Explore Semantic Pixel Sets Based Local Pattern With Entropy Information for Face Recognition and Application in Backpropagation

M Iqbal Pradipta

1 Faculty of Computer Science and Information Technology, Universitas Sumatera Utara, Medan, Indonesia

* mhdqbalpradipta@gmail.com

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 backpropagation networks.

1. 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. [1]-[4]. In addition to writing recognition, face 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. 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 [5]-[8]. Feature extraction is an important factor in the face recognition process but to get strong features to describe facial images is still a problem [9]. 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 to face 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 is 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.
2. Methodology

2.1. Image Processing
Image processing is an attempt to transform an image into another image using certain techniques. The first stage is data acquisition, which is reading face images that have been collected and scanned. In each handwritten number image is carried out the pre-processing stage of the image. At this stage the face image will be processed into a uniform and appropriate image for the next stage. The next step is extracting features from each image. In this study we used a combination of two feature extraction methods, namely the semantic pixel method of set-based local patterns and learning the number of sets based on the information entropy. The value of features obtained from both methods are then combined and used as back propagation network inputs.

2.2. Normalization
Normalization is the process of changing the size of an image, either adding or subtracting, to a specified size without removing important information from the image. With the normalization process, the size of all images to be processed becomes uniform.

2.3. Local Binary Pattern
Local Binary Pattern found by Ojala as a good scale texture descriptor. Description LBP is a pixel created by a threshold value whose value is from a 3 x 3 matrix that compares the value around the

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**Figure 1.** Designing algorithm step
center pixel. The pattern of LBP operators generally allows the radius of distance to be called r and the number of samples from the center of the image called s. This parameter is indicated by the LBPs, r notation. Example, the original LBP operator with a radius of 1 pixel and sample point 8 then the notation is LBP8,1.

2.4. 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 [9].

2.5. Semantic pixel set-based local patterns
Semantic pixel method of each image is divided into regular NxM blocks, and sets (Ni) per block are given the same size to get information on the entropy of each block. Then the pixels in the block are grouped back into Ni which is an understanding of semantic itself.

![Image](image_url)

**Figure 2.** Distribution of blocks in semantic pixels (Chai Z, et al, 2012)

2.6. Learning the number of sets based on entropy information
Entropy is a term defined in information theory as a measurement of uncertainty associated with random variables. Then, it can use a histogram of intensity in each face block to estimate the probability density function (PDF) to calculate entropy information.

The entropy value of each face block I is defined as follows:

\[
S(i) = \sum_{k=1}^{n} p(x_k) \log_2 \left( \frac{1}{p(x_k)} \right) = -\sum_{k=1}^{n} p(x_k) \log_2 p(x_k)
\]  

(1)

Finally, the monotonic form function is used to map the entropy value of the number of collections. The monotonic function \( F(x_i) \) is implemented using a linear function:

\[
F(x_i) = \frac{(x_i - \text{min})}{\text{max} - \text{min}} \times (\text{new}_{\text{max}} - \text{new}_{\text{min}}) + \text{new}_{\text{min}}
\]

(2)

And all feature vectors of all block collections (1: t) will be combined representing an image pattern.

\[
X = [H_{1,1}H_{1,2} \ldots H_{1,N_i} \ldots H_{1,N_i}]
\]

(3)
2.7. Backpropagation

The first Back Propagation algorithm was developed in 1986 by Rumelhart, Hinton and Williams to determine weights and used for multi-layer perceptron training [4].

3. Results and Discussion

3.1. Implementation

Analysis and facial recognition models must be implemented into the program code to be able to know the ability of the combination of semantic pixel methods and their entropy information. Encoding is divided into five main modules, namely:

a. Image processing module
   Is a module to carry out all image processing processes and carry out feature extraction processes.

b. Network training module
   Is a module to carry out the backpropagation network training process.

c. Network testing module
   Is a module to carry out the backpropagation network testing process that has been trained.

3.2. 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.

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

| Total Iteration | Network Method | Object Accuracy | MSE    | Object |
|-----------------|----------------|-----------------|--------|--------|
| 4000            | Backpropagation| 98.8%           | 0.046050 | 166    |
| 5000            | Backpropagation| 98.8%           | 0.010903 | 166    |
| 3000            | Backpropagation| 98.8%           | 0.012869 | 166    |

From the table above aims to get the lowest MSE because the lower the error error, the object that will be recognized is easier, from the table iterates three times.

In figure 4 above, it shows from the visualization of the data carried out for several iterations. For example, the iteration when 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.

3.3. Test Results
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, ie 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 5.
Table 3. Test result for Mark

| Image         | Target | Accuracy Level | Output         |
|---------------|--------|----------------|----------------|
| Ujimark5.jpeg | Mark   | 0.99487        | Mark           |
|               | Wozniak| 0.00401        | Wozniak        |
|               | Chelsea Islan | 0.00025    | Chelsea Islan |
|               | Iqbal  | 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.

4. 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%.

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