IMPLEMENTATION OF BACKPROPAGATION ALGORITHM FOR CLASSIFICATION OF FINGERPRINT EXTRACTION BASED FEATURE CO-OCCURRANCE MATRIX

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ABSTRAK

In classifying the types of fingerprint images, accuracy is important because to produce an image of the fingerprint detection systems required good accuracy. The method used to detect the fingerprint image, used as a consideration. The method used in this research is the co-occurence matrix for characteristic texture and Back Propagation methods for classification.

Previously, a research has been done to prove that the method of matrix co-occurrence can extract the characteristic texture as well. The co-occurrence matrix is produce characteristic textures such as numberic data, measurement result that called continues, contrast, homogeneity, dissimilarity, energy, and entropy. Furthermore, there is also research that implements Backpropagation method for fingerprint classification. Both use data continue as input data to the Backpropagation method, and resulting a good accuracy.

From what has been described and elaborated, proven to be fully tested using the method of confusion matrix obtained accuracy rate of 90% with a learning rate of 0.5 and 0.01 errors. the growing up training data obtained, the better the accuracy.

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Keywords: features images, feature extraction, the co-occurrence matrix, classification, Backpropagation.

1. INTRODUCTION

Fingerprints are one's personal identity and will not be his equal. Although none have the same fingerprint, generally there are five types of fingerprint patterns, the whorl (circle), Right Loop (plugs to the right), Left Loop (plugs to the right), Tented Arch and Arch (bow). These five types of fingerprints that have the same properties and characteristics that perennial nature or attached to a lifetime on a human finger. In addition to perennial nature, fingerprints also are immutability as human fingerprints can not be changed, except for a condition in this case is most likely serious accidents so damaging patterns of fingerprints. The nature of the latter is individuality, which means all the originality of its owner which is not possible with anyone and have done research on the classification of types of fingerprints by Eko Sediyono, who conducted research on the introduction of types of fingerprints using Wavelet Symlet for feature extraction process to produce a level of accuracy The highest recognition of 80% [1].

In classifying and detecting an object accuracy is important because to produce a system of classification and detection of an object required good accuracy. The accuracy of which are obtained from the selection of appropriate methods and extraction. Previous studies have been conducted by A. J. Arriawati, doing an introduction to the image using Matrix Co-Occurrence with the highest recognition rate reaches 100% and the lowest recognition rate reaches 55.557%. From these studies, it is known that the Co-Occurrence Matrix method, an optimal method for the extraction of feature [2]. Further research has been conducted also on fingerprint classification by Karno L S, Dr. Deni Saepudin, Bedy Purnama with 81.67% accuracy rate [3]. From this research it is known that Backpropagation algorithm can produce good classification. The reason researchers use ANN-BP because of some other methods of JST, backpropagation is the most suitable method for classification. This is reinforced by previous studies showing that the classification results obtained using backpropagation high classification accuracy. Backpropagation method is an excellent method in dealing with the introduction of complex patterns [4]. Of the problems and the solutions that have been described, this thesis research will classify the type of fingerprint image on the basis of fingerprints by applying the method of Co-Occurrence Matrix and Back Propagation algorithm for image classification. So therefore this study is titled "Back Propagation algorithm implementation for the classification of types of fingerprint feature extraction matrix based co-occrrence". Expected classification of back propagation algorithm can classify types of fingerprints and measuring the level of classification accuracy.

1.1 Pattern

Pattern is an entity that is defined and can be identified and named by its features (feature). These characteristics are used to distinguish a pattern with other patterns. Characteristic of the good is having

distinguishing characteristic is high, so that the grouping is based on the features of the pattern can be performed with high accuracy.

A pattern is a composite / composite of traits that are characteristic of an object [6]. Some examples of patterns.

1. Letter, have characteristics such as height, thickness, vertex, and the curvature of the line.
2. Sound, has characteristics such as amplitude, frequency, tone and intonation.
3. Signature, have characteristics such as length, complexity, and pressure.
4. Fingerprints, have characteristics such as arches, and the number of lines.

Feature on a pattern obtained from the measurements of the test object. Lodging on the pattern present in the image, the characteristics of which can be obtained based on information from [6]:

1. Spatial: pixel intensity and histogram.
2. Edge: direction and strength.
3. Contours: lines, ellipses and circles.
4. Region / shape: perimeter, area and center of mass.

