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Mushroom Images Identification Using Orde 1 Statistics Feature Extraction with Artificial Neural Network Classification Technique

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Abstract. There are many kinds of mushrooms difficult to identified manually. Because of that, a certain system that can be used to identify mushrooms is needed. One feature that artificial intelligence has is image identification. One image that can be identified mushroom image. Mushroom image identification can contribute to artificial intelligence technology development. Computer-based mushroom image identification can be done by conducting a segmentation process that converts the original image to a grayscale image. The mushroom image pattern characteristics are selected and separated using a feature extraction process. Mushrooms feature extraction conducted by using orde 1 statistics. Feature extraction results are classified using the Artificial Neural Network method with the Backpropagation Algorithm. Classification process carried out by training and testing with neurons variations 5, 10, 15 and 20, while hidden layers are 0.1, 0.3, 0.5, 0.7, and 0.9 with 10,000 times iteration. 30 images that are consist of 15 images for training data and 15 images for test data. From research can be seen that mushroom image identification using orde 1 statistics features extraction with artificial neuron network has the best result with 93% accuracy on neuron 20. Mushroom's image identification system that is developed can be implemented in other applications.

1. Introduction

Progress and application of pattern recognition have included in various fields, one of them is the agriculture area. Agricultural and plantation products industry is growing very rapidly. Post-harvest events are closely related to the quality of the product produced which ultimately determines the selling price that can be accepted by the farmers [1].

The development of computer technology continues to increase and has been able to recognize many characteristics of the image with its pattern. Pattern recognition is something that is easily done by a human but not so for computers. Someone can easily recognize the type of fungus based on its shape or color. However, it is a difficult task for computers that are not yet equipped with intelligent systems. The similarities and differences between types of fungi can be ideas to be developed into a new study [2] [3].

There are many kinds of Feature Extraction methods, which one is the feature extraction process with Orde 1 Statistics which has several parameter values namely Mean, Variance, Skewness, Kurtosis, and

Entropy [4]. The use of technology is so great that computers can work by mimicking the workings of the human brain by utilizing artificial neural network methods [5].

Classification technique used by Artificial Neural Networks with Backpropagation Algorithm. Artificial Neural Networks trains the network to get a balance between the ability of the network to recognize patterns used during training and the ability to respond correctly to input patterns similar to the patterns used during training [6]. As for this study, the type of fungus that will be identified is Kancing Mushroom, Kuping Mushroom, Merang Mushroom, Lingzhi Kerang Mushroom, and Tiram Merah Mushroom.
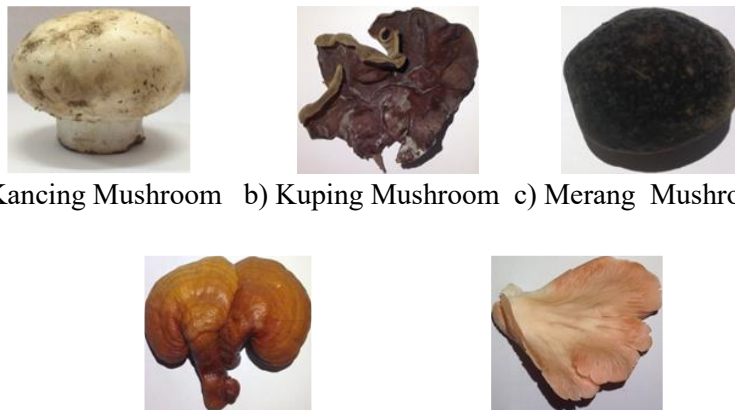
a) Kancing Mushroom   b) Kuping Mushroom   c) Merang Mushroom

