# Robust Face Recognition Technique with ANFIS in Compared with Feedforward Backpropagation Neural Network Using Specific Features of Wavelet Transform and HOG

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*Abstract* - **The aims of the research were to study a face recognition using ANFIS (Adaptive Neuro-Fuzzy Inference System) technique to compared with feedforward backpropagation neural network that used specific Features of Wavelet Transform and HOG (Histogram of Oriented Gradients for feature extraction). The result found that the accuracy of ANFIS face recognition technique was 99% and feedforward back propagation neural network was 98 %.**

*Keywords* - **Face Recognition, ANFIS (Adaptive Neuro-Fuzzy Inference System), Feedforward Backpropagation Neural Network, Wavelet Transform, HOG (Histogram of Oriented Gradients for Feature Extraction)**

## I. INTRODUCTION

### *A. Statement of the Problems*

The use of Face Recognition to prove an identity by using Digital Image Processing [1] as various theories are used for example; a detection using Harr Feature method and bring Harr Feature method to apply with a color model RGB-HSVYcbCr [2] the color model used will help solve problems in the area of unequal dispersed color by using Histogram Equalization [3] to help correct the picture features for improvement and by using the primary color model the face recognition can bear with lighting conditions which makes the face recognition more accurately or using Face Detection features[4] i.e. eyes nose mouth as primary features to use in finding positions for detection reference by Template Matching theory [5] to find the closest picture with Template Matching or using Face Recognition [6] by using various theories i.e. detecting main factors of face features [7] to detect pictures to indicate that the detected Face Recognition picture is matching with others or using other arithmetic means to consider an increase in efficiency for several personal recognition [6] by using I-Gain method or the Neural network back propagation together with the Color Model [6] in order to use a Face Recognition more efficiently.

Face Recognition is important and considering a branch of an Artificial Intelligence. There are many types of Recognition i.e. a letter recognition, a sound recognition, a face recognition etc. A face recognition has an important process in which a picture from a camera is transformed from RGB to gray color and adjust size to 80x100 Pixel to become medium size then import by extracting features of Wavelet transform using Single-level discrete 2-D wavelet transform. The result will be Vector 72 member size then import HOG (Histogram of oriented gradients). HOG is set up to 15x15 Pixel then import algorithm for both techniques of recognition, ANFIS and Neural network back propagation, to compare the test result efficiency of face recognition further.

The Haar-Like Feature Detection technique is developed from the method of Viola and Jones which is a method to detect an object in the picture by building features indicating the differences between white and black color. This method helps enable feature detections required even in a little light condition. This research brings a pattern of the feature detections to apply in the process of face recognition detection and proposes an uncomplicated method by extracting specific feature techniques of Single-level discrete 2-D wavelet transform then input image. Thereafter, inputting HOG before entering ANFIS technique and Neural Network which makes the system efficient and enable to detect face recognition accurately. Topic #2 will explain about the method used, Topic#3 the details of system development, Topic# 4 the testing method and discussion, Topic#5 a conclusion of the research.

### *B. Objectives*

To develop a method and to increase an efficiency in face recognition system by using whole face features together with a specific face features comparison using ANFIS (Adaptive Neuro-Fuzzy Inference System) technique to compare with neural network back propagation then apply specific feature of Wavelet transform and HOG.

### *C. Scope of Study*

The development of increasing an efficiency of face recognition system using face features coupled with specific face features of the following scopes as follows;

- A motion picture experimented a video pictures from a computer.
- A motion picture experimented an uncomplicated background picture.
- A motion picture experimented a straight face with emotions i.e. smile, laugh, speak, etc.
- A motion picture experimented with unequal lighting environment.
- A motion picture experimented a single man or woman.

## II. THEORY

### *A. Face Recognition System*

Face recognition system has 3 main components:

First, searching a position of Face Detection in the motion picture.

Second, Feature Extraction from face features then keep the data in storage or to compare with a picture face features.

Third, Face recognition inputting a specific data of specific face features from the second Feature Extraction to compare with a specific data of face features then make a result assessment on the closest face features as shown in Fig. 1.

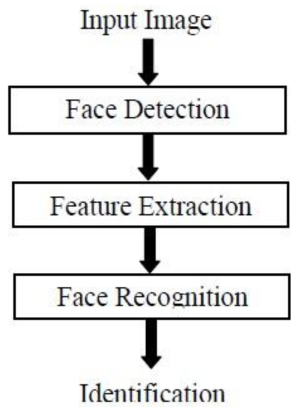



**Fig. 1** Shows a Main Component of Face Recognition

### *B. Wavelet – Based Transformation*

Wavelet – Based Transformation has an influence from Fourier Analysis method using an analysis of discontinued wavelet whereby Fourier capability can only be found in the existing frequency in order to further develop a short time Fourier to learn that the frequency will by exist in which period of time by using Window functions to compare a Wavelet. However, a Short time Fourier capability is still limited in terms of the unknown existing frequency at any point. This development becomes a Wavelet – Based Transformation in which the analysis is focused on scale and a study of Resolution.

Wavelet is a function that is not a new concept but an existing function has been used since 1800 by Joseph Fourier who found this function by laying down sines and cosines to replace other functions. However, in order to analyze scales, the Algorithm Wavelet can be used to manage the data that has different scale or resolution. If looking at a large window, a clear outstanding feature can be noticed. On the other hand, if looking at a small window a small outstanding feature can be also noticed.

### *C. HOG (Histogram of Oriented Gradients for Feature Extraction)*

Capturing a superiority of face by explaining a picture from the frequency value of direction from gradients is the method to capture features in the picture by dispersing the gradient's deepness or the direction's border by separating pictures in small cells. Within a cell, it is composed of Gradients' direction kept in Histogram format in which the cell characteristics can be explained to increase an effectiveness in accuracy and to be able to normalize by calculating an indicator of deepness from the cell overlapped in the picture in blocks to reduce the impact from a light change and less shade. The Gradients assessment can be found from using ID - discrete derivative masks. Finding the first derivatives from vertical and horizontal axis by the method of [-1, 0, 1] and $[-1, 0, 1]^T$ to formulate values of mask in x and y axis in order to calculate Histogram cell relationship whereby Pixel in the cell will have direction and weight from Gradients' calculation and finding a picture's direction resulting in a picture explanation in Histogram format.

