International Journal Of Health, Engineering And Technology (IJHET) *E-ISSN 2829 - 8683*
Volume 1, Number 2, July 2022, *Page. 63 - 70*
Email : editorijhess@gmail.com

Signature Recognition Using Backpropagation Artificial Neural Network Method

Layla Mutiara Hasibuan [1*)], Achmad Fauzi [2)], Magdalena Simanjuntak [3)]
[1,2,3)] STMIK Kaputama Binjai, Indonesia

[*]Correspoding Author
Email : laylamutiara29@gmail.com

Abstract

A signature is a sign or symbol that is a miniature version of its owner. A signature is also a biometric feature that can be used to verify a person's identity. The signature used as a personal identification as well as the presence of a signature in a document states that the party who signed, knows and approves or as ratification of the entire contents of the document and becomes legal evidence. Signature recognition is done using an artificial neural network with backpropagation algorithm. In the backpropagation algorithm, signatures are trained to recognize a person's signature with some data such as target data, training data and test data. Then the network is tested for networking. The results of the application are used to recognize signature recognition using the backpropagation method obtained with different accuracy according to the original data obtained from feature extraction. Where the lowest accuracy is 30% and the highest accuracy is 100%..

Keywords: Recognition, Signature, JST, Backpropagation

INTRODUCTION

A signature is a sign or symbol which is a miniature version of its owner. The signature is not just any sign or symbol, but a symbol that is legally and is the original image of the owner. A signature is also a biometric feature that can be used to verify a person's identity. The signature used as self-identification as well as the presence of the signature in a document states that the party who signed, knows and agrees or as ratification of the entire contents of the document and becomes valid evidence. This signature recognition is often found in the administrative activities of government and private institutions, such as in banking where the transaction process for cash withdrawals, deposits, clearing demand deposits and other transactions requires a signature from the customer.
At the time of recognizing a person's signature manually it is very difficult to do, especially if many documents are validated based on the signatures of the authorized party then this will take longer if it is done by one person to match each signature from one archival document with other archives. And a person's signature can differ significantly and from instance to instance, so its extremely strong accuracy requires multiple signature samples and an advanced verification process. This attracts the attention of researchers in conducting research that will create an application to identify signatures that can be done using a computer, so that it will save time and be more efficient than manually.

RESEARCH METHODS

In this study raised the type of development on the software that will be used in this thesis, then in the first stage carried out is an analysis of the necessary requirements. The needs analysis is the initial stage to determine what kind of application will be made. In designing a signature

recognition application, there is a lot of information about the introduction of signature recognition, such as calculation techniques that will be used to design a signature recognition application

Artificial Neural Network(ANN) Application

The application of an artificial neural network is an adaptive system that can change its structure to solve problems based on external and internal information flowing through the network. Some of the applications of artificial neural networks are as follows:

1. Pattern Recognition
   Artificial neural networks can be used to recognize patterns (eg letters, numbers, sounds, or signatures) that have changed slightly. This is similar to the human brain which is still able to recognize people it has not seen for a while (perhaps the face/body shape has changed slightly).
2. Network Processing (Signal Processing)
   An artificial neural network (ADALINE model) can be used to suppress noise in telephone lines.
3. Forecasting (Forecasting)
   Artificial neural networks can also be used to predict what will happen in the future based on patterns of events that have existed in the past. This can be done considering the ability of the artificial neural network to remember and make generalizations from what already exists.

***Backpropagation* Algorithm Application**

The backpropagation algorithm is a guided training which has many layers. The algorithm for a network with one hidden training layer (with a binary sigmoid activation function) is as follows:

1. Backpropagation Algorithm
   At this stage, nasalization of the weights (taking the initial weight value with a fairly small random) after carrying out the next steps until the stopping condition has not been met.
2. Advanced Propagation Stage.
   Each input unit (xi,i = 1,2,3,... ...n) looks for signal xi and forwards the signal to the layer above it (hidden layer).
3. *Backpropagation* (Back Propagation).
   Receive the target pattern associated with the learning input pattern, calculate the error information.