d) Lingzhi Kerang Mushroom   e) Tiram Merah Mushroom

Figure 1. Image of mushroom Identification

Figure 1 shows the camera being a module that serves to capture the characteristics of the mushroom image. The captured image data is stored in the file format * .jpg. Some examples of images used in this study as shown in Figure 1.
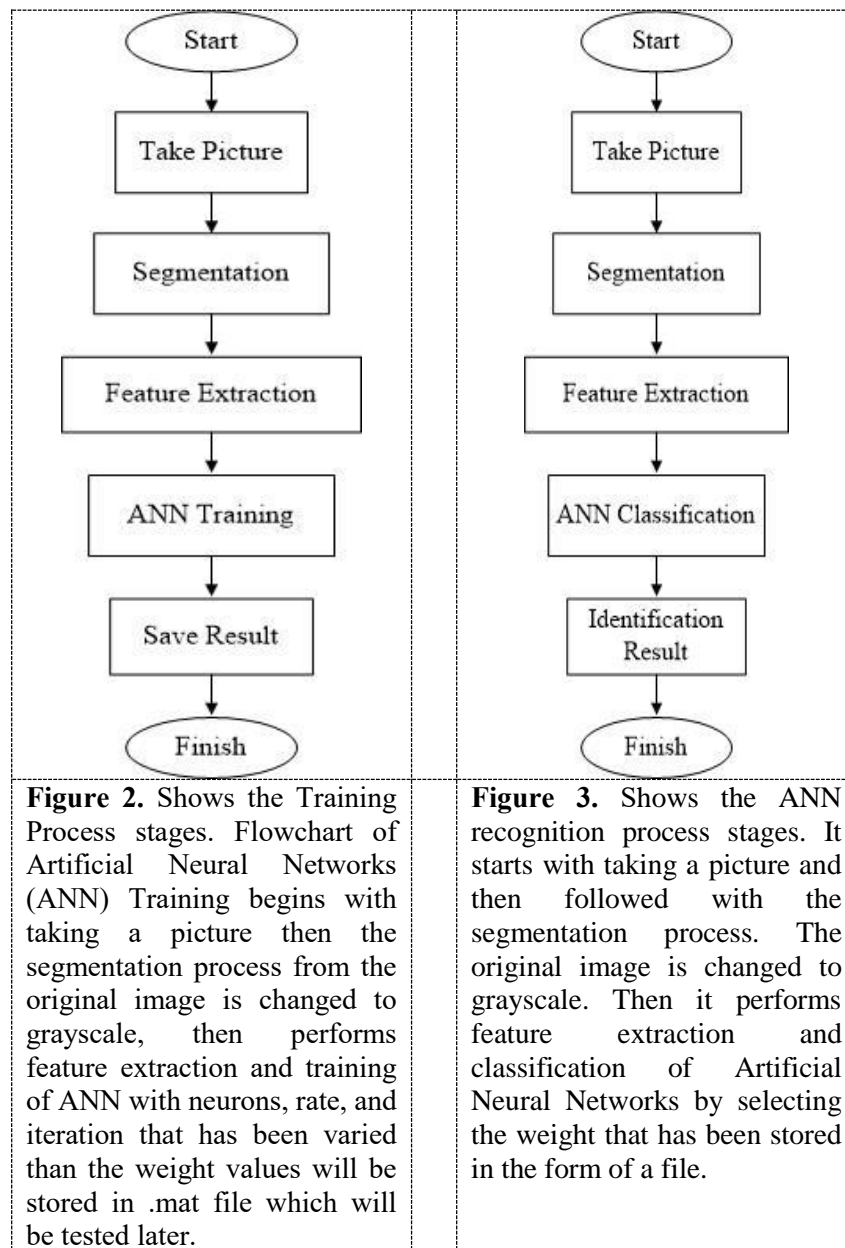
Of the types of mushroom that will be tested for each of the 30 mushroom images, 15 data will be used as training data and 15 data will be used as test data as Table 1.

