IMPLEMENTATION OF NAÏVE BAYESIAN METHOD FOR TRANSLATING INDONESIAN SIGN LANGUAGE

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ABSTRACT

Sign language is a language that focus on body language, and lip gesture, instead of voice to communicate. People with hearing impaired is the main group that use this language , usually with the combination of palm gesture, hand movement, body language and facial expression to describe what is in their mind. The way to differentiate the meaning between one sign and others is by differentiate the image of sign language appearance. Principal Component Analisys is a method that can extract the characteristic of multi frame image which have same dimension, the result of the exctraction is used for classification with naïve bayesian. Naïve. Naïve Bayesian method is a simple probabilistic classification method that count the set of probability which sum up the frequency and value combination from dataset that given.

Based on result of the research that has been done, known that signn language identification can be done using classification based with multi frame that used PCA method to extract the retinal image texture and naïve Bayesian as a method to classified. Based on the testing result that has been done, the obtained accuracy levelof the identification that used PCA method and naïve Bayesian is 68%.

Keywords:Sign Language Identification, PCA, Naive Bayesian, Artificial Intelligence.

1. INTRODUCTION

Sign language is a language that focus on body language, and lip gesture, instead of voice to communicate. People with hearing impaired is the main group that use this language , usually with the combination of palm gesture, hand movement, body language and facial expression to describe what is in their mind. There are two sign language form that used in Indonesia, Bahasa Isyarat Indonesia (BISINDO) and Sistem Isyarat Bahasa Indonesia (SIBI). BISINDO is a sign language that developed by people with hearing-impaired, while SIBI is a signe language that developed by Indonesian government to make it fit with Ejaan yang disempurnakan (EYD) [1].

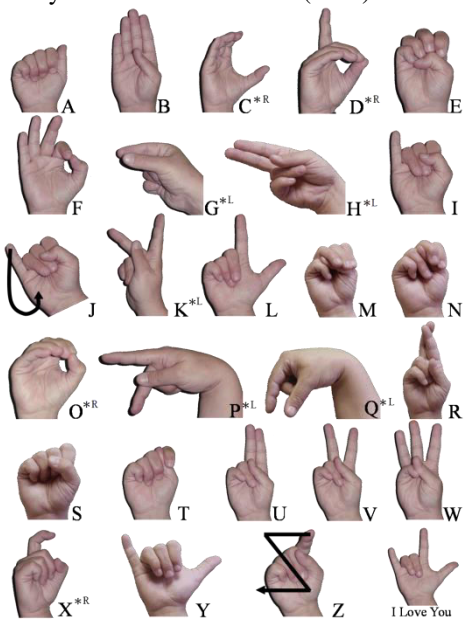
Research that has been done to identify Indonesian sign language using webcam as the input device is Handgesture To Text With Artificia Intelligence KNN (K-Nearest Neighbour) Method which the say to identify alphabet of Sistem Bahasa Isyarat Indonesia (SIBI) using webcam as the input device with KNN method, the result of the accuration is 91,8% but J and Z letter are couldn't identified yet because it consist of more than 1 gestures[6]. While the research to classify gesture that has been done is Analysis and Implementation Lip Gesture Reader to Text Application Using Support Vector Machine Method which says PCA is used as extraction method to get feature from group of image with same dimension[4], then in research Appearance Based Recognition of Words in American Sign Language it says that tracking is not used to avoid the possibility of error that might happen during segmentation[2]. Research that Compare accuration level of some method to classify sign language is Tamil Sign Language to Speech Translation which says that to classify sign language with static image as the input, Naïve Bayesian have the highest accuration reaching 93% rate of accuration compared to Proximal Support Vector (PSVM) method with 91% accuration rate and K-Nearest Neighbor (KNN) method with 78% accuration rate [5].

Based the problems and the solutions that have been described, this study will identify sign language that consist more than one gestures that fit with Sistem Isyarat Bahasa Indonesia (SIBI) to texts using PCA method for extraction and Naïve Bayesian for classification.

