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Comparison of Static Signature Identification using Artificial Neural Networks Based on Haar, Daubechies and Symlets Wavelet Transformations

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Abstract

Signature is a biometric attribute that is quite important for each individual that can be used as self-identity. Until now, the signature is still used as a sign of legal approval and is agreed upon by everyone. This makes the signature worthy of attention from a security aspect. Various approaches have been proposed in the development of signature identification to minimize signature forgery. This study will discuss the identification of signatures by using the image of the signature on paper. This identification consists of two processes, namely training and testing by utilizing Artificial Neural Networks Backpropagation and Wavelet Transform. Optimal results are obtained by using ANN which has learning rate 0,09, two hidden layers, each 20 and 10 nodes with the most superior Wavelet Haar reaching 94.44%

Keywords: signature, ANN, identification, backpropagation, wavelet

1 Introduction

The rapid development of technology in this era has changed the lifestyle in society. The need for proof of the validity of a transaction or document is important because of the increasing number of diverse activities. Proof of validity in the form of personal data such as signatures is still used as personal data and the validity of a document. Nowadays, many self-data recognition using electronics have been developed, such as iris recognition, fingerprints, facial recognition, and so on, but until now the conventional method in the form of signatures is still very much needed. Signatures are considered a fairly easy way and without expensive costs so that in this modern era, signatures are still considered valid proof of legal use. Personal data is an attribute of each individual whose validity needs to be protected. A signature is a biometric attribute that has ownership which is physiologically the hallmark or character of each individual. Biometrics is the science of automatic recognition of individuals. Biometrics depends on a person's physiology and behavior, so this attribute is attached to an individual with its own uniqueness and characteristics. This proves that the signature is a very important individual attribute and the need for ownership protection. Visually, it is difficult for the human eye to compare signatures that look similar even with the same pattern. This limitation makes signatures often misused by irresponsible parties. Solo Pos once published news in the media that there had been fraudulent acts committed by CPNS applicants. The fraud that occurred in Solo was an act of falsifying signatures on diplomas or important documents contained in the application files of Candidates for Civil Servants (CPNS) by falsifying signatures on documents as much as 40% and this number is not a small number [1]. The news shows that many acts of forging signatures have been carried out and as if it is considered normal. Of course this is detrimental to the owner of the signature and the recipient of the fake document.

Systems with artificial intelligence are needed to help humans compare signatures. Optimal accuracy is the goal of system development in order to minimize signature forgery. The system built will be able to reduce human work in comparing similar signatures with physical visual limitations. A system with advantages in the field of pattern recognition will be built using an artificial neural network and wavelet switching. ANN consists of neurons that can communicate between network layers. There are four types of wavelets to find optimal accuracy. The input data used is a static signature (offline) with paper media and then scanned with a scanner. In this study, wavelets are used to perform pre-processing. Wavelet is a mathematical function that offers high temporal in high frequency images, while low frequencies will be better frequencies [2]. This advantage is expected to provide quality information so that it can support the learning process in the network.

2 Research Methodology

Handwriting is an interesting object challenging pattern recognition. There are also studies that use handwriting as an object for optical character recognition. The system can be used to recognize English characters (A-A,a-z), numbers (0-9) as well as special characters or symbols (x,$,%,^,&,*). The research was conducted by training a neural network using the Backpropagation algorithm. The results of handwriting pattern recognition using neural networks achieve very high accuracy [3].

Other research related to signatures was also carried out by using Backpropagation ANN. Identification of the signature is expected to provide a sense of security for the owner of the signature. The system is able to recognize the signature and the owner of the signature to reduce the act of forging signatures. This system produces signature identification in the form of accuracy and the face of the signature owner [4].

The next research is about speech signal pattern recognition using wavelet switching and artificial intelligence. Speech signal is biometric data such as handwriting, fingerprint, iris and so on. Biometric is data owned by individuals and has a unique character. The pattern recognition phase of the system built with a neural network design has provided a fairly high recognition accuracy. The accuracy obtained from the speech signal pattern recognition is 81.96% [5]

2.1 Handwriting Signature

A signature is an individual identity that has its own characteristics and patterns. The uniqueness of the signature is often used as an attribute or a marker of the validity of a document. Until now, signatures are still often used anywhere and anytime to mark the

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validity of every transaction, even on important documents. Visually, it is difficult for the human eye to compare existing signatures. At first glance, the signature looks similar, but it could be that the signature was forged by an irresponsible person. Human physical limitations (eye disorders, fatigue and focus) can affect the results of interpretation so that it can result in someone's inaccuracy in seeing and even comparing signatures. Based on these problems, a system is needed that can assist in comparing signatures that look the same but can be forged. The system is expected to ease human work in determining the authenticity of signatures. The signature itself is divided into two techniques, namely offline (static) and online (dynamic). A signature with an offline technique is a signature that is done on a piece of paper and scanned for processing, while a signature with an online technique is a signature that is done on a digitizer device. Basically there are three types of forgery, namely random forgery, a signature that is done accidentally because forgers only know the name of the owner of the signature and use his name with his own pattern to forge, while simple forgery is a signature made by someone who has absolutely no practice or even has no previous experience in imitating signatures, and skilled forgery is a sign hand made by someone who has experience in copying signatures [6].