### *D. Adaptive Neuro-Fuzzy Inference System: ANFIS*

ANFIS is a Fuzzy model which is mentioned and brought to apply in various work within ANFIS applied and integrated in both Neural network back propagation and Fuzzy. This makes strong advantages of each model to support and to reduce each model limitation for a model learning data adjustment as it is a strength of Neural network back propagation. However, the limitation in explaining a model learning integration is quite difficult to communicate to understand comparing with general human perspectives or general communication. The basis of Fuzzy model developed from Crisp Logic by comparing the rule If-Then to decide ambiguously or Fuzzy Logic.

The Basic Fuzzy models, Mandani Fuzzy and Sugeno, are mentioned. Both methods have some differences in Output function value and Output Membership Function. The latter method can choose either the Line function or Constant function. In this case, ANFIS model is developed from Sugeno Fuzzy.

1. Sugeno Fuzzy structure or TS: Takagi-Sugeno Fuzzy is shown in Fig. 2. The data sample input in 2 dimensions is brought to be assessed in function and Input Membership Function. The result to be used to determine Rule Weight or Firing Strength for the variable assessment from an output and a relationship of an equation (1) can be exhibited.

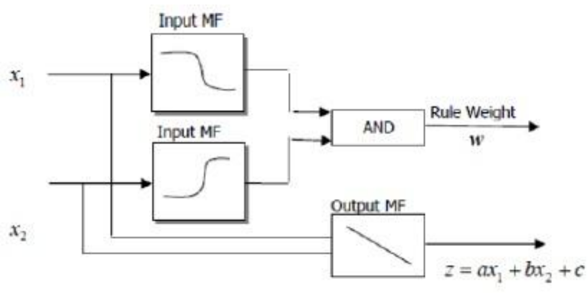



**Fig. 2** Fuzzy Structure Model Sugeno Fuzzy

$$Y_{out} = \frac{\sum_{i=1}^{n} w_i Z_i}{\sum_{i=1}^{n} w_i} \tag{1}$$

n represents a number of Fuzzy rule. Whereby, w is resulted from comparing values of Fuzzy rules received from the Input Membership Function as determined by specialists to choose various functions in many models. In this research, Gaussian Function is selected due to the dispersed data which is in line with a Function. Gaussian Function in output membership (Output MF) can be chosen from 2 models; Zero Order or determining the output membership by a constant number to set a=b=0 and the First Order or set by a Line equation $z = ax_1 + bx_2 + c$. In case of ANFIS application, the latter model is chosen by showing a relationship between Sugeno Fuzzy model and ANFIS in the next topic.

2. ANFIS Structure

In order to explain the learning process before applying, a structure of Sugeno Fuzzy can be dispersed in 5 layers as seen in the relationship in the Fig. 3. The equation (1) can be written separately by each ANFIS layer. The following result from (2-7).

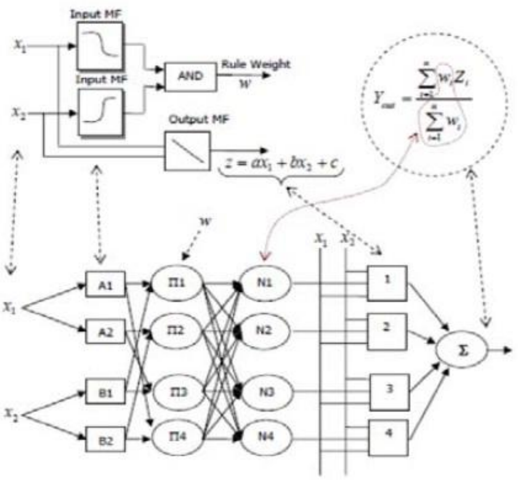



**Fig. 3** A Relationship between TS Fuzzy Model and ANFIS

The first layer or Input layer determined Input data to be represented by x with the dimension equals n and can be represented by an equation in (2).

An example of Fig. 3, where n = 2

$$x_\theta = \left[x_{1,\theta}, x_{2,\theta}, \cdots, x_{i,\theta}, \cdots, x_{n,\theta}\right]' \tag{2}$$

$1 \leq i \leq n$ and θrepresents the number of registration of Test kits.

The second layer or Fuzzification Layer. In case of a research, Gaussian Membership Function is selected. Therefore, the result can exhibit in an equation (3).

$$y_{i,j}^{(\mu)} = e^{-\frac{(x_{i,\theta} - c_{i,j})}{2\sigma_{i,j}^2}} \tag{3}$$

As (μ) represents an Output sign in a Layer $21 \leqslant i \leqslant n1 \leqslant j \leqslant R$ where n represents a size of dimension, R represents a number of rules of Fuzzy c and σ represents a middle point value and the width of Gaussian Membership Function determined by the default with Subtractive Clustering Function.

The third layer or Fuzzy Rule Layer. In this layer, the result from the second layer is brought to combine with Fuzzy rule which is determined by an equation (4) and it can be compared with the weight of the w rule in Fuzzy TS model where by Ru represents the Output symbol.

$$y_j^{(Ru)} = \prod_{i=1}^{n} \left( y_{i,j}^{(\mu)} \right) \tag{4}$$

The fourth layer or Normalization Layer exhibits the result in equation (5) whereby μ represents a symbol of the Output in the fourth layer.

$$y_j^{(\bar{\mu})} = \frac{y_j^{(Ru)}}{\sum_{j=1}^{R} y_j^{(Ru)}} \tag{5}$$

The fifth layer or Defuzzification Layer exhibits in (6). This layer can be compared with Sugeno Fuzzy Output function membership.

$$y_j^{(Df)} = y_j^{(\bar{\mu})} \cdot \left( \sum_{i=1}^{n} \left( k_{j,i} x_{i,\theta} \right) + k_{j,(n+1)} \right) \tag{6}$$

Where Df represents an Output symbol in the fifth layer and k represents a parameter from solving an equation in a part of learning forward by solving a problem following Moore-Penrose Pseudo Inverse of a Matrix. The result shows that k value, the metric size, equals [R x (n + 1)].