1.1 Sign Language

Sign language is one of media for communaction purpose which use body language and lip gesture. In this world the way to use sign language is unique in each country and might be different, as example England and Amerika use different sign language although they use same written language, while England and Spain although they have different written language but the two countries are using the same sign language, because up until now there are no international standard for sign language. In Indonesia, there are two sign

language, Bahasa Isyarat Indonesia (BISINDO) and Sistem Isyarat Bahasa Indonesia (SIBI).



Gambar 1. Abjad Sistem Isyarat Bahasa Indonesia

1.2 Artificial Inteligence

Artificial intelligence is one of the branch of science dealing with the use of machines to solve complex problems in a more humane way. This is usually done by following characteristics and analogy to think of human intelligence, and applying them as algorithms recognized by the computer.

The rapid development of technology led to the development and expansion of the scope that requires the presence of artificial intelligence. Intelligent characteristics already started needs in different disciplines and technologies. Artificial Intelligence is not only served in various other disciplines. Sliced between psychology and artificial intelligence gave birth to an area known as cognition and psycolinguistics. Sliced between electrical engineering and artificial intelligence gave birth to the various sciences such as image processing, control theory, pattern recognition and robotics.

Artificial intelligence is used to analyze the image of the scenery in the calculation of the symbols that represent the content of the scene after the image is processed to obtain a special characteristic. Artificial intelligence can be seen as three integrated unity of perception, understanding and action. Perception decodes the signals from the real world in images become symbols of a more simple, understanding manipulating these symbols to facilitate extracting certain information, and action to translate the symbols that have been manipulated into other signals that may be the end result.

1.3 Image Processing

To continue with the introduction of an object owned by the texture of the object we need a technique for image processing. The image processing is image processing by using a computer to produce a better quality image. Generally, operations in image processing applied to the image when:

1. Repair or modify the image needs to be done to improve the quality of appearance or to highlight some aspects of the information contained in the image.
2. The elements in the image need to be grouped, matched, or measured.
3. Part of the image must be combined with other parts of the image.

Image Processing aims to improve the image quality to be easily interpreted by humans or machines (in this case the computer).

1.4 Preprocessing

Preprocessing is to facilitate the process of generating the value of feature extraction. At this stage the input image has been obtained and the process will be conducted resize and threshold.

1.5 Resize

In the process of preprocessing image resize is performed. Resize is a process of changing the resolution or size horizontally and vertically in an image, it is necessary to produce the same size on all images entered. The purpose of resizing the image is to accelerate the process of feature extraction of color and texture features on the image which has the dimensions (size) is large.

1.6 Threshold

Threshold or binary image on a digital image is a process to change the color where every pixel only contains information on the intensity of black and white. To get the binary value of the image goes through a threshold. Threshold function to facilitate image classification process to be more focused on individual pixels.

1.7 Principal Component Analysis (PCA) Method

The extraction process is a PCA (Principal Component Analysis), where the results of the projection is extracted with PCA calculation to get the feature of the image. Featured are important components of training Image- image obtained from the training process. Feature is what will be used to identify the image to be recognized. The beginning stage of extraction PCA is the formation of matrix data were taken from each image pixel. The image data is represented in sizes of matrix m x n, where m is the number of images that are trained and n is the dimension of the image, and then do the extraction process is the image with smaller dimensions which results are projected into a matrix as in the following equation [6].

$$x = \begin{bmatrix} x_{1,1}x_{1,2}\ x_{1,3} \cdots & x_{1,n} \\ x_{2,1}x_{2,2}x_{2,3} & x_{2,n} \\ x_{3,1}\ x_{3,2}x_{3,3} & x_{3,n} \\ \cdots & \cdots \\ x_{m,1}x_{m,2}x_{m,3} \cdots & x_{m,n} \end{bmatrix} \quad (1)$$

