Classification of Typical Food from Sulawesi using Artificial Neural Network and Wavelet Haar

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Keywords: Artificial Neural network, backpropagation and wavelet Haar.

Abstract: Food is the important thing in every region, but not everyone knows the form and type of the food. Therefore, this article used backpropagation algorithm and wavelet haar 2D method to classify food. The research used appropriate image data and tested the images using 32*32*3 wavelet Haar 2 D which was changed to 3072. Extracted feature was processed into 1 dimensional and trained backpropagation neural network to be able to classify food. The result of backproppagation training was a dataset of 4.160 images. Samples with 10 iterations had 80 % training Acc and 80% validation Acc. Samples with 50 iterations had 81.63 % training Acc and 81.42% validation Acc. Samples with 100 iterations had 82.7 % training Acc and 82.71% validation Acc. Samples with 150 iterations had 83.29 % training Acc and 82.11% validation Acc and sample with 200 iterations had 84.31 % training Acc and 82.34% validation Acc.

1 INTRODUCTION

Food product is everything which originates from biological source for consumption of every living being to be an energy source for the body to perform various activities (Turmchokkasam and Chamnongthai, 2018). Typical food, especially from Sulawesi, i.e. Southeast, South, West, and North Sulawesi, are very diverse and have different quality and flavour (Chen et al., 2013). Food is the important thing in every region to be consumed and to be the pride of local people. However, not everyone knows the types of food in Sulawesi. Therefore, this writing required an implementation using food image from every region (Fu et al., 1976)(Biphenyls, 2015). The processing used wavelet Haar and Artificial Neural Network to introduce food images to classify various food from the regions using backpropagation algorithm (Sarlashkar et al., 1998) (Singh et al., 2012). Artificial Neural Network (JST) can be a problem solving algorithm to perform data mapping, regression, modeling, grouping, classification and analysis using wavelet Haar 2D method which can extract image (Debska and Guzowska-swider, 2011) (Liu et al., 2010).(Wu et al., 2009).

2 LITERATURE REVIEW

Below are previous studies :

The process of identifying food items from an image is quite an interesting field with various applications. In this paper, an approach has been presented to classify images of food using convolutional neural networks. Unlike the traditional artificial neural networks, convolutional neural networks have the capability of estimating the score function directly from image pixels. A 2D convolution layer has been utilised which creates a convolution kernel that is convolved with the layer input to produce a tensor of outputs. There are multiple such layers, and the outputs are concatenated at parts to form the final tensor of outputs. We also use the Max-Pooling function for the data, and the features extracted from this function are used to train the network.(Attokaren et al., 2017)

Face recognition is an efficient biometric technique which automatically identifies the face of an individual from adatabase of images. This paper proposes a face recognition technique using Gabor wavelet and Backpropagation Neural Network. In the proposed method, Gabor wavelet coefficients are used for creating feature vector due to its representative capability of the primary visual cortex of Human Visual System. The method also uses Principal Component Analysis for dimensionality reduction. The re-

Trisno, . and Robo, S.
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DOI: 10.5220/0009909903300335
In *Proceedings of the International Conferences on Information System and Technology (CONRIST 2019)*, pages 330-335
ISBN: 978-989-758-453-4
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duced feature vector is used as the input of the classifier, the Backpropagation Neural Network. (Thomas et al., 2013) Artificial Neural Network (ANN) classifiers have been successfully implemented for various quality inspection and grading tasks of diverse food products. ANN are very good pattern classifiers because of their ability to learn patterns that are not linearly separable and concepts dealing with uncertainty, noise and random events. In this research, the ANN was used to build the classification model based on the relevant features of beer. Samples of the same brand of beer but with varying manufacturing dates, originating from miscellaneous manufacturing lots, have been represented in the multidimensional space by data. The classification has been performed for two subsets, the first that included samples of good quality beer and the other containing samples of unsatisfactory quality. (Debska and Guzowska-swider, 2011)

