Identification of Scan Signatures on Thesis Certification Sheet with Haar Wavelet and Euclidean Distance Method

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Abstract — A signature is a person's official identity that can be used for authorization in the field of education, for example, authorization in the form of a ratification of a student's thesis exam. However, there are cases of students who fake examiners' signatures using an original signature scanned. To check the library cannot do it in real-time, because of a lack of human resources. Therefore, a system that can identify the thesis or thesis validation sheet collected by students to the library requires original signatures or scans using the Haar wavelet method and Euclidean Distance. The results of this study are Haar Wavelet and Euclidean Distance methods capable of identifying scan signatures on the thesis or thesis examination validation sheet.

Index Terms— Scan Signature, Haar Wavelet, Euclidean Distance

I. INTRODUCTION

A signature is a person's official identity that can be used for endorsement in the banking, taxation and education fields. The signature is used for the ratification of transactions or administrative endorsement. Nonetheless, the process of scanning signatures of other people signature is time consuming and some may get something or achieve a certain goal in the wrong way.

Thus, time spent for endorsement has been shortened by many AMIKOM Yogyakarta Universities in collection of theses or theses in the endorsement sheet, which this authorization sheet requires the original examiner signature and the thesis examiner. Moreover, the authorization involves with the hand protectors raised by the researcher who is scanning. For checking the library cannot be done in real-time, because it reduces human resources that cannot separate or trust the thesis or this thesis uses the original hand pointer or hand scan pointer that checks directly by the library staff, whether people who have expertise in signature approval.

Then, a questionable system of information is needed, namely a thesis or thesis collected by the student in the approval sheet signed by the appointed examiner lecturer or signed by hand scanning, which can be used by library staff or students when Script Checking process. If any mistakes identified, it can be followed up quickly.

In the previous research, optimal results were obtained using ANN (Artificial Neural Network) which had two hidden layers, 10 and 20 nodes respectively, using Haar Wavelet variants at level 4, learning level 0.12. Training and testing on this exam, each providing an accuracy of 95.56% and 100% [1]. From the results of testing a high level of hand image recognition using the 2DPCA method it reached 97% using images up to 150x150 pixels and 200x200 pixels. Optimal accuracy can be achieved by using a size of 150x150 with an accuracy of 97% and a speed of 0.37679 seconds [2]. Pre-processing and extracted using Wavelets and using Backpropagation. The signature scoring system can be obtained 90 images with 100% approval with the data collected while the assessment of the new data obtained an accuracy of 46%. [4]. While the results of this study are prototypes that can identify signs by scanning thesis / thesis sheets using the Haar Wavelet and Euclidean Distance methods.

II. RELATED WORKS

The Haar Wavelet and Euclidean Distance method is able to identify each signature validation scan on exam sheets thesis or thesis and the level of accuracy in the use of the Haar Wavelet and Euclidean Distance method.

A. Digital Image Processing

Image processing is a form of processing signals with input in the form of an image (image) and transformed into another image as an output with certain techniques. Image processing is implemented to correct image signal data errors that occur due to transmission and during signal acquisition, as well as to improve the quality of image appearance so that it is more easily interpreted by the human visual system by manipulating and analyzing images [5].

The following are the elements contained in digital imagery [6]:

1. Brightness. Brightness is the intensity of light emitted by pixels from images that can be captured by the visual system. Brightness at a point (pixels) in the image is the average intensity of an area that surrounds it.

2. Contrast, Contrast states the distribution of light and darkness in an image. In a good image, the dark and light composition is spread evenly.

3. Contour, Contour is the condition caused by changes in the intensity of neighbouring pixels. Because of this change the eye is able to detect the edges of objects in the image.

4. Color. Color as a perception that is captured by the visual system against light waves reflected by objects.

5. Shape (Shape). Form is the intrinsic property of a 3-dimensional object with the understanding that form is the main intrinsic property of the human visual system.