Flowchart Design

Flowchart is the flow of the running of a system that will be created. The following is a flowchart of signature recognition:

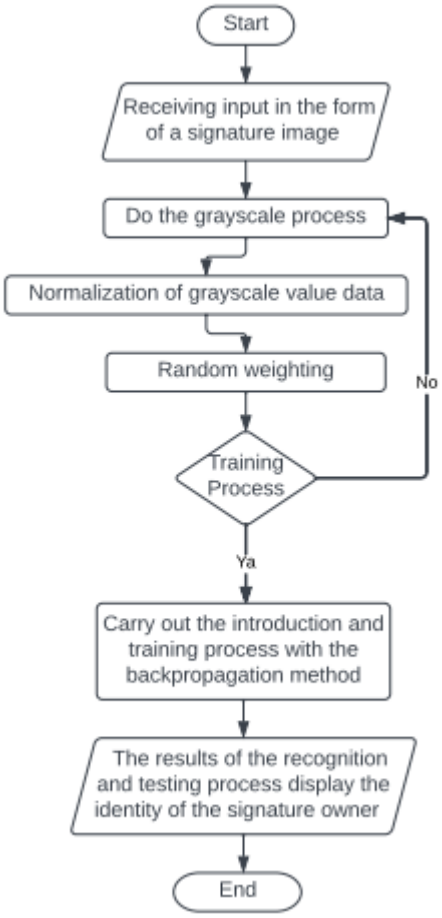


Figure 1. Flowchart

RESULTS AND DISCUSSION

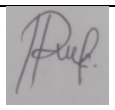
Data Analysis

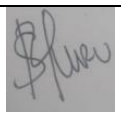
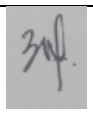
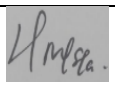
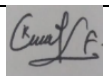
Data analysis was carried out using several stages from collecting signatures, determining test data and training data to target data and carrying out the calculation process with the backpropagation method.

Research Supporting Data

This study uses data in the form of signature images. Signature data consists of signature images from 10 different respondents. Each respondent provides 3 signature images so that the amount of data is 30 signature images. The type of image used is an image with a .jpg extension and goes through preprocessing to get input data.

Tabel 1.1 Signature Image

No	Name	Signature Image
1.	Raoudha Puspita	

2.	M. Ihsan	
3.	Siti Rianti Rizki Utami	
4.	Tengku Haliza Nur	
5.	Divya Angreny	
6.	Marisa	
7.	Benny Nugraha	
8.	Annisa Dwi Lestari	
9.	Desy Nastuty	
10.	Rizwan Fauzan	

Application of Method

The application of the method is needed in solving a problem that is very difficult to determine in the assessment process. The following is the first step in converting the signature data to image data and turning it into grayscale.

r =	173	170	167	135	110
g =	168	165	162	130	105
b =	172	171	166	136	109
	131	126	119	116	107
	126	121	114	111	102
	132	127	120	117	108
	127	118	112	113	110
	122	113	107	108	105
	128	119	113	114	111
	128	132	140	134	119
	123	127	135	129	114
	129	133	141	135	120
	133	153	170	152	124
	128	148	165	147	119
	134	154	171	153	125

Gambar 3.1 Nilai Pixel pada Input Gambar

Next do the calculations from the original image value to the grayscale image.

GRAY=(R+G+B)/3
Pixels -1 (x =1, y =1)
RGB = (173, 168, 172)

Backpropagation ANN Design

The network training process is carried out using input data and training calculations using the backpropagation method:

1. Learning Rate (α) = 0.2
2. Target Error = 0.01
3. Maximum epoch = 1000
4. Initial weight of input to hidden layer (V_{ij}):

Hidden Layer (Vij)				
V_1	V_2	V_3	V_4	V_5
0,2	0,4	0,3	0,2	0,1
0,4	0,2	0,2	0,1	0,3
0,1	0,3	0,1	0,4	0,2
0,1	0,2	0,4	0,3	0,1
0,2	0,3	0,1	0,2	0,4

5. The initial weight is biased to the hidden layer (V_{0j}):

Hidden Layer (V_{0j})				
V_{01}	V_{02}	V_{03}	V_{04}	V_{05}
0.2	0.3	0.1	0.4	0.2

6. Initial weight of hidden layer to output layer (W_{jk}):

Output Layer (Wij)				
W_{11}	W_{21}	W_{31}	W_{41}	W_{51}
0.1	0.3	0.2	0.4	0.2

7. The initial weight is biased to the output layer (W_{0j}):

W_{01}	0,1

Advanced Propagation Stage (*forward propagation*)

$Z_{in1} = V_{01} + X_1 * V_{11} + X_2 * V_{21} + X_3 * V_{31} + X_4 * V_{41} + X_5 * V_{51}$
$= 0,2 + (1*0,2) + (0,086*0,4) + (0,1*0) + (0,021*0,1) + (0,130*0,2)$
$= 0,46$