2.2 Artificial Neural Network

Artificial Neural Network (ANN) is one of the reliable networks in recognizing an object. ANN is a mathematical model by analogizing how the human brain works in processing an object. Humans can recognize objects by starting with data collection as memory input so that when they meet the object at a different time, someone will remember the object. The workings of neurons in the human brain have the power to collect signals obtained from adjacent neurons through dendrites. Electrical activity will be transmitted by neurons through axons consisting of thousands of branches. Neurons will work when they get stimuli from outside to be conveyed to neighboring neurons so they can give the correct response. The network is interconnected through several stages or processes and has parallel distributed processing [7]. In ANN, neurons are referred to as nodes and the parts are divided into three parts, namely the input layer, hidden layer and output layer. The number of nodes and the number of layers depends on the needs of the system, so in the ANN learning phase requires some simulation to get the most

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appropriate and optimal ANN architecture. ANN characteristically has a layer consisting of a number of nodes (Input layer, Hidden layer and Output layer) which holds the activation function. ANN with input layer, hidden layer and output layer can be seen in Figure 1 below.

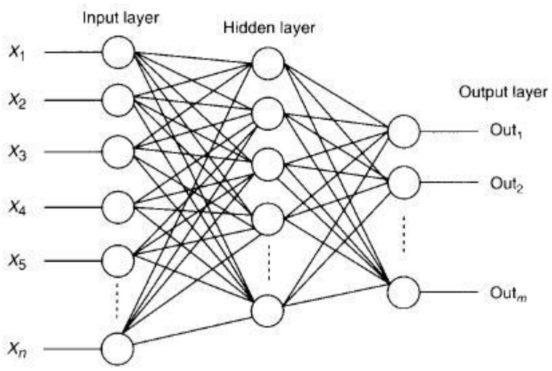

Figure 1. Artificial Neural Network Representation [**8**]

2.3 Backpropagation

In this study, ANN was collaborated with the Backpopagation algorithm in identifying signature patterns. The way the Backpropagation algorithm works is by utilizing an error condition in the output layer, it will change the weight by means of back propagation after the forward propagation process is complete [9]. The backpropagation algorithm cycle consists of two stages, namely forward pass (forward propagation) and backward pass (backward propagation). The backpropagation algorithm is a guided learning approach because the desired result is already known. After finishing processing, there may be differences in the predicted results. If this happens, the network will immediately be subjected to backward propagation to get a smaller error tolerance. A smaller error will also provide an optimal percentage of the identification results.

2.5. Wavelet Transform

Preprocessing in this study utilizes wavelet transfer in preprocessing to represent the time and shape frequency signal. Wavelet switching is one of the mathematical tools that has a transfer layer function so that it can produce coefficients that represent the characteristics of the signal [10]. Wavelet has advantages, namely in terms of signal analysis. The wavelet's signal analysis is multi-resolution so that it provides better signal

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accuracy and analysis. The advantages of wavelets are because of their advantages in providing multi-resolution signals. It aims to analyze features that may not be detected by one resolution so that they will still be detected using another resolution [11] [12]. Discrete Wavelet Transform (DWT) is an option as an efficient method that can be used to retrieve information in the image in the form of discrete data. In utilizing wavelets, it is also necessary to determine the level of decomposition to obtain optimal accuracy. Low resolution image is decomposed by DWT into different subbands, namely low-low (LL), low-high (LH), high-low (HL), and high-high (HH). Figure 2 is a decomposition image on wavelet level 2.