6. Texture (Texture). Texture is the regularity of certain patterns that are formed by the arrangement of pixels in a digital image. Texture information can be used to distinguish the surface properties of an object in images that are associated with coarse and fine.

B. Pattern Recognition

Pattern recognition is a discipline that studies ways to classify objects into several classes or categories and recognizes data trends. Depending on the application, these objects can be patients, students, applicants for credit, images or signals or other measurements that need to be classified or sought for their

regression functions. Usually this subject is called pattern recognition or pattern recognition.

Data mining often called knowledge discovery in database (KDD), is an activity that includes gathering, using historical data to find order, put patterns of relationships in large data sets. The output from data mining can be used to improve future decision making. So the term pattern recognition is now rarely used because that includes the part of data mining.

Machine learning is an area in artificial intelligence that is related to the development of techniques that can be programmed and learned from past data. Pattern recognition, data mining and machine learning are often used to refer to something similar. This biding intersects with probability science and sometimes optimization also. Machine learning is an analytical tool in data mining.

An observation such as a pattern or object is usually marked by several attributes. For example, objects of people, can be characterized by attributes of height, weight, face shape and others. This attribute is often called a variable [9].

C. Image Type

The value of one pixel has a value in a certain range, from the minimum value to the maximum value. The range varies depending on the type of color. But in general the scope is 0-255. Images with such depictions are classified into integer images. The following are the types of images based on the pixel value.

- Binary Imagery

The Digital images that only have two values of black and white pixels. Binary imagery is also referred to as B & W image (black and white) or monochrome image. Only 1 bit is needed to represent the value of each pixel of a binary image.
Binary imagery often appears as a result of processing such as segmentation, floating, morphological or dithering.

- Grayscale Imagery

The Grayscale images are digital images which only have one channel value on each pixel, in other words the value of the RED = GREEN = BLUE. This value is used to indicate the level of intensity. The colors that are owned are colors from black, gray, and white. Gray level is the level of ash with various levels from black to white.

- Color Imagery

Each pixel of a color image (8 bits) is only represented by 8 bits with the maximum number of colors that can be used is 256 colors. There are two types of 8-bit color images. First, an 8-bit color image using a 256 color palette with each palette having a certain RGB colormap. This model is used more often. Second, each pixel has the 8-bit format as follows:

TABLE I
Color series of 8-bit colors

Bit-7	Bit-6	Bit-5	Bit-4	Bit-3	Bit-2	Bit-1	Bit-0
R	R	R	G	G	G	B	B

- Color Imagery (16-bits)

The 16-bit color image (usually referred to as high color image) with each pixel represented by 2 bytes of memory (16 bits). The 16-bit color has 65,536 colors. In its bit formation, the red and blue values take place in 5 bits on the right and left. Green

components have 5 bits plus 1 extra bit. The selection of green components with 6-bit series is due to human vision more sensitive to green.

TABLE II
Color series of 16-bit colors

Bit-14	Bit-13	Bit-12	Bit-11	Bit-10	Bit-9	Bit-8	Bit-7	Bit-6	Bit-5	Bit-4	Bit-3	Bit-2	Bit-1	Bit-0
R	R	R	R	R	G	G	G	G	G	G	B	B	B	B

- The image of colors (24-bits)

Each pixel of the image of 24-bit color is represented with 24 bits for a total of 16,777,216 color variations. This variation is more than enough to visualize all the colors that human vision can see. Human vision is believed to only be able to distinguish up to 10 million colors. Every pixel (RGB) information point is stored into 1 byte of data. The first 8 bits store the blue value, then followed by the green value in the second 8 bits and the last 8 bits are red.

