CLASSIFICATION OF SIGNATURES USING TEMPLATE MATCHING METHOD

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Abstract

Template Matching is one of the methods used for digital image processing, usually used to recognize the shape or pattern of an image. The shape or pattern that is often used to be recognized is in the form of character images, letters, numbers, or fingerprints. In the research conducted, signature pattern recognition was made using Template Matching for signature classification. Signature is chosen in research conducted with the aim of knowing whether the signature can be recognized using the Template Matching in addition to character images of letters, numbers, or fingerprints. Template Matching works by matching each pixel in the image matrix that has been digitally processed with the reference image (template) and because Template Matching is an applied method of convolutional technique, Template Matching combines two numbers to produce a third number series, so that the correlation coefficient (r) of the Template Matching will be obtained between -1 and +1. The results of the trials carried out show that the signature pattern recognition with Template Matching can recognize the signature image tested with a recognition accuracy rate of 96% with as many as 100 signature images.

Keywords: *Pattern Recognition, Template Matching, Convolution Techniques, Signatures*

1. INTRODUCTION

Template Matching is one of the methods used for digital image processing, usually used to recognize the shape or pattern of an image. According to [1] said the Template Matching method is a simple algorithm that matches each pixel of a matrix with another matrix. The greater the deviation from the comparison matrix, the lower the similarity level, Template Matching algorithm is an algorithm that is easy to implement and has a very high percentage of successful character matching. In research [1] using Template Matching to identify Japanese letters, especially katakana which is used to introduce Japanese to the wider community. The accuracy results obtained in this study are 85% of the test data of 20 images with a size of 15x15 pixels.

In previous research conducted, [2] stated that Template Matching is a technique in digital image processing that functions to match each part of an image with the image that becomes the template (reference). The input image is compared with the template image in the database, then the similarity is searched using a certain rule. Image matching that produces a high level of similarity or similarity determines that an image is recognized as one of the template images. In research [1] using Template Matching was used to identify the type of motif on the Sasirangan fabric. The results of the accuracy obtained in this research are 83.33% of the test data of 30 images of Sasirangan cloth with a size of 150x150 pixels.

Based on previous research, this research will try to classify signatures using Template Matching, to find out whether Template Matching can recognize the shape or pattern of an image other than the character image of letters, numbers or fingerprints, in this research it is in the form of a signature pattern and to determine What is the amount of accuracy generated by Template Matching with signature image data of 200x200 pixel size.

2. RESEARCH METHODOLOGY

The research flow can be seen in Figure 1:

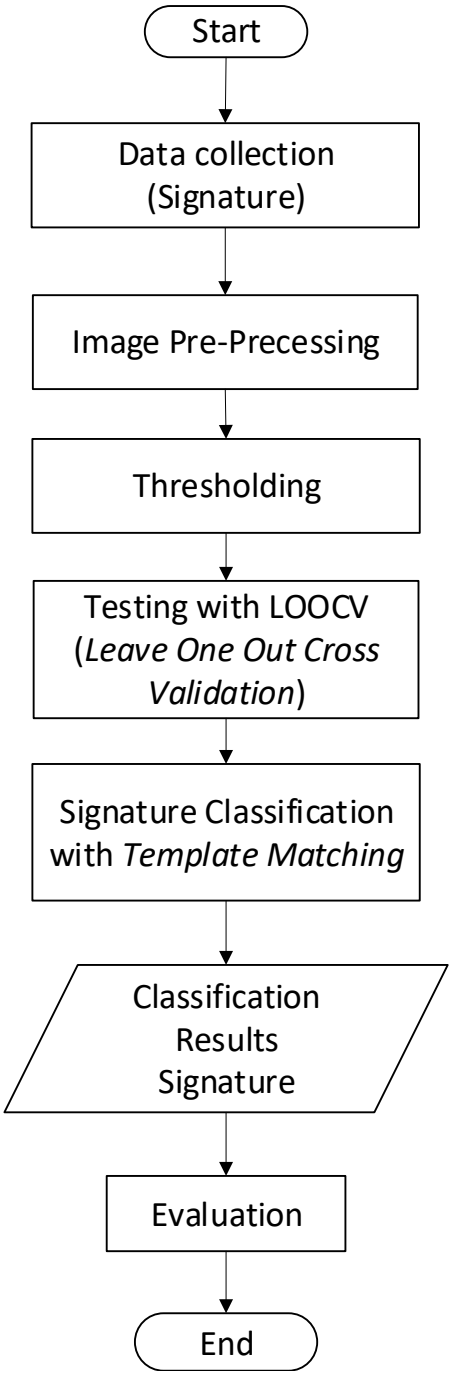

Figure 1 Research Flow

2.1 Data Collection

The data used is signature image data, taken from 10 respondents, each person giving 10 signatures, so that the total data obtained is 100 signature images. Data is taken through the collection process and processed using the smartphone's rear camera measuring 3456 x 4608 (16MP) on the same day with a distance of 15 cm. Table 1 is a table for naming classes according to the respondent's signature owner.

Table 1 Signature Class

No	Class
1	Ardhi
2	Ayif
3	Annisa
4	Bawai
5	Muna
6	Juhdi
7	Rahimah
8	Sajjali
9	Yugo
10	Yuninda

2.2 Image pre-processing

In the image pre-processing stage, the signature image will go through the image cropping process with the aim of taking the signature image only, cropping is done with an appeal of 1:1 or square, at the cropping stage, also changes the image format from JPG to PNG for image optimization. without reducing image quality after cropping. After the cropping process is complete, proceed with resizing the image with a size of 200x200 pixels. The next process is to change the image from an RGB (Red, Green, Blue) image to a greyscale image. In the image pre-processing process, the cropping-resizing process uses the help of the *Adobe Photoshop CS6* application and for the greyscale process using the *python library*, *opencv-python*. In Figure 2, you can see an example of a signature image that has gone through the pre-processing process.

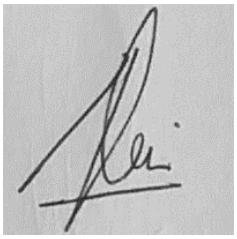

Figure 2 Greyscale with Image Name Sajjali_1.png

2.3 Thresholding

Image thresholding according to [3] says a method used to separate objects and backgrounds. Thresholding is a simple and effective technique for image segmentation. The thresholding process is often referred to as the binarization

process. In some image processing applications, a gray level image is the first threshold to become a binary image (an image that has a gray level of 0 or 255). In the research conducted, given a threshold value of 128. The pixel value becomes 0 if the greyscale pixel value is less than or equal to 128 and the pixel value becomes 1 if the greyscale pixel value is more than 128. The thresholding process uses the help of the *python library*, namely *opencv-python*.

2.4 Image Testing

Image testing used in the research is Leave One Out Cross Validation (LOOCV), the way LOOCV works is to take 1 data from the total data and test 1 data taken as testing to all data as training except 1 data taken as the previous testing. In this study, it means that from 100 signature images, 1 is taken as testing and will be tested to the other 99 signature images as training. This process is repeated from the first image to the last image.

2.5 Template Matching

At this stage, Template Matching calculation is carried out to find the value of the correlation coefficient (r) which is useful for the classification of the signature owner. The highest correlation coefficient (r) is taken to be the prediction class for the signature class. The formula used is:

$$r = \frac{\sum_{k=1}^{N}(x_{ik}-\bar{x}).(y_{jk}-\bar{y})}{\sqrt{\sum_{k=1}^{N}(x_{ik}-\bar{x})^2.\sum_{k=1}^{N}(y_{jk}-\bar{y})^2}} \quad \ldots(1)$$

r is the correlation coefficient, x_{ik} is the image that is the reference, $\bar{x}$ is the average value of the reference image. Whereas y in the input image, $\bar{y}$ the average value of the input image, and n is the number of image pixels. According to [1], this algorithm matches each pixel in a digital image matrix with the image that becomes the template (reference).

2.6 Classification Results

The classification result is in the form of a prediction made by the system using 100 signature images with the signature owner classification output. In table 2, you can see the classification results from Figure 2.

Table 2 Image Classification Results

Image	Actual Class	Class of the System
Sajjali_1.png	Sajjali	Sajjali

2.7 Evaluation

Evaluation is a process for comparing the output results of a system designed with the actual conditions by actual data.

$$\text{Accuracy} = \frac{Recognizable\ Classification}{Total\ Data} \times 100\% \quad \ldots(2)$$

3. RESULTS AND DISCUSSION

3.1 Results

Table 3 shows the classification results that can be recognized by the system, according to the actual data.

