IMPLEMENTATION METHOD OF SUPPORT VECTOR MACHINE (SVM) AND ZONING FOR HANDWRITING RECOGNITION CHECKING CASE EXAM ANSWERING

Muhammad Ferderico Soleh[1], Ken Kinanti Purnamasari[2]

[1,2]Teknik Informatika - Universitas Komputer Indonesia
Jl. Dipatiukur 112-114 Bandung
E-mail : ferdericosoleh@email.unikom.ac.id[1], ken.kinanti@email.unikom.ac.id[2]

ABSTRACT

Handwriting is one part of the language of the language in general. Handwriting can be shared by all people and posts each person is different, depending on the level of uniqueness and characteristics possessed. Been many studies that examined in regard to the image of handwriting recognition. The results of image recognition obtained handwriting varies and is influenced by the training data and methods of feature extraction and classification. In this research, feature extraction methods used are zoning (Image Centroid Centroid-Zone Zone Zone), the classification method used is Support Vector Machine to perform image recognition of handwriting that will be implemented in the evaluation kasu essay exam answers. The results of the evaluation of exam answers in this research is influenced by the handwriting recognition accuracy is obtained. Before performing the classification process, the image of handwritten going through a phase Grayscale, Threshold, segmentation, Resize and feature extraction Zoning. And further training and testing process is done by a method Support Vector Machine. Having obtained his recognition results then the last step is the evaluation of exam answers with rabin-Karp method which only served to determine the degree of similarity between the results of introduction and test answers provided. Handwritten characters that can be recognized, there are 62 characters consist of A-Z, a-z and 0-9. Training data used in this study using handwriting samples 1 to 62 existing class data, which means that (1 x 62 = 62) and 100 handwriting samples for training data, which means there are 6,200 characters (100 x 62 = 6200). Then the test data used there are 1 data writing essay from different answers. Based on the results of tests performed on test data using 10 combinations parameters of training, then obtained the best accuracy of 77.6%.

Keywords: Artificial Intelligence, Support Vector Machine, Zoning, handwriting image recognition, image processing, SVM.

1. PRELIMINARY

Handwriting is one part of the language of the language in general. Handwriting can be shared by all people and posts each person is different, depending on the level of uniqueness and characteristics possessed. Based on these differences are many studies that discuss about handwriting. The research was done because of the performance limitations performed by the system is fairly slow in checking and assessment exam answers, and not finding the optimum results from the use of the previous methods which discusses the study of handwriting recognition Handwriting Recognition. In that research, get the best average accuracy of 55.7% [1].

Support Vector Machine (SVM) is a learning system that uses space hypothesis of a linear function in a high-dimensional spaces feature developed by Boser, Guyon, Vapnik, and was first presented in 1992 in Annual Workshop on Computational Learning Theory. Method of Support Vector Machine (SVM) used in this study because it has been implemented for a wide variety of research with a similar issue is raised handwriting recognition and fairly efficient in its use [2]. Use of the method of classification would be combined with a method of feature extraction Zoning-Zone Centroid Zone and Image Centroid Zone are believed to be capable of producing accurate results in handwriting recognition, the method is selected because based on previous research, if the classification method of SVM and Zoning combined would be more accurate [2].

Method of Support Vector Machine has already been used in classifying some cases, such as the application of SVM method on the introduction of characters Sunda [2], the application of the method of classification Support Vector Machine on accreditation data elementary school [3], the identification of the signature [4], pattern recognition jawi [5], the Persian handwriting recognition using SVM [6], and a handwritten character recognition numbers and mathematical operators based Algorithm Support Vector Machine and Hybrid [7], the method of support vector machine had been combined with other methods Zoning in the case of handwriting recognition letter hijaiyah [8], and is also applied in the introduction

of script Sunda with SVM [9]. From these studies used various methods of classification Support Vector Machine (SVM) with accuracy results vary. These results are influenced by the training data and feature extraction methods are used. In this study using Support Vector Machine multiclass (One Vs All), this method is used for the comparison study multiclass (svm) [23], have earned the best average accuracy of 90%.

Thus, in this study will be made handwriting recognition application essay using Support Vector Machine classification by the Zoning feature extraction (Image Centroid Centroid-Zone Zone Zone). Then after that will do the calculation accuracy is done by counting the number of handwritten characters that can be recognized by the application.