Image processing and analysis based on the continuous or discrete image transforms are classic techniques. The image transforms are widely used in image filtering, data description, etc. Nowadays the wavelet theorems make up very popular methods of image processing, denoising and compression. Considering that the Haar functions are the simplest wavelets, these forms are used in many methods of discrete image transforms and processing. (Mehala and Kuppusamy, 2013)

3 METHODOLOGY

3.1 Research Material

In this study the author uses, some datasbase are categorized into 6 classes. This dataset contains food images. Each image on the puppet databes has a size of 32x32. This food image is collected from several sources namely google image. Each puppet dataset has a total image of 100 per class. Food images are used for training data. validation and classification testing

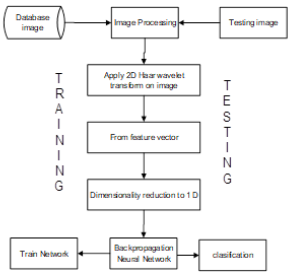

Figure 1: Research flowchart

The research flow was Collect image data as necessary, process image using wavelet Haar 2 D size 32*32*3 which was transformed into 3072 which was feature extracted into 1 dimensional. After the image became 1 dimensional, train network was performed using backpropagation of neural network and then classification was performed.

3.2 Artificial Neural Network

Artificial neural network is a computer program which has biological properties which is designed to simulate information process which uses validated model and has complex ability to learn nonlinear input-output relation using sequential training procedure (Bhotmange and Shastri, 2011) (Basu et al., 2010).

Artificial neural network is also an artificial intelligence method which is developed progressively and which produces result in estimation contrasted with other traditional scientific models, e.g. regression, correlation, science, engineering, etc. (Vonk et al., 1995). Below is a figure of the hidden layer of artificial neural network:

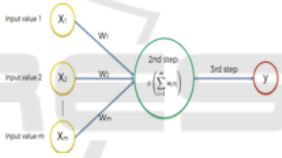

Figure 2: layer of artificial neural network (Naik and Patel, 2017)

This study used 2 hidden layers of artificial neural network using backpropagagtion algorithm (De Villiers and Barnard, 1993).

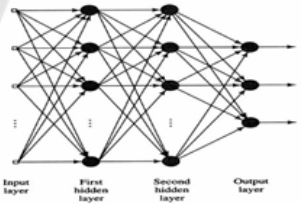

Figure 3: architecture of backpropagation (Thomas et al., 2013)

Backpropagation is one of the algorithms in artificial neural network training. The algorithm works backward, from the output layer to the input layer to renew value in hidden layer based on the obtained error value. Below are the steps of Backpropagation Algorithm:

1. Starts from the input layer, count the output of every processing element through the input layer.
2. Count error on the output layer, i.e. the difference between the actual data and the target.

3. Transform the error on appropriate in the input side of processing element.
4. Back propagate the error on the output of every processing element to the error in the input. Repeat the process until the input is reached.
5. Change all weights using errors on the connected processing input elements and output elements.

Backpropagation Algorithm The equation to calculate neuron in the hidden layer :

X input of training vector

$$X = (x1, ..., xi, , ..., xn). \quad (1)$$

T output of training target

$$T = (t1, ..., ti, ..., tm) \quad (2)$$

α learning level
Xi input of unit i
Voj bias in hidden unit j
Zj Hidden unit j

Clean input for Zj connected with z_inj :

$$z\_in_j = v_{oj} + \Sigma_i x_i v_{ij} \quad (3)$$

The outcome of activation of zj connected with z_inj

$$z_j = f(z\_in_j) \quad (4)$$

Wo k Bias for output unit k
Yk output for k
Clean input for Yk connected with y_in k

$$y\_in_k = w_{ok} + \Sigma_j z_j w_{jk} \quad (5)$$

The outcome of activation of Yk connected with z_ yk

$$y_k = f(y\_in_k) \quad (6)$$

Activation of bipolar sigmoid function (column) is also referred to as hypothesis function which is used to form limit which has (-1, 1) range.

$$f_2(x) = \frac{2}{1+exp(-x)} - 1, \quad with \quad f_2'(x) = \frac{1}{2}[1+f_2(x)][1-f_2(x)] \quad (7)$$

3.3 Wavelet

Wavelet is a basis. Wavelet basis comes from a scaling function and is also referred to as a scaling function. Scaling function can be arranged from a number of copies which have been dilated, translated and scaled. The function is derived from dilation equation, which is considered the basis of wavelet theory.