Where
x = matrix image
Once the image data matrix is formed, then the next process is the process of calculation for finding the average results of the entire image. Search the average value of the goal to know every noise or expression vector that could undermine the accuracy of the calculation of the PCA, which can be calculated using the equation:

$$\alpha = \frac{(x_{1,i} + x_{2,i} + x_{3,i} + \ldots + x_{m,i})}{m} = \frac{\sum_{j=1}^{m} x_{j,i}}{m} = [\tau_1, \tau_2, \ldots \ldots \ldots, \tau_n] \quad (2)$$

Where
α = average matrix of the entire image
x1, i ... xm, I = Matrix image 1 through images all m
m = Number of image matrix

It is seen that the results of the calculation of the above equation is an array that contains the value of n, (τ1, τ2, ..., τn). The array will be used to find the average value of zero (zero mean), once formed into a matrix 1xN first. However, the size of the matrix of the average value does not correspond with the image data matrix mxn sample size, it is necessary to doubling the average value.
The result of the calculation of the average value of zero is used to get the value of covariance matrix. Covariance matrix is a matrix of reduction of the extraction process PCA, which has smaller dimensions than the dimensions of the original image matrix. Here is a covariance matrix equation.

Y * YI = C ... (3)
Where :
Y = Matrix Zero Means
YI = Transpose Matrix Zero Means

Once the covariance matrix is obtained then the next step is to determine the eigenvector matrix. Eigen matrix can be searched using the equation:

$$C - Z = |C - \lambda I|$$

$$|C - \lambda I| = 0 \quad (4)$$

Where C is the covariance matrix. Z is a matrix eigenvector with λ as a constituent scalar and I is the identity matrix, the equation if it is implemented to form a matrix into the following equation:

$$\begin{bmatrix} C_{11} C_{12} \ldots C_{1,n} \\ C_{21} C_{2,2} \ldots C_{2,n} \\ \ldots \ldots \ldots \ldots \\ C_{m,1} C_{m,2} \ldots C_{m,n} \end{bmatrix} - \lambda \begin{bmatrix} 1\,0 \ldots 0 \\ 0\,1 \ldots 0 \\ \ldots \ldots \ldots \ldots \\ 0\,0 \ldots 1 \end{bmatrix} = 0$$

$$\begin{bmatrix} C_{11} C_{12} \ldots C_{1,n} \\ C_{21} C_{2,2} \ldots C_{2,n} \\ \ldots \ldots \ldots \ldots \\ C_{m,1} C_{m,2} \ldots C_{m,n} \end{bmatrix} - \begin{bmatrix} \lambda\,0 \ldots 0 \\ 0\,\lambda \ldots 0 \\ \ldots \ldots \ldots \ldots \\ 0\,0 \ldots \lambda \end{bmatrix} = 0$$

$$\begin{bmatrix} C_{11} - \lambda & C_{12} & \ldots & C_{1,n} \\ C_{21} & C_{2,2} - \lambda & \ldots & C_{2,n} \\ \ldots & \ldots & \ldots & \ldots \\ C_{m,1} & C_{m,2} & \ldots & C_{m,n} - \lambda \end{bmatrix} = 0 \quad (5)$$

1.8 Naïve Bayesian Classification

Naïve Bayesian classification is a simplest method of using the existing opportunities, where it is assumed that every variable X is free (independence) [4]. Because the assumptions are not mutually dependent variable, then obtained:

$$P(X \mid Y = y) = \prod_{i=1}^{q} P(X_i \mid Y = y) \quad (6)$$

There are several steps in the classification using Naive Bayesian method, the following steps are:

1. Training:
Calculate the average (mean) of each feature in the training dataset.

$$\mu = \frac{\sum x_i}{n} \quad (7)$$

Where :
μ = mean eigenvektor dataset
n = total data
$\sum x_i$ = total data

Then calculate the variance of the training dataset as on..

$$\sigma^2 = \frac{1}{n-1} \sum_{i=1}^{n} (x_i - \mu)^2$$

Where:
σ^2= varians
μ= mean
x_i = data value
n = data number

Testing :

1. Calculate the probability (Prior) for each class that is by counting the amount of data each class divided by the total number of overall data.
2. Next calculate the probability density. Expressing the relative probability density function. Data with mean μ and standard deviation σ, the probability density function is:

$$\varphi_{\mu\sigma}(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Where :
x = the input data
π = 3,14
σ = standard deviation
μ = mean

