EVALUATION OF HISTOGRAM OF ORIENTED GRADIENT (HOG) AND LEARNING VECTOR ALGORITHM

by Pujiono Pujiono

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EVALUATION OF HISTOGRAM OF ORIENTED GRADIENT (HOG) AND LEARNING VECTOR ALGORITHM QUANTIZATION (LVQ) IN CLASSIFICATION CARICA VASCONCELLEA CUNDINAMARCENCIS

Annisa Fitrianingtiyas Herdajanti
Faculty of Computer Science
Universitas Dian Nuswantoro
Semarang, Indonesia
annisafh02@gmail.com

Yunita Dwi Setiyaningrum
Faculty of Computer Science
Universitas Dian Nuswantoro
Semarang, Indonesia
yunitadwisetiyaningrum@gmail.com

Guruh Fajar Shidik
Faculty of Computer Science
Universitas Dian Nuswantoro
Semarang, Indonesia
guruh.fajar@research.dinus.ac.id

Ricardus Anggi Pramunendar
Faculty of Computer Science
Universitas Dian Nuswantoro
Semarang, Indonesia
ricardus.anggi@research.dinus.ac.id

Ahmad Zainul Fanani
Faculty of Computer Science
Universitas Dian Nuswantoro
Semarang, Indonesia
a.zainul.fanani@dsn.dinus.ac.id

Pujiono
Faculty of Computer Science
Universitas Dian Nuswantoro
Semarang, Indonesia
pujiono@dsn.dinus.ac.id

Abstract—Papaya fruit has various types, one of which is carica. Carica is another name for a papaya which grows in mountain areas, such as Dieng and Wonosobo. The fruit, which when ripe, will be a breech ovoid and has a size of about 6-15 cm x 3-8 cm. So, classification is needed to differentiate carica maturity levels so that in the processing process producers can easily get good quality Carica fruit. The method used as research is the LVQ method to classify carica fruits. And HOG (Histogram of Oriented Gradients) algorithm is one method for extracting features from image objects. The process of HOG is to convert an RGB (Red, Green Blue) image to grayscale. Following are the steps of the HOG algorithm process: Image Conversion, Gradient Computer, Spatial Orientation Binning, Block, and Windows Detector. From the results of extracting HOG on training and testing data, there are some conclusions including; 104 datasets consisting of 80 training data and 24 testing data that were applied to classify the maturity level of carica fruit using the HOG and LVQ methods can produce the highest accuracy rate of 91,67% with HOG size values are 256, 128, and 64. And the size of HOG processes is 256 with the fastest time which is equal to 38.52 seconds. According to research conducted by the HOG and LVQ methods, it can and successfully be applied to the image of carica fruit to classify the maturity of the fruit.

Keywords — Classification, Histogram of Oriented Gradients (HOG), Learning Vector Quantization (LVQ), Carica Vasconcellea Cundinamarcencis.

I. INTRODUCTION

In this country, Indonesia has often dubbed an agricultural country. The prosperous and very fertile land of the country also illustrates that Indonesia's rich nature. Lots of vegetables, fruits, and other plants that grow in this beloved country. One of them is papaya fruit. From 2014 statistics, papaya fruit production is 840,112 tons and has an average yield of 82.23 kg/tree [1]. This papaya fruit has various types, one of which is carica.

Carica is another name for a papaya which grows in mountain areas, such as Dieng and Wonosobo. The fruit, which when ripe, will be a breech ovoid and has a size of about 6-15 cm x 3-8 cm. This fruit is widely used as juice, syrup, or sweets which are typical souvenirs from Dieng. As a commodity used to make processed food, only mature carica fruit is needed. That's why classification is needed to distinguish carica maturity so that in the processing process producers can easily get good quality Carica fruit.

This study, the authors classify carica fruit using the HOG and LVQ algorithms as the method. The method used as research is the LVQ method to classify carica fruits. And the HOG (Histogram of Oriented Gradients) algorithm is one method for extracting features from the texture of object images. The process of HOG is to convert an RGB (Red, Green Blue) image to grayscale. Following are the steps of the HOG algorithm process: Image Conversion, Gradient Computer, Spatial Orientation Binning, Block, and Windows Detector. [2]

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II. Related Research

In this study, the authors obtained several supporting references or references related to research topics including:

The research [3][4][5][6], that explained the HOG algorithm got results that the HOG feature method produced a bandwidth range of 0.09-0.22 and the accuracy reached 100%. Later on other studies with the HOG algorithm produced execution times of 11.9 seconds. Other studies that combine HOG with various types of classification algorithms produce an accuracy of 91.76%. And the last research was combining HOG and DWT resulted in an accuracy of 77.14%. From several studies, it was concluded that the HOG algorithm included a good feature method.