The sixth layer of Summation Neuron or ANFIS Output from the equation (7). The result equals the equation (1).

$$TS\left(x_\theta, \{k, c, \sigma\}\right) = y_\theta^{(TS)} = \sum_{j}^{R} y_j^{(Df)} \tag{7}$$

Whereby $TS\left(x_\theta, \{k, c, \sigma\}\right)$ represents Sugeno Fuzzy. An assessment can be made when determining Input value of $x_\theta$ and Parameter $\{k, c, \sigma\}$

### *E. Artificial Neural Network: ANN*

A prototype of Artificial Neural Network consists of a calculation without linear in parallel system and Biological Neural Network learning model (Lippmann, 1987) comprising of Neural (Node or assessment unit) gathering in layers to receive data in many word data and can be assessed by using a single or many values (Klimasauskas, 1993). The calculation in the system composed of simple functions i.e. summation function, multiplying function (Arciszewski and Ziarko, 1992) while a learning ability from several examples is to find a problem solving. Although receiving inaccurate data or mistakes, the system will compare inaccurate results and adjust a method of assessment to receive the most accurate result. The system will assess data quickly by a computer (Flood and Kartam, 1994).

1. **Basic Concept of Artificial Neural Network: ANN**

Lippmann (1987), Chester (1993) and Kireetoh (1995) explained that Neural was similar to human nerves accepting an incoming input and was stimulated. Each cell consisted of the end of nerve stream called "Dendrite", the incoming data input. While sending data to nerve stream is called "Axon", an output data from cells. These cells worked with Electrochemical system when motivated by a stimulant or by other cells. A neural stream ran through Dendrite to Nucleus as it decided whether to motivate other cells or not. If the stream was stronger, nucleus would motivate other cells further through its Axon. The final result of the same motivation or similar attributes would give an absolute value.

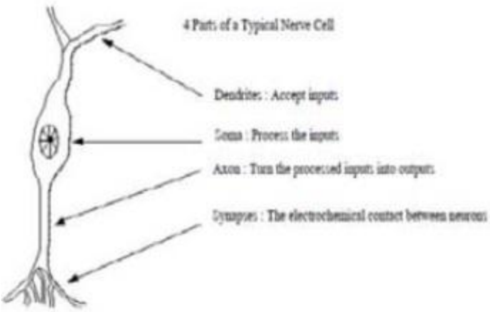



**Fig. 4** A Structure of Brain Neural Network

The Artificial Neural Network is an Artificial Intelligence created to imitate human's Neural system (Lippmann, 1987; Caudill and Butler, 1990; Klimasauskas, 1993; Medsker et al., 1993). The Artificial Neural Network system works simailarly to human's Neural system, learning from past experience and being able to find an answer even though data input is an error or incomplete, by finding a method to solve a problem from its past experience and being able to further develop to correspond with human.

2. **Creating the Artificial Neural Network Model**

The Artificial Neural Network, a learning engine, is based on a fundamental concept relating to improve control variables within itself with internal factors in the system comprising of five main factors; learning unit, Neural Network, learning plan, and analyzing process (Adeli, 1992). Elazouni et al. (1997). Elazouni devided a component of Artificial Neural Network in three stages; 1) design, 2) creating a model, and 3) testing and finding a result whereby the design stage is composed of two parts which are the structural problem analysis and the problem analysis. However, creating a model stage will be subdivided into three steps; 1) selecting data, 2) selecting a Network model, and 3) teaching and testing a Network.

3. **Data Input**

The Artificial Neural Network comprises of independent variables or data input and dependent variables or result by selecting related variables used in the Network (Smith, 1993) in two methods; the first method, data will be transformed in a suitable format and the second method is to select data using a fundamental between predictiveness and covariance.

Normally, selected independent variables are able to predict the result if they are related. On the other hand, if two independent variables are related the model will be sensitive and a problem will occur so called "over fitting and limit generalization". By this reason, when selecting data, selection must be only independent variables that can predict to receive a result or variables. Those selected independent variables must not be related. However, it depends on the Network used to reduce the samples for teaching and time spent in learning. The data selection for input should be suitable because selecting data is an important factor to create a model (Wu and Lim, 1993).

4. **Hidden Layer**

A Hidden Layer is an assessing layer between an Input Layer and a Result Layer. Usually, a Hidden layer may have more than one layer while a Network will be able to assess a suitable function from more complicated problems (Lippmann, 1987). The receiving data from the Hidden Layer will be a new variable to be sent to a Result Layer or Variable layer. If Back propagation has less Hidden Layers, the Network may not find ways to solve a problem (Karunasekra, 1992). On the contrary, if there are too many Hidden Layers the Network will take longer time to learn(William, 1993).William remarked that many Hidden Layers would not help the Network run more efficiently or in other words Rumelhart (1988), remarked that having too many Nodes in each layer would make the Network unable to find the ending point. Too many Nodes in the Hidden Layers will create a problem called "Over fitting" where by the Network will create a new structural model exceeding a fact from a Noise of data instead of finding suitable function to make appropriate Intelligence Analysis correctly (Smith, 1993). Therefore, to make the Network most efficient, Nodes in the Hidden Layer must be determined to be as least as possible (Khan, Topping and Bahreininejad, 1993) Berke and Hajela (1991) suggested that a number of Node in the Hidden Layer should be between an average sum of Node in Input data and the Result Layer. Rogers and Ramarsh (1992) gave an opinion that setting Nodes in the Hidden Layer should consider the sum of Node in the Data input Layer and the Result Layer. Soemardi (1996) remarked that the number of Node in the Hidden Layer should be 75 percent of Node in the Data input Layer. In conclusion from the opinion, a number of Node in the most Hidden Layer should be equal to the sum of Node in the Data input Layer and the Result Layer and the least number of Node should be 75 percent of Nodes in the Data input Layer or equals to the average sum of Node in the Data input Layer and the Result Layer.

5. **Weights and Biases**

Weights are replaced by numbers to show a strength to connect each Node being integrated. The sum of weight input will improve an assessment in each Node. Weight is a strength relation (Mathematics) in connection which will impact the passing of data through one Layer to another Layer (Medsker et al., 1993). Usually, weight is determined and brought into the Network in learning process based on the principle to ensure that the Network can solve a problem and reduce the time in learning. For networks, weight is equal a multiplication of a number of Node in every connection and the value of Bias is equal to a sum of a number of Node in every connection.

