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Research Paper

Explore Semantic Pixel Sets Based Local Pattern with Entropy Information for Face Recognition and Application in Back Propagation

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ABSTRACT

In this paper, a combination of the Local Binary Pattern method with a semantic pixel set of entropy information is used on back propagation networks for face recognition. This method divides the sample data into NxM zones and calculates the feature value of each zone. In this paper the sample data is divided into 6x9 zones, ie 54 zones with the size of each zone is 10x10 pixels. The LBP method is a uniform pattern of each zone and makes comparisons to zones that have the most number of active pixels. Then from the LBP method the semantic method is used to extract the entropy information from each image. From the feature extraction, there are 107 feature values, 54 of LBP and 53 methods of semantic method. The value of the feature is used as input for classification using back propagation networks. 100 sample data were used for training and 60 different sample data were used for recognition level test. From the test conducted got the recognition rate using a combination of two methods of this extraction feature is 98%.
Keywords: *Back propagation, Face Recognition, Semantic Pixel Based Local Pattern.*

INTRODUCTION

Current digital image processing is not only limited to digital image processing, but also includes character recognition techniques such as alphanumeric characters, handwriting, etc. (Emanuel and Hartono, 2008). In addition to writing recognition, facial recognition is also one of the interesting topics to be used as an area of research in the field of image processing and pattern recognition in recent years.

Face recognition is a popular biometric technique. Because it can be applied in several applications, for example: application access control, video, and human interaction with computers (Jain and Li, 2005).

The initial stage for facial recognition is image processing and feature extraction. The selection of a good feature extraction method is one of the important factors to achieve a high level of recognition (Jain and Taxt, 1996). Feature extraction is an important factor in the face recognition process but to get strong features to describe facial images is still a problem (Zhao et al, 2003).

Local descriptors that are known at this time, such as the Gabor wavelet method are one of the best performances, but the method still requires too much processing time in the extraction feature. (Serrano et al, 2010) while Local Binary Pattern (LBP) is more popular, very simple, and very fast to calculate (Pietikäinen et al 2011).

Most methods used such as LTP, TP-LBP, and Multi-scale LBP, where to represent faces have not got maximum results due to variations in expression.

Semantic pixel method set Local Binary Pattern (sps-LBP) is an approach to solve image block problems involving variations in expression, sps-LBP is the development of modified LBP.

Sps-LBP is one approach that is intended to solve the problem of dividing blocks using the simple clustering method to divide pixels into an area by assuming the value of intensity. In sps-LBP the face image is divided into a number of square regions of origin and then the pixels in each area of origin are again grouped in a semantic manner.

The workings of the semantic pixel set method based on LBP is to divide the pixels in an area of origin of images into sets (sets) so as to make it better to use spatial information when building histograms (Chai et al, 2012).

In this study for each sample data that has gone through the image processing process, feature extraction will be carried out. First, the Local Binary Pattern (LBP) operator is used for image texture classification and then applied for facial recognition, the semantic pixel method is a method for grouping pixels into sizes selected based on the image used LBP method, after that the image is extracted using probability density function (PDF) to calculate entropy information.

The ability of the semantic value by taking a description of the image from entropy information using the PDF function was tested to recognize image images with the next step using backpropagation artificial neural networks. It is expected that with these two feature extractions it can increase the level of recognition in terms of facial recognition.

LITERATURE REVIEW

Image

Image (image) is an image in a two-dimensional field. Viewed from a mathematical point of view, the image is a continuous function of the light intensity in the two-dimensional field (Munir, 2004). The light source illuminates the object, the object returns to reflect part of the beam of light. This reflection of light is captured by optical devices, such as the eyes in humans, cameras, scanners (scanners) and so on, so that the image of an object called the image is recorded.

Digital imagery is a visual representation of an object after experiencing various transformations of data from various forms of numerical circuits. Digital images can be classified into several types:

1. Binary imagery

Binary imagery (binary image) is an image that only has two gray values: black and white. The object pixels are 1 and the background pixels are 0. When displaying images, 0 is white and 1 is black.

To change the grayscale image to a binary image, the process carried out is to change the quantization of images by means of globalimage thresholding. Each pixel in the image is mapped into two values, 1 or 0. With the floating function:

$$f_g(i,j) = \begin{cases} 1, f_g(i,j) \leq T \\ 0, lainnya \end{cases} \quad \text{..... (2.1)}$$

2. Gray Image (Grayscale)

Gray image is an image that each pixel contains one layer where the intensity value is in the interval 0 (black) - 255 (white). To calculate the grayscale image, use the formula:

$$I(x,y) = \alpha.R + \beta.G + \gamma.B \text{..... (2.2)}$$

with I (x, y) is the gray level of a coordinate obtained by setting the color R (red), G (green), B (blue) indicated by the parameter values α, β and γ. In general the values of α, β and γ are 0.33. Other values can also be given for the three parameters provided that the total is 1 (Putra, 2009).

