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SIGN LANGUAGE DETECTION SYSTEM USING ADAPTIVE NEURO FUZZY INFERENCE SYSTEM (ANFIS) METHOD

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ABSTRACT
Sign language is a language that prioritizes communication with hands, body language, and lip movements to communicate. The deaf are the main group who use this language, often combining hand shape, hand, arm and body orientation and movement, and facial expressions to express their thoughts. The sign language detection system is designed using the Adaptive Neuro Fuzzy Inference System (ANFIS). This study uses data from the kaggle.com dataset, which is a site that provides research data on artificial intelligence. This study was conducted to recognize empty hand signals. Where it will help users naturally without any additional help. The test is carried out using a data set as evidenced by 1 display. In this process, the characteristics of the hand were carried out using the Histogram Oriented Gradient (HOG) method. Meanwhile, to separate it from the background image, it is used with color segmentation. The results of the process are then taken for classification. The classification process uses the Adaptive Neuro Fuzzy Inference System method. The results of the tests carried out for accuracy are as much as 92,00%.
Keywords: *ANFIS, Histogram Oriented Gradient (HOG), Object Detection, Color Segmentation, Sign Language*

1. Introduction

As social beings, humans need to interact with other people every day. One form of interaction that occurs is communication. Every communication that exists, of course in every communication, one person receives information from another. Thus, one can get to know the other person better. However, not all communication can be established correctly(Amara, et al., 2018; Borman, et al., 2019).

Sign language is a language that prioritizes communication with hands, body language, and lip movements to communicate(Slonimska, et al., 2022). The deaf are the main group who use this language, often combining hand shape, hand, arm and body orientation and movement, and facial expressions to express their thoughts. In fact, contrary to what many believe, there is no successful implementation of International Sign Language(Andrian, et al., 2017; Bakti & Pranoto, 2017; Aditya, et al., 2022).

MATLAB is a high-performance programming for technical computing that can be used to integrate computation, visualization, and programming such as complex mathematical notation. The name MATLAB itself stands for Matrix Laboratory. MATLAB is also known as an interactive system whose basic data elements are arrays and do not require dimensions. Users can solve some technical computing problems such as matrix formulation, vectors, and write programs in languages such as C or Fortran(Borman & Priyopradono, 2018).

Adaptive Neuro Fuzzy Inference System (ANFIS) is a structure that combines a fuzzy system and an artificial neural network system. By using a hybrid learning procedure, ANFIS can build an input-output mapping which is both based on human knowledge (on fuzzy if-then rules) with the right membership function(A Annisa, et al., 2017).

2. Literature Review

2.1 Survey Methodology

According to experts, namely Kerlinger, stating that the methodology survey research is research conducted on large or small populations, but the data studied are data from samples

taken from the population, to find relative events, distributions, and relationships between variables. sociological and psychological(Lazuardi, et al., 2021). The RQ Formulation of effectiveness in research should focus on 5 elements known as PICOC:

1. Population (F): target group for investigation (e.g. people, software, etc.)
2. Intervention (I): determine the aspect of the investigation or problem that is of interest to the researcher
3. Comparation (C): The aspect of the investigation to which the Intervention (I) will be compared.
4. Outcomes (O): Effects and outcomes of the Intervention
5. Context (C): the setting or environment of the investigation

Table 1 - Review of PICOC

Survey Theme Title: Sign Language Detection System Using Adaptive Neuro Fuzzy Inference System (ANFIS)	
Population	Object Detection, Sign Language, ANFIS
Intervention	a. How to make a system for sign language detection using the Adaptive Neuro Fuzzy Inference System (ANFIS)? b. How to analyze the accuracy of the Adaptive Neuro Fuzzy Inference System (ANFIS) in detecting sign language?
Comparison	N/A
Outcomes	a. To determine the performance of the Adaptive Neuro Fuzzy Inference System (ANFIS) in detecting sign language. b. Utilizing image processing techniques to detect sign language.
Context	Public Dataset

2.2 Sign Language

Sign language is a language that prioritizes communication with hands, body language, and lip movements to communicate. The deaf are the main group who use this language, often combining hand shape, hand, arm and body orientation and movement, and facial expressions to express their thoughts. In fact, contrary to what many believe, there is no successful implementation of International Sign Language. Sign language is unique for each country(Amrutha & Prabu, 2021; Rastgoo, et al., 2021; Elakkiya, 2021).

