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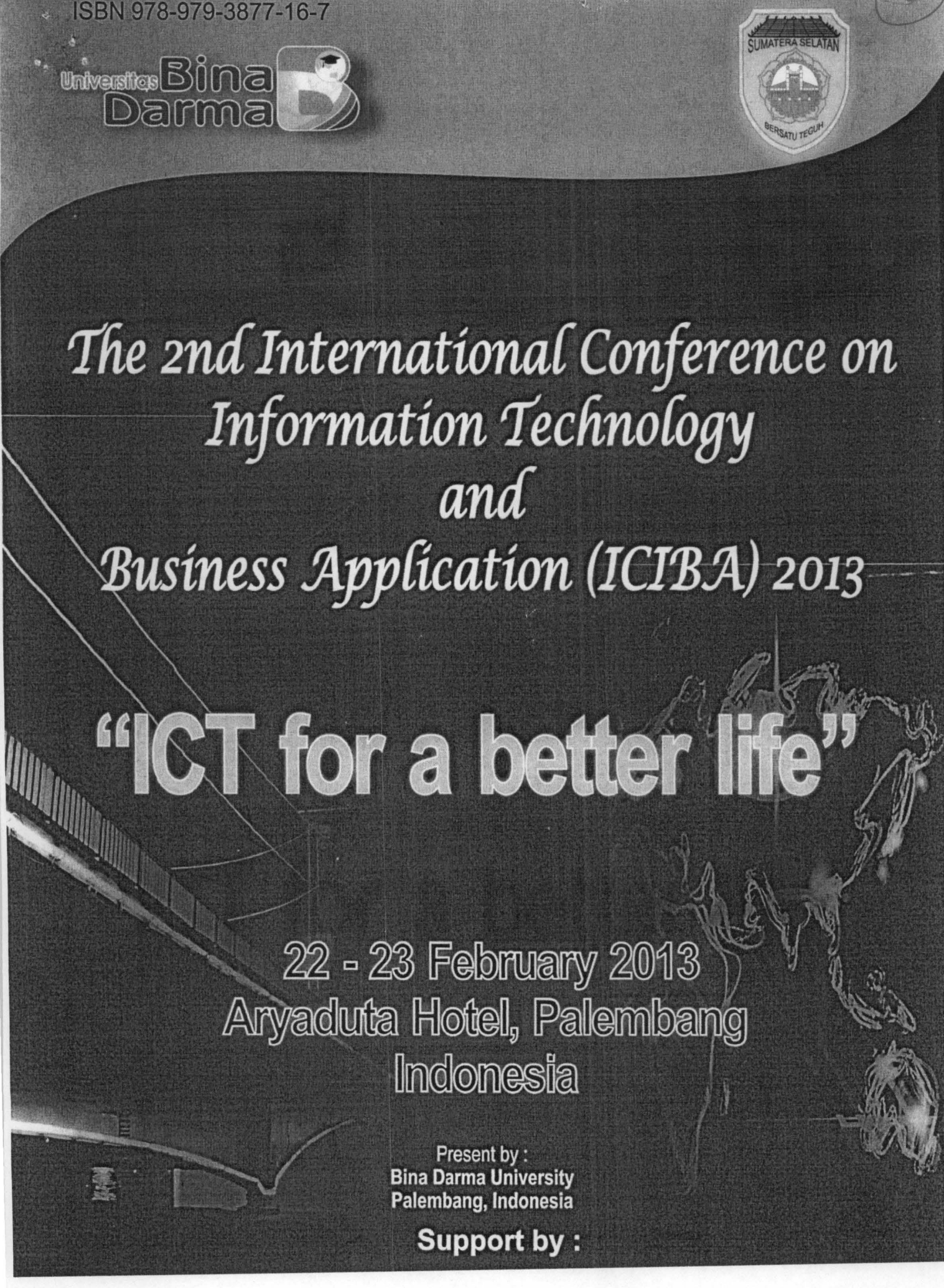