1.1 Digital Image Processing

Digital image processing means to perform two-dimensional image processing by digital computers. According Efford (2000), the image processing is a general term for various techniques existence to manipulate and modify the image in various ways [15]. Photos are examples of two-dimensional images that can be processed easily. Each photo in the form of a digital image can be processed using specific software. In this research image processing is done such as grayscale, threshold, segmentation, resize and feature extraction.

1.1.1 *Grayscale*

Grayscale image handling shades of black and white, which of course produces a gray color effect. Color image is expressed with intensity. In this case, the intensity ranges between 0 and 255. Value 0 indicates black and white value of 255 states [19]. Here is the conversion formula is colored image (RGB) into *grayscale*.

$$I = (0.2989* R)+(0.5870*G)+(0.1141*B) \quad (1)$$

Information :
R: red value component (Red) of a pixel point
G: green value component (Green) on a pixel point
B: component value of blue (Blue) of a pixel point

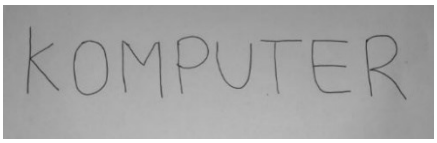


Figure 1 Sample Image Results Grayscale

1.1.2 *Threshold*

Threshold method used in this study is sauvola threshold. Sauvola threshold is a threshold method which is able to provide improved by calculating a threshold using dynamic value range of the standard deviation scores grayscale image [18]. Sauvola included in the local threshold where the threshold value is determined by the value of the neighboring pixel. Here is the formula sauvola threshold T (x, y).

$$T(x,y) = m(x,y) * (1 + k * (\frac{s(x,y)}{R} - 1)) \quad (2)$$

$$m(x,y) = \frac{\sum_{i=min}^{i=max} \sum_{j=min}^{j=max} img(i,j)}{i*j} \quad (3)$$

$$s(x,y) = \sqrt{\frac{\sum_{i=min}^{i=max} \sum_{j=min}^{j=max} (img(i,j)-m(x,y))^2}{(i*j)-1}} \quad (4)$$

Keterangan :
R : The maximum value of the standard deviation (128 for grayscale images)
k : *Kernel with values between 0.2 - 0.5.*
m: The function that produces the average value of a number of image pixels.
s : Function that produces standard deviation value of a pixel image
T : The function that generates a threshold value (threshold)
x : The width value of the image coordinates
y : coordinate high value image

Once the threshold value T (x, y) has been established, then enter into the following equation.

$$f(x,y) = \begin{cases} 0, & img(x,y) < T(x,y) \\ 255, & img(x,y) \geq T(x,y) \end{cases} \quad (5)$$

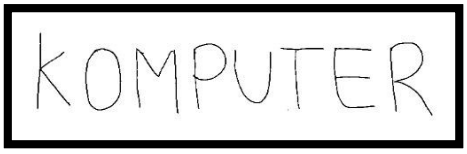


Figure 2 Sample Image Results Threshold

1.1.3 Segmentation

Segmentation is a technique for dividing an image into multiple regions (region) where each region has a resemblance attributes [19]. To what extent such distribution is carried out depends on the problem at hand. Ideally, the segmentation step is stopped when the desired object has been successfully separated. In this research, segmentation is done by cutting the rows and columns of images. The first cutting is done for the entire line of the image of handwritten, followed by cutting a column for each image of the cutting line.

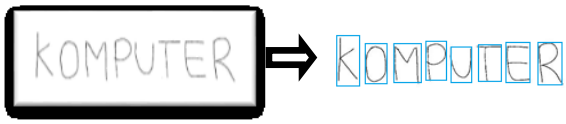


Figure 3 Sample Image Results Segmentation

1.1.4 *Resize*

Resize the image means changing the magnitude of the digital image in pixels. Adakala resized to be smaller than its original size, and

sometimes vice versa. The process of resizing the image can affect the image size is larger or smaller and also the image quality to be better or worse.

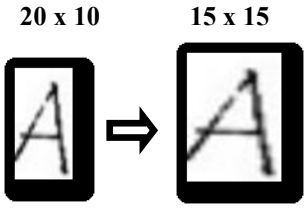


Figure 4 Sample Image Results Resizing

1.1.6 Feature Extraction Zoning

Zoning is a feature extraction, feature extraction with the main concept is the division of the image into the same number of zones to be recognized traits of each character of letters and numbers, which will produce a value that will be processed on the stage classification. Steps in zoning algorithm Centroid Zone-Image

.