$Z_{in2} = V_{02} + X_1 * V_{12} + X_2 * V_{22} + X_3 * V_{32} + X_4 * V_{41} + X_5 * V_{51}$
$= 0,3 + (1*0,4) + (0,086*0,2) + (0,3*0) + (0,021*0,2) + (0,130*0,3)$
$= 0,76$

$Z_{in3} = V_{03} + X_1 * V_{13} + X_2 * V_{23} + X_3 * V_{33} + X_4 * V_{41} + X_5 * V_{51}$
$= 0,1 + (1*0,3) + (0,086*0,2) + (0,1*0) + (0,021*0,4) + (0,130*0,1)$
$= 0,43$

$Z_{in4} = V_{04} + X_1 * V_{14} + X_2 * V_{24} + X_3 * V_{34} + X_4 * V_{41} + X_5 * V_{51}$
$= 0,4 + (1*0,2) + (0,086*0,1) + (0,4*0) + (0,021*0,3) + (0,130*0,2)$
$= 0,71$

$Z_{in5} = V_{05} + X_1 * V_{15} + X_2 * V_{25} + X_3 * V_{35} + X_4 * V_{41} + X_5 * V_{51}$
$= 0,2 + (1*0,1) + (0,086*0,3) + (0,2*0) + (0,021*0,1) + (0,130*0,4)$
$= 0,37$

Sigmoid activation function in hidden layer*:*

$$z_1 = \frac{1}{1 + e^{-Z_{in1}}} = \frac{1}{1 + e^{-0,46}} = 0,61$$
$$z_2 = \frac{1}{1 + e^{-Z_{in1}}} = \frac{1}{1 + e^{-0,76}} = 0,68$$
$$z_3 = \frac{1}{1 + e^{-Z_{in1}}} = \frac{1}{1 + e^{-0,43}} = 0,60$$
$$z_4 = \frac{1}{1 + e^{-Z_{in1}}} = \frac{1}{1 + e^{-0,71}} = 0,67$$
$$z_5 = \frac{1}{1 + e^{-Z_{in1}}} = \frac{1}{1 + e^{-0,37}} = 0,59$$

Operation on *output layer:*

$y_{in1} = w_{k1} \sum_{i=1}^{5} z_j \, w_{kj}$

Y_{in} = $W_{01} + Z_1 * W_{11} + Z_2 * W_{21} + Z_3 * W_{31} + Z_4 * W_{41} + Z_5 * W_{51}$
=0,2+(0,61*0,2)+(0,68*0,3)+(0,60*0,1)+(0,67*0,4)+(0,59*0,2)
= 0,95

Binary *sigmoid* activation function on *output layer*:

$$y_1 = \frac{1}{1 + e^{-y_{in1}}} = \frac{1}{1 + e^{-0,95}} = 0,72$$

Reverse Propagation Stage (*Backpropagation)*:

$\delta_k = (T_k - Y_k) \, f \, (Y_{nk})$
$\delta_1 = (T_k - Y_k) \, f \, Y_{in}(1 - Y_{in})$
$\delta_1 = (1 - 0,72) \, 0,72(1 - 0,72)$
$\delta_1 = 0,056$

Calculating weight fix W_{jk}:

$\Delta w_{jk} = \alpha . \delta_1 . Z_j$
$\Delta w_{11} = \alpha . \delta_1 . Z_1$ = 0,2*0,056*0,46 = 0,005
$\Delta w_{12} = \alpha . \delta_2 . Z_2$ = 0,2 * 0,056* 0,76 = 0,008
$\Delta w_{13} = \alpha . \delta_3 . Z_3$ = 0,2 * 0,056 * 0,43 = 0,004
$\Delta w_{14} = \alpha . \delta_4 . Z_4$ = 0,2 * 0,056* 0,71 = 0,007
$\Delta w_{15} = \alpha . \delta_5 . Z_5$ = 0,2 * 0,056 * 0,37= 0,004

Calculating bias correction :

$w_{01} = \alpha . \delta_1$ = 0,2 * 0,056 = 0,011
Hidden unit sums *deltainput* :
$\delta_{in1} = \delta_1 * w_{11} = 0,1 * 0,056 = 0,005$
$\delta_{in2} = \delta_1 * w_{21} = 0,3 * 0,056 = 0,016$
$\delta_{in3} = \delta_1 * w_{31} = 0,2 * 0,056 = 0,011$
$\delta_{in4} = \delta_1 * w_{41} = 0,4 * 0,056 = 0,022$
$\delta_{in5} = \delta_1 * w_{51} = 0,2 * 0,056 = 0,011$