The results of Fourier transform: frequency.

1.2 Texture

In image processing there are an image recognition techniques, one of which is the introduction of the image based on texture analysis. Texture analysis plays an important role in digital image processing for texture analysis developed with the aim that the computer can understand, model making, as well as the process to be able to mimic the texture of the learning process of the human eye or vision.

1.3 Methods Matrix Co-Occurrence

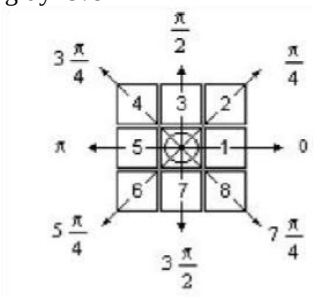
Co-occurrence matrix or matrix co-okurensi is one of the statistical methods that can be used for texture analysis. Kookurensi matrix formed from an image by looking at pixels in pairs that have a certain intensity. This method is based on the hypothesis that in a grayish texture will occur. For example, d is defined as the distance between two pixel positions, namely (x1, y1) and (x2, y2); and 0 is defined as the angle between them. Kookurensi then the matrix is defined as a matrix that states the spatial distribution between the two neighboring pixels which have an intensity i and j, which has a distance d between them, kookurensi matrix is given by:

$$P(i,j) = \frac{V(i,j)}{\sum_{i,j=0}^{n-1} V(i,j)}$$

Where :

P: Probability emergence of a couple of degree of gray

$V(i,j)$: The number of pairs of points with a particular gray level



Picture 1.1 Relation Between Pixel

A pixel which neighbors the range and between them, can be located in eight different directions, for more details can be seen in Figure 2.4 In the method Matrix Co-occurrence Haralick et al propose different types of characteristic statistical textures that can be extracted Some of these include among others are : Contrast (contrast), homogeneity (homogeneity), Entropy (Entropy), Energy (Energy) and Dissimilariti (dissimilarity).

The equation for these features are as follows:

1. Kontras (*Contrast*)

Indicates the size of the deployment (moment of inertia) elements of the image matrix. If located far from the main diagonal, the value of great contrast. Visually, the contrast value is a measure of the variation between the degree of gray an image area. The results contrast calculation related to the amount of gray in the image intensity diversity.

Formula

$$\sum_{i,j=0}^{n-1} (Pi,j).(i-j)^2$$

Where:

i and j are grayish nature of two adjacent pixels resolution

p (i, j) is Probability column (i, j)

2. *Homogenity*

homogeneity indicates a kind of gray degree of homogeneity image. Homogeneous image will have a great homogeneity prices.

Formula

$$\sum_{i,j=0}^{n-1} \mathrm{P(i,\ j)} / [1 + (\mathrm{i - j})^2]^{(2.2)}$$

Where:

i and j are grayish nature of two adjacent pixels resolution

p (i,j) adalah *Probabilitas kolom(i,j).*

3. *Entropy*

Entropy can show size shape irregularity, if the value of Entropinya for great image transition degree keabuan evenly and small value if not regular image structure (varies).

The formula:

$$-\sum_{i,j=0}^{n-1} P(i,j)\ \log(P(i,j)) \quad (2.5)$$

Where:

I and j are the nature of the keabuan of 2 adjacent pixels resolution

p (i, j) is the Cooccurence Matrix Symmetric Ternormalisasi

4. *Energy*

Energy stated size concentration couple with the intensity of a certain keabuan at the matrix, where the (i, j) States the value in row i and column j on matrix kookurensi.

The formula

$$\sum_{i,j=0}^{n-1} P(i,j)^2 \quad (2.6)$$

Where:

I and j are the nature of the keabuan of 2 adjacent pixels resolution

p (i,j) is *Cooccurence Matrix* Simetris Ternormalisasi

5. Dissimilarity

Linear inequality measure declaring the Dissimilarity degree keabuan the image so that it can provide clues to the existence of linear structures in the image.

Rumus

$$\sum_{i,j=0}^{n-1} P(i,j).|i-j| \quad (2.7)$$

Where:

I and j is the nature keabuan from adjacent pixels resolution 2

p (i, j) is a matrix of relative frequencies of 2 adjacent pixels resolution.