Table 1. Source of mushroom image data

Mushroom Image	Amount of data	Training Data	Test Data	Format
Kancing Mushroom	30	15	15	*.jpg
Kuping Mushroom	30	15	15	*.jpg
Merang Mushroom	30	15	15	*.jpg
Lingzhi Kerang Mushroom	30	15	15	*.jpg
Tiram Merah Mushroom	30	15	15	*.jpg

2. Methods

The stages of the process in the system developed to include the process of image acquisition, image processing to obtain image features, and the classification process with Backpropagation neural networks consisting of training and testing [7].

Figure 2. Shows the Training Process stages. Flowchart of Artificial Neural Networks (ANN) Training begins with taking a picture then the segmentation process from the original image is changed to grayscale, then performs feature extraction and training of ANN with neurons, rate, and iteration that has been varied than the weight values will be stored in .mat file which will be tested later.

Figure 3. Shows the ANN recognition process stages. It starts with taking a picture and then followed with the segmentation process. The original image is changed to grayscale. Then it performs feature extraction and classification of Artificial Neural Networks by selecting the weight that has been stored in the form of a file.

2.1. Orde 1 Statistics Feature Extraction

Orde 1 Statistics Feature Extraction is a feature retrieval method based on the characteristics of the image histogram. The histogram shows the probability of the occurrence of the value of the gray degree of pixels in an image. From the values in the resulting histogram, we can calculate several orde 1 characteristic parameters, including mean, skewness, variance, kurtosis, and entropy [4].

a. *Mean (μ)*

$$\mu = \sum_n fn\, P(fn) \tag{1}$$

Formula (1) used to calculate the Mean value. It indicates the size of the dispersion of an image where fn is a gray intensity value and p (fn) shows the value of the histogram (probability of occurrence of that intensity in the image)

b. *Variance (σ2)*

$$\sigma^2 = \sum_n (fn - \mu)^2 P(fn) \qquad (2)$$

Formula (2) shows the variation of elements on the histogram of an image

c. *Skewness (α3)*

$$\alpha_3 = \frac{1}{\sigma^3} \sum_n (fn - \mu)^3 P(fn) \qquad (3)$$

Formula (3) used to calculate Skewness and it indicates the degree of slackness of the relative histogram curve of an image.

d. *Kurtosis (α4)*

$$\alpha^4 = \frac{1}{\sigma^4} \sum_n (fn - \mu)^4 P(fn) - 3 \qquad (4)$$

Formula (4) shows the level of the relative curve of the histogram curve of an image

e. *Entropy (H)*

$$H = -\sum_n P(fn).^2 \log P(fn) \qquad (5)$$

Formula (5) shows the size of form irregularities in an image

2.2. Artificial Neural Network
Artificial Neural Networks can store knowledge obtained from the results of training. This ability is similar to the function of the human brain so that artificial neural network systems can be used in an area that requires human intelligence. In carrying out the learning process, Artificial Neural Network can modify its behavior by the circumstances of its environment and can regulate itself to produce a response that is consistent with a series of inputs. Some Artificial Neural Networks have the ability to abstract the essence of a series of inputs. For several years generally, the application of Artificial Neural Networks centered on three main areas, namely data analysis, pattern recognition, and control functions. Artificial neural networks have excellent abilities in pattern recognition techniques [8]. Backpropagation architecture consists of one or more input units plus one bias unit, one hidden screen consisting of one more unit plus one bias unit, and one or more output units such as Figure 4.
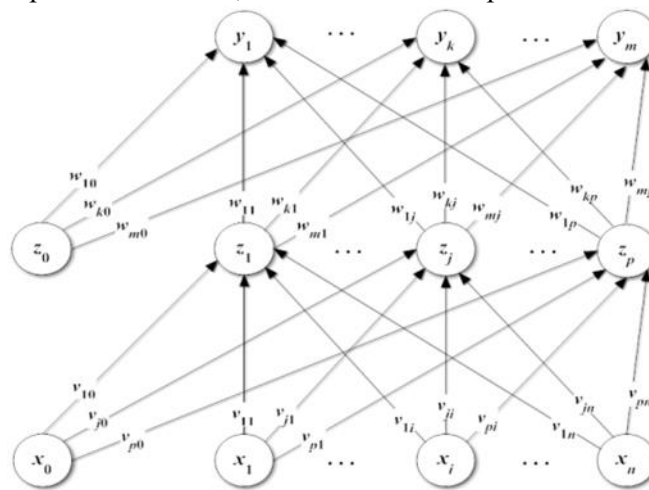