3. After the probability density values obtained, then calculate the posterior of each class using the equation.$\text{posterior} = \frac{\text{prior x likehood}}{\text{evidence}}$
   Or can be written :
   $\text{Posterior} = \frac{P(C_i) x\ P(X1 \ldots\ldots\ldots\ldots\ldots Xn|C_i)}{P(X1 \ldots\ldots\ldots\ldots\ldots Xn|C_i)}$
4. After the posterior value of each class are obtained, the class corresponding to the input data is the class that has the greatest posterior value.

1.9 Confusion Matrix Testing

Tests conducted on the classification method contained in the accuracy of the classification results. The accuracy of the classification affect the performance of a classification method. To perform the test accuracy confusion matrix can be used, confusion matrix is a matrix of predictions that compared with the original class of the input data. Each column of the matrix corresponding to the result of the classification and each line in the input. The accuracy of a classification where i = j explain the accuracy of classification in each class [9]. The following example of Confusion Matrix can be seen in Table 2..

Tabel 2 Confusion Matrix

Kelas		Hasil Klasifikasi	
		0	1
Target	0	00	01
	1	10	11

Formula used to calculate accuracy:

$$\frac{\text{total accuration}}{\text{total data}} X\ 100\% = \text{Accurationi}\%$$

2. CONTENTS OF RESEARCH

2.1 Problem Analysis

Sign language is a language that focus on body language, and lip gesture, instead of voice to communicate. People with hearing impaired is the main group that use this language , usually with the combination of palm gesture, hand movement, body language and facial expression to describe what is in their mind. There are two sign language form that used in Indonesia, Bahasa Isyarat Indonesia (BISINDO) and Sistem Isyarat Bahasa Indonesia (SIBI). BISINDO is a sign language that developed by people with hearing-impaired, while SIBI is a signe language that developed by Indonesian government to make it fit with Ejaan yang disempurnakan (EYD) [1].

Research that has been done to identify Indonesian sign language using webcam as the input device is Handgesture To Text With Artificia Intelligence KNN (K-Nearest Neighbour) Method which the say to identify alphabet of Sistem Bahasa Isyarat Indonesia (SIBI) using webcam as the input device with KNN method, the result of the accuration is 91,8% but J and Z letter are couldn't identified yet because it consist of more than 1 gestures[6]. While the research to classify gesture that has been done is Analysis and Implementation Lip Gesture Reader to Text Application Using Support Vector Machine Method which says PCA is used as extraction method to get feature from group of image with same dimension[4], then in research Appearance Based Recognition of Words in American Sign Language it says that tracking is not used to avoid the possibility of error that might happen during segmentation[2]. Research that Compare accuration level of some method to classify sign language is Tamil Sign Language to Speech Translation which says that to classify sign language with static image as the input, Naïve Bayesian have the highest accuration reaching 93% rate of accuration compared to Proximal Support Vector (PSVM) method with 91% accuration rate and K-Nearest Neighbor (KNN) method with 78% accuration rate [5].

Naive Bayesian algorithm is one that can classify images based training provided. Before the classification process, image extraction will be done in advance to obtain the characteristics of the image. The method will be used for the extraction is PCA.

2.2 Sistem Analysis

System analysis in this study will explain the processes that existed at the sign language identification system directly using a webcam as an input medium. Here is a process flow system to be built can be seen in Image 2:

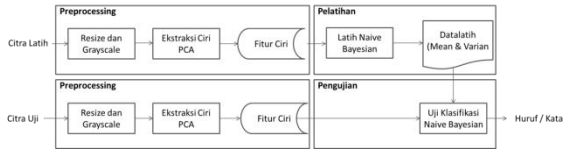


Image 2 Blok Diagram Sistem

2.3 Training Image Analysis

Based on previous studies mentioned by testing using the number of frames 10, 20, 30, when the number of frames yng used is 20 frames, the accuracy will increase from when using 10 frames, but when the number of frames used is 30 frames, the level of accuracy remains constant [4]. Based on this study it frame to be used amounted to 30 frames. Data in the form of 30 frames are extracted using IrfanView software from the previously recorded video using the webcam on cue form the letters A-Z, and a few words with a combination of two forms that suitable with I Kamus Isyarat Bahasa Indonesia edisi kedua 2000. Jakarta : Departemen Pendidikan Nasional. [9]. The distance between user with the webcam when taking the sample data is 80-90cm, and the retrieval time is noon 11:00 pm. Sample to be analyzed is 6 frame the letter I with similar forms of movement and the letter A is composed of more than one form of movement to know the results of the image identification sign language consisting of more than one form of movement.

Tabel 3 I and J SIBI Letter

Huruf	Bentuk Isyarat					
	Frame-1	Frame-2	Frame-3	Frame-4	Frame -5	Frame-6
I						
J						

2.4 Preprocessing Process Analysis

Preprocessing aims to get the value of characteristic features that will be used as input in the training and testing of Naive Bayesian, in this study preprocessing consists of three phases, which are resizing, threshold and PCA extraction.

2.5 Resize

Resize is a process of changing the image size, the process is carried out to match the size of the image of sign language that feed either during training or during testing. Based on research Analysis and Implementation of Motion Applications Introduction Lip Being Text Using Support Vector Machine method is called when testing the effect of dimension on the level of accuracy using the dimension 40x40, 60x60, and 80x80, the highest accuracy in the dimensions 80x80 obtained by 75% [4]. In this study, the image will resize be 80x80 pixels

.

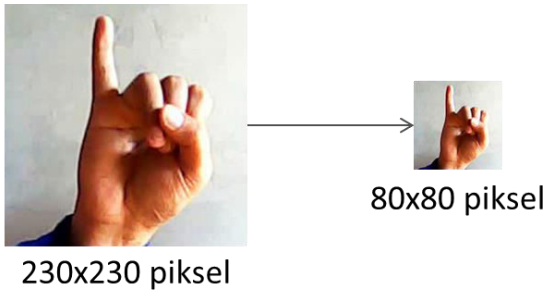


Image 3 Resize Process

2.4 Threshold

Threshold is the process of converting an RGB image into a binary image, this process aims to simplify the previous pixel value RGB image has three values into a single value at each pixel. Converting a color image information into binary image can be performed with a single operating threshold, ie the pixel values are classified into two groups as shown in the following formula:

$$f_0(x,y) = \begin{matrix} 0, & f_0(x,y) < 100 \\ 255, & f_0(x,y) \geq 100 \end{matrix}$$

Pixels whose intensity values below 100 is converted to black (the intensity value 0), whereas pixels intensitanya value above 100 is converted into white color (the intensity values = 255).

Example calculation of threshold:

The input image used in the example calculation of this threshold is the image dimensions have resize like in image 4.



Image 4 Letter I RGB Image with 80x80 dimension

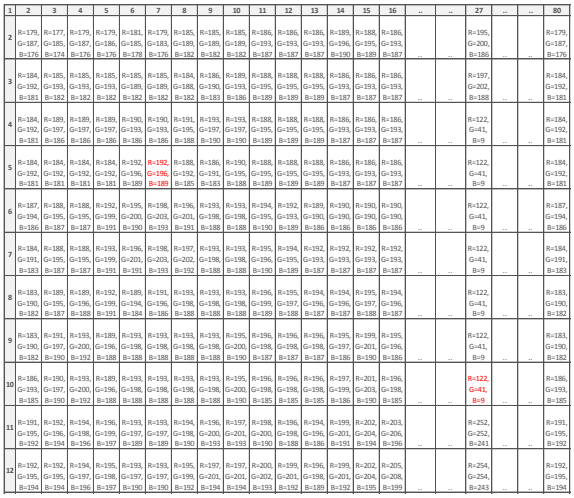


Image 5 Matrix RGB Value

Examples of the RGB value of the pixel (5.5), are :
R: 188
G: 192
B: 196
The calculation of threshold pixels (5.5):
Threshold = (188 + 192 + 196) / 3
Threshold = 188
188> 100
Pixel value = 255
Examples of RGB pixel values (10.27), are :
R: 122
G: 41
B: 9
The calculation of threshold pixels (5.5):
Threshold = (122 + 41 + 9) / 3
Threshold = 57
57 <100
Pixel value = 0
The results of the input image that has been at the threshold can be seen in Image 6.