1.4 Artificial Neural Networks

Neural networks are one of the artificial representation of the human brain which is always trying to simulate the learning process in the human brain. The term artificial neural network used because here it is implemented using a computer program which is able to solve a number of calculation process during the learning process

Neural network (ANN) is an information processing system that has the characteristics resemble the nervous tissue biology (JSB). JST created as a generalization of a mathematical model of human understanding (human cognition) which is based on the following assumptions [3].

1. Information processing occurs on simple elements called neurons
2. The signal flow between the nerve cells/neurons through a connecting connection
3. Each connection has a corresponding weighting liaison. These weights will be used to duplicate/multiplying the signal that is sent through it.
4. Each nerve cell activation function will apply towards a weighted summation of results signal that goes to him to determine the output signal.

1.5 Function Activation

The activation function is a function that is used to activate each of the affected neurons in the network. Many of the functions that are used as pengaktif, including the following:

1. The Function Of The Undak Binary (Hard Limit)

   Network with a single layer often use undak function to convert input from a continuous-valued variable to an output binary. Functions of hard limit formulated.

$$Y = \begin{cases} 0, jika\ x \le 0 \\ 1, jika\ x > 0 \end{cases} \quad (2.8)$$

2. Undak Binary Function (Threshold)

   This function is often called a function or function threshold niali Heaviside, formulated.

$$Y = \begin{cases} 0, jika\ x < \theta \\ 1, jika\ x \ge \theta \end{cases} \quad (2.9)$$

3. The Bipolar functions similar to undak binary, only the resulting output in the form of 1, 0 or-1.

   This function is formulated.

$$Y = \begin{cases} 1, jika\ x > 0 \\ 0, jika\ x = 0 \\ -1, jika\ x < 0 \end{cases} \quad (2.10)$$

   The Bipolar functions (with Threshold) functions that generate output in the form of 1, 0 or-1.

$$Y = \begin{cases} 1, jika\ x \ge \theta \\ -1, jika\ x < \theta \end{cases} \quad (2.11)$$

4. Linear functions (identity)

   Linear functions have the same output value to the value input, formulated: y = x.

5. Function Sturating Linear

   This function is formulated.

$$Y = \begin{cases} 1, jika\ x \geq 0 \\ x + 0{,}5\ , jika\ -o{,}5 \leq x \leq 0{,}5 \\ 0, jika\ x \leq 0 \end{cases} \quad (2.12)$$

6. Fungsi Symetric Saturating Linear

This function is formulated.

$$Y = \begin{cases} 1, jika\ x \geq 0 \\ x\ , jika\ -1 \leq x \leq 1 \\ -1, jika\ x \leq -1 \end{cases}$$

7. The Sigmoid Function Is Binary

Neural network used for training by using the method of backpropagation. This function is formulated:

$$y = f(x) = \frac{1}{(1+e^{dx})} \quad (2.14)$$

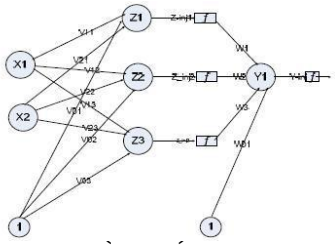
8. The Sigmoid Function Bipolar

The output of this function has a range between 1 and-1. This function is formulated:

$$y = f(x) = \frac{1-e^{-x}}{(1+e^{-x})} \quad (2.15)$$

1.6 Method Of Backpropagation

Backpropagation is one artificial neural network architecture that is very popular is a multilayer feedforward networks. In General, such a network consists of a number of units of the neuron as a the input layers, one or more layers of node-node computational layer neurons, and a hidden layer node-node computational output neurons. Dipropagasikan input signals to the next direction (the direction of the output layer), layer upon layer. This type of network is the result of generalizing from a single layer perceptron architecture, so commonly referred to as the multilayer perceptron (MLPs). Error back propagation algorithm is MLPs that uses the principle of learning terawasi. Back propagation (in the direction of the input layer) occurred after the network generate output containing errors. In this phase the entire synaptic weights (which has no zero activation) in the network will be adjusted to correct/minimize the error occurred (error correction rule). For the training phase, the partners network propagation to the front and back done repeatedly for a set of data, then the exercise is repeated for a number of epoch (one for the entire lewatan session data of exercise in a training process networks) until the error happened reached the limit of small specific tolerance or zero [3].