1. Calculate the value centroid input image

$$x_c = \frac{(x_1.p_1 + x_2p_2 + \ldots + x_np_n)}{(p_1 + p_2 + \ldots + p_n)}$$

$$y_c = \frac{(y_1.p_1 + y_2p_2 + \ldots + y_np_n)}{(p_1 + p_2 + \ldots + p_n)}$$



2. Devide into the same number of zones

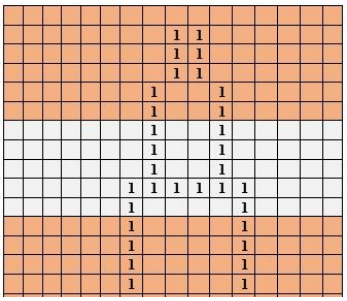


Figure 5 Distribution of Image Character A Into the same zone

3. Calculate the distance from the black pixel centroid

$$d(P, C)\sqrt{(x_p - x_c)^2 + (y_p - y_c)^2}$$

d	= jarak antara dua titik
P	= koordinat titik berat
C	= koordinat *pixel*
x_p	= koordinat x titik berat
y_p	= koordinat y titik berat
x_c	= koordinat x *pixel*
y_c	= koordinat y *pixel*

Perhitungan jarak setiap zona dapat dilihat dibawah ini.

Zona Atas (1)

(8,1) : distance $=\sqrt{(8-8)^2 + (1-8)^2} = 7$

(9,1): distance $=\sqrt{(9-8)^2 + (1-8)^2} = 7.07$

(8,2): distance $=\sqrt{(8-8)^2 + (2-8)^2} = 6$

4. Hitung Jarak Rata-Rata Antara Titik.

Zona 1 : The average distance

$$= \frac{(jarak(8,1)+Jarak(9,1)+Jarak(10,5)+\cdots+Jarak(2,9)}{Banyak\ Titik\ (10)}$$

$$= \frac{51.61592037200608827}{10} = 5.161592037200608827$$

Zona 2 : Rataan Jarak

$$= \frac{(jarak(7,1)+Jarak(10,1)+Jarak(7,2)+\cdots+Jarak(11,5)}{Banyak\ Titik\ (14)}$$

$$= \frac{71.2813549963260149}{14} = 5.0915253568804296357$$

Zona 3 : Rataan Jarak =

$$\frac{(jarak(6,1)+Jarak(6,2)+Jarak(6,3)+\cdots+Jarak(11,4)}{Banyak\ Titik\ (8)}$$

$$= \frac{48.6168949049599383}{8} = 6.07711186311999228$$

5. Didapatkan tiga nilai fitur rata-rata.

Zone 1(on) = 5.1615920372006088

Zone 2(Middle) = 5.0915253568804296

Zone 3(Under) = 6.0771118631199922

Steps Zoning Feature Extraction-Zone Centroid Zone.

1. Steps taken as stages image centroid zone, the difference is the value of the result features and centroid value obtained from each zone.
2. 3 Result Value from feature extraction

Zona 1(On) = 1.436505818199174

Zona 2(Middle) = 2.11511398444594

Zona 3(Under) = 2.7788337094433146

Table 1 Results Feature Value Of 3 Character

Karakter	Nilai Fitur ICZ (Image Centroid Zone)	Nilai Fitur ZCZ (Zone Centroid Zone)
	ICZ 1= 5.1615920372006 2= 5.0915253568804 3= 6.0771118631199	ZCZ 1= 1.43650581819917 2 = 2.11511398444594 3 = 2.77883370944331
	ICZ 1= 2.3030865650810 2 = 2.6943777608364 3 = 2.3030865650810	ZCZ 1 =2.9401919977662 2 =2.8277084050488 3 = 2.303086565081