3.4 Wavelet Haar

The wavelet type used in this study was wavelet Haar. Wavelet Haar is wavelet which is supported compactly, the oldest and simplest wavelet. Wavelet Haar is orthogonal, meaning related with perpendicular angle or in other words is referred to in mathematics and supported compactly.(Deshmukh,)

The scaling function of Wavelet Haar is presented in figure 4 below

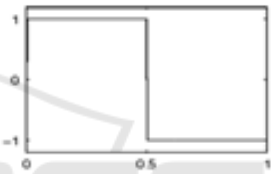

Figure 4: Scaling function of wavelet

Image composition of wavelet transformation of image is filtering image with wavelet filter. The result of filtering is 4 image sub-fields of the original image. The four image sub-fields are in the wavelet areas. The four image sub-fields are low pass-low pass (LL), low pass–high pass (LH), high pass-low pass (HL), and high pass-high pass (HH). The process is called decomposition. It can be resumed with low pass-low pass (LL) image as the input to get decomposition. Below is an image decomposition from level 1 to level 3.(Prihartono et al., 2011)

Figure 5: levels of wavelet decomposition

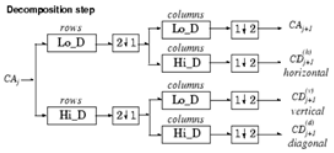

Figure 6: Steps of 2D composition

2↓1 remove column with odd index 1↓2 remove line with odd index x convolute line with filter X x convolute line with filter X

Lo_D is low pass filter for decomposition, Hi_D is high pass filter for decomposition, CA is approximated coefficient, CD h is coefficient of horizontal detail, CD is coefficient of vertical detail, and CD is coefficient of diagonal detail. (Misiti et al., 2009)

Below is the research flowchart

Process The stage of the image results by using haar wavelet to backpropagation can be seen in the picture below.

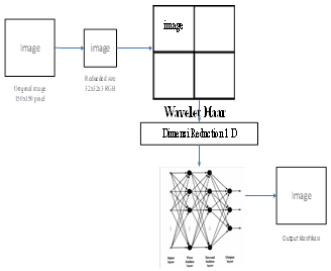

Figure 7: Image processing using wavelet haar and backpropagation

The parts are the same as those described in the Haar image process but here add the backpropation algorithm process. the data will be trained with artificial neural networks using a backpropagation algorithm which has 2 layers of hiden, the first hiden 768 and the second 384 with a lot of input, which is 3072 where input data comes from the size of the image that has been extracted to 32x32x3 (3 = RGB)

4 RESULTS AND DISCUSSION

4.1 The Processes of Wavelet and Backpropagation of Neural Network

This step firstly changed the sizes of images and all pixels on all images for input. Then they were processed for classification. The example is presented below.

Figure 8: Wavelet process into Artificial Neural Network

4.2 Feature Extract Image

The result of 2D haar wavelet. The process using this database with 600 images in jpg format used light source to differentiate shape of food, light, dark, color, etc. The decomposition of wavelet 2-D of image was similar with the case of one dimensional. Two dimensional wavelet and scaling function were obtained by collecting tensor from one dimensional wavelet and scaling function. The DWT type of both dimensions leaned toward decomposition ad details in three orientation (horizontal, vertical, and diagonal). The charts below explain basic decomposition steps for image.