6. **Summation and Transfer Function**

Summation function is a function to find an average weight of every connecting Node. The procedures are to input data in each Node and to multiply by a weight of every Node and sum all Nodes together as shown in Fig. 5. Whereas Transfer function is a relationship between a level of stimulation within a Node (N) under conditions: 1) continuous and 2) value of function Sigmoy will increase when N increases (Smith, 1993).

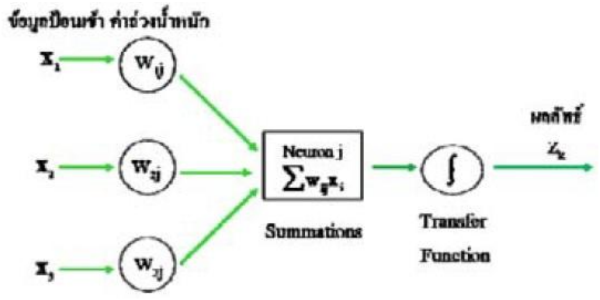



**Fig. 5** A Working Process in Artificial Neural Network in Sub Nodes

7. **Learning Rate and Momentum**

If Back-propagation Algorithm Network is big with a large learning kit, the Network will be long learning (Khan et al., 1993). Back-propagation Network has a limitation as it cannot impose exact time in learning. The Network may be lost and cannot find the answer with the least mistake by finding the answer at local minimum before global minimum as shown in Fig. 6. Therefore, it is very important to select a suitable Learning rate and momentum for Backpropagation Algorithm. However, the principle in finding a suitable Learning rate and momentum is to trial-and-error (Anderson et al., 1993).

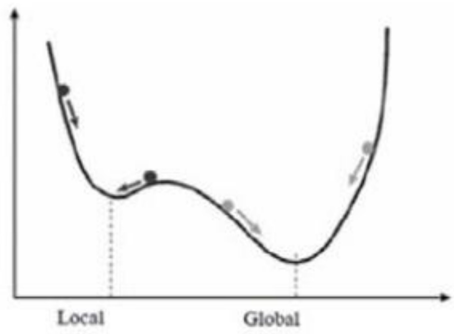



**Fig. 6** Shows Local Minimum and Global Minimum

When the learning rate reaches the high point, it will effect in a quick learning which makes the learning end at local minimum. On the other hand, if the Network has a low learning rate it will prolong a learning time to approach global minimum (Khan et al., 1993). Each layer in the same Network may have a different learning rate (Bhokha, 1998). To solve the problem when it occurs, the momentum can be input to multiply with the corrected weights in the previous circle to make a fast learning (Khan et al., 1993).

8. **Training or Learning**

A learning process is one of a learning process in a Network from Trial and Error with three principles: 1) calculate to find answer, 2) check the correct answer, and 3) adjust weights and recalculate (Medsker et al., 1993). A training process is to bring an error from previous calculation to adjust weights for the next training. The answer received is more accurate (Klimasauskas, 1993).

In a learning process, it is related to an adjustment of each Node using a learning experience from a Network as learning in each round will bring an assessment result to compare with actual values from an experiment which may have a deviation. Thereafter, the Network will retrace learning in the next round and adjust weights in the next assessment to be more accurate. Bhokha (1998) mentioned that an adjustment might be up or down. Klima Sauskas (1993) suggested that the evaluation of a better learning from Network, all indicators must be looked at i.e.

mean square error in the Result Layer. Lippmann (1987) and Smith (1993) mentioned that the learning process could be divided into two characteristics;

1) Supervised training comprises of a pair of input data and the actual result when the Network starts to learn from the input data and calculate the result then compare with actual result to find the deviation to be resent back to the Network with a weight adjustment for the Network to calculate a new result with least deviation.

2) Unsupervised training was discovered by Kogonen (1984) which is quite different from a model that simulates a human brain while the actual result may not be used for a comparison but would rather use a statistical attribute of a testing kit to classify in groups after inputting data. The model will make a possible assessment in series (Heaton, 2004).

- **Back-Propagation Learning**

In 1950, Rosenblatt had built a simple single layer Network called "Perception". Afterwards, Widrow and Hoff built a new Algorithm which could be explained by Delta rule by using a data learning with adjusted weights called Widroe-Hoff rule (Lippmann, 1987). Thereafter in 1986, Rumelhart, Hilton and Williams studied more and found Back-propagation learning processor Generalized Delta Rule (GDR) which is widely acceptable as a learning process by supervised training with a system of multilayer feed forward (Bhokha, 1998) as shown in Fig. 7. For the Back-Propagation Network, weight (w) will be adjusted in every learning cycle for the least error by adjusting weights from output layer then adjust Back-propagation to the last hidden layer and the next layer until the first hidden layer.

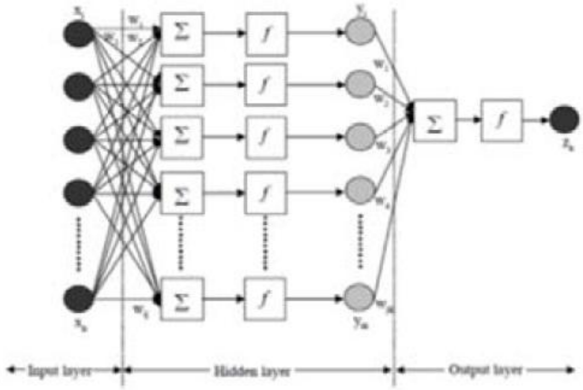



**Fig. 7** Back-Propagation Artificial Neural Network

## 9. Stop Training

Stop training Network can be performed in two ways: 1) determine training cycle (Epochs) and 2) determine an acceptable value of error. Bhokha, (1998) Carpenter (1993) suggested to determine a number of a training cycle at 20,000 - 100,000. Another method is to determine a deviation between actual data and a result that the Network can calculate (Khan et al., 1993). A caution is that training a Network too long will make a problem called over fitting as shown in Fig. 8, in which the Network can learn to achieve the least error result. When testing with a testing set it appears that it cannot give a good the result (Bhokha, 1998).