Secondly, the result of research [7][8][9] that explained the LVQ algorithm got results: in the classification researchers distinguish into two categories: normal and abnormal. And the results of accuracy obtained were 68.85% for DDSM mammography data, while the results of accuracy of automatic MRI data were 79.35%. And conducted by classifying strokes based on pathological abnormalities. Classification is done using CTS (Computer Tomograph Scan). Clinical data consists of 32 features that contain: symptoms, history, laboratory results, and physical examination. The accuracy of the LVQ algorithm reaches 96% and the AUC value is 0.952.

In the research [10], that from 300 data were tested by classifying the age level and maturity of carica fruit using the artificial neural jarring algorithm. The maturity level is divided into 3, namely: young, old, and mature. And the level of aging is divided based on the age of the quotation.

From the above research, the results of HOG accuracy as extraction features and LVQ as a classification method that will be implemented to classify carica fruit maturity.

III. Literature Study

The authors obtained several supporting references or references related to research topics including :

3.1 Carica Fruit

Carica in Latin (Vasconcellea Cundinamarcencis) is a fruit that is almost similar to papaya because it has a stem that is not woody, a small tree measuring 1-2 meters that resembles a papaya tree. The fruit, which when ripe, will be a breech ovoid and has a size of about 6-15 cm x 3-8 cm. This fruit is widely used as juice, syrup, or sweets which are typical souvenirs from Dieng. Carica plants can grow on wet highlands between 1,500 - 3,000 meters above sea level, not
high rainfall and wet soil conditions. [1]

Fig. 1. Carica Fruit

3.2 Histogram of Oriented Gradients (HOG)

Histogram of Oriented Gradient is one method in image processing to extract the characteristics of an image or image. The histogram of Oriented Gradient states that an object can be represented properly based on texture or shape. To get information in an image, the image is divided into several cells, then each cell is counted as a Histogram of Oriented Gradient. The initial step of the Histogram of Oriented Gradient (HOG) method is to convert an RGB (Red, Green, Blue) image into a Grayscale image [3]. Conversion from RGB to grayscale images, because grayscale images only produce one color channel so the computing process is easier. The picture below is an example of changing the original image to grayscale image :

Fig. 2. The Orginal Image of Carica Fruit

Fig. 3. The Grayscale Image of Carica Fruit

Below this formula is used to obtain gray values:

$$L = 0{,}144 * R + 0{,}587 * G + 0{,}299 * B \quad (1)$$

Information :

L : the gray value of each pixel
0.144 : weight/weight of each element in red
0.587 : weight/weight of each element in green
0.299 : weight/weight of each element in blue
R : value an intensity in the red element
G : value an intensity in the green element
B : value an intensity in the blue element

After that, calculate the gradient value at each pixel, after obtaining the gradient value, the next step is to determine the number of orientation bin used to create the histogram, in this process called the spatial orientation binning, then the grouping of cells is needed to be larger which is often called a block. It seems that the blocks often overlap because each cell contributes values more than once, the end result of the block normalization is to produce features.

3.3 Learning Vector Quantization (LVQ)

According to the Big Indonesian Dictionary, classification is a systematic arrangement in groups or groups according to established rules or standards.

Harrolds Librarians Glossary states that classification is a logical grouping of objects according to their similarities.

Learning Vector Quantization is one method of classifying patterns where each output unit represents a particular class or category. When passing data training the output unit is modified (by changing the weight value through supervised training).

Learning Vector Quantization (LVQ) is used to classify carica imagery that has been extracted using features using the previous HOG.