3. Color Image

Color images are digital images that have color information on each pixel. The color image coloring system has several types such as RGB, CMYK, HSV, etc.

Image processing

Image processing is processing or an attempt to transform an image / image into another image using certain techniques.

Feature Extraction

Feature extraction is the process of measuring data that has been normalized to form a feature value. Feature values are used by classifiers to recognize input units with target output units and facilitate classification because these values are easy to distinguish (Pradeep et. Al, 2011).

Another definition of feature extraction is one of the most important steps in the face recognition process, but to get discriminatory and strong features to describe facial images is still a problem for now.

Broadly speaking, features are all measurement results that can be obtained. The feature can also describe the characteristics of the object being monitored (Putra, 2009). An example of a low level feature is signal intensity. Features can be either symbol, numeric or both. An example of a symbol feature is color. An example of a numerical feature is weight. Features can be obtained by applying the feature search algorithm to the input data. Features can be expressed with continuous, discrete or discrete-binary variables. Binary features can be used to indicate the presence or absence of a particular feature.

Artificial Neural Network

Artificial Neural Networks are computational networks that simulate nerve cell networks (neurons) from the central nervous system of living things (humans or animals) (Graupe, 2007). Artificial neural networks were first designed by Warren Mc-Culloh and Walter Pitts in 1943. Mc Culking-Pitts found that combining many simple neurons so that they become a nervous system is an increase in computational energy.

Artificial neural networks are arranged with the same assumptions as biological neural networks (Puspitaningrum, 2006):

Information processing occurs in processing elements (neurons).

The signal between two neurons is transmitted through connection links.

Each connection link has associated weights.

Each neuron applies an activation function to the network input (number of weighted input signals). The aim is to determine the output signal.

Reverse Propagation Algorithm

The first Back Propagation algorithm was developed in 1986 by Rumelhart, Hinton and Williams to determine weights and is used for multi-layer perceptron training (Graupe, 2007). The back propagation method is a very good method of dealing with the problem of complicated complex patterns. . This method is a popular neural network method. Some examples of applications that involve this method are compressing data, detecting computer viruses, identifying objects, synthesizing sounds from text, and others (Puspitaningrum, 2006).

The term "back propagation" is taken from the workings of this network, namely that the gradient error of hidden units is derived from re-broadcasting the errors associated with the output units. This is because the target values for hidden units are not given (Puspitaningrum, 2006). Back propagation is a supervised learning method. This method requires a predetermined value to get the desired output in the learning process.

MATERIAL AND METHODS

This research is carried out through stages:

1. The research begins by gathering references related to the issues raised, the semantic pixel set-based local patterns with learning based on information entropy, artificial neural networks, back propagation and facial recognition.
2. Collect data
   a. Collect facial image images with the conditions given.

b. The research begins by gathering references related to the issues raised, namely methods with semantic pixels by taking entropy information and applying it to the backpropagation method.
c. Programs using the Python programming language are built to apply the theories and methods used.

3. Analysis
   In doing this image recognition, the writer needs analysis, namely:
   1. Analyze how the grayscaling image algorithm works.
   2. Analyze how the image thresholding algorithm works.
   3. Analyze how the normalized image algorithm works.
   4. Analysis takes the value of features from the semantic pixel set based method.
   5. Analysis using the back propagation algorithm for training images and test images so that they get the right recognition process.
4. Designing
   The semantic pixel set-based local patterns formula takes the entropy value from the divided image in square form, the value taken is the trained image that will be forwarded to the back propagation neural network algorithm, from the back propagation it will be concluded how accurate both algorithms it goes on.

RESULTS AND DISCUSSION

Implementation

Analysis and facial recognition models must be implemented into the program code to be able to find out the ability of the combination of semantic pixel methods and their entropy information.

Encoding is divided into five main modules, namely:

1. Image processing module
   Is a module to carry out all image processing processes and carry out feature extraction processes.
2. Network training module
   Is a module to carry out the back propagation network training process.
3. Network testing module
   Is a module to carry out the back propagation network testing process that has been trained.

