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Recognition of person's character through the shape of signature using Radial Basis Function Neural Network (RBFNN) method

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Abstract. Signatures are a marker or identity that exists in a document. Signatures have an important role in verifying and legalizing documents. The purpose of this study is to apply image processing techniques to signatures and to identify patterns of signature images based on entropy values. The stages of the research include taking respondents' data in the form of analog image signatures, then the acquisition of digital signature images by scanning the signatures. The next step is to convert digital hand images from true color to binary. The last step is calculating the entropy value, recording the entropy value calculation time using Matlab software and looking at the distribution of entropy values from each signature image. From this method, the result of 50 data of signatures taken from students of the Islamic University of Madura (UIM) of the FMIPA, there are 11 to 1st type, 1 to 2nd type, 13 to 3th type, 4 to 4th type, 9 to 5th type, 3 to 8th type, 7 to 9th type and 2 to 11th type.

1. Introduction

Signature at this time is one of the most important things in information for evidence and information in print media whether digital. A signature is the result of the process of writing someone specifically as a symbolic substance. Signatures so far are still used as legal evidence and information, in writing as well as electronic and digital. The shape of the signature of every common person is not the same. Importantly, a person's signature changes frequently over time, this change concerns the position, size and pressure factor of the signature. In the end, certain changes, habits and mental condition.

In everyday life everyone needs something unique to distinguish them from others. Naturally, every human being is unique to each other, even for twins even though they can still be distinguished by using their fingerprints. One way that can be used to distinguish someone from others is using technology to support signature patterns, including biometrics, which use human protection characteristics [2].

In general, signing a signature can be done manually by matching the signature at the time of the transaction with a valid signature. The manual system has a weakness while the signature checker

is not careful in matching. Therefore, we need a method that is able to analyze the characteristics of the hand so that it is easy to improve one's signature [3].

In graphology, the form of a signature is resolved with structural graphic elements in order to obtain information about one's personality. From the results of graphological analysis of the form of signatures, graphologists can find out a person's personality and logistics. Some guidelines for analysis, writing, writing, seven basic elements: speed, pressure, shape, dimensions, continuity, direction and order [4].

Today, graphology is widely used in the world of crime and the world of management. As an example of its application, in the corporate world that will recruit many employees, handwriting is unlikely to be analyzed one by one by an expert in a short time, therefore we need a computer program technology that can help the analysis. One technique of handwriting pattern recognition (handwriting recognition) that is currently still very accurately used in computer programs is the Radial Fuction Basic artificial algorithm which previously performed image extraction to eliminate the noise using the Principal Component Analysis method [5].

Image recognition or image processing is a process to change an image so that it produces an image in accordance with the wishes or improve image quality. Therefore, in this study, the extent to which the Radial Basis Function method will be able to recognize a signature pattern in identifying a person's personality. In this study, it has been designed to recognize signature patterns in terms of six features through six networks in parallel so as to provide automatic personality identification results. The system to be designed will identify two features using ANN with the Multilayer Perceptron architecture with the Radial Base Function algorithm [6].

Here the artificial neural network is used for training and then the data is stored in the data storage and then compared with the image of the related signature. Sampling the signature using a pen with different thickness, resulting in differences in thickness on the signature. The thin thickness of the signature will then be subjected to a process of skeletonization to retrieve the signature framework in the image [7].

Radial Basis Function Neural Network (RBFNN) has been widely used in various studies, for example research conducted by [3] on the recognition of signature patterns using the moment invariant method and the radial basis nerve function network. This research resulted in training error of 12% and classification accuracy (introduction) reached 80%. As for the data testing the error occurred 20% with an accuracy of 80%. The most recent study was carried out by Juliaristi in 2014 for forecasting with the Radial Basis Function Neural Network model in dengue fever data in D.I.Y that produced MAPE and MSE training respectively 0.4919% and 5.144, MAPE and MSE testing 0.786% and 11.384%.

Of all available ANN algorithms, RBFNN has the advantage of being a simpler algorithm and faster computing when compared to the backpropagation algorithm and so on, so that the RBFNN is considered suitable in solving this problem. Therefore, from the background description the authors make with the title "Introduction to Someone's Character Through the Form of Signatures Using the Radial Basis Function Neural Network (RBFNN) Method" which is to facilitate the process of personality recognition using computer program technology.