D. Image File Format

The standard file format used today consists of several types. These formats are used in storing images in a file. Format has its own characteristics. The following is an explanation of some of the formats commonly used today.

a. Bitmap (.bmp)

The .bmp format is a standard, non-compressed storage format that can be used to store binary images to color images. This format consists of several types, each of which is determined by the number of bits used to store a pixel.

b. Tagged Image Format (.tif, .tiff)

The .tif format is an image storage format that can be used to store bitmap images to compressed palette images. This format can be used to store uncompressed images and compressed images.

c. Portable Network Graphics (.png)

The .png format is a format for storing compressed images. This format can be used in grayscale images, images with color palettes as well as full color images. The .png format is also capable of storing information up to now; alpha with storage of 1 to 16 bits per channel.

d. JPEg (.jpg)

.jpg is a format that is very commonly used today, especially for image transmission. This format is used to store the image compression results of the JPEG method.

e. MPEg (.mpg)

This format is used in the internet world and is intended as a format for storing mobile images (video). This format supports video with loss compression.

f. Graphics Interchange Format (.gif)

This format can be used on color images with 8-bit palettes. Generally used in web applications. Low quality causes this format not to be too popular among digital image processing researchers.

g. RGB (.rgb)

This format is an image storage format created by silicon graphics to store color images.

h. RAS (.ras)

The. ras format is used to store images in RGB format without compression.

i. Postscript (.ps, .eps, .epfs)

This format was introduced to store images of electronic books. In this format, the image is represented in a decimal or hexadecimal value sequence encoded into ASCII.

j. Portable Image Format

This format has several parts including portable bitmap, portable graymap, portable pixmap and portable network map with consecutive formats such as. pbm, .pgm, .ppm and .pnm. this format is good for storing and re-reading image data.

k. PPM

PPM consists of two general parts, namely the introduction and the image data section. The introduction has three small parts, the first is the PPM identifier which can be P3 (for ASCII Imagery) and P6 (for binary imagery). The second introductory part is the length and width of the image. The third part of the introduction is the maximum value of the color component. The specialty is in the image data can be saved comments by giving a sign '# 'before comment.

l. PGM

This format is almost similar to the PPM format except that this format stores grayscale information (one value per pixel). The identifiers used are p2 and p5.

m. PBM

PBM is used to store binary imagery. Similar to PPM and PGM, this PBM format has an introduction, except that the introduction does not have the third part (an explanation of the maximum value of pixels). The fulfilment that is applied is p1 [3].

E. Scan Signature Technique

- Haar Wavelet Transform

The Wavelets are mathematical functions that cut up data into different frequency components, and then study each component with a resolution matched to its scale. They have advantages over traditional Fourier methods in analyzing physical situations where the signal contains discontinuities and sharp spikes. Wavelets were developed independently in the fields of mathematics, quantum physics, electrical engineering, and seismic geology. Interchanges between these fields during the last ten years have led to many new wavelet applications such as image compression, turbulence, human vision, radar, and earthquake prediction. This paper introduces wavelets to the interested technical person outside of the digital signal processing field. I describe the history of wavelets beginning with Fourier, compare wavelet transforms with Fourier transforms, state properties and other special aspects of wavelets, and finish with some interesting applications such as image compression, musical tones, and de-noising noisy data [10].

The fundamental idea behind wavelets is to analyze according to scale. Indeed, some researchers in the wavelet field feel that, by using wavelets, one is adopting a whole new mindset or perspective in processing data. Wavelets are functions that satisfy certain mathematical requirements and are used in representing data or other functions. This idea is not new. Approximation using superposition of functions has existed since the early 1800's, when Joseph Fourier discovered that he could superpose sines and cosines to represent other functions. However, in wavelet analysis, the scale that we use to look at data plays a special role. Wavelet algorithms process data at different scales or resolutions. If we look at a signal with a large "window," we would notice gross features. Similarly, if we look at a signal with a small "window," we would notice small features. The result in wavelet analysis is to see both the forest and the trees, so to speak. This makes wavelets interesting and useful. For many decades, scientists have wanted more appropriate functions than the sines and cosines which comprise the bases of Fourier analysis, to approximate choppy signals (1).