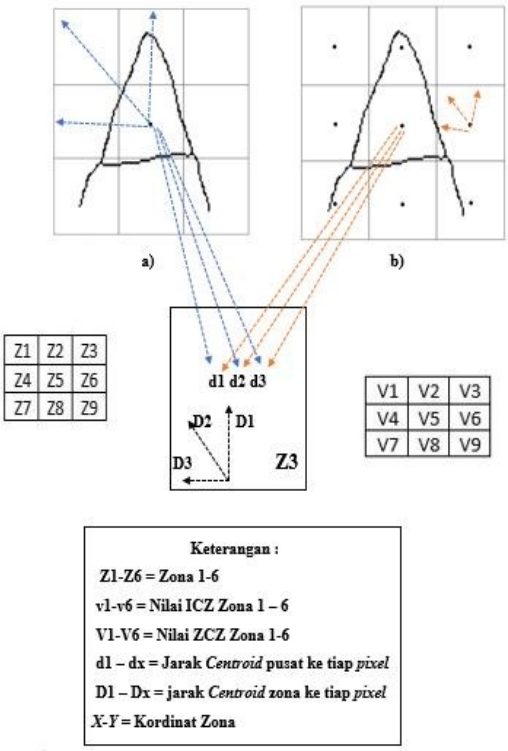


Figure 6 Schema object search black

1.2 *Support Vector Machine* (SVM)

Support Vector Machine is a learning method that is used for binary classification, the basic idea is to find the best hyperlane that serves as dividing the two classes in the input space [21].

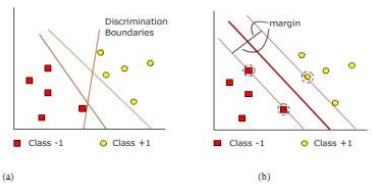


Figure 7 Process for hyperplane by SVM

In contrast to the neural network approach that seeks hyperlane separation between classes, SVM tried to find and separating hyperlane the best that are in two classes, image (a) shows patterns that are members of two classes +1 and -1, pattern is at -1 members then symbolized by the color red, while the color patterns on +1.

1.2.1 Learning Systems

Learning in the context of SVM is the process by which the parameters of SVM freely adapted through a learning process binary two classes, namely:

1. Supervised Learning (Learning With Supervision)
   Supervised or active learning is a learning process requires teachers. What is meant here is something that
   teachers have the knowledge about the environment. Teachers can be represented as a set of sample input-output. The construction of knowledge is done by teachers by giving the desired response to the SVM. Network parameters vary based training vectors and the error signal (error signal is the difference between the output and the response desired SVM). This change process is done repeatedly, step by step, with the aim that the SVM could have a similar capability with the teacher. In other words, SVM is trained to be able to map a set of sample input-output with high accuracy. In this learning process, the expected output has been previously known.

2. Unsupervised Learning (Learning Without Supervision)
   Unsupervised or self-organized learning does not require the teacher to monitor the learning process. In other words, there is no set of sample input-output or a particular function to be learned by the network. One example of unsupervised learning is a competitive learning. In this method, it is not specified whether the results were as expected during the learning process.Dalam penelitian ini proses pembelajaran yang digunakan adalah supervised learning.

1.2.2 SVM *Training*

Support Vector Machine (SVM) is included in the process of unsupervised learning (supervised learning). SVM is a method of classification patterns of each unit of output represents a specific category or class. In this method, a competitive layer will automatically learn to classify input data vectors. The classes were obtained as a result of competitive layer is only dependent on the distance between the input vector. If two vectors approximately equal, then a layer of competitive would put both the vector into the same class. Here is the architecture of the method Support Vector Machine.

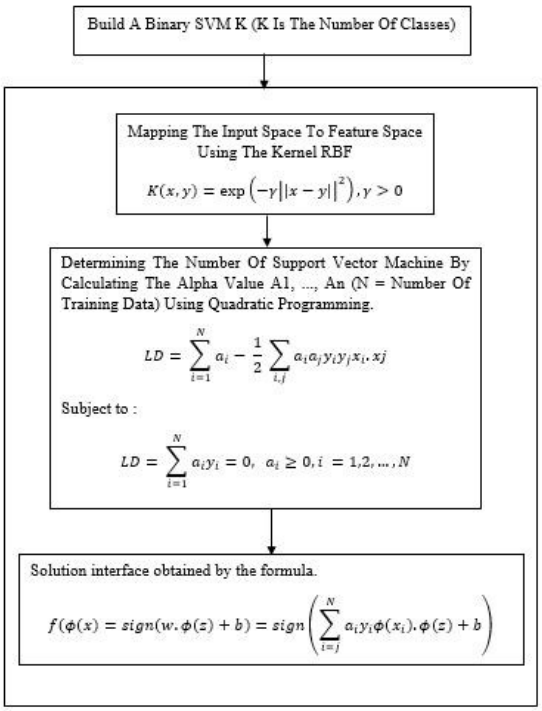


Figure 8 Block Diagram Algorithm Process Training SVM multiclass

While the algorithm SVM method are as follows.