Steps of the LVQ algorithm:

1) Initialization: the initial weight of the j-input variable towards the i-class (W), the maximum epoch (MaxEpoch), the expected minimum error (Eps), the Learning rate.
2) Put in :
   1) Data Input: x (m, n); with i = 1,2, .., n and j = 1,2, .., m
   2) Targets are classes: T (1, n); with k = 1,2, .., n
3) Initial condition initialization:
   1) Epoch = 0
   2) Err = 1
4) Work if: (epoch <MaxEpoch), the minimum error value is reached or the value of error = 0 and (α> Eps)
5) Epoch = Epoch + 1;
6) Work for i = 1 to n
7) Determine the Distance so that ‖ xij-wij ‖ nimimum (call it Cj)
8) Fix Wj with conditions:
   1) If T = Cj then: Wij (new) = wij (old) + α (xij-wj (old)) (3.29)

   ii. If T ≠ Cj then: Wij (new) = wij (old) - α (xijwij (old)) (3.30)
9) Reduce the value of α Reduction of α = 0.1 * α

   the condition stops if the value α = 0.0001. [11]

IV. PROPOSED METHOD

The preprocessing process is one of the steps taken to increase success in this experiment. Below is a scheme of his thoughts :

Fig. 4. Scheme of Proposed Method

Preprocessing (Figure 4) is one of the steps taken to increase success in this experiment. the process carried out is the grayscaling process, this process is carried out to convert RGB color images into gray-scale images.

V. EXPERIMENT AND RESULT

5.1 Dataset

The image acquisition process is taking the image of Carica that has been picked from the tree. The training image acquisition process has been classified based on the fruit maturity level, which is 104 carica image data including 26 decay carica images, 26 mature carica images, 26 half-baked carica images. and 26 raw carica images. For test data, 24 carica images are used for test data. This dataset is 512 x 512 pixel which will be classified into 4 classes namely: raw, half-cooked, ripe, and rotten.

Fig. 5. Class of carica fruit (a. raw), (b. half-cooked), (c. ripe), (d. Rotten)

5.2 Experiment and Result

From the results of the study concluded by the figure below, Figure 6 is a graph of HOG time execution result:

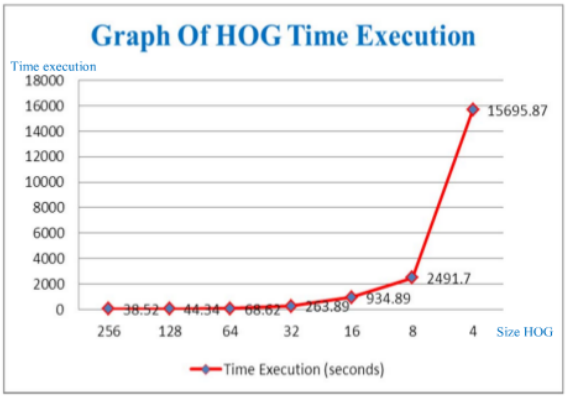

Fig. 6. Graph of HOG Time Execution Result.

From figure 6 above it can be concluded that the 256 sizes of HOG processes with the fastest time which is equal to 38.52 seconds.

5.3 Evaluation

To calculate the percentage of results from the classification of Carica imagery using the LVQ method using HOG texture extraction as follows:

$$Accuracy = \frac{True\ Data}{Total\ Data} \text{ x } 100\% \qquad (2)$$

TABLE I. THE RESULT OF EVALUATION

Total of Dataset	Data Training	Data Testing	HOG Size	Accuration (%)
104	80	24	256	91.667
			128	91.667
			64	91.667
			32	87,5
			16	87,5
			8	87,5
			4	66,67

From this experiment, the authors get the test results that have been done on 104 dataset sets (consisting of; 80 training data and 24 testing data). Can be seen in table 1 above, namely by testing the dataset at each HOG size = 256, 128, 64, 32, 16, 8, 4. And it was concluded that the highest level of accuracy in the above test was 91,67% at HOG size = 256, 128, and 64.

The results of tests conducted in this study, found that differences in cell size in HOG did not significantly affect the results of accuracy. This is because, the classification in this case LVQ considers the pattern of information (features) obtained using different HOG measures that have the same characteristics.

CONCLUTION

From the research carried out on 104 datasets consisting of 80 training data and 24 testing data that were applied to classify the maturity level of carica fruit using the HOG and LVQ methods can produce the highest accuracy rate of 91,67% with HOG size values are 256, 128, and 64. And 256 size of HOG processes with the fastest time which is equal to 38.52 seconds. According to research conducted by the HOG and LVQ methods, it can and successfully be applied to the image of carica fruit to classify the maturity of the fruit.

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