Figure 4. Backpropagation Architecture

Figure 4 Illustration of backpropagation architecture with n input (x_1, x_2, ..., x_i, ..., x_n) plus one unit of bias (x_0),a hidden screen consisting of p units (z_1, ..., z_j, ..., z_p) plus one unit of bias (z_0),and the units of output (y_1, y_2, ..., y_k, ..., y_m). v_{ji} is the line weight of the input unit x_i to the hidden screen unit z_j. v_{j0} is the line weight that connects the bias in the input unit to the hidden screen unit z_j. w_{kj} the weight of the hidden screen unit z_j to the output unit y_k. w_{k0} is the weight of the bias on the hidden screen to the output unit y_k.

2.3. Backpropagation Algorithm

The Backpropagation training /network learning algorithm steps are shown as follows:

1. Present the pattern on the input screen (Xi), give the target for each pattern (ti), and specify the number of hidden screen neurons and the rate of training
2. Initialize the initial weight values (WO), on the hidden screen and output screen
3. For each training data, do step 4 through step 11
   Advanced Propagation
4. Hidden screen

$$z\_net_j = v_{jo} + \sum_{i=1}^{n} X_i\, V_{jl} \tag{6}$$

$$z_j = f(z\_net_j) \rightarrow \text{sigmoid activation function} \tag{7}$$

with (j= 1,2,…p)

5. Output screen

$$y\_net_k = W_{ko} + \sum_{j=1}^{p} Z_j\, W_{kj} \tag{8}$$

$$y_j = f(y\_net_j) \rightarrow \text{sigmoid activation function} \tag{9}$$

with (k= 1,2,…m)
Reverse Propagation

$$\delta_k = (t_k - y_k)\, f(y_{net_k}) = (t_k - y_k) y_k (1 - y_k) \tag{10}$$

$$\delta\_net_j = \sum_{k=1}^{m} \delta_k \, W_{kj} \tag{11}$$

$$\delta_k = \delta_{net_j} f\left(y_{net_j}\right) = \delta\_net_j \, z_j \left(1 - Z_j\right) \tag{12}$$

6. Calculate all changes in weight

$$\Delta W_{kj} = \alpha \delta_k Z_J \qquad k = 1,2,\ldots\ldots, m; \, j{=}0,1,\ldots p \tag{13}$$

$$\Delta V_{kj} = \alpha \delta_J X_J \quad j = 1,2,\ldots\ldots, p; \, i{=}0,1,\ldots p \tag{14}$$

Change in line weight leading to output unit:

$$W_{kj}\left(new\right) = W_{kj}\left(old\right) + \Delta V_{kj} \, k = 1, 2, \ldots m \, ; \, j{=}0,1,\ldots,p \tag{15}$$

Change the line weight to the hidden unit:

$$V_{Jj}\left(new\right) = V_{Jj}\left(old\right) + \Delta V_{Jj} \, J = 1, 2, \ldots m \, ; \, i{=}0,1,\ldots p \tag{16}$$

The results of the network learning process obtained the final weight value in the last iteration or iteration when the error value was reached, this weight value will be used in testing the test image shown as follows:

1. Present the input pattern that will be tested (Xi)
2. Use the weight of the training process to do advanced propagation
3. Advanced Propagation
4. Hidden Screen

$$(\, j{=} 1,2,\ldots p) \tag{17}$$

$$z\_net_j = V_{Jo} + \sum_{i=1}^{n} X_i \, V_{ji} \tag{18}$$

$$z_j = f\left(z\_net_j\right) \;\rightarrow\; \text{Sigmoid activation function} \tag{19}$$