T : Target class training data
c : The distance difference between the weight of the smallest
x : Data trainer
W : Data weight class
xi : An index of data
yi : Lots of training data
N : Much of the data in the input layer / the number of image pixels
a : Lagrange Multiplier (alpha)

1.3 *Rabin-Karp*

Rabin-Karp is a string matching algorithm that uses a hash function as a comparison between the search string (m) with a substring of the text (n). Rabin-Karp algorithm is based on the fact if the two strings together the hash value of its price must be the same. But there are two problems that arise from this, the first problem is that there are so many different strings, this problem can be resolved by reassigning some strings with the same hash value. The second problem is not necessarily the strings that have the same hash value suited to handle it for any string that has been assigned to do the matching string Brute-Force. The key to Rabin-Karp algorithm is efficient, there is the election of its hash value. One effective way is to treat every substring as a number with a certain base [20]. Phase steps done in the evaluation essay is tokenizing process and case folding, filtering, Rabin-Karp algorithm (K-gram, hashing, similarity).

1.3.1 *Tokenizing* dan *Case Folding*

At this stage of tokenizing and folding case made the process of separating the text into a word, then change all the words that have been ditoken to lowercase (lowercase).
Sample text:
Bandung ada di Provinsi Jawa Barat
Result *tokenizing* dan *case folding* :
bandung, ada, di, provinsi, jawa, barat

1.3.2 *Filtering*

Filtering is the stage of taking important words from the results of tokenizing and folding case, by using stoplist or stopword (discard the less important word). Examples of words which belong to the stoplist like: 'on', 'is', 'is', 'a', 'and', 'who', 'this'. Here is an example of the filtering process.
before filtering:
bandung, ada, di, provinsi, jawa, barat
After filtering :
bandung, provinsi, jawa, barat

1.3.3 K-gram

K-gram is a sequence of terms of length K. Most are used as terms is the word. K-gram is a method that is applied to the generation of words or characters. K-gram method is used to take pieces of code number k letters of a word that continuity is read from the source text to the end of the sentence or document [24]. Here is an example of K-gram with the value of k = 4.
Sample text:
bandungprovinsijawabarat
Result K-gram :
band, andu, ndun, dung, ungp, ngpr, gpro, prov, rovi, ovin, vins, insi, nsij, sija, ijaw, jawa, awab, waba, abar, bara, arat
In the above sentence are 21 K-grams.

1.3.4 *Hashing*

Hashing is a way to transform a string into a value that is unique to a certain length (fixed-length) that serves as a marker of the string. Function to generate this value called a hash function, while the resulting value is called the hash value. Hash value is generally described as a fingerprint is a short string consisting of letters and numbers that look random (binary data written in hexadecimal) [21]. Here is the equation to get the value of hashing for each K-gram.

$$H = C_1 * a^{(k-1)} + C_2 * a^{(k-2)} + C_3 * a^{(k-3)} \ldots C_k * a() \quad (13)$$

Keterangan :
H : value hashing
C_k : Ascii value of each letter in the K-grams
a : constant value / base
k : lots of character

1.3.4 *Similarity*

Similarity is used to calculate the degree of similarity of a text, where the comparison is the value of the hashing process. To measure the

percentage of similarity using Dice's Similarity Coefisient where the same hash value of the two text documents abstracts
different amounts are calculated and stored in the form of an array. Here is the equation of Dice's similarity method Similarity Coefisient. Similarity is used to calculate the degree of similarity of a text, where the comparison is the value of the hashing process. To measure the percentage of similarity using Dice's Similarity Coefisient where the same hash value of the two text documents abstracts different amounts are calculated and stored in the form of an array. Here is the equation of Dice's similarity Coefisient.

$$S = \frac{2 * C}{A + B} \quad (14)$$

Keterangan :

S = Value similarity between the two texts
A = Total collection of K-grams in the text 1
B = Total collection of K-grams in the text 2
C = Number of K-grams of the same text as compared

2. RESEARCH CONTENTS

In this research will be built application handwriting recognition method Support Vector Machine (SVM), then the input of the image of a hand-written exam answers. Data input is processed by the image processing and implementing the method of Support Vector Machine using training data from 100 samples of handwriting, so that the output data or the accuracy of the expected value is high. After the image of handwriting is recognized, then the next system can evaluate the test answers from the text recognition results using the Rabin-Karp.

