	
6	Person 6	
7	Person 7	
8	Person 8	
9	Person 9	
10	Person 10	

3.2 Image Retrieval Using SOM and NCC

The image retrieval system (CBIR) process begins with extracting image features based on texture and color characteristics in the image with a total of 7 features. Furthermore, the results of the

image feature extraction are input data for training and testing using the SOM and NCC methods in the image retrieval system. The experiment will be carried out using the number of image retrieval as many as 10 face images. The acquisition of accuracy results in image retrieval with the SOM-NCC method can be seen in Figure 4 as follows.

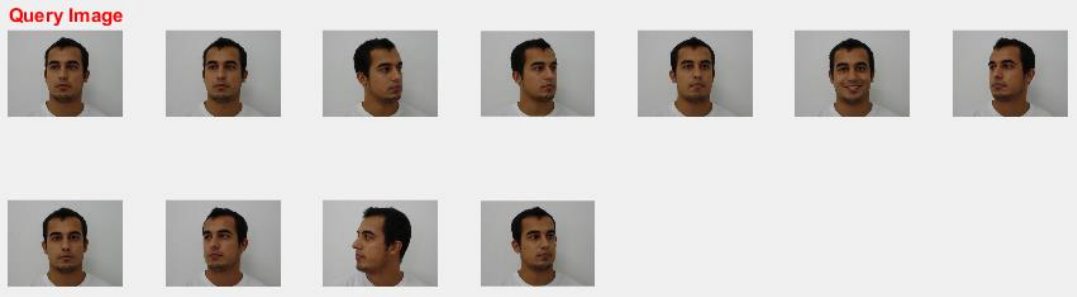


Figure 4. Image Retrieval Results Using the SOM-NCC Method

Correct : 10
Wrong : 0
Accuracy : 100%

Figure 4 shows the results of image retrieval accuracy from a query image. The above process is carried out for each image and calculated for each appropriate image accuracy. The next step is to calculate the accuracy of the image data group by calculating the average accuracy. The results obtained in the experiment with the SOM-NCC method on the face image retrieval system can be seen in table 2 as follows.

No.	*Name*	*Accuracy*
1	Person 1	96.92%
2	Person 2	91.54%
3	Person 3	92.31%
4	Person 4	84.62%
5	Person 5	98.46%
6	Person 6	100%
7	Person 7	93.08%
8	Person 8	100%
9	Person 9	95.39%
10	Person 10	83.85%
Average Accuracy		**93.62%**

3.3 Image Retrieval Using SOM

The experiment will be carried out using the number of image encounters as many as 10 face images using the SOM method with random weights. The acquisition of accuracy results in image retrieval with the SOM method can be seen in Figure 5 as follows.

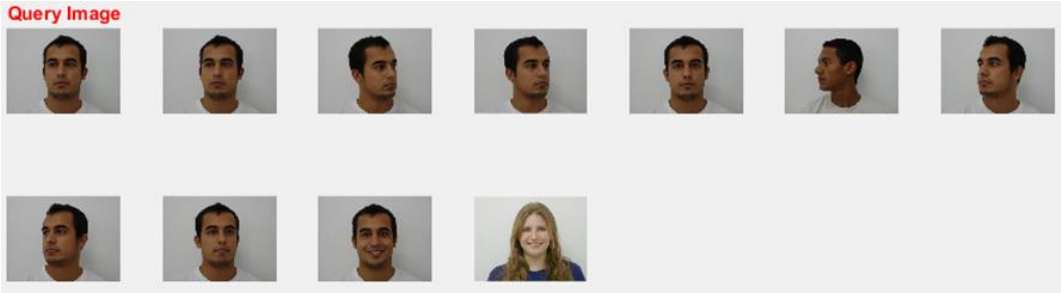


Figure 5. Image Retrieval Results Using the SOM Method

Correct : 8
Wrong : 2
Accuracy : 80%

Figure 5 shows the results of image retrieval accuracy from an image query. The above process is carried out for each image and calculated for each appropriate image accuracy. The next step is to calculate the accuracy of the image data group by calculating the average accuracy. The results obtained in the experiment with the SOM method on the face image retrieval system can be seen in table 3 as follows.

No.	*Name*	*Accuracy*
1	Person 1	96.15%
2	Person 2	93.08%
3	Person 3	76.92%
4	Person 4	83.85%
5	Person 5	100%
6	Person 6	100%
7	Person 7	93.08%
8	Person 8	100%
9	Person 9	92.31%
10	Person 10	80.77%
Average Accuracy		**91.62%**

Based on the research results, the average accuracy of the image retrieval system using a combination of SOM and NCC methods is 93.62%. While the average accuracy of the image retrieval system using the SOM method is 91.62%. The two methods have a difference in accuracy with the SOM-NCC method, which is 2% superior to using the SOM method.

In the proposed method, the appropriate initial weight is selected using the NCC equation, so as to improve the performance of the SOM method. The ordinary SOM method generally uses random weights and if the initial weight is chosen incorrectly, less than optimal results will be obtained. The NCC method was chosen because the work process is more effective in finding data that has the highest similarity in a collection of images. The image with the highest similarity is used as the initial weight in the SOM network and determines the image that will be displayed as the result of image retrieval.

4. Conclusions

Based on the research results obtained, the accuracy of the face image retrieval system using a combination of SOM-NCC methods obtains an average accuracy of 93.62%. While the results of the accuracy of the image retrieval system using SOM obtained an average accuracy of 91.62%. The results of the accuracy of the image retrieval system using a combination of SOM and NCC have increased by 2%. This is because the selection of the initial weight values obtained is more precise, so as to improve the performance of the SOM network.

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