2.3 MATLAB

Matlab is an abbreviation of Matrix Laboratory and is a programming language that was created with the aim of being a tool for complex calculations or simulations of a system that you want to simulate, in matlab it is absolutely necessary to have knowledge of matrices that can be studied in mathematics. To start/end using matlab we can do the same thing when we run an application in windows(Zheng, et al., 2021; Isabona & Ojuh, 2021).

2.4 Detection Object

Object detection in digital image processing is a technique used to determine the presence of certain objects in digital images. The recognition process can be done in various ways which generally read the characteristics of all objects in the input image. The properties of the object on the input screen are compared to the reference object or template. The results of the comparison can be used to determine whether the object is recognized as the template in question. The process of reading and comparing an object usually faces difficulties when the object is overlapped or covered by other objects in the image. This can lead to incorrect feature readings, especially if both objects are read as one object and the object is partially obscured by another object. This event is also known as the overlap problem in digital image processing(Liu, et al., 2021; Zaidi, et al., 2022).

2.5 Digital Image Processing

Image processing or known as digital image processing is a method used to process or manipulate digital images stored on a two-dimensional scale (Gonzalez & Wood, 2002). The purpose of image processing is to process and process from the original image to produce other images according to needs. Image or image capture is done using a video camera or other equipment that can transfer images (scanner). The basis of image processing is RGB color processing at each pixel(Fajriani, et al., 2018; Hou, et al., 2021).

3. Research Methods

3.1 Population and Sample

In this study, the image of the semar bag flower spread from various sources on the internet. Meanwhile, the sample in this study only took 26 types of hand shapes with a total sample of 2159 images for 1727 train data and 432 images for testing data.

Table 2 - Variable Hand Image

No.	Variable	Train	Test	Variable Definition
1	A	64	16	Image of Hand Shape A
2	B	64	16	Image of Hand Shape B
3	C	64	16	Image of Hand Shape C
4	D	64	16	Image in the form of a D hand
5	E	64	16	Image of Hand Shape E
6	F	64	16	Image of F Hand Shape
7	G	64	16	Image of G Hand Shape
8	H	64	16	Image of H Hand Shape
9	I	64	16	Image of Hand Shape I
10	J	64	16	Image in the form of a J . Hand
11	K	64	16	Image of K Hand Shape
12	L	64	16	Image of L Hand Shape
13	M	63	16	Image of M . Hand Shape
14	N	64	16	Image of N Hand Shape
15	NOTHING	64	16	Image Not Formed
16	O	64	16	Image of O Hand Shape
17	P	64	16	Image of P Hand Shape
18	Q	64	16	Image of the Shape of a Q . Hand
19	R	64	16	Image of R Hand Shape
20	S	64	16	Image of S Hand Shape
21	T	64	16	Image of T Hand Shape
22	U	64	16	U Hand Shape Image
23	V	64	16	V Hand Shape Image
24	W	64	16	Image of W Hand Shape
25	X	64	16	Image of Hand Shape X
26	Y	64	16	Image of Y . Hand Shape
27	Z	64	16	Z Hand Shape Image

3.2 Research Informants

Research informants are people who can provide information. Research informants are people, objects or institutions (organizations), whose nature is being investigated. Research informants in this study were Indonesian Sign Language Detection.

3.3 Research Instruments

One of the quality of research results is influenced by the quality of research instruments. In qualitative research, the researcher becomes the instrument or tool of the research. Researchers as instruments must be validated by understanding qualitative research methods.