2.1 General System Architecture

The process is carried out in the system is divided into sections where each process has its respective role in performing handwriting recognition and evaluation of test answers. The following process is performed in Figure 9.

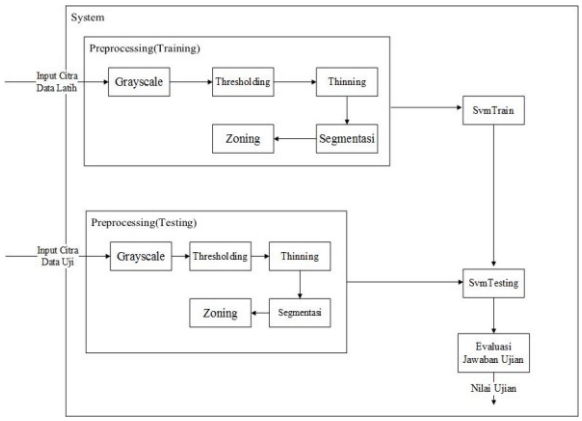


Figure 9 System Architecture

2.1.1 Handwriting Image

The input data used in this system, namely the handwritten image format .jpg or .png image. The image can be obtained through the scan or photograph with a resolution of at least 8 megapixel camera. Imagery used handwriting written with a pen on paper with white background. The color image is not too dark so that applications can more optimally perform character recognition of each handwritten. In this study of input data automatically resize to a size of 750x1300 pixels.

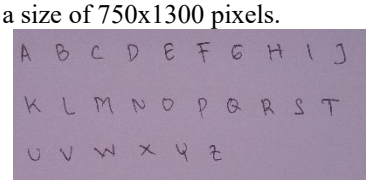


Figure 10 Sample image input Handwriting

2.1.2 Image processing

In the image processing carried out several processes so that the input image can be used at various stages of classification using Support Vector Machine (SVM). Here is a description of the image processing is performed in accordance with the architecture of the system are made.

1. *Grayscale*
   After the image of the handwriting is already incorporated into the application, and then do the grayscale image. Grayscale is an early stage is carried out in the image processing stage. The results of this process will produce a image with the color range from 0 to 255 which is a scale of gray.
2. *Thresholding*
   The next step in image processing is thresholding. This process is performed on grayscale images. Threshold method used in this study is sauvola threshold. Sauvola included into the local threshold, wherein the threshold value is obtained depending on the number of neighbors used. The end result of this process is a black and white image.

3. Segmentation
   In the process of segmentation, image thresholding should have been through the process. This is done so that the system easier to cut the image. Segmentation is performed on the line image in advance, so we get the image of the cutting line. Then cropped image of the columns on each cutting line. The outcome of this process is to get the image of a character from an image of handwriting.
4. *Resize*
   Image segmentation results, of course they vary in size. Therefore, it needs to be homogenized into a certain size so that the system can consistently read the image. In

this study resize the image to a size of 15 x 15 pixels.

5. Feature Extraction

Binerisasi is the last process in the image processing stage is done. Binerisasi used to obtain a value of 0 or 1 on a black and white image. The outcome of this process is a sequence of binary digits that will be used as a data input at the stage of classification using Support Vector Machine (SVMBinerisasi is the last process in the image processing stage is done. Binerisasi used to obtain a value of 0 or 1 on a black and white image. The outcome of this process is a sequence of binary digits that will be used as a data input at the stage of classification using Support Vector Machine (SVM).

2.1.3 *Support Vector Machine* (SVM)

The classification method used hearts Research singer is Support Vector Machine (SVM). Classification is done taxable income imagery Posts About It passed the process of image processing. The process of translating The Singers performed Namely ON Phase Process Training and Testing. The following explanation is to review each process.

1. SVM training

Used in the training process of SVM training data that consists of data classes and training data. The amount of training data used in this study, namely, the class data as many as 62 images (A-Z, a-z, 0-9) and the training data as many as 6,200 images (A-Z, a-z, 0-9). Then also used training parameters (learning rate, reduced learning rate, Max. Epoch and minimum error). Once the training process is done, the end result will update the data in the weight class of all classes of data. Data weighting is what will be used in the testing stage.