In this study, coding was done using the Python 2.7 programming language, because the Pyhon language does not have a module to do image processing so that additional complete modules are needed, check at https://www.python.org/download/releases/2.7/

Testing

After the implementation phase is carried out testing the ability of the combination of zoning methods and diagonal based feature extraction on the back propagation network for the introduction of handwritten numbers. To find out the addition of the level of recognition obtained by using a combination of methods, two other networks were built with the same architecture and parameters but each one uses only an extraction method, namely zoning or diagonal based feature extraction. The network that uses a combination of zoning and diagonal based feature extraction methods uses 123 feature values, a network that uses the zoning method uses 54 feature and network values using the diagonal based feature extraction method using 69 feature values as input.

Network Preparation

The three networks have the same hidden layer and output layer, 96 hidden layer neurons and 10 output layer neurons. The input layer is built according to the extraction method used, namely Semantic pixel information entropy (54 input neurons), Semantic Pixel Rate Information Entropy (69 input neurons) and its combination (107 input neurons) to be included in backpropagation. The architecture of the three networks can be seen in table 1.

Table 1 Tested Three Networks Architecture

Network	Extraction Method	Input Layer	Hidden Layer	Output Layer
I	*Semantic pixel information entropy*	54	-	-
II	*Semantic Pixel Rate Information Entropy*	54	-	-
III	*Backpropagation*	108	96	3

So, according to the table for networks I and II, I will explain for the input layer stage, the value is clearly 54 and both networks are given blanks for hidden layers and output layers because it is not needed, which is only needed for network III because it is needed for training tests and tests test, then for backpropagation input a combined layer from networks I and II, for hidden layers we need 96 layers and the output layer (output layer) we only need 3 input layers.

Before being tested, the three networks were trained to use training data with training parameters, namely the learning rate of 0.1, momentum 0.5 and the limit of error 0.01. The three networks are trained until the error value (MSE) achieved is smaller than 0.01.

Table 2 Accuracy of Iteration Values

Amount of Iteration	Network Method	Accuracy of Object	MSE	Object
4000	*Backpropagation*	98.8 %	0.046050	166
5000	*Backpropagation*	98.8 %	0.010903	166
3000	*Backpropagaion*	98.8 %	0.012869	166

From the table above aims to get the lowest MSE because the lower the error error, the object to be recognized is easier, from the table iterates three times, the first iteration is 4000 with accuracy of object 98.8% and error error (MSE) 0.04 with the introduction of 166 objects. Unlike the iteration of 5000 accuracy of fixed objects and the error error is getting better with an accuracy of 0.010903. Then the results achieved for 5000 iterations are better with the least MSE, so we use 5000 iterations.

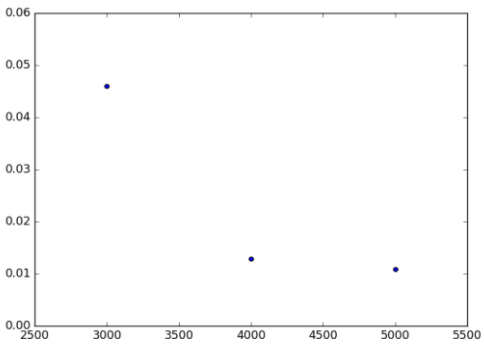

Figure 1 Accuracy of Iteration Values

In figure 1 above, it shows from the visualization of the data performed for several iterations. For example, the iteration at 3000 shows an error error value above 0.04, iterating when 4000 error errors are generated 0.02. it is better than the previous one and in the end the last iteration of 5000 produces an error of 0.01. Then it can be concluded that the larger the iteration should produce a smaller error error than the smaller iterations.

Test Result

After the three networks were trained, testing the level of recognition of the three networks was conducted. The level of introduction is tested using tested using test data, i.e. new data that is not used at the training stage. The results of the introduction of test data from the three networks tested can be seen in Figure 2.

Figure 2 Mark Zuckerberg as a test image

Source:https://www.forbes.com/sites/briansolomon/2013/04/11/mark-zuckerberg-undocumented-immigrants-should-be-part-of-our-future/#536d3c6759ae

The test results from the program can be seen in table 3 below.

Table 3 Test Results For Mark

Picture	Target	Level of Accuracy	Output
Ujimark5.jpeg	Mark	0.99487	Mark
		0.00401	Wozniak
		0.00025	Chelsea Islan
		0.00001	Iqbal

Information:
Image : Test data that is not trained during backpropagation.
Target : The name of the test data that should be displayed.
Accuracy Level : Percentage of value when the data is tested.
Output : The name of all data you want to test is related to the results accuracy.

Then we see from the table above with the image ujimark5.jpeg with the target mark, because it is known from the picture above that is Mark's image so that the target is marked as Mark, the accuracy closest to the output is Mark with an accuracy of 0.99487, then the image is tested again with a fixed target the mark with wozniak output is close to the second but the accuracy is too far and not even close to 50% at 0.00401, so the output for Chelsea island and Iqbal, with 0.00025 and 0.00001 the difference is too striking.