Image 6 80x80 Treshold Image

Having obtained the pixel values of 0 and 255, then the value of 255 can be converted into a value of 1, so that the matrix is composed of two values: 0 and 1.

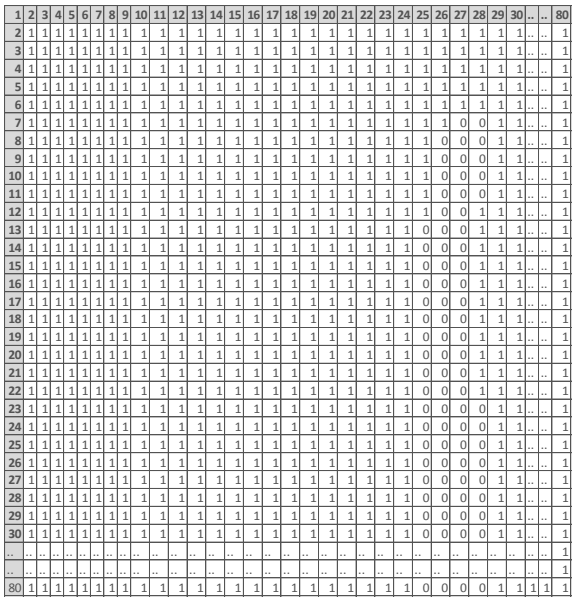


Image 7 80x80 threshold Matriks

2.5 Feature Extraction Using PCA Method

Using the image that has been through the stage resize and threshold, the next step is feature extraction using PCA Here are the stages of feature extraction using PCA hand image, obtained eigenvector of each eigenvalue as follows:

Eigenvalues I:{-0.0034909006025451994;0.0034979702072709005; 1.0729490167158229 ; 4.427050983125396}
Eigenvektor :
For Eigenvalue -0.0034909006025451994:
[0.9956553327487252 ; 1 ; 0 ; 0 ; 0 ; 0]
For Eigenvalue -0.000003534722971764206-0.00349441486790229 55î:
[0.999976502646367-0.004367896648869726î ; 1 ; 0 ; 0 ; 0 ; 0]
For Eigenvalue -0.000003534722971764206+0.00349441486790229 55î:
[0.999976502646367+0.004367896648869726î ; 1 ; 0 ; 0 ; 0 ; 0]
For Eigenvalue 0.0034979702072709005:
[1.0043916651514138 ; 1 ; 0 ; 0 ; 0 ; 0]
For Eigenvalue 1.0729490167158229:
[-1 ; 1 ; -5.854101991377212 ; -1 ; 1 ; 1]
For Eigenvalue 4.427050983125396:
[-1 ; 1 ; 0.8541019662490332 ; -1 ; 1 ; 1]
The next step is to calculate the average of each eigenvalue eigenvector. By using the same steps in it will get the letter J eigen vector table as follows

Tabel 4 Letter I and J Eigenvectors

Huruf	EigenVektor					
I	0.332609	0.166667	0.166667	0.334065	-0.80902	0.309017
J	0.665218	0.324559	0.233768	0.668131	-1.61803	0.618034

2.6 Naive Bayesian Analysis Training Process

Training naive Bayesian done to get the mean and variance. Here's an explanation of the training process naive Bayesian:

2.7 Train Data

Train Data is the stage for the training data using naive Bayesian method. Of the characteristic features listed in Table 3.4, then calculated the mean and variance of each class, the mean and the variance will be used to search probabillitas likelihood, the density formula. The mean value can be calculated using equation 2.8 and variance values can be calculated using the equation:

$$\mu = \frac{\sum x_i}{n}$$

Where :
μ = mean
n = number of data
$\sum x_i$ = total of data values

$$\sigma^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \mu)^2$$

where :
σ^2= varians
μ= mean
x_i = data values
n = number of data

Following the calculation of the mean and variance based eigen vectors in Table 4:

Class I

μ Eigenvektor Class I

$$= \frac{\begin{array}{c}0.332609222 + 0.166666667 \\ +0.166666667 + 0.334065278 \\ + 0.809016999 \\ +0.309016994\end{array}}{6} = 0.22165$$

Tabel 5 Mean and Varian letter I and J

Huruf	Nilai	Fitur
		Eigenvektor
I	Mean (μ)	0.22165
	Varian (σ^2)	0.15708429686
J	Mean (μ)	0.14861333333
	Varian (σ^2)	0.78327432239

2.8 Save Data Train

Save data is a step to save the mean and variance of the training process the data into a txt file.

2.9 Naive Bayesian Testing Process Analysis

Testing is performed to classify the image of sign language are included with the already trained data, so that we could know the results of the classification.

2.9 Testing Image

Test image is an image that will go through the testing phase of training data, previously performed the same stage with the image cultivated to obtain the value of Feature Feature. Examples of imagery to be tested can be seen in Table 6.

Tabel 6 Example of Testing Image

Bentuk Isyarat					
Frame-1	Frame-2	Frame-3	Frame-4	Frame -5	Frame-6
					

The following feature extraction feature value test images can be seen in Table 7.

Table 7 test images' eigenvector

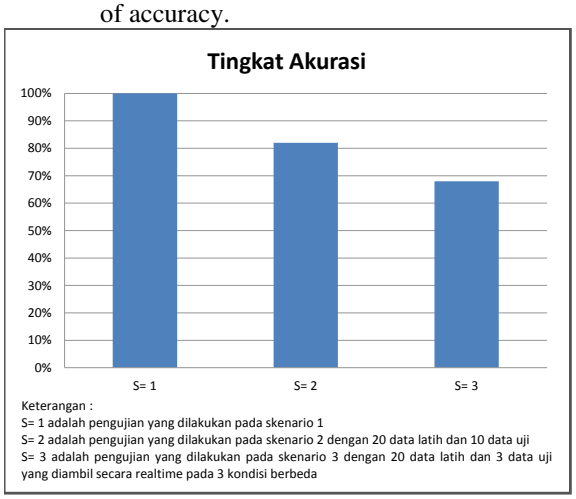
EigenVektor					
0.332609	0.196667	0.166667	0.334065	-0.80902	0.309017

After the testing process Naive Bayesian posterior values obtained sign language letter J is greater than sign language letter I, then the class is suitable for test images above are sign language letter J.

3. TESTING AND RESULTS

Testing method aims to determine the outcome of PCAdan naive Bayesian methods in identifying sign language. In this study, plan testing is done with a few scenarios. Here's a scenario that will be done.

1. Test the image of sign language that has been used as training data.
2. Test the image of sign language that has not been previously trained and tested the effect of the amount of training data on the level of accuracy.



Based on the testing that was done PCA and naïve Bayesian methods can be used to identify the image of sign language. and based on the above test concluded that the consistency of training data which affects the level of accuracy when testing in real time using a different site conditions dihasilkan.cenderung accuracy rate drops.

4. CLOSURE

4.1 Conclusions

The results of the research that has been done in the preparation of this paper as well as referring to the purpose of research, it can be concluded.

1. PCA and naive Bayesian method can be used to identify sign language based imagery.
2. The accuracy of PCA and Naive Bayesian methods in identifying sign language based on a collection of images using a webcam is 68%.

4.2 Suggestions

Based on the results of the research that has been reached at this time, there are some suggestions that might be helpful if there were going to conduct similar research, namely:

1. Dataset imagery used should have the same quality.
2. To obtain a high level of accuracy in classifying the various images, you should use a lot of training data.
3. Add a tracking method so that the bounding area can follow the position of the hand.

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