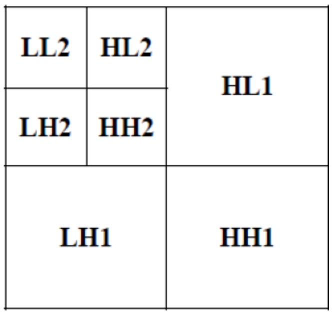

Figure 2. Level 2 decomposition on Wavelet **[10]**

3 Results and Discussion

Identification of the signature image is divided into two phases, namely training and testing. This image data is obtained from 15 individuals where each individual will write as many as 6 signatures as input data. The signature image sample with a size of 256x256 pixels will be subjected to preprocessing. The static signature image is scanned using a scanner to reduce limitations on rotation, and shooting distance. This digital image is then cut into a size of 256x256 pixels and then converted into a black and white image (threshold). Black and white images will make it easier for the system to learn image patterns and provide a lighter computing load than Greyscale or RGB. The black and white image will then be subjected to some predetermined wavelets.

This study uses several kinds of wavelets to obtain optimal accuracy. Normalization is done before training using Backpropagation ANN. In this training phase, the results will be weighted. Each weight according to its respective ID will be stored in the data

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store. The results of this training are in the form of weights that will be stored in the data store. This stored weight will be input data which will later be seen for its ability to produce pattern characteristics. This input data is then tested on several existing wavelets. The signature image identification flow can be seen in Figure 3.

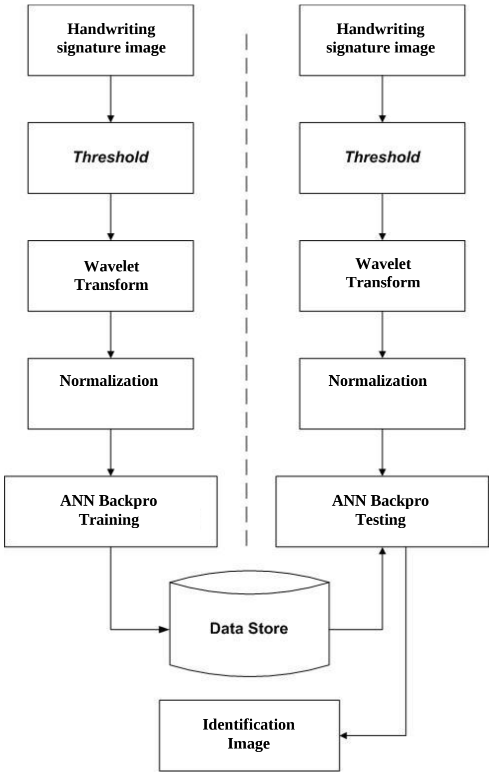

Figure 3. Flow Diagram

Each signature image is resized to 256x256. If the image size is smaller, the computational load will be lighter, but the pattern characteristics will also decrease. The size of 256x256 is an option in implementing signature identification. The simulation carried out has the aim of getting optimal accuracy from the existing wavelets. The wavelets being tested are Haar Wavelets, Daubechies 2, Daubechies 3, and Symlets 3. The selection of these four wavelets refers to previous studies which obtained a fairly high accuracy in pattern recognition identification. The wavelet decomposition used is level 4 in obtaining information. The choice of level or decomposition is also related to the amount of information. The higher the level on the wavelet, the less information will be obtained. So in this study is expected to provide optimal identification results as well.

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The learning rate used is 0.9 with two hidden layers of 20 and 10 nodes, respectively. Figure 4 shows the process of image signature training, and the simulation of the four wavelets can be seen in Figure 5. The figures below also shows the MSE and epoch results for each wavelet.

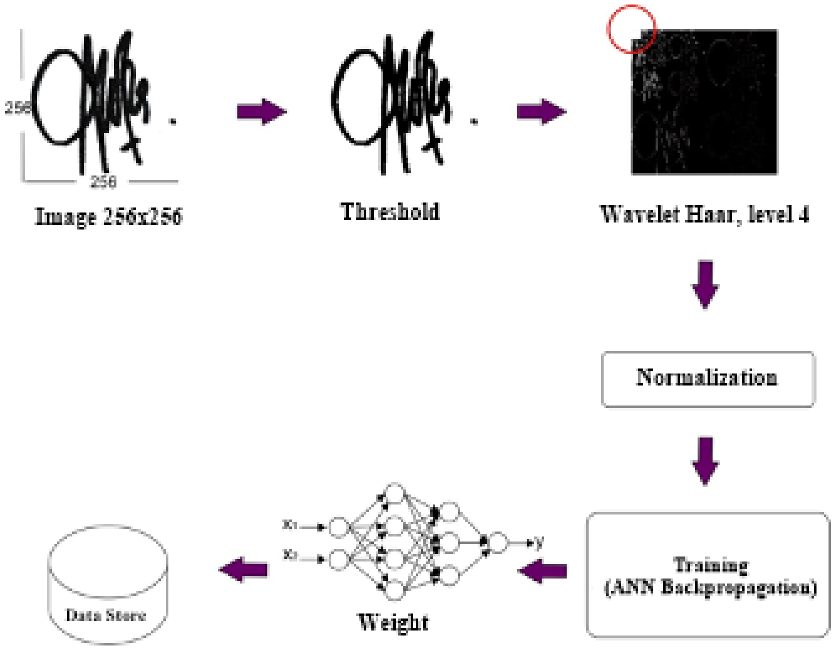

Figure 4. Training on the Identification process

Table 1. Image Identification Comparison Results with level 4 wavelet switching, learning rate 0.09.