2. Literature review

Signature

A signature is the result of the process of writing someone specifically as a symbolic substance. A signature is the most widely used form of identification.Examples of each person's signature are generally identical but not the same. This means that a person's signature changes frequently over time. This change involves the position, size and signature pressure factor. In fact, these changes are influenced by time, age, habits and certain mental states [3].

Recognition of Signature Forms

To analyze a person's signature, there are some basic things that must be considered, among others [5]:

Clear Signature

Someone who has an easy-to-read signature shows confidence, is open (extroverted), straight forward, and how to think as is or practical. Conversely in Figure 1, if the signature is made complicated and abstract so it is difficult to read indicating the owner is closed, good at keeping secrets and tends to lie. Nevertheless, from the positive side a person is very careful in acting [8].

(a)   (b)

Figure 1. Sign Form (a) Clear, (b) Unclear

Scribble under the Signature

The last line in the form of a line under the signature is a symbol of the desire of individuals to get support from others. Figure 2: The longer the baseline strokes, the stronger the signatory owner's need for support, for example in making a decision, full of confidence nor giving up easily. Scribbled lines under the signature is a symbol of the desire to show the uniqueness of himself, that he is different compared to others, for example unique ways of thinking and ideas[9].

Figure 2. Streaks under the signature

Backward Pull

There is also a pull of the signature line which is made by drawing the line in the opposite direction, backwards (to the left) first. The signature method shown in Figure 3 shows that the autograph maker always sees the past as a basis for action or making decisions in his life. The longer lines or curves made to the left show a strong dominance of the past in the life of the owner of the signature. In addition, the owner of the signature feels comfortable with his past and often reminisces about the past [8] Examples of signatures with the left are more dominant.
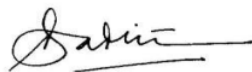

Figure 3. Reverse backward to the left

Scribble Ends the Signature

Another unique way of making a signature when ending a signature, such as going up and showing the direction of progress, as in Figure 4, indicates that this person has a foresight or a desire to move forward and is relatively open to change. The longer the line, as if off to the right, indicates the persistence in the struggle to achieve the desired achievement. If the final line is just cut off, as shown in Figure 5, indicates limiting his desires, not daring to take risks, and hesitant in making decisions and often discouraged or not daring to continue his hopes. Signatures that end with a line down Figure 6 indicate a decreased energy, lack of enthusiasm, and realistic thinking that overcomes idealism [10].

(a) Ascending Signature

This type of signature signifies a person's high ambition, foresight or desire to move forward and is relatively open to change. If the signature goes up, then this person might have good luck in his life.

Figure 4. Ascending

(b) Disconnected Signatures

This type of signature means limiting their desires, not daring to take risks, and hesitating in making decisions and often discouraged or not daring to continue their hopes.

Figure 5. Disconnected

(c) Signatures Decrease and Increase Then Decrease.

A sign that decreases is a sign that you can easily feel as minimum as possible in a day. In addition, there is lethargy, depression, and despair in life. You seem to be easily slipping to end the line down in Figure 6 (a) Figure 6 (b), Indicating decreased energy, lack of enthusiasm, and realistic thinking that overcomes idealism.

(a)   (b)

Figure 6. Forms of Signatures (a) Declining, (b) Up and down

Signatory Zones

According to [8] the character of a person through a signature when associated with the zone (area) as in handwriting, there are certain parts in the signature where the upper area is made dominant, either by curved traction or a combination with high upward lines. This type of signature shows the level of aspiration, ideal thinking patterns, high ideals, and great expectations. Conversely, if the dominant signature in the lower zone is emphasized, it indicates an individual who thinks analytically, is realistic, and is energetic in acting [8].

The curved line at the top of the signature indicates the expression of thoughts and feelings of the owner of the signature. Curved lines made sharp or detailed Figure 7 shows the characteristics of the ability to formulate their thoughts and feelings appropriately and the ability to process special words so that it is difficult to be misinterpreted. This sharp curved line indicates a straightforward nature, speaking without storing false feelings so that often the words make the listening ear red, sometimes considered outrageous and pay less attention to courtesy. Conversely, a soft upper arch line shows a cautious attitude in expressing oneself, tends to be diplomatic, friendly, properly guarded words so as not to offend others [11], as Figure 8.