3.4 Data Collection Techniques

Data collection techniques can be used to collect data according to research procedures so that the required data is obtained. Data collection techniques are the most strategic step in research because the main purpose of research is to collect data. The data collection technique in this study used the Documentation Technique. Documentation is a method of reviewing and processing data according to pre-existing documents and supporting research data.

3.5 Application of the Methodology

The following are the stages of the methodology used in the research:

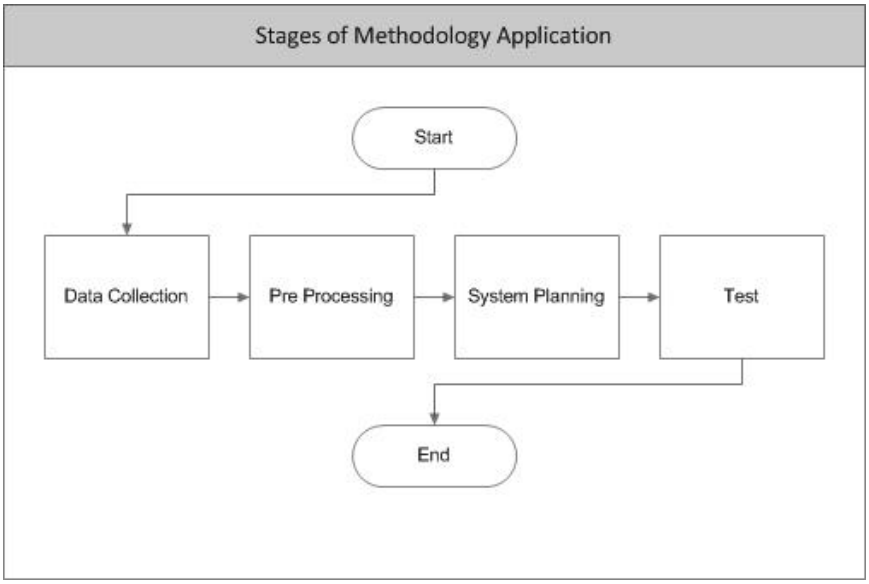

Fig 1. Stages of Methodology Application

3.6 Test Design

The test design is the stage to find out how the performance is based on the system that has been built. This test design aims to see whether the results of the analysis and design carried out are in accordance with what is expected. At this stage, researchers will detect Sign Language with the Adaptive Neuro Fuzzy Inference System (ANFIS) method.

4. Results and Discussions

4.1. Implementation Methodology

In this study to detect sign language using the method of Neuro Fuzzy Inference System (ANFIS), the dataset taken is2,159 imagesfrom the Kaggle website public dataset. The data sources used are primary data sources and secondary data sources. . in the form of 26 types of hand shapes with a total sample of 2159 sample images of 2159 images for data train 1727 and images for data testing 432. The stages to be carried out are Data Collection, Preprocessing, System Design and, Testing then after passing the process will produce output, namely whether the sign language being tested can be detected or not.

4.2. Data collection

This data collection uses 2,159 images that have 4 attributes in the form of variables, training, testing andVariable Definitio nobtained from the Kaggle website. The images used in this study are in the form of hand drawings based on the alphabet in each movement.

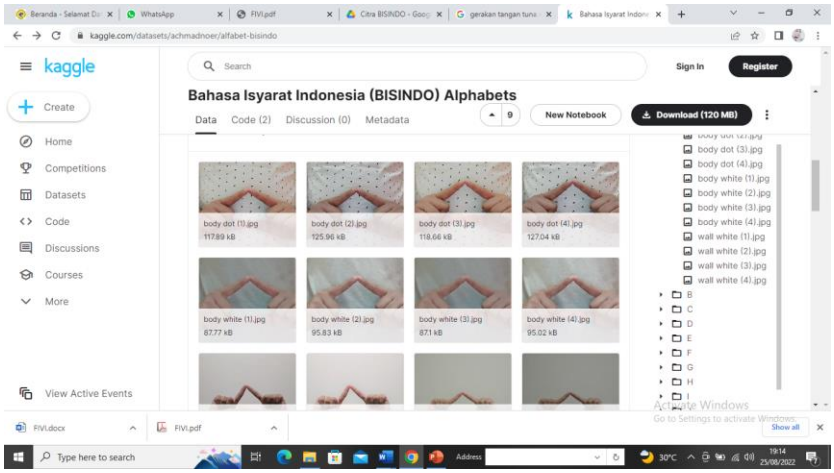

Fig 2. Image of Alphabet Hand Shapes

Then on the Kaggle website from the data of 2,159 variable images of hand movements, before being saved, the image can be selected first which images can be used in this study. The stored images will be used to carry out the training and testing process.