Table 3 Image Classification Results

No	Class	Number of Images	Succeed	Failed	Presentation
1	Ardhi	10	10	0	100%
2	Ayif	10	9	1	90%
3	Annisa	10	10	0	100%
4	Bawai	10	10	0	100%
5	Muna	10	10	0	100%
6	Juhdi	10	10	0	100%
7	Rahimah	10	10	0	100%
8	Sajjali	10	10	0	100%
9	Yugo	10	8	2	80%
10	Yuninda	10	9	1	90%

In diagrammatic form, it can be seen in Figure 3:

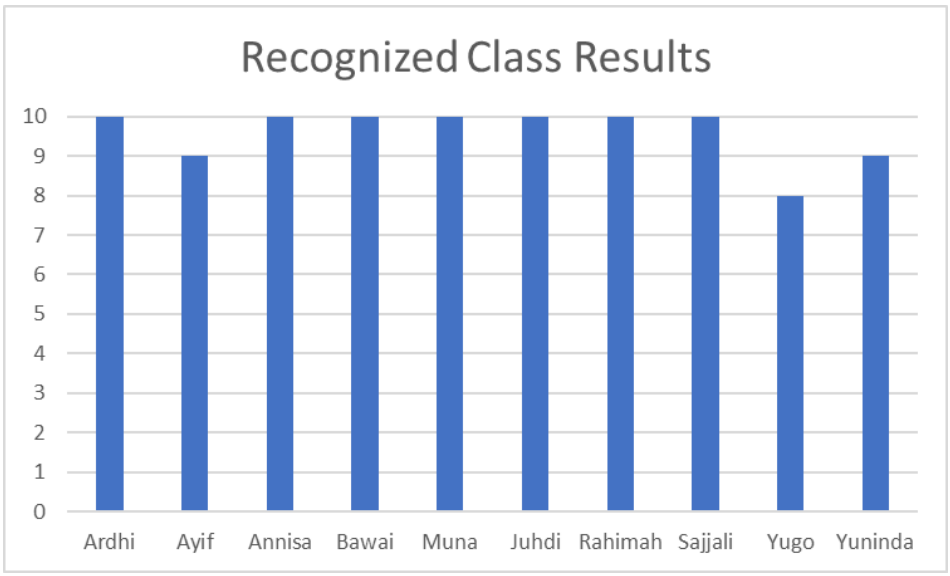

Figure 3 Recognized Class Results

The results show that the accuracy resulting from the signature pattern recognition of 200x200 pixels using Template Matching is the number of data successfully divided by the total data.

$$\text{Accuracy} = \frac{96}{100} \times 100\% = 96\% \quad \ldots(3)$$

So that the resulting accuracy is 96% for signature pattern recognition 200x200 pixel size with 100 signature images used.

3.2 Discussion

In table 3 it can be seen that the results of the signature pattern recognition were carried out, there was an introduction error in the Ayif class once recognized as the Juhdi class, there were two recognition errors in the Yugo class which were recognized as Rahimah and Sajjali classes and there was a re-introduction error in Yuninda class once recognized as Ardhi class. Accuracy results reach 96% due to several factors, including taking images on the same day with a distance of 15 cm, using a resolution that is large enough to 200x200 pixels, and the pre-processing process carried out, such as cropping-resizing, is done well without cutting the sign image important hand. The pre-processing process uses the help of the *Adobe Photoshop CS6* application and for the greyscale process until the Template Matching calculation uses the help of the *python library*, *opencv-python*.

4. CONCLUSION

Template Matching turns out to be able to recognize signature patterns in addition to shapes or image patterns of letters, numbers, or fingerprints. Based on this study using image data of 100 signatures, an accuracy of 96% was obtained, the results of accuracy reached 96% due to several factors, including taking images on the same day with a distance of 15 cm, using a large enough resolution of 200x200 pixels, and the pre-process. processing, such as cropping-resizing, is done well without cutting out important parts of the signature image. In further research, it is expected to use a resolution greater than 200x200 pixels, because the larger the size of the resolution used, the more pixels are produced, so that the resulting image quality is better, which is expected to be able to recognize signatures better than the size in the study which has been done.

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