(a) Sharply Signed Curved Lines Signs

This type of signatures shows the ability to formulate the mind sharply and the ability to process special words so that it is difficult to be misinterpreted.

Figure 7. Sharp Curved Lines

(b) Soft Top Arch Lines
This type of signature shows the attitude of caution in expressing themselves tends to be diplomatic, friendly, his words are maintained properly so as not to offend others.

Figure 8. Soft Upper Curved Lines

If the first letter of the name of the owner of the signature stands out more strongly and is made with a very large letter compared to the letter afterwards or given an ornament, this indicates that the person has a unique personality, wants to be noticed, is more spontaneous, is happy with praise, and needs to be seen [9] as Figure 9.
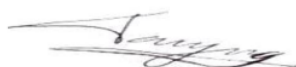

Figure 9. The signature is ornamented

If the first word or self name, is made larger than the family name, as in Figure 10, this indicates that the person wants to be seen as a unique person, different from their family. Conversely, if the last name (family) is highlighted, this indicates that the person has pride in his family. But sometimes the assertiveness affixes the family name in the signature there is a tendency to take cover behind the shadows of the family [8].
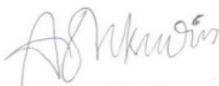

Figure 10. Character signatures are different from family

Interpreting the signature alone is actually not enough to provide an accurate interpretation, because one also needs to compare with other handwriting, this is to get consistency between the signature and other traits contained in the handwriting so that the description of the author's personality becomes more complete and tends to be accurate. The signature used for interpretation should also be the signature written at the end of the paper (below), not at the beginning of the writing (above). The signature at the beginning of the writing is usually made spontaneously and mindfully, so that it can be less reflective of the actual individual. The signature that is done at the end of the writing is usually spontaneous, so that it better reflects the basic personality of the author [8].

Representation of Digital Images
Computers can process digital electronic signals that are binary signals (worth 1 and 0). Digital imagery must have a certain format that is suitable so that it can present imaging objects in the form of binary data combinations. In color imagery, the number of colors can vary from 16, 256, 65536 or 16 million colors, each of which can be represented by 4, 8, 16, or 24 data bits for each pixel. The existing color consists of 3 main components, namely the value of red (red), the value of green (green), the value of blue (blue). The combination of the three main components forming these colors is known as RGB color [5].

Gray Level (Gray Scale)

The brightness of the image is presented at the value of each pixel. The higher the pixel number, the brighter (white) the image is. While the smaller the value of a pixel, resulting in the color of the image becomes dark. A common scale system has 256 levels for each pixel and is known as grayscale [5].

Previous Research

Radial Basis Function Neural Network (RBFNN) has been widely used in various studies, for example research using radial basis function modeling that has been done by [3] on recognition of sign patterns using the invariant moment method and neural network radial function. This research resulted in training errors of 12% and classification qualifications (80) reaching 80%. As for testing data errors that occur 20% with an accuracy of 80%. The most recent study was carried out by Juliaristi in 2014 for forecasting with the Radial Basis Function Neural Network model for dengue fever data in DIY which resulted in MAPE and MSE training respectively 0.4919% and 5.144, MAPE and MSE testing 0.786% and 11.38 %.

Digital Image Components

Digital image (digital image) is a continuous image (x, y) that has been discredited both spatial coordinates and the level of coordination. Each point usually has coordinates according to the position in the image. These coordinates are usually expressed as indices u and v only with positive integers, which can start from 0 or 1. The unit or part obtained from the image is called a pixel. How do you make the perfect picture from horizontal and vertical distances? Pixels (0,0) are located in the upper left corner of the image, where your index moves right and index v moves down. To show coordinates (m-1, n-1) This is the opposite of the vertical and horizontal directions that apply to the graph system in mathematics which is shown in the following equation [12]:

$$f(x,y) = \begin{bmatrix} f(0,0) & f(0,1) & f(0,m-1) \\ f(1,0) & f(1,1) & f(1,m-1) \\ f(n-1,0) & f(n-1,1) & f(n-1,m-1) \end{bmatrix}$$

Extraction of Principal Component Analysis (PCA)