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IDENTIFICATION OF MEDICINAL PLANT BASED ON FRACTAL BY USING CLUSTERING FUZZY C-MEANS

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Abstract. *Identification of medicinal plant species automatically is still a problem in recognizing various kind of medicinal plants in Indonesia. The research purpose is to develop medicinal plant identification system by using fractal and Fuzzy C-Means (FCM) clustering. Fractal method is used to extract image feature of the medicinal plant leaf. However, FCM clustering is needed to classify image feature medicinal plant into some class or cluster. Two fractal approaches used in this research are fractal dimension and fractal code. Fractal dimension is based on similarity of the medicinal plant leaf image pattern and counted by box counting method, however fractal code is based on similiarity of the medicinal plant leaf image texture. This research used data from the collection in Biofarmaka IPB plantation and glasshouse of Ex-Situ conservation of Indonesian Tropical Forest. 600 data are used in this research consists of 20 variety of medicinal plants for each 30 samples. This experimental result shows that 85.04% of FCM clustering is based on fractal dimension and 79.94% FCM clustering is based on the fractal code.*

1 INTRODUCTION

Indonesia is one of nations who has a great potentiality in providing medicinal plants. It is distinctly proved that 40,000 species plants in the world, 30,000 species which are high level plants, grow in Indonesia, and 7,000 of them are medicinal plants, Ref.[8]. A great variety of medicinal plants makes difficulty in identifying them, therefore a capability of identification medicinal plants is very important.

A process of identification is depend upon a result of feature extraction. Leaf becomes one of elements which can be used to extract. The shape and the texture of leaf can be classified as a characteristic of medicinal plant. One of them is to extract feature based on fractal. There are two features extraction approaches by using fractal method : first, fractal dimension is based on shape design similarity level of an image, second, fractal code is based on the similarity of texture design on itself and its image, Ref.[1].

To make the process of medicinal plant identification is easier, we firstly categorize plants by using clustering Fuzzy C-Means (FCM). This clustering takes fuzzy

classification model which classified one data that can be a species of all classes or a shaped cluster and each data in one class or cluster might be identified by a member degree.

Some researches using fractal methods such as, Ref.[2] takes fractal dimension in Iris Recognition System which classify 3 methods e.g. Bayes, Euclidian and K-nearest neighbor (K-NN). Ref.[5] used fractal code to introduce a character design and an Arabian digit by using Support Vector Machine (SVM) and Radial Basis Function (RBF) Neural Network. Other researcher that used fractal method and clustering FCM is Ref.[6] which used fractal dimension and FCM in classifying undersea images. Ref.[3] use fractal code and FCM to insert watermark on a picture.

Based on those former researchers, it is suggested that this research urge the identification system of medicinal plants based on fractal using clustering FCM might be.

2 STAGGES OF THE RESEARCH

The stages of the research can be shown at Pig.(1).