2. Testing SVM

SVM used in the testing process image of handwritten essay, then also do image processing as the previous process.



Figure 11 Test Sample Image

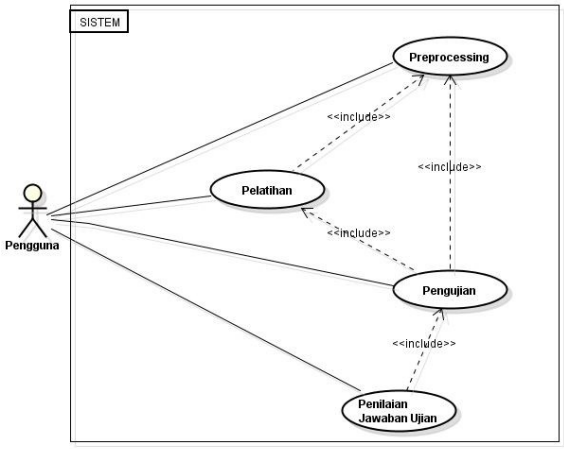
After processing the image, and then proceed with the testing process by comparing the weights of each test images with the weight class that has been updated in the previous training phase. The results of this testing are in accordance with the digital text written on the test images. However, in the process of testing it is possible the results obtained are less than perfect. Results from this test that will be reprocessed in evaluating the exam answers.

2.1.4 Evaluation Exam Answers

The evaluation process exam answers in this study only determine the degree of similarity between the key answers to exam answers obtained from the testing process SVM. The method used is Rabin-Karp consisting of K-gram, hashing and similarity with the initial process of folding case tokenizing and then filtering. The final results obtained in this process is the value of the test is based on the similarities between the text answers to the exam answer key.

2.2 Use Case Diagram

Use case diagrams are modeling that shows the interaction between the system by the user (actor). In the use case that is made using five use cases, where there is a use case that is related to another use case. Here is the use case diagram for the application is built.



Gambar 12 Use Case Diagram

2.3 Testing Accuracy

In testing the accuracy will be calculated the value of accuracy or suitability of the results of a handwriting recognition application essay. In this study testing the accuracy used 10 parameters combined training with 10 test images of handwritten essay different. Here is a table of combinations of parameters used.

Table 2 Parameter Training Combination

Combination	*Probability*	Gamma	*Nu*	C
1	1.5	0,5	3	1.2
2	1.8	0,7	2	1.1
3	1.9	0,9	1	1.5
4	2	0,5	0,5	1
5	2.6	0,2	0,4	1.7
6	2.1	0.5	0,5	2

7	3	1.5	0,6	1.4
8	1	0,5	0,7	1.6
9	0.5	2	0,8	1.8
10	1.2	1.1	0,5	1.3

Table 1 above is a combination of training parameters used in the system to do an introduction to each of the test images handwriting. Testing is done one by one for each combination of parameters of training for all test images are used, so that the results obtained with an average accuracy of handwriting recognition. Here is a table of test results obtained.

Table 3 Test result

Combination	Acuuration
1	70%
2	60,8%
3	76%
4	77,6%
5	71,4%
6	70,9%
7	66,6%
8	74%
9	71,7%
10	75,7%

From the table above test results, the combination of best practice parameter is a combination of parameters to the fourth with an average accuracy obtained amounted to 77.6%. The combination of training parameter used is Probability = 2, Gamma = 0.5, Nu = 0.5, and C = 1.

3. CLOSING

3.1 Conclusion

Based on the results of testing handwriting recognition system in case of essay using Support Vector Machine then obtained the best accuracy of 77.6%. Accuracy is influenced by the parameters of the training, the training data and test data are used.

3.2 Suggestion

In order to further research on handwriting recognition using Support Vector Machine in the case of evaluation essay has a higher accuracy, the following are suggestions that can be considered, namely:

1. It takes handwriting image segmentation method for writing case huddle.
2. In the evaluation phase stuffing reply brief, it can be used a method of evaluation answer other answers such methods TF-Idf, Metaphone, Zhu-Takaoka, and Cosine Similarity.
3. It takes another feature extraction methods are better for the image as Wavelet Transform, Hybrid Feature and template matching

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