Picture 1.2 Backpropagation Network

It can be seen that the act as a dendrite is X 1 and x 2, i.e. the input data on the network. There are two synapses or weights namely V and W, whereas the Z and Y are part of soma or badal cells from the network. And acting as the axon or the data output is Y the following learning algorithms. the method of backpropagation.

Langkah 0 :

The awarding of the penimbang initialization (rated small randomly)

1. Step 1 :

If the condition stops not reached, repeat steps 2 through 9 until the end of the iteration condition is fulfilled (condition stops if it reaches maximum looping looping or mean square error (MSE) is smaller than the ratio study)

2. Step 2 :

Untuk masing-masing pasangan data pelatihan (training data) lakukan Step 3 hingga 8

Propagasi maju (Feedforward)

3. Step 3 :

Masing-masing unit masukan (Xi, I = 1,…,n) menerima sinyal masukan Xi dan sinyal tersebut disebarkan ke unit-unit bagian berikutnya (unit-unit lapisan tersembunyi)

4. Step 4 :

Masing-masing unit dilapisan tersembunyi dikalikan dengan faktor penimbang dan dijumlahkan serta ditambahkan dengan biasnya :

Z_(in_j)=V_oj+∑_(I=1)^n▒〖X_i V_ij 〗

(2.16)

Then calculate in accordance with the activation functions are used:

Z_j=f(Z_(in_j))

(2.17)

Bila yang digunakan adalah fungsi sigmoid maka bentuk fungsi tersebut adalah :

Z_j=1/(1+〖exp〗^(-z_in_j))

(2.18)

5. Step 5

Masing-masing unit keluaran (Yk, k=1,2,3,…m) dikalikan dengan faktor penimbang dan dijumlahkan :

Y_(in_k)=W_ok+∑_(j=1)^p▒〖Z_j W_jk 〗

(2.19)

Menghitung kembali sesuai dengan fungsi aktifasi

y_k=f(y_(in_k))
(2.20)
Backpropagation dan Error
6. Step 6 :
Each unit output (clincher, to = 1, ..., m) received a target pattern corresponding to the input pattern while training and calculated the error:
δ _k=(t_k-y_k) f^' (〖y_in〗 _k)
(2.21)
Because f ^ '(y_in〗 〖_k) = y_k using sigmoid function, then:
f^' (〖y_in〗 _k)=f(〖y_in〗 _k)(1-f(〖y_in〗 _k))
=y_k (1-y_k)
(2.22)
Calculating the weighing factor correction (later to fix
w_jk
ΔW_kj=α.∂_k.Z_j
(2.23)
Calculating the correction fixes:
ΔW_0j=α.∂_k
(2.24)
And use the value δ_k on all units the previous layer.
7. Step 7 :
Each weighing connecting the output layer units with units in the hidden layer (Z_j, j = 1, ..., p) multiplied by the delta and summed as an input to the next layer units.
δ_in_j = Σ_ (k = 1) ^ n▒ δ_k W_jk 〖〗 (2.25)
Furthermore, multiplied by the derivative of the activation function to calculate the error.
δ _j=δ_in_j f'(y _in_j)
(2.26)
Then calculate the weights improvement (used to fix V_ij)
ΔV_ij=αδ_j X_i
(2.27)
Then calculate the weights improvement (used to fix Vij)
ΔV_oj=αδ_j
(2.28)
Fixing weights and biases
8. Step 8:
Each output unit (yk, k = 1, ..., m) fixed bias and penimbangnya (j = 0, ..., p)
W_jk (new) = W_jk (old) ΔW_jk
(2.29)
Each unit is hidden (ZJJ: 1, ..., p) fixed bias and penimbangnya (j = 0, ..., n)
V_jk (new) = V_jk (old) ΔV_jk (2:30)
8. Step 9 :
Test conditions of dismissal (the end of the iteration) testing is done by calculating the dismissal of the mean square error (MSE). Where MSE values it would take the average squared error between the output and the target chain, here is the formula of MSE