By their definition, these functions are non-local (and stretch out to infinity). They therefore do a very poor job in approximating sharp spikes. But with wavelet analysis, we can use approximating functions that are contained neatly in finite domains. Wavelets are well-suited for approximating data with sharp discontinuities. The wavelet analysis procedure is to adopt a wavelet prototype function, called an analyzing wavelet or mother wavelet. Temporal analysis is performed with a contracted, high-frequency version of the prototype wavelet, while frequency analysis is performed with a dilated, low-frequency version of the same wavelet. Because the original signal or function can be represented in terms of a wavelet expansion (using coefficients in a linear combination of the wavelet functions), data operations can be performed using just the corresponding wavelet coefficients. And if you further choose the best wavelets adapted to your data, or truncate the coefficients below a threshold, your data is sparsely represented. This sparse coding makes wavelets an excellent tool in the field of data compression. Other applied fields that are making use of wavelets include astronomy, acoustics, nuclear engineering, sub-band coding, signal and image processing, neurophysiology, music, magnetic resonance imaging, speech discrimination, optics, fractals, turbulence, earthquake-prediction, radar, human vision, and pure mathematics applications such as solving partial differential equations. [10].

The first mention of wavelets appeared in an appendix to the thesis of A. Haar (1909). One property of the Haar Wavelet is that it has compact support, which means that it vanishes outside of a finite interval. Unfortunately, Haar Wavelets are not continuously differentiable which somewhat limits their applications [10].

III. METHODOLOGY

The Haar Wavelet is the oldest and simplest wavelet [7]. The reason for using Haar Wavelet is because it is a better method used to represent texture and shape characteristics. Besides, Haar Wavelet requires a smaller computation time than the transformation of another wavelet, the characteristics obtained from images that have passed the decomposition process. namely, double to be able to operate. Figure 3 shows the HAAR matrix size L = 8x8. Lines 1 to L / 2 are low pass filters and L / 2 + 1 to L lines are high pass filters.

>> MatriksHaar(8)							
0.7071	0.7071	0	0	0	0	0	0
0	0	0.7071	0.7071	0	0	0	0
0	0	0	0	0.7071	0.7071	0	0
0	0	0	0	0	0	0.7071	0.7071
0.7071	-0.7071	0	0	0	0	0	0
0	0	0.7071	-0.7071	0	0	0	0
0	0	0	0	0.7071	-0.7071	0	0
0	0	0	0	0	0	0.7071	-0.7071

Figure 1. Haar Matrix Size 8x8

The wavelet base is a different model of the wavelet family which has various qualities according to the criteria that are owned [8].

In the Haar wavelet, the wavelet function is defined in Equation 1:

$$\psi(t) = \begin{cases} 1 & 0 < t < 0.5 \\ -1 & 0.5 < t < 1 \\ 0 & selainnya \end{cases} \tag{1}$$

For the scaling function in the Haar Wavelet defined in Equation 2:

$$\varphi(t) = \begin{cases} 1 & 0 < t < 1 \\ 0 & selainnya \end{cases} \tag{2}$$

In the decomposition process, the Haar Wavelet applies a bank filter with h (0) = h (1) = 1 / √2 as a low-pass coefficient that produces an approach image and g 0 = 1 / √2, g 1 = 1 / √2 as high-pass coefficients that produce detailed images. The decomposed image will be a quarter of the size of the actual image. Illustration of image decomposition process can be seen in Figure 2.
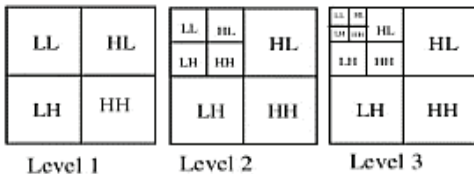