Principal Component Analysis (PCA) was first discovered by Turk in 1991 which was used for facial image recognition. PCA is a method for finding patterns from data in many dimensions. The function of PCA is to be able to compress data by extracting data features without removing the information in the data. PCA is more widely used for image feature extraction purposes, where the number of pixels of the image is far greater than the amount of sample data used. To perform a matrix sample projection of training images, each training image is arranged in the form of row vectors [5]. The projection on PCA is a representation of the set of data X in the form of eigenvectors from the covariant variant matrix of X. An eigenvector with a large eigenvalue has an important role in the process of changing the pixel matrix value, which is by removing the eigenvalue that is close to zero will not cause loss of data information or only a minimum loss of information. PCA requires data input that has zero-mean properties for each feature. The zero-mean properties of each data feature can be obtained by subtracting all the average values. Data set X with dimensions M x N from equation (1), where M and N are rows and columns [13]

$$X = \begin{vmatrix} x_{11} & x_{12} & \cdots & x_{1N} \\ x_{21} & x_{22} & \cdots & x_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ x_{M1} & x_{M2} & \cdots & x_{MN} \end{vmatrix} \qquad (1)$$

For the jth feature, from equation (1) the average value is searched according to equation (2)

$$\bar{x}_j = \frac{\sum_{ij=1}^{n} x_{ij}}{n} \qquad (2)$$

The next step is that all values in the column are reduced by the average, and formulated as follows [14]:

$$X'_{ij} = x_{ij} - \bar{x}_j \tag{3}$$

with

$X' = x'_{ij}$
$i = 1,2,....M$
$j = 1,2,....N$
$\bar{x}_j = j$th average value

A neural network is always characterized by a connection pattern between neurons (architecture), a method for determining its weight (algorithm), and an activation function used. [15]

Function of Base Radius Neural Networks (RBF)

Radial Function Base Network (RBF) which is an alternative to a network of advanced multilevel feed Neural (MFN) has been developed. This network consists of three layers, namely the input layer, the hidden layer and the output layer. The activity functions are basic functions and linear functions at the output layer. This network has been used extensively. RBF is a multidimensional nonlinear function mapping that depends on the distance between the vector input and the vector center. RBF with input n-dimension R^(n) and output dimension-$m\in$R^n. While the architecture of RBFNN [5].Can be seen in Figure 12.
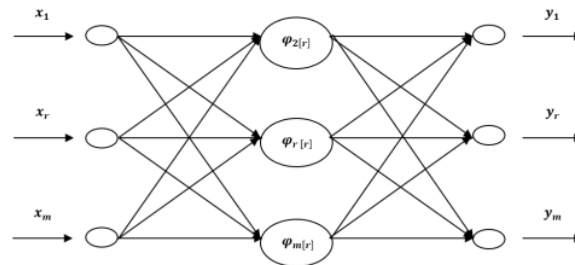

Figure 11. Architecture diagram of RBF ANN

Multiquadratic function $\phi(\chi) = (x^2 + \sigma^2)^{1/2}$
Multiquadratic inverse function $\phi(\chi) = 1/(x^2 + \sigma^2)^{1/2}$
Gauss function $\phi(\chi) = exp(-x^2 + \sigma^2)^{\frac{1}{2}}$

Where x is the Euclidean norm between the inputx vector and the center of the hidden neuron. The RBF network output with kernel$\tilde{N}$ for an input vector xR is given from equation 9 below:

$$F_{\tilde{N}}(x) = \sum_{i=1}^{\tilde{N}} \beta_i \emptyset_i(x) \tag{4}$$

With$\beta_{i= [\beta_{i1},\beta_{i2},...,\beta_{im}]}T$ is the weight connecting the i-kernel with output neurons, and $\emptyset\_i$ (x) is the i-kernel output of equation 9 with the Gaussian equation as follows:

$$\phi_i(x) = \phi(\mu_i, \sigma_i, x) = \exp\left(\frac{\|x - \mu_i\|2}{2\sigma^2}\right) \tag{5}$$

With

x_i : Variable input to-i, $i = 1,2,.....p$
C_j : The center of the neuron is hidden to-j, $j = 1,2,.....m$
σ:Standard deviation of the center / hidden neuron center

$$\sigma = \left(\frac{1}{n-1}\sum_{i-1}^{n}(c_i - \bar{c})^2\right)^{1/2} \tag{6}$$

With : $\mu_i = [\mu_{i1}, \mu_{i2}, \dots \mu_{im}]^T$ is the center of the i-th kernel and σi is width. For N random samples are different(x_i, t_i) With $x_i = [x_{it}, x_{i2}, \dots x_{im}]T \in R^n$ and $t_i = [t_{i\,1}, t_{i2}, \dots t_{im}]T \in R^m$, RBF with kernel (N) can be modeled mathematically [3].