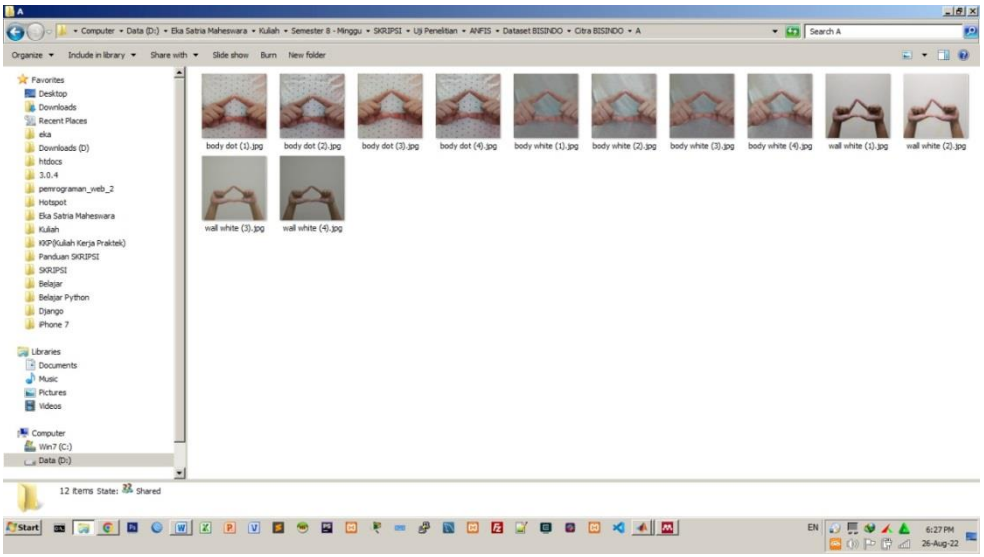

Fig 3. Image Download Results

4.3. Dataset Creation

After the image data is downloaded, then create a dataset folder containing the train folder and the test folder. In the train and test folders, folders are created based on the image variables in each Alphabet consisting of AZ. The sample dataset is 2159 images for 1727 train data and 432 images for testing data. Before making the dataset for the detection process, the collected image files are put into a folder. Then the creation of the dataset is done using the Matlab Programming application with several stages carried out. Before making the dataset for the detection process, the image files that have been collected into a folder earlier, are entered into the matlab program directory first. Then the creation of the dataset is done using the Matlab application.

4.4. Test

Tests are carried out to obtain accuracy results from each test model that was previously made. The image data used in this study is 26 variable image data with a total sample of 2159 images for 1727 train data and 432 images for testing data. Next, we conduct image data training, with the results of the test accuracy, where the correct number of datasets is divided by 100. After conduct model training, then evaluate the performance of the model on the test set. Evaluation is carried out to see the possibility of failure of the image object that is read in the detection process, it will also get the accuracy value and with the highest probability that will be obtained from the entire test model.