MSE=(∑_(i=1)^n▒ 〖e_j〗 ^2)/n
(2.31)

2. Conten of Research

2.1 Problem Analysis

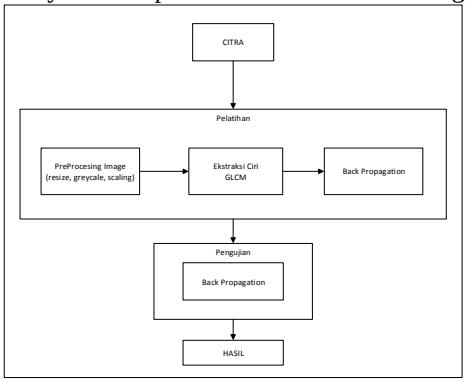
In classifying the types of fingerprint image accuracy is important because to produce an image of the fingerprint detection systems required good accuracy. The method used to detect the fingerprint image was used as a justification. The method used in this research is the co-occurence matrix for feature extraction and Back Propagation methods for classification. Previous studies have been conducted to prove that the method of matrix co-occurrence can extract characteristic texture of fine, matrix co-occurrence yield feature extraction in the form of numeric data, measurement results, or called the data continues in the form of contrast, homogeneity, dissimilarity, energy, and entropy. Furthermore, there are also studies that implements Backpropagation method for fingerprint classification. Both continue to use the data as input data to the Backpropagation method, and produce good accuracy. From what has been described and elaborated, so in this study will do the analysis, by combining feature extraction method Matrix Co-occurrence and classification methods Backpropagation in classifying types of fingerprint image. And test the accuracy and kecepatanya in testing with various scenarios prepared.

2.2 Process

On the analysis of this process would explain the sub process owned by the analysis of the system to be built. Can be seen in Figure 8.

2.2.1 *Matrix Co-Occurrence Analysis*

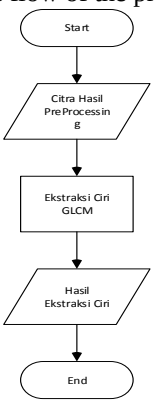
Analysis of the process that will be conducted in this research is the analysis of image classification based on granular texture. work process stages in conducting classification ranging from data input to output data. Here are the stages of the process analysis to be performed can be seen in Figure 3.1.



Picture 2.1 Flow of Process

2.2.2 Matrix Co-occurrence Training

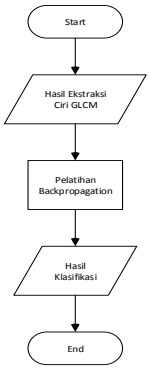
Co-Occurrence matrix describes the results of GLCM and extraction is the process to get the key features on the image. This stage will be menhitung 5 the value of statistics from kookurensi i.e. kontas, its homogeneity, dissimilarity, entropy and energy with angle of 00, 450, 900, and 1350. After all the values obtained from the point will then be averaged. Following the flow of the process.



Picture 2.2 Flow of *Matrix Co-Occurrence*

2.2.3 Matrix Co-Occurrence Training

Training analysis is carried out to classify the data already obtained from the results of the calculation of co-occurrence matrix. The data already obtained from all results feature matrix co-occurrence is then made into a dataset and then trained using Back Propagation method. Here is the flow of a process that must be done.



Picture 2.3 Training Process Flow

2.3 Data Analysis

2.3.1 Input and Analysis

The data entered will be in sports is the fingerprint of the thumb, where the fingerprint is fed through several stages such as the above step, including preprocessing, i.e. Co-Occurrence Matrix and then algotitma Back Propagation.

Imput Data.