3. Main Results
PCA and RBF Processes

From 12 PCA centers and 50 PCA trainings, images can be processed using the RBF method. The initial step in this process is to determine the basis functions to be used. In this case the base function used is the Gaussian basis function.

The next step is to determine the center of each node in the hidden layer. In this study many centers (c_i) to be used numbered 12center originating from 12 macros formed in the form of the letter 't' which were made comparisons for 50 training data. Based on PCA results,$c_1 = 0,7832$, $c_2 = 1,4158$, $c_3 = 2,1254$, $c_4 = 1,1156$, $c_5 = 2,1665$, $c_6 = 0,4363$, $c_7 = 0,3.1193$ $c_8 = 0,1650$ $c_9 = 1,8923$, $c_{10} = 0,1788$ $c_{11} = 0,1787$ $c_{12} = 0,6491$.

The next step is to initialize the weight of w randomly with a random value between 0 and 1, then set the convergence rate to $0 < \alpha < 1$. Learning rate in this study was determined, $\alpha = 0.01$ with a maximum epoch of 10.

Simulation of Radial Basis Function Neural Network (RBFNN) Method Using MATLAB

In this step simulation is carried out to apply the completion of a person's character recognition through the form of signatures using the radial basis function (RBF) method using MATLAB. GUI results for character recognition can be seen in Figure 13.

Figure 12. Display the character recognition GUI

From the GUI display, by inputting the signature data from the training image and filling the column in accordance with the provisions of max epoch = 10, and learningrate = 0.01, then the signature image can be crossed so as to produce a signature form that is in accordance with the specified characteristics. An example of the results of the introduction can be seen in Figure 14 with the 9th image input and Figure 15 with the 13th image input.

Figure 13. Results of the identification of the 9th type of Signature Form

Then it can also be seen the results of the introduction of the 13th image input in Figure 15.

Figure 14. Example of the Results of the Recognition of the 13th Signature Form

From the 50 signature images obtained, it can be seen the results of the PCA as well as the results of character recognition with the Radial Basis Function Neural Network (RBFNN) method. The results of simulating a person's character recognition through signature forms can be seen in Table 1.

Table 1. Results of Signature Recognition

Number of Data	Information	Data to Name of the Sign with Weight Selected Information
3,5,6, 19, 29,33,34,42,43 ,44,47	1st type	This type has the meaning of limiting individual desires, not dare to take risks, lack of courage to continue expectations
12	2nd type	This type shows a decrease in energy that is less enthusiastic and realistic thinking that defeats idealism
4,7,10,15,18,2 6,27,28,35,36, 45,48,49	3th type	This type shows a high individual ambition, always forward-looking outlook, a desire to advance, and relatively open to change
13,20,30,37	4th type	This type shows the ability of individuals to formulate thoughts sharply, their feelings are right, their words are difficult to misinterpret.
1,8,9,14, 16,38,39,46,50	5th type	This type shows that the individual easily feels that there is a minimum of depressed and hopeless moods in life
11,21,31	8th type	This type shows a decrease in energy, lack of enthusiasm, and realistic thinking that overcomes idealism.
2,22,23,24,32, 40,41	9th type	This type shows the characteristics of the ability to think and feel appropriately, the ability to process special words so that it is difficult to be misinterpreted.
17,25	11th type	This type shows as someone who is unique, wants attention, and needs to be seen.

4. Conclusions

The conclusions from the results of this study, there were 50 signatures taken from Madura Islamic University (UIM) FMIPA students. there are 11 to 1st type, 1 to 2nd type, 13 to 3th type, 4 to 4th type, 9 to 5th type, 3 to 8th type, 7 to 9th type and 2 to 11th type.For further research, it is expected that the data used does not only refer to the form of the signature, it can be seen from the speed, shape, pressure, dimensions, direction and regularity.

Acknowledgements

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