Figure 2. Illustration of Image Decomposition Process

- Euclidean Distance

Some methods of calculating similarity or dissimilarity of images are commonly called distance. Determine the size of the proximity distance between data elements, namely the Euclidean Method, as in Equation 3 and 4, which comparing the minimum distance of the testing image, with the database image training. The Euclidean distance of the two x and y vectors is calculated by the equation; the general form is in Equation 5:

$$x = (x_1, x_2, ..., x_n) \tag{3}$$
$$y = (y_1, y_2, ..., y_n) \tag{4}$$
$$d(x,y) = \sqrt{(y_1 - x_1)^2 + (y_2 - x_2)^2 + ... + (y_n - x_n)^2} \tag{5}$$

The smaller the d value (x, y), the more similar the two vectors are matched. Conversely, the greater the value of d (x, y), the more different the two vectors are matched [9]. The Distance Euclidean process is done by comparing the proximity of the distance values of two variables, namely the test image with a reference image to find the value of the closest distance. The result of the calculation used as a comparison is the smallest value (the closest distance).

IV. RESULTS

The process flow compares the image of the original signature and the image of the scanned signature on the thesis test sheet, with the Haar Wavelet method and the Euclidean distance method.

A. Identification process

Stages of signature identification (digital image processing) as follows:

1. Start (Pre-Processing)

In this process the image file format used is JPEg (.jpg), JPEG is a very common format used to transmit and store compressed images.

2. Crop Signature Images and Resize

Before resizing, the signature image is first cropped (cut) especially in the signature area first, then the signature image will be resized so that the image size is the same, making it easier in the process. Based on existing data, all are changed to be equalized to the size according to the reference image, so that the test image matrix that is matched with the Haar Wavelet method and the Euclidean Distance method are the same as the reference data.

3. Grayscle

In this process, all test images are changed to gray color, to make it easier for the next stage. Grayscale is a digital image that has only one channel value in each pixel, or part Red = Green = Blue. Each pixel RGB (Red Green Blue) from the image is taken its value, averaged from the three RGB values, and initialized with the average value to create a grayish color from the image matrix that has been done by the grayscale process.

4. Thresholding Method

The thresholding method is one of dithering. Dithering is a technique to simulate a high color gradation display, while the color gradation shown is actually not from the color gradation of the image. The parameter to be changed is actually the point and density point. This is done to obtain image quality that is almost the same as the resulting image. For example: if the image is color (relatively large image file size) dithering does it by reducing the number of colors (image file size becomes relatively small) and rearranging neighbouring pixels with low color gradations into pixel patterns capable of simulating high color gradations. Each thresholding method uses the T threshold as a benchmark for deciding whether a pixel is changed to black or white [6]. Usually T is calculated by the equation 6.

$$T = \frac{f_{maks} + f_{min}}{2} \tag{6}$$

Where f-maks is the maximum value of the image and f-min is the minimum intensity value in the image.

If f (x, y) is the value of the pixel intensity at the position (x, y) then the pixel is replaced white or black depending on the following conditions at Equation 7 and 8.

$$f(x,y) = 255, jika \ f(x,y) \geq T \tag{7}$$

$$f(x,y) = 0, jika \ f(x,y) < T \tag{8}$$

For example, suppose the image is known as 4x4 pixel grayscale with 8-bit depth as follows.

TABLE III
Image in 4x4 pixel grayscale with 8-bit depth

250	246	246	249
246	250	250	248
251	250	250	247
251	250	250	247

With this method, the Thresholding, T value is:

$$T = \frac{f_{maks} + f_{min}}{2} = \frac{251 + 246}{2} = 248.5$$

If the value of T = 248.5 is applied to the image, the following image is obtained calculated as illustrated in Table IV.

TABLE IV
Image in 4x4 pixel grayscale with threshold value

255	0	0	0
0	255	255	0
255	255	255	0
255	255	255	0

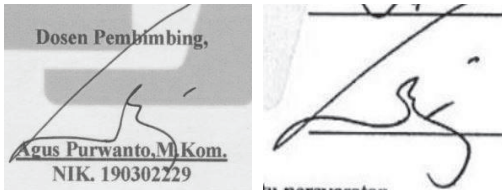Based on the Table IV values, the image is viewed as in Figure 3.