Wavelet	Epoch	MSE	Accuracy
Haar	100000	0,0909	94,44%
Db2	100000	0,0634	87,78%
Db3	1382	0,0858	91,11%
Sym3	16724	0,1022	87,78%

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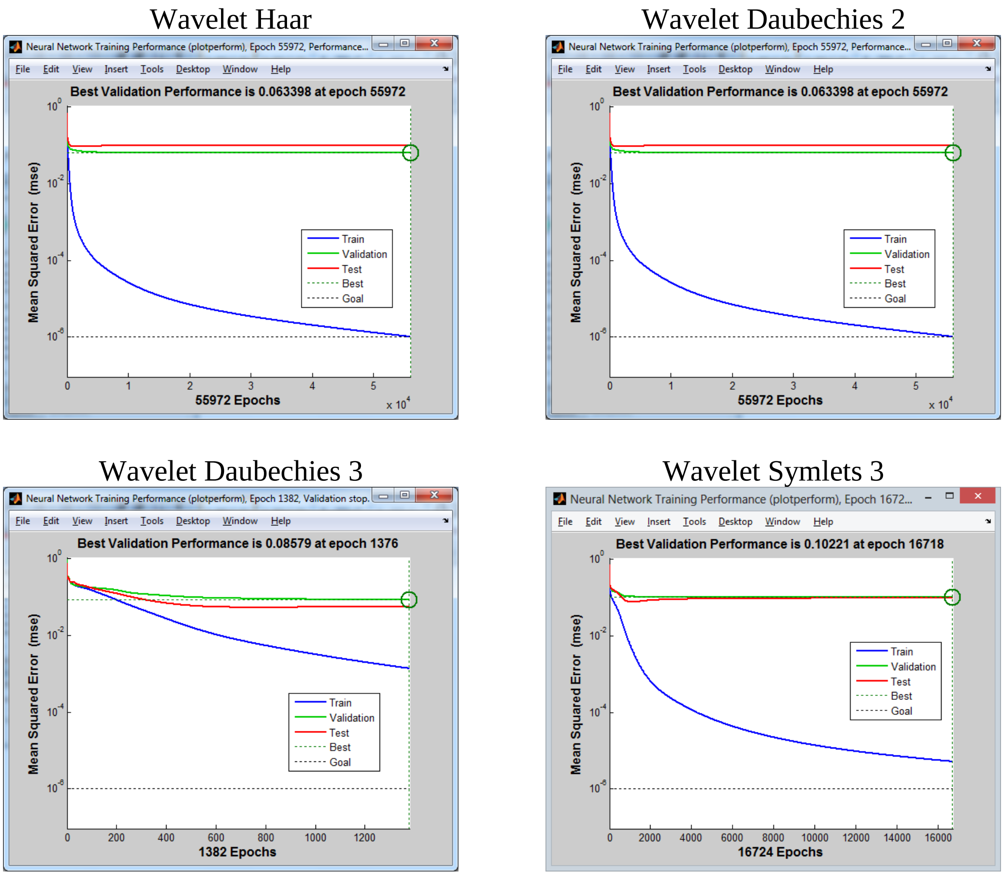

Figure 5. ANN Performance Results using wavelet

The accuracy results from Table 1 show that each wavelet has its own reliability in providing accuracy. Wavelet Haar, epoch 100000, MSE 0.0909 is the most superior by getting an accuracy of 94.44%. Backpropagation ANN achieves optimal results in performing static signature pattern recognition by utilizing the advantages of wavelets in preprocessing

4 Conclusion

The identification of the signature image has been successfully applied by involving two processes, namely training and testing. Based on the simulation that has been done, it can be concluded that the comparison of signature identification using wavelet switching and ANN has been successfully constructed. Image size 256 x 256 by scanning using a scanner and preprocessing several simulations have been carried out to get optimal results. Simulations have been carried out on several types of wavelets,

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namely Haar, Daubechies 2, Daubechies 3, Symlets 3, with 4 levels of decomposition and a learning rate of 0.09. The simulations carried out resulted in the most superior accuracy being 94.44% using the Haar wavelet transformation.

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