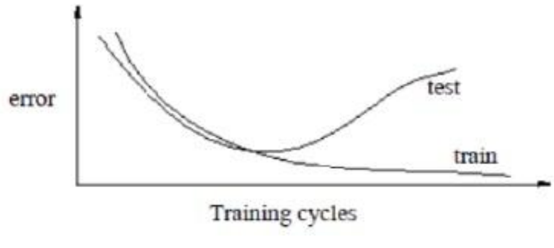



**Fig. 8** Over Fitting Case

## 10. Samples

Samples are known data of independent and dependent for Network training. Yeh et al. (1993) mentioned that the source of data set can be divided into three types: 1) a questionnaire, 2) statistical data, and 3) from the experiment. A set of data will be separated into two sets; Training set and test set. Klimasauskas (1993) commented that there should be at least five test sets for Network training.

In this research, the researcher experimented a Face detection and Face recognition of 20 samples by taking photo samples then made the system practice for a Face recognition. An important process was to transform the picture from a camera from RGB to Gray Scale, to adjust to 80x100 Pixel to a medium size and to import by extracting a wavelet transform using Single-level discrete 2-D wavelet transform. The result would be vector size 72 members. Thereafter, importing HOG (Histogram of Oriented Gradients) by setting HOG to 15x15Pixel then bringing Algorithm to memorize both techniques, ANFIS and Neural network back propagation, in order to compare an efficiency test result of a Face detection later.

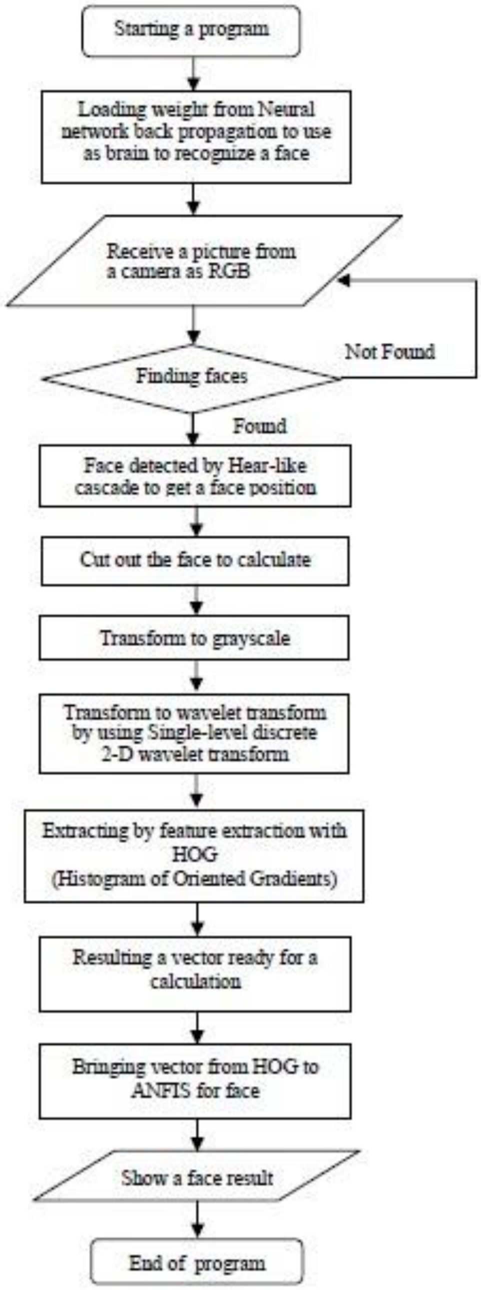
11. **Testing a Network**

Smith (1993) commented that testing Network was to test how good the Network could learn from a training set by unused training data for testing called a "test set" in which the Network can deliver an accurate result when using the test set and become reliable in testing. Network can be divided into two types: 1) a divided two sets of data (McKim et al., 1996). The first set is to train the Network to memorize the data and the second set is to test the Network where the different result between the actual value and the value from the test set will be calculated in a system error. The least system error will show a higher ability to predict and 2) using all the training and testing set by bringing them to train the Network and then use them to test the Network.

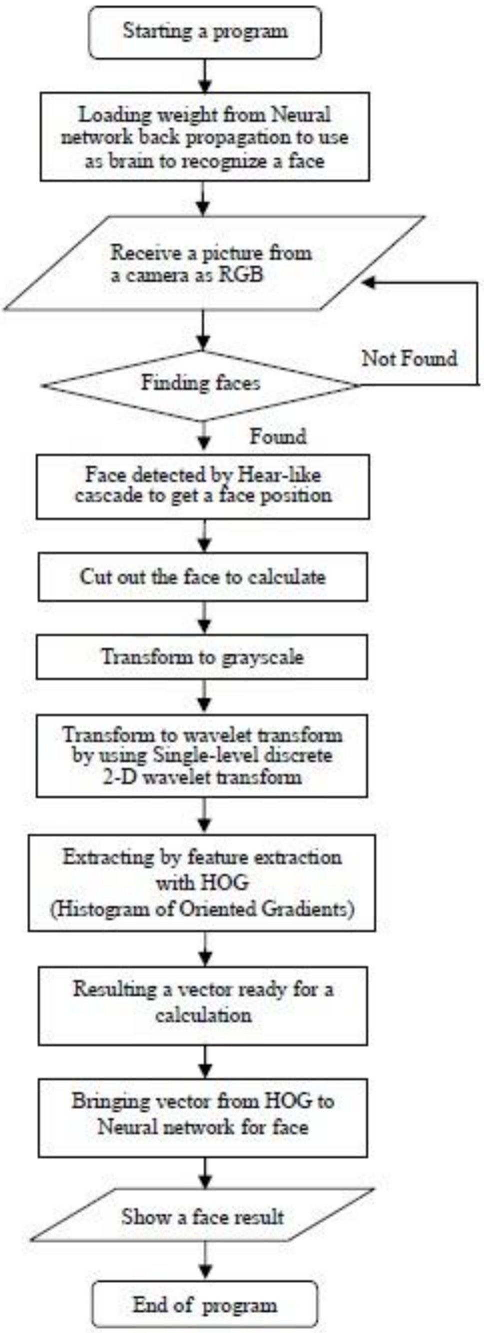
In testing a Face detection and Face recognition from 20 samples, the result appeared to have a least error as stated in a topic of the testing system result.