5. Output screen

$$(\, k{=}1,2,\ldots.m) \tag{20}$$

$$y\_net_k = W_{ko} + \sum_{j=1}^{p} Z_j \, W_{kj} \tag{21}$$

$$y_j = f\left(y\_net_j\right) \;\rightarrow\; \text{Sigmoid activation function} \tag{22}$$

6. Output testing process

2.4. Accuracy

Decision making based on feature extraction and classification is the result of a system decision to identify mushroom images to measure the performance of a mushroom image identification system. The percentage accuracy of system performance can be calculated by Formula (23).

$$\text{Accuracy(\%)} = \frac{ricognized \; amount}{N} \; x \; 100 \tag{23}$$

N is the total number of images tested.

3. Result

The best training process results using the weight variations in the number of hidden screen neurons are shown in Table 2.

Table 2. Training Results with variations in neurons

Learning Rate	Value Error Accuracy Training	Accuracy (%)
0.1	0.04	80
0.3	0.08	100
0.5	0.09	100
0.7	0.17	40
0.9	0.12	46

Table 2 the results of the training with variations in neurons were obtained at the learning rate of 0.1 Final Training Error Value 0.04 with 80% accuracy. Results with a learning rate of 0.3 Final Training Error Value 0.08 with 100% accuracy. Results with a learning rate of 0.3 Final Training Error Value 0.09 with 100% accuracy. Results with learning rates 0.7 Final Training Error Value 0.17 with 40% accuracy. Results with learning rates 0.9 Final Training Error Value 0.12 with 46% accuracy.

Table 3. Best Image Recognition Results with 93% accuracy

Input /Output	Kancing	Kuping	Merang	Lingzhi Kerang	Tiram Merah
Kancing	14	0	0	0	1
Kuping	2	13	0	0	0
Merang	0	0	15	0	0
Lingzhi Kerang	0	1	0	14	0
Tiram Merah	1	0	0	0	14

To calculate accuracy using the formula (25) to obtain accuracy (%) = 70/75 × 100 = 93% Table 3 Test results with 30 images that consist of 15 images as standard images and 15 images as test images. In the results above, it can be seen that for 14 Mushroom Button, the image is identified as Button Mushroom and 1 Image is known as Tiram Merah, for Kuping mushroom 13 the image is recognized as Kuping mushroom, 2 images are recognized as Button mushrooms, for Merang mushroom 15 images are recognized as Merang mushrooms, for Lingzhi Shellfish mushrooms 1 image of mushrooms is recognized as Kuping mushrooms and 14 images are known as Lingzhi Shellfish mushrooms, for Red Oyster Mushrooms 1 image is identified as Button Mushroom and 14 images are known as Oyster Mushrooms. Accuracy values obtained from the accuracy formula. The number of results identified is divided by the total of all images multiplied by 100 so that the accuracy of this test is obtained by 93%.

Research on identification of this mushroom has been done using different methods namely, by using Orde 1 Statistics Extraction Method and Distance Classification, the data used are 30 data, of which 3 data are training data and 27 data are experimental data. 4 distance classifications are used, namely the Euclidean Distance Classification method, giving an accuracy of 78%, while the Manhattan Distance Classification method produces an accuracy value of 82%. The experimental results carried out on the One Minus Correlation Coefficient Distance Classification method provide an accuracy rate of 57%, and the Minkowski Distance Classification method produces an accuracy value of 65%. From these results, it can be seen that the highest accuracy value is from the Manhattan Distance Classification Method and the Minkowski Distance Classification method produces the lowest accuracy value [9].

4. Conclusion
One thing that can be concluded in this study is that the accuracy of the system to identifying and recognizing the image of the fungus is strongly influenced by internal network parameters, namely the rate of learning, the number of hidden screen neurons, and Iterations. The highest percentage of accuracy reaches 93% it means the result is good, and for further research can be tried without changing to grayscale first.

5. References
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