Fig. 3. Original Signature Image and Scan with Grayscale Image

4. Display of the Grayscale GUI

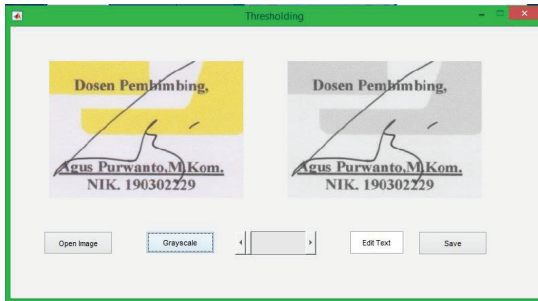Figure 4 shows the thresholding process of the original signature image in the application.

Fig. 4. Original Signature Image and Scan with Grayscale Image

5.Calculation of images using the Haar Wavelet in MATLAB

Calculation with the Haar Wavelet method with MATLAB is by entering training data and testing data. This training data is in the form of data image (.jpg) image of the original signature, while the testing data is in the form of image (.jpg) image of the scanned signature on the validation sheet of the thesis.

6. Calculation of images using the Euclidean Distance method in MATLAB. Table V shows the Identification Results Testing using a scanned signature and original signature can be analyzed with the percentage of success.

TABLE V
Test Result

No.	Testing	training signature	Value of Euclidean Distance Scan signature	Testing Signature	True / False Results
1.	Testing 1	Agus_A	2.4183	Agus_S	True
2.	Testing 2	Dhani_A	4.0715	Dhani_S	True
3.	Testing 3	Rudy_A	1.2394	Rudy_A	True
4.	Testing 4	Bayu_A	1.1634	Bayu_AA	True
5.	Testing 5	Andi_A	3.9633	Andi_S	True
6.	Testing 6	Erik_A	1.0040	Erik_AA1	True
7.	Testing 7	Dina_A	1.0364	Dina_AA	True
8.	Testing 8	Ema_AA	1.155	Ema_AA1	True
9.	Testing 9	Anggit_A	1.0280	Anggit_AA1	True
10	Testing 10	Sukma_A	1.088	Sukma_AA	True

Distance is an important aspect in developing classification and regression methods. Many methods developed depart from the concept of distance. to measure the distance of two points x and y, (d (x, y), using several concepts of distance. size of distance must meet the following conditions [9]:

1. D (x, y) ≥ 0 (non-negative) There is no distance that has a negative value.

2. D (x, y) = 0 if and only if x = y (identity of indiscernible). The distance between an object or a point and an object or point itself is zero.

3. D (x, y) = d (y, x) (symmetry)The distance from x to y is the same as the distance from y to x.

4. D (x, z) ≤ d (x, y) + d (y, z) (triangle inequality)

From table 1 the results of the above tests can be given online if the Euclidean value Distance between 0 - 1 or the closest means training data and testing data is original/appropriate, but if the Euclidean Distance value above 1 means training data and different testing data/scan.

Accuracy is a measure of how good the model is correlated between results with attributes in data has been provided.

For the accuracy of the data on the success of image processing, namely by the formula:

$$\text{Accuracy (\%)} = \frac{\sum Data\ Uji\ Benar}{\sum Total\ data\ uji} \times 100$$

The accuracy of success data from image processing in the research of the scan signature image with the wavelet haar method and Euclidean distance is: (10/10) *100 = 100%

V. CONCLUSION

Based on the results of classification testing and discussion, then obtained conclusion: Haar Wavelet and Euclidean Distance methods are able to identify scanned signatures on the thesis/thesis examination validation sheet and the publication document validation sheet. The level of accuracy in the use of the Haar Wavelet method and Euclidean Distance is 100%.

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