## III. DEVELOPMENT DETAILS

### *A. Overview of Face Recognition by ANFIS Technique*




### *B. Overview of Face Recognition by Neural Network Technique*




### *C. Design and Development*

1. **Preparing a Picture for Practicing**

- Receiving a picture as RGB from a camera.
- Transforming to grayscale.
- Adjusting to a medium size to 80x100.

2. **Improving a Picture before Face Detection**

- Importing wavelet transform by using Single-level discrete 2-D wavelet transform. The result will be vector size 72 member.

- Importing HOG (Histogram of Oriented Gradients) by setting HOG to 15x15.

- Bringing the result from HOG to Algorithm to memorize both techniques.

## IV. TESTING AND DISCUSSION

### *A. Testing for Efficiency to Detect Faces*

The Test will be divided into two parts as follows;

1. **Testing an Efficiency to Detect Faces by ANFIS Technique**

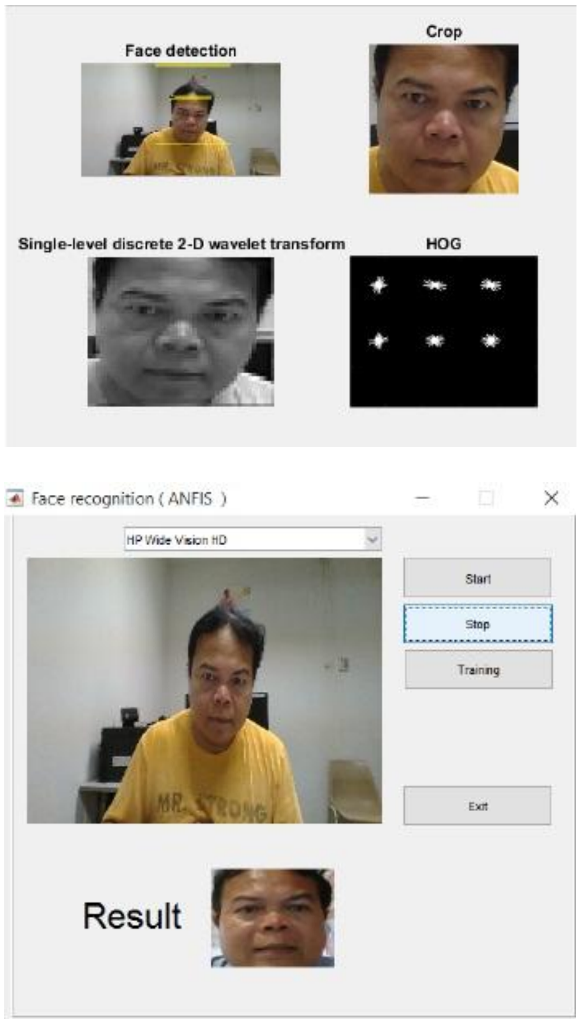



**Fig. 9** Shows a Testing Result of Efficiency to Detect Faces by ANFIS Technique

From fig. 9, it shows that detecting faces through all processes by ANFIS technique which makes the system recognize faces correctly by 99%.

2. **Testing an Efficiency to Detect Faces by Neural Network Back Propagation Technique**

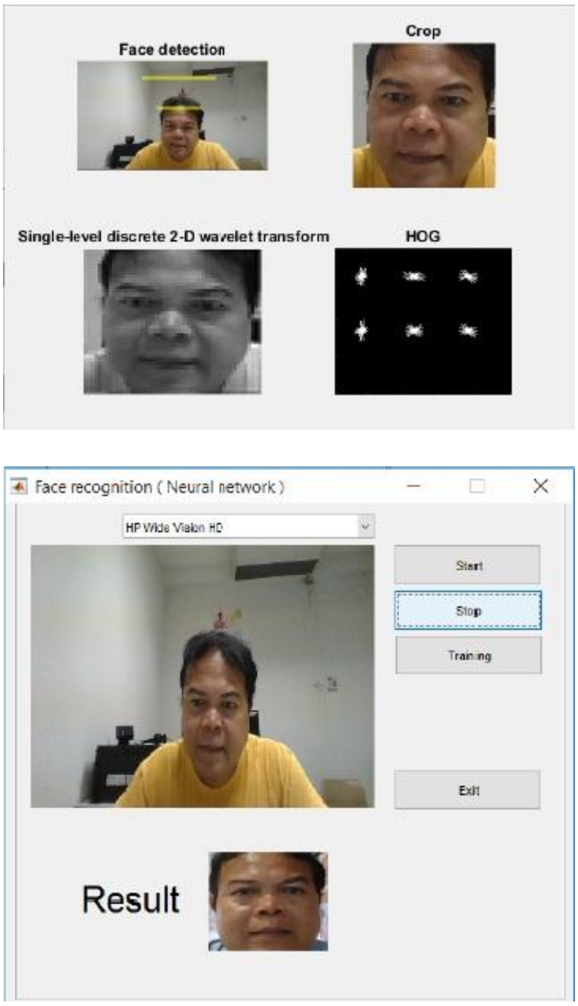



**Fig. 10** Shows a Testing Result of Efficiency to Detect Faces by Neural Network Back Propagation Technique

From fig. 10, it shows that detecting faces through all processes by Neural network back propagation technique which makes the system recognize faces correctly by 97%.

### *B. Testing for Efficiency of Algorithm to Detect Faces*

The Test will be divided into two parts as follows;

**1. Testing an Efficiency of Algorithm to Detect Faces by ANFIS Technique**

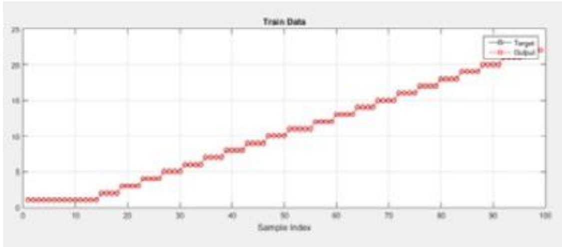


**Fig. 11** Shows a Testing Result of Algorithm Efficiency to Detect Faces by ANFIS Technique

A graph compares a difference in error of the actual answer with ANFIS calculation. If the result is good, all spots will be overlapped as shown in Fig. 12.