Figure 9: Approximation

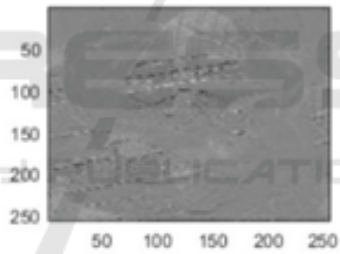

Figure 10: Horizontal

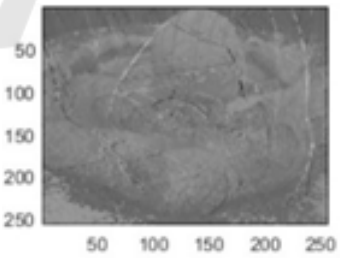

Figure 11: Vertical

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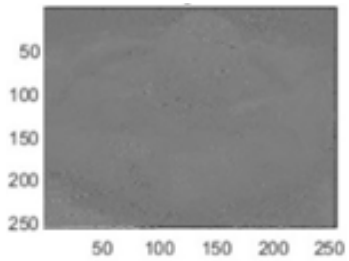

Figure 12: Diagonal

Below is the result of 2D haar wavelet

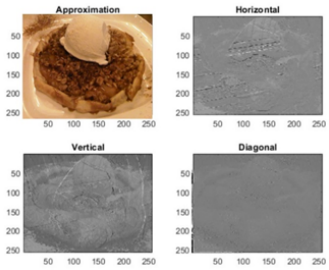

Figure 13: Diagonal

4.3 Classification

Classification was performed using Backpropagation artificial neural network. Two hidden layers were used and the number of neurons in the hidden layers was found using trial and error method to get optimal classification.

The commands of 'anaconda, python and hard' tools were used for the classified neural network procedure. A snapshot is shown below

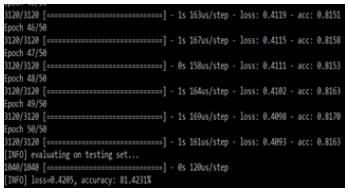

Figure 14: Diagonal

The validation result is presented in Figure 15 training and validation with backpropagation. Below is the table of ANN training.

Epoch	Training acc	Validation acc
10	80%	80%
50	81.63%	81.42%
100	82.57%	81.71
150	83.29	82.11
200	84.31	82.34

Figure 15: Training and Validation of Backpropagation.

Epoch= iteration
Training= model learning image
Validation= model able to match training and testing images
Acc= the measurement

Some cases were considered in Figure 15, Training samples were collected. Samples with 10 iterations had 80 % training Acc and 80% validation Acc. Samples with 50 iterations had 81.63 % training Acc and 81.42% validation Acc. Samples with 100 iterations had 82.7 % training Acc and 82.71% validation Acc. Samples with 150 iterations had 83.29 % training Acc and 82.11% validation Acc and sample with 200 iterations had 84.31 % training Acc and 82.34% validation Acc. Below is the result of artificial neural network classification

Figure 16: Diagonal

The system managed to read the image as cakalang. The detailed result is presented in Figure 17

Test Image	Accuracy	Classification Result	Actual Image	Description
0.jpg	99.97%	cakalang	cakalang	Correct
1.jpg	52.49%	Klapetart	Mie kacang	Incorrect
2.jpg	97.17%	Klapetart	klapetart	Correct
3.jpg	98.61	mie kacang	mie kacang	Correct
4.jpg	95%	nasijaha	nasijaha	Correct
5.jpg	91%	mujabakar	mujabakar	Correct
6.jpg	40%	Klapert	mujabakar	Incorrect
7.jpg	87%	mujabakar	mujabakar	Correct
8.jpg	90%	nasijaha	nasijaha	Correct
9.jpg	44.42%	cakalang	mujabakar	Incorrect
10.jpg	92.87%	cakalang	cakalang	Correct

Figure 17: lassification Result.

5 CONCLUSION AND SUGGESTION

Implementing Artificial Neural Network can solve the research problem because backpropagation and wavelet method used pattern recognition, forecast or estimation and image extraction. The research result of backpropagation algorithm of neural network showed different accuracy levels. Training and validation accuracy scores were quite good. The researchers suggested continuing this study to produce

more accurate process using other programs and functions of artificial neural network training with optimized bias. Backpropagation algorithm is often used as a suggested toolkit although it requires more memory than other algorithms. This algorithm shows better performance.

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