Figure 3 Steven Wozniak as Test Image
Source:https://www.n-tv.de/technik/Apple-1-mit-allen-Komponenten-und-Originalverpackung-unterm-Hammer-article11549561.html

The test results from the program can be seen in table 4.5 below.

Table 4 Test Results For Wozniak

Picture	Target	Level of Accuracy	Output
Ujiwozniak.jpeg	Wozniak	0.97583	Wozniak
		0.01404	Mark
		0.00092	Chelsea Islan
		0.00004	Iqbal

Information:
Image : Test data that is not trained during backpropagation.
Target : The name of the test data that should be displayed.
Accuracy Level : Percentage of value when the data is tested.
Output : The name of all data you want to test is related to the results accuracy.

Then we see from the table above with the test image wozniak.jpeg with the wozniak target, it is known that the target image is wozniak so the target tested is wozniak, the accuracy closest to the output is wozniak with an accuracy of 0.97583, then the image is retested but the mark output close to the second but the accuracy is too far and not even close to 50%, so with the output for Chelsea island and Iqbal, the difference is too striking.

Figure 4 Chelsea Islan as a test image
Source:https://hello-pet.com/foto-chelsea-islan-di-instagram-ini-bikin-hati-tenang-1823549

The test results from the program can be seen in table 5 below.

Table 5 Test Results for Chelsea

Picture	Target	Level of Accuracy	Output
Ujichelsea3.jpeg	Chelsea	0.96891	Chelsea
		0.01710	Mark
		0.00045	Wozniak
		0.00084	Iqbal

Information:

Image : Test data that is not trained during backpropagation.
Target : The name of the test data that should be displayed.
Accuracy Level : Percentage of value when the data is tested.
Output : The name of all data you want to test is related to the results accuracy.

Then we see from the table above with the image ujichelsea3.jpeg with the Chelsea target, it is known that the target of the image is Chelsea so that the target tested is Chelsea, the accuracy closest to the output is Chelsea with an accuracy of 0.96891, the mark output approaches the second but the accuracy is too far not even close to 50%, so with the output for Wozniak and Iqbal, the difference is too striking.

Table 6 Test Test Results.

Picture	Target	Accuracy Results	Output
Wozniak26.jpg	Wozniak	0.92051	Wozniak
		0.04084	Mark
		0.00490	Chelsea
		0.00425	Iqbal
ujiwozniak3.jpg	Wozniak	0.94408	Wozniak
		0.01119	Mark
		0.00364	Chelsea
		0.00260	Iqbal
ujiwozniak4.jpg	Wozniak	0.93709	Wozniak
		0.05733	Mark
		0.00416	Chelsea
		0.00018	Iqbal
ujiwozniak5.jpg	Wozniak	0.98790	Wozniak
		0.01023	Mark
		0.00112	Chelsea
		0.00007	Iqbal
ujiwozniak6.jpg	Wozniak	0.97304	Wozniak
		0.02418	Mark
		0.00204	Chelsea
		0.00003	Iqbal
ujiwozniak7.jpg	Wozniak	0.99161	Wozniak
		0.00770	Mark
		0.00018	Chelsea
		0.00002	Iqbal
ujiwozniak8.jpg	Wozniak	0.48351	Wozniak
		0.04949	Mark
		0.04166	Chelsea
		0.01158	Iqbal
ujiwozniak9.jpg	Wozniak	0.99826	Wozniak
		0.00093	Mark
		0.00014	Chelsea
		0.00002	Iqbal
ujiwozniak10.jpg	Wozniak	0.88468	Wozniak
		0.05390	Mark
		0.00805	Chelsea
		0.02033	Iqbal
ujiwozniak11.jpg	Wozniak	0.84979	Wozniak
		0.00760	Mark
		0.07052	Chelsea
		0.00204	Iqbal
ujiwozniak12.jpg	Wozniak	0.93920	Wozniak
		0.02110	Mark
		0.00150	Chelsea
		0.00475	Iqbal
ujiwozniak13.jpg	Wozniak	0.93920	Wozniak
		0.02110	Mark
		0.00150	Chelsea
		0.00132	Iqbal
ujiwozniak14.jpg	Wozniak	0.84979	Wozniak
		0.00760	Mark
		0.07052	Chelsea
		0.00204	Iqbal
ujichelsea.jpg	Chelsea	0.00010	Wozniak
		0.00010	Mark
		0.99621	Chelsea
		0.00007	Iqbal
ujichelsea2.jpg	Chelsea	0.00019	Wozniak
		0.01514	Mark
		0.89549	Chelsea
		0.00200	Iqbal
ujichelsea3.jpg	Chelsea	0.00023	Wozniak
		0.01254	Mark
		0.97741	Chelsea
		0.00059	Iqbal
ujichelsea4.jpg	Chelsea	0.00019	Wozniak
		0.00024	Mark
		0.99611	Chelsea
		0.00017	Iqbal
ujichelsea5.jpg	Chelsea	0.00008	Wozniak
		0.00006	Mark
		0.99938	Chelsea
		0.00004	Iqbal
Ujichelsea6.jpg	Chelsea	0.01581	Wozniak
		0.04864	Mark
		0.29977	Chelsea
		0.00622	Iqbal
ujichelsea7.jpg	Chelsea	0.00031	Wozniak
		0.00111	Mark
		0.99817	Chelsea
		0.00003	Iqbal
ujichelsea8.jpg	Chelsea	0.04529	Wozniak
		0.57468	Mark
		0.36922	Chelsea
		0.00018	Iqbal
ujichelsea9.jpg	Chelsea	0.00002	Wozniak
		0.04084	Mark
		0.99453	Chelsea
		0.00425	Iqbal
ujichelsea10.jpg	Chelsea	0.00028	Wozniak
		0.00074	Mark
		0.99659	Chelsea
		0.00024	Iqbal
ujichelsea11.jpg	Chelsea	0.00162	Wozniak
		0.00631	Mark
		0.98888	Chelsea
		0.00011	Iqbal
ujichelsea12.jpg	Chelsea	0.00580	Wozniak
		0.00239	Mark
		0.98938	Chelsea
		0.00007	Iqbal
ujichelsea13.jpg	Chelsea	0.00224	Wozniak
		0.00538	Mark
		0.98419	Chelsea
		0.00015	Iqbal
ujichelsea14.jpg	Chelsea	0.00031	Wozniak
		0.00207	Mark
		0.98899	Chelsea
		0.00101	Iqbal
ujimark.jpg	Mark	0.02313	Wozniak
		0.96634	Mark
		0.00384	Chelsea