Picture 2.4 Fingerprint image

Because the input image will be tested has a different size then resizing was undertaken. Resize image size where the stage is there is scaled down from its original size, it aims to get the input of all the input image. Why should 64x64, as with the size of the already formed a pattern that will be used as research



Picture 2.5 Fingerprint image Size 64x64

2.4 Method Testing

2.4.1 Method Testing of Confusion Matrix

1. Testing the learning rate 0.1

Data uji		kklasifikasi							
		Whorl	Rightloop	Leftloop	Tentedarch	Arch	Jmlh	Benar	Salah
Debim	Whorl	1					1	1	
Putra	Whorl	1					1	1	
Icha	Right		1				1	1	
Yulia	Right		1				1	1	
Tono	Left				1		1		1
Nina	Left			1			1	1	
Dea	Tented		1				1		1
Agung	Tented				1		1	1	
Fitri	Arch			1			1		1
Jemmy	Arch					1	1	1	
Jumlah							10	7	3

Eat the test results with learning rate 0.1 is 7/10 x 100% = 70%

2. Testing the learning rate 0.2

Data uji		kklasifikasi							
		Whorl	Rightloop	Leftloop	Tentedarch	Arch	Jmlh	Benar	Salah
Debim	Whorl	1					1	1	
Putra	Whorl	1					1	1	
Icha	Right		1				1	1	
Yulia	Right		1				1	1	
Tono	Left					1	1		1
Nina	Left			1			1	1	
Dea	Tented				1		1	1	
Agung	Tented					1	1		1
Fitri	Arch					1	1	1	
Jemmy	Arch				1		1	1	1
Jumlah							10	7	3

Eat the test results with learning rate 0.2 is 7/10 x 100% = 70%

3. Testing the learning rate of 0.3

Data uji		kklasifikasi							
		Whorl	Rightloop	Leftloop	Tentedarch	Arch	Jmlh	Benar	Salah
Debim	Whorl	1					1	1	
Putra	Whorl	1					1	1	
Icha	Right		1				1	1	
Yulia	Right		1				1	1	
Tono	Left		1				1		1
Nina	Left			1			1	1	
Dea	Tented				1		1	1	
Agung	Tented			1			1		1
Fitri	Arch			1			1		1
Jemmy	Arch				1		1		1
Jumlah							10	6	4

Eat the test results with learning rate of 0.3 is 6/10 x 100% = 60%

4. Pengujian learning rate 0,4

Data uji		kklasifikasi							
		Whorl	Rightloop	Leftloop	Tentedarch	Arch	Jmlh	Benar	Salah
Debim	Whorl	1					1	1	
Putra	Whorl	1					1	1	
Icha	Right		1				1	1	
Yulia	Right		1				1	1	
Tono	Left			1			1	1	
Nina	Left			1			1	1	
Dea	Tented				1		1	1	
Agung	Tented			1			1		1
Fitri	Arch			1			1		1
Jemmy	Arch					1	1	1	
Jumlah							10	8	2

Eat the test results with learning rate is 8/10 0.4 x 100% = 80%

5. Testing the learning rate 0.5

Data uji		kklasifikasi							
		Whorl	Rightloop	Leftloop	Tentedarch	Arch	Jmlh	Benar	Salah
Debim	Whorl	1					1	1	
Putra	Whorl	1					1	1	
Icha	Right		1				1	1	
Yulia	Right		1				1	1	
Tono	Left			1			1	1	
Nina	Left			1			1	1	
Dea	Tented				1		1	1	
Agung	Tented					1	1		1
Fitri	Arch					1	1	1	
Jemmy	Arch					1	1	1	
Jumlah							10	9	1

Eat the test results with learning rate 0.2 is 9/10 x 100% = 90%

2.5 Kesimpulan pengujian

Based on the table above the fingerprint on the sports method using confusion matrix can be obtained at the level of accuracy as follows.

$$\frac{10}{10} X\ 100\% = 90\%$$

Then from the results of the calculation with the confusion matrix can be inferred from the results of this testing is the more training data used will be the more accurate data that will be tested.

3. END

3.1 Conclusion

From the results of testing already done it can be concluded that the algorithm backpropagatio and co-occurrence matrix method can perform classification. Proven by doing testing method using confusion matrix obtained a 90% degree of accuracy with learning rate 0.5 and erro 0.01, it's more and more data dikarena trainer then accuracy will be the better.

3.2 Sugestion

From the results of research and analysis it does dani training and testing, there are suggestions if anyone is going to do similar research, that is.

1. To get a good degree of accuracy required the amount of training data.
2. Size on the image of the fingerprint is very influential on the outcome of its classification, the greater the fingerprint image then the better level of accuracy and its classification.
3. It's good method added to or replaced to test.

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