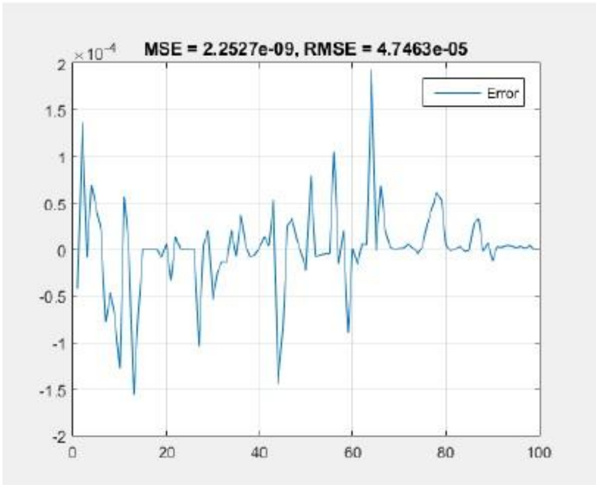



**Fig. 12** Compares a Difference in Error of the Actual Answer with ANFIS Calculation. It Shows a Little Error.

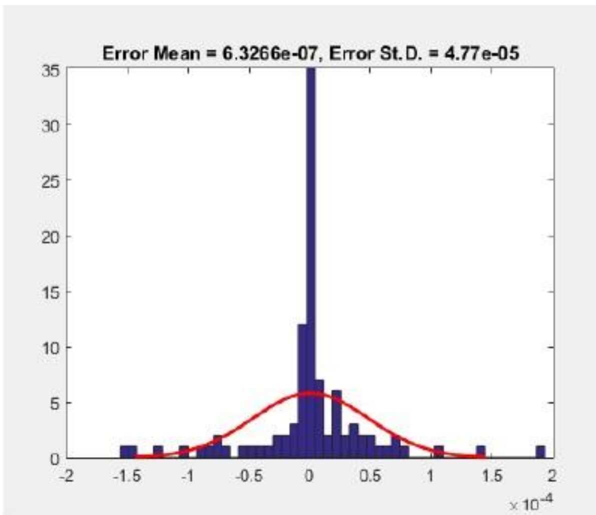



**Fig. 13** Shows an Average of Error Mean and Standard Deviation

An average of Error Mean and Standard Deviation has a small value which results a little error.

2. **Testing Algorithm Efficiency to Detect Faces by Neural Network Back Propagation Technique**

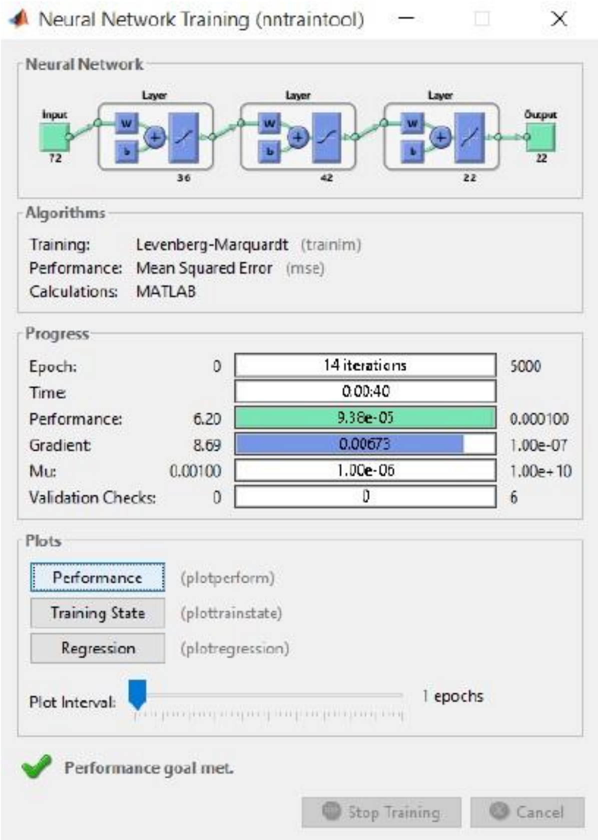



**Fig. 14** Shows a Training Part to Test Algorithm Efficiency to Detect Faces by Neural Network Back Propagation Technique

This part shows a training by looking at a Performance stripe. If lower the setting error value, the system will stop training which considers a good result.

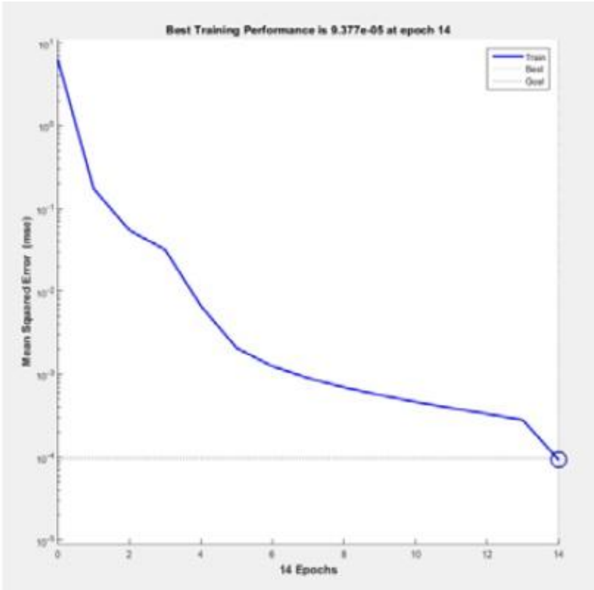



**Fig. 15** Show SMSE (Mean Square Error)

MSE (Mean square error) implies when the value falls down continuously, how close the answer would be. From the graph shown above, it stops training at cycle 14 MSE 10e-5x Axis is the number of y Axis which is MSE.