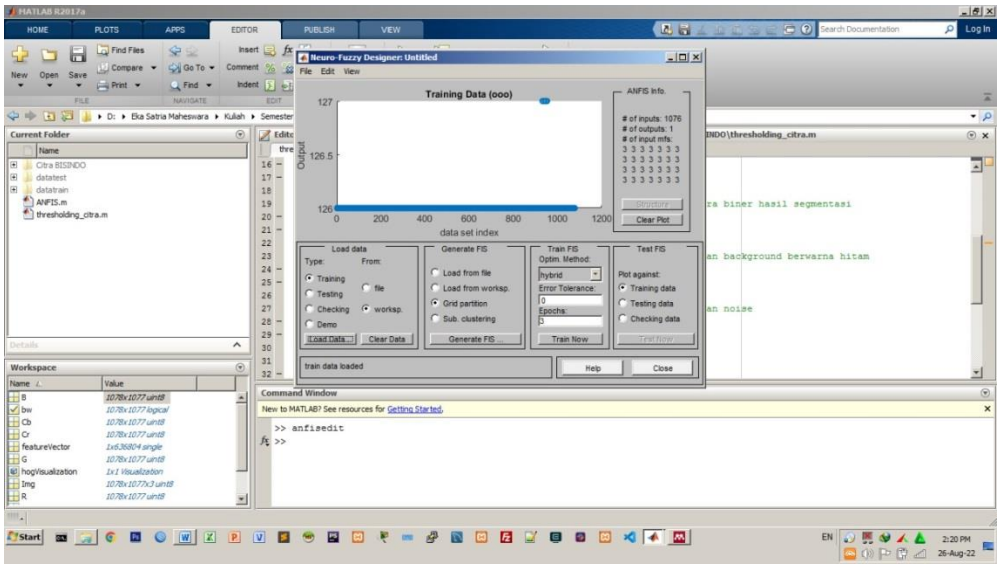

Fig 4. Training Evaluation

The image above is the code used to view the performance evaluation of the Neuro Fuzzy Inference System (ANFIS), from the image it can be seen that the evaluation of the accuracy generated from the train data with an accuracy value of 92.00%.