		0.00430	Iqbal
ujimark2.jpg	Mark	0.04075	Wozniak
		0.95901	Mark
		0.00020	Chelsea
		0.00000	Iqbal
ujimark3.jpg	Mark	0.02539	Wozniak
		0.97414	Mark
		0.00027	Chelsea
		0.00003	Iqbal
ujimark4.jpg	Mark	0.03602	Wozniak
		0.94559	Mark
		0.00665	Chelsea
		0.00424	Iqbal
ujimark5.jpg	Mark	0.00220	Wozniak
		0.99710	Mark
		0.00013	Chelsea
		0.00000	Iqbal
ujimark6.jpg	Mark	0.00021	Wozniak
		0.99945	Mark
		0.00014	Chelsea
		0.00001	Iqbal
ujimark7.jpg	Mark	0.04896	Wozniak
		0.94187	Mark
		0.00141	Chelsea
		0.00229	Iqbal
ujimark8.jpg	Mark	0.20908	Wozniak
		0.43205	Mark
		0.17690	Chelsea
		0.00329	Iqbal
ujimark9.jpg	Mark	0.05008	Wozniak
		0.94830	Mark
		0.00065	Chelsea
		0.00001	Iqbal
ujimark10.jpg	Mark	0.04374	Wozniak
		0.95475	Mark
		0.00037	Chelsea
		0.00001	Iqbal
ujimark11.jpg	Mark	0.43055	Wozniak
		0.26517	Mark
		0.07338	Chelsea
		0.01328	Iqbal
ujimark12.jpg	Mark	0.67933	Wozniak
		0.19595	Mark
		0.01098	Chelsea
		0.00154	Iqbal
Ujimark13.jpg	Mark	0.21017	Wozniak
		0.25753	Mark
		0.19943	Chelsea
		0.01293	Iqbal
ujimark14.jpg	Mark	0.06441	Wozniak
		0.92876	Mark
		0.00398	Chelsea
		0.00167	Iqbal

CONCLUSIONS AND ECOMMENDATIONS

Conclusion

Based on the results of analysis and testing carried out in previous chapters, it can be concluded that the use of a combination of semantic pixel learning of entropy methods can increase the level of introduction of back propagation networks. From the tests carried out achieved an recognition rate of 90%.

Recommendations

In this study, the network used was only trained to reach the error limit of 0.01. The value of the error achieved after training is not the minimum condition. Therefore, further research is expected to achieve minimum conditions, in order to get a better level of recognition.

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