Calculate information *output*:

$\delta_j = \delta_{inj} . Z_j \, (1 - Z_j)$
$\delta_1 = \delta_{in1} . Z_1 \, (1 - Z_1) = 0,005 * 0,46 \, (1 - 0,46) = 0,0012$
$\delta_2 = \delta_{in2} . Z_2 \, (1 - Z_2) = 0,016 * 0,76 \, (1 - 0,76) = 0,0029$

$\delta_3 = \delta_{in3} . Z_3 (1 - Z_3) = 0{,}011 * 0{,}43 (1 - 0{,}43) = 0{,}0026$
$\delta_4 = \delta_{in4} . Z_4 (1 - Z_4) = 0{,}022 * 0{,}71 (1 - 0{,}71) = 0{,}0045$
$\delta_5 = \delta_{in5} . Z_5 (1 - Z_5) = 0{,}011 * 0{,}37 (1 - 0{,}37) = 0{,}0025$

Calculating weight fix:

$\Delta v_{jk} = \alpha * \delta_i * X_i$
$\Delta v_{11} = \alpha * \delta_1 * X_1$ = 0,2 * 0,0012* 1 = 0,0002
$\Delta v_{12} = \alpha * \delta_2 * X_2$ = 0,2 * 0,0029 * 1= 0,0005
$\Delta v_{13} = \alpha * \delta_3 * X_3$ = 0,2 * 0,0026* 1 = 0,0005
$\Delta v_{14} = \alpha * \delta_4 * X_4$ = 0,2 * 0,0045 * 1 = 0,0009
$\Delta v_{15} = \alpha * \delta_5 * X_5$ = 0,2 * 0,0025* 1 = 0,0005

Tabel 3.4 Change of each weight

V_1	V_2	V_3	V_4	V_5
0,0002	2,06	0	5,04	3.12
0,0005	4,98	0	1,21	7,54
0,0005	4,47	0	1,09	6,67
0,0009	7,74	0	1,89	0,0001
0,0005	4,3	0	1,05	6,5

Calculating bias weight improvement:

$\Delta v_{0j} = \alpha . \delta_j$

Tabel 3.5 Change of each bias weight

	V_{0j}
V_{01}	0,0002
V_{02}	0,0005
V_{03}	0,0005
V_{04}	0,0009
V_{05}	0,0005

***Update* change in weight and bias:**

$$W_{jk}(baru) = W_{jk}(lama) + \Delta W_{jk}$$

$W_{11}(baru) = 0{,}1 + 0{,}005 = 0{,}105$
$W_{21}(baru) = 0{,}3 + 0{,}008 = 0{,}308$
$W_{31}(baru) = 0{,}2 + 0{,}004 = 0{,}204$
$W_{41}(baru) = 0{,}4 + 0{,}007 = 0{,}407$
$W_{51}(baru) = 0{,}2 + 0{,}004 = 0{,}204$

$$V_{ij}(baru) = V_{ij}(lama) + \Delta V_{ij}$$

$V_{11}(baru) = 0{,}2 + 0{,}0002 = 0{,}2002$
$V_{21}(baru) = 0{,}4 + 0{,}0005 = 0{,}4005$
$V_{31}(baru) = 0{,}1 + 0{,}0005 = 0{,}1005$
$V_{41}(baru) = 0{,}1 + 0{,}0009 = 0{,}1009$
$V_{51}(baru) = 0{,}2 + 0{,}0005 = 0{,}2005$

CONCLUSION

There is a change in weight at the initial weighting stage at random where the change occurs according to the calculation in the application of the method which will change again if the next iteration stage is carried out. And the weight change will stop when the results of the iteration have reached the maximum limit. As for the calculation of the accuracy that has been tested on one of the sample signatures, the result is 80%. Where the results are carried out by testing the correct data and data so as to produce the possibility that the signature is genuine.

REFERENCES

A. D. Dongare, R. R. Kharde, Ana A. D. Kachare, "Introduction do Artificial Neural Network," *In. J. Eng. Innov. Technol.*, vol. 2, no. 1, Pp. 189-194,2012.

D. Putra, Pengolahan Citra Digital, Yogyakarta: Penerbit ANDI, 2010.

Puspitanigrum, D., 2006, Pengantar Jaringan Syaraf Tiruan, Yogyakarta : Andi.

Sri Kusuma Dewi, Sri Hartati. (2016), *Neuro-Fuzzy*, Yogyakarta, Andi Offset.

Suyanto, 2011, *Artificial Intelligence*, Bandung : Informatika.