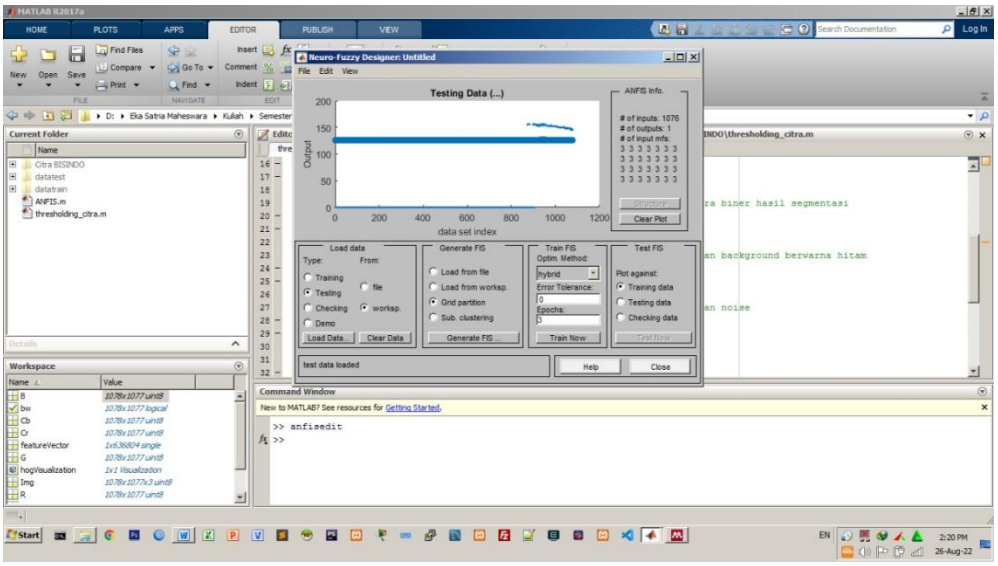

Fig 5. Test Evaluation

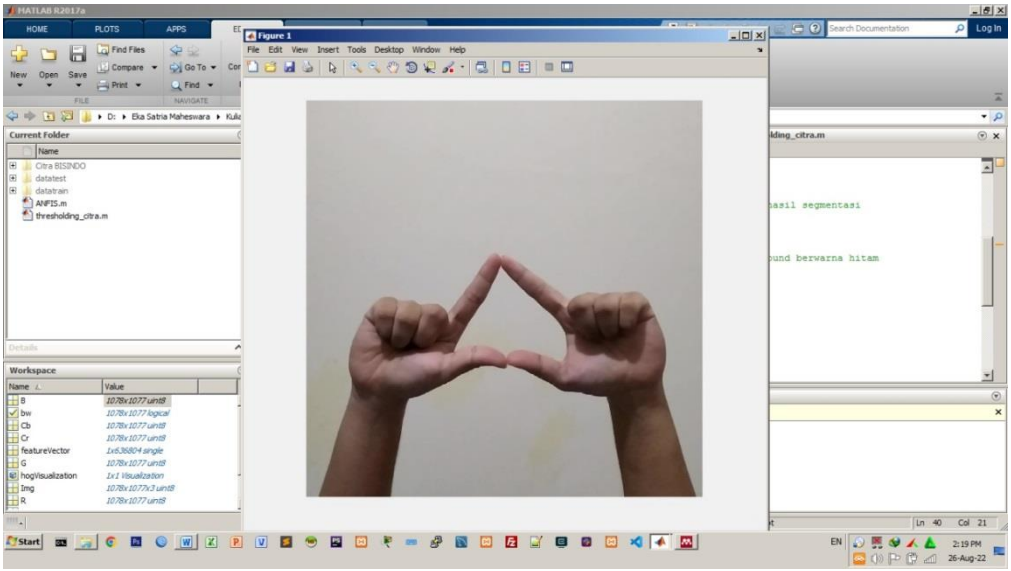

Fig 6. Image Figure 1

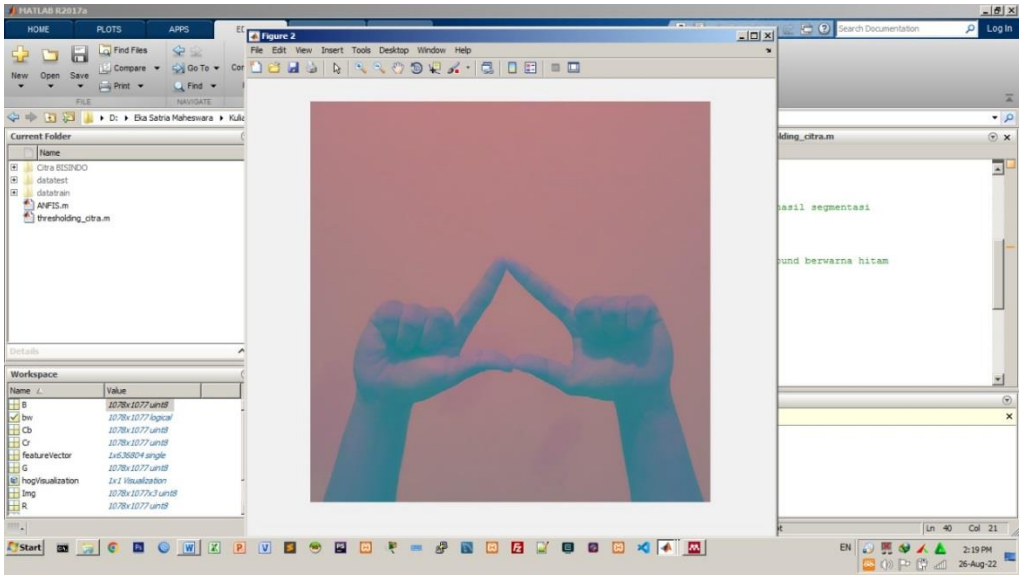

Fig 7. Image Figure 2

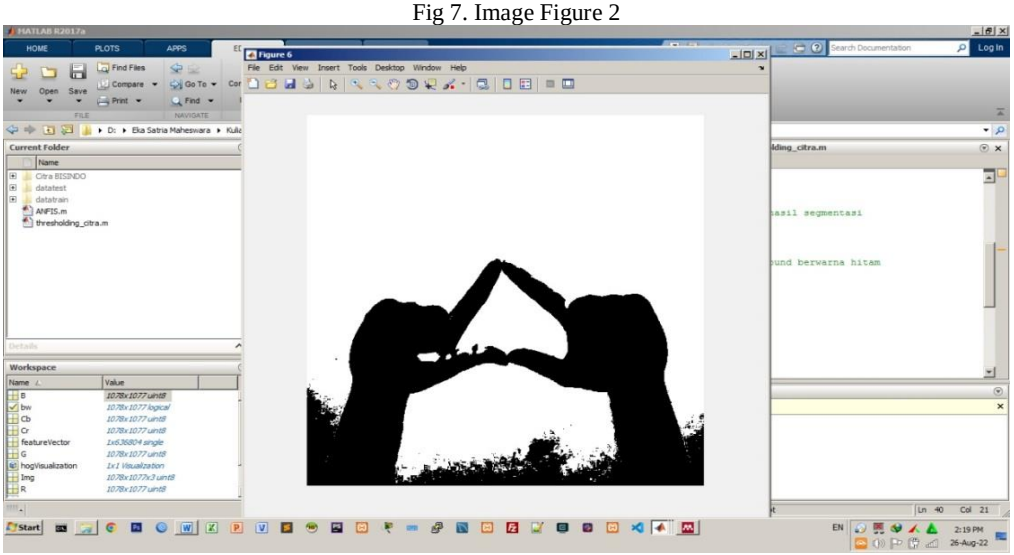

Fig 8. Image Figure 3

The following is the source code in the form of a figure image from 1-10 which has grayscale:

```
clc; clear; close all; warning off all;
%1. read native RGB image
Img = imread('Citra BISINDO/A/wall white (1).jpg');
figure, imshow(img);
%2. Converts the image color space that was originally in the RGB color space to the YCbCr .
color space
YCbCr = rgb2ycbcr(Img);
figure, imshow(YCbCr);
%3. Extracting each component of the YCbCr . image
Y = YCbCr(:,:,1);
Cb = YCbCr(:,:,2);
Cr = YCbCr(:,:,3);
figure, imshow(Y);
figure, imshow(Cb);
figure, imshow(Cr);
%4. Doing thresholding on the Y component so that a binary image is obtained from
segmentation
bw = im2bw(Y,.6);
figure, imshow(bw);

%5. Complement the image to make the object white and the background black
bw = imperfect(bw);
figure, imshow(bw);
%6. Performing morphological operations in the form of area opening to remove noise
bw = bwareaopen(bw,50);
figure, imshow(bw);
%7. Displaying segmented RGB images
R = Img(:,:,1);
G = Img(:,:,2);
B = Img(:,:,3);
R(~bw) = 0;
G(~bw) = 0;
B(~bw) = 0;
RGB = cat(3,R,G,B);
figure, imshow(RGB);
%HOG Extract
[featureVector,hogVisualization] = extractHOGFeatures(Img);
figures;
imshow(img);
hold-on;
plot(hogVisualization);
```

The image above is the code used to view the performance evaluation of the Neuro Fuzzy Inference System (ANFIS), from the image it can be seen that the evaluation of the accuracy generated from the test data with an accuracy value of 92.00%

4.5 Final Test Results

The evaluation of the detection results from the Adaptive Neuro Fuzzy Inference System (ANFIS) method, which was trained using a data train of 208 images, obtained an evaluation value resulting from the test data of 104 images.

Table 1 - Evaluation of Accuracy Value

Adaptive Neuro Fuzzy Inference System (ANFIS)	
Training Accuracy	*Testing Accuracy*
92.00%	92.00%

5. Conclusion

Based on the research and the results of the application of the Adaptive Neuro Fuzzy Inference System (ANFIS) method in classifying 26 types of images, the following conclusions can be drawn: Accuracy will be achieved better if larger data trains are used. This is evidenced by testing the amount of training data as much as 80% and validation data as much as 20% in each test model. By evaluating the ANFIS, the accuracy value based on train data is 92.00% and test data is 92.00% accuracy value.

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