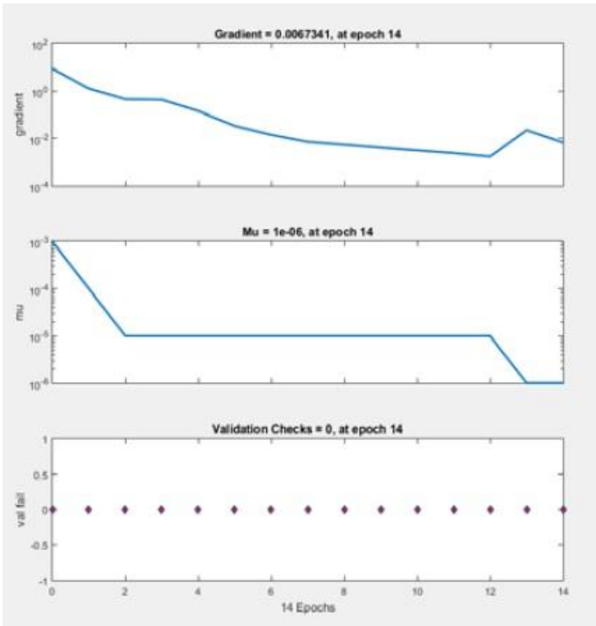



**Fig. 16** Shows Gradient, Mu, and Validation

To make a graph reading more simple, x Axis is a number of training cycle whereas a validation is a graph comparison to check if the training is good enough. If it is good, then all the spots will be overlapped which means the training is very good.

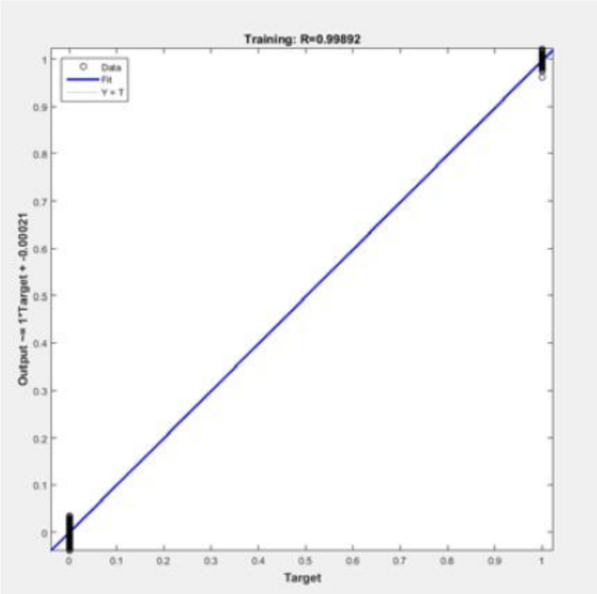



**Fig. 17** Shows a Graph Measurement to Measure an Efficiency of Movement Result in Value

A graph measurement to measure an efficiency of movement result in value, the graph in dotted line and in blue line are just overlapped.

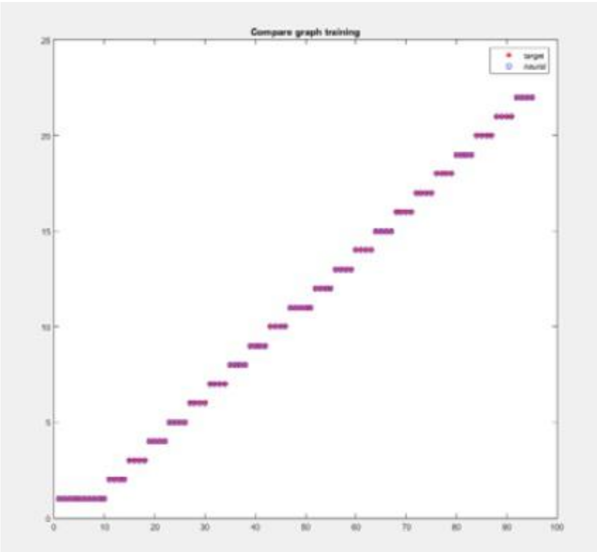



**Fig. 18** Shows a Graph Comparing Target and Neural

A graph comparing Target and Neural which are just overlapped. This shows that detection result and face recognition are very accurate.

### *C. Discussion*

This research brings a theory a digital image assessment which is a classification of Haar-Like Feature Detection and the area of interest to apply with ANFIS technique and to compare with Neuron Network technique by developing a format to detect faces. It was found that the testing result from both programs could detect faces and search for an personal identity very correctly and accurately by ANFIS technique where the correctness value is on average at 99% and Neuron technique is at 98% considering a very good criterion and harmonizing with an Algorithm efficiency measurement from both programs as it was found that the efficiency to detect faces was very good.

**TABLE I**
**COMPARISON ANFIS TECHNIQUES**

| Comparison of techniques for face detection and face recognition | Rate of recognition |
|---|---|
| PCA+ Neuro-Fuzzy Classifiers [8] | 85.00% |
| 2D-PCA+ ANFIS [8] | 97.10% |
| ANFIS with using specific Features of Wavelet Transform and HOG (Histogram of Oriented Gradients for feature extraction) (Proposed Method) | 99.00% |

**TABLE II**
**COMPARISON FEEDFORWARD BACKPROPAGATION NEURAL NETWORK TECHNIQUES**

| Comparison of techniques for face detection and face recognition | Rate of recognition |
|---|---|
| Waveketface+k-NN [9] | 93.00% |
| Discrimininant Waveletface+MLP [9] | 93.90% |
| Discriminant Waveletface+NFL [9] | 94.10% |
| Discrimininant Waveletface+k-NN [9] | 95.50% |
| Discriminant Waveletface+NFP [9] | 96.90% |
| Back Propagation Neural Network using wavelet transform and HOG (histogram of oriented gradients for feature extraction) (Proposed Method) | 98.00% |

Besides, it was also found that the light and the distance of a camera had an impact on a quality of data assessment. However, the result was satisfactory.

## V. CONCLUSION

From the experiment of the face recognition technique by Haar-Like Feature Detection and to extract the specific features by Single-level discrete 2-D wavelet transform then importing to neural network back propagation, the study revealed that the rate of face recognition by ANFIS was correct at 99% and the result of recognition by neural network back propagation technique was 98% respectively as it was also found that detecting face rate was 1% less than ANFIS technique when extracting the only specific face feature before detecting a face to compare with the result.

## REFERENCES

**(Arranged in the order of citation in the same fashion as the case of Footnotes.)**

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