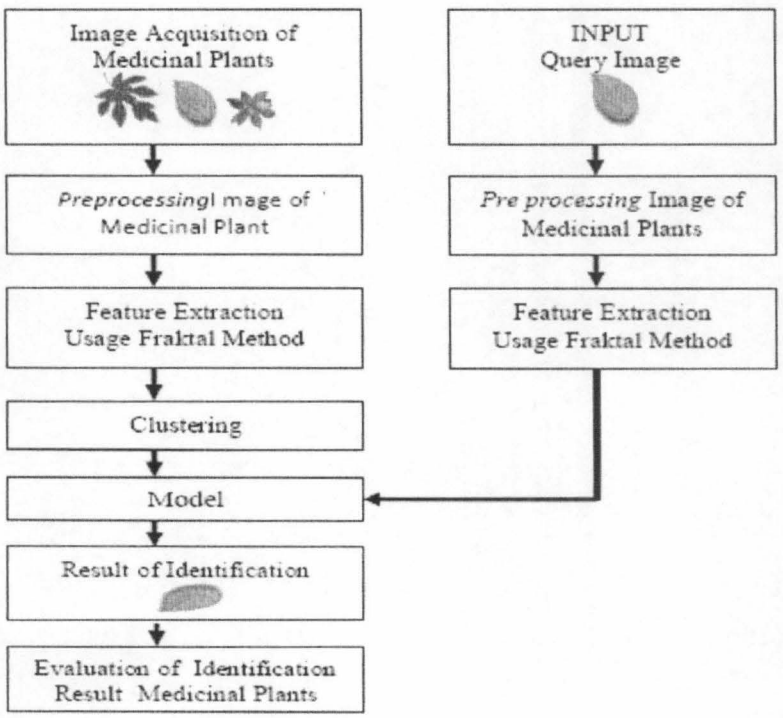

Figure 1: Stages of the research.

2.1 Image Acquisition of Medicinal Plants

In this stage, medicinal plant image is acquisitioned by using a sensor array of digital camera. Data used in this research is a collection of medicinal leaf plants at Biofarmaka IPB plantation and a glasshouse of Ex-Situ conservation of Indonesian Tropical Forest, IPB's Department of Forestry. There are 600 data used in this research, included 20 species of medicinal plants and each of them consists of 30 samples. The data is divided

into practice data and test data which each of them 67% and 33% (20 practice data and 10 test data).

2.2 PreprocessingImage of Medicinal Plant

Preprocessing conducted in this research is to customize the image measurement into 16 x16 pixel and change the image shape into grayscale 8 bit format. (2^8 = 256 ash degree).

2.3 Feature Extraction of Medicinal Plant using Fractal Method

There are two fractal method approaches which are used to extract feature, they are fractal dimension and fractal code.

Fractal Dimension

Fractal dimension of medicinal leaf plant image is counted by using box counting method which is as the same as, Ref.[7].

$$D(s) = \frac{\log(N(s))}{\log(s)} \quad (1)$$

with :

N = a number of measurement box r which filled with an object pixel

D = fractal dimension object

r = ratio.

These are the box counting levels :

1. Dividing medicinal leaf plant image for r shaped boxes.
2. Counting a number of boxes *N (r)* which has object space of the image
3. Counting log value *(l/r)* and *log (N).*
4. Making a straight line by using value *D(s).*
5. Counting the slope from the straight line which is a fractal dimension of medicinal plant image.

Fractal Code

Fractal code is based on main characteristic of the fractal, which has slope of itself, Ref.[9]. These are some stages of fractal coding such as :

1. Showing pixel intensity value of the original image.
2. Setting domain block by dividing the original image into sub-image 8x8 pixel and 4x4 pixel. The averages of each four pixels from the sub-images are counted into 4x4 pixel and 2x2 pixel.
3. Setting the range block by dividing the original image by using Quadtree partition. The partition will divide the image into four parts as recursively become 2x2 pixels.
4. Counting the contrast scale factor (s) or the brightness factor (g) and root mean square (RMS) with the similarity of 2, 3 and 4 , Ref.[10].

$$S = \frac{n^2\left(\sum_{i=1}^{n} d_i r_i\right) - \left(\sum_{i=1}^{n} d_i\right)\left(\sum_{i=1}^{n} r_i\right)}{n^2 \sum_{i=1}^{n} d_i{}^2 - \left(\sum_{i=1}^{n} d_i\right)^2} \quad (2)$$

$$g = \frac{\sum_{i=1}^{n} r_i - s \sum_{i=1}^{n} d_i}{n^2} \quad (3)$$

$$RMS = \frac{\sum_{i=1}^{n} r_i^2 + s\left(s\sum_{i=1}^{n} d_i^2 - 2\left(\sum_{i=1}^{n} d_i r_i\right) + 2g\sum_{i=1}^{n} d_i\right) + g\left(gn^2 - 2\sum_{i=1}^{n} r_i\right)}{n^2} \quad (4)$$

With:

s = contrast scale
g = brightness level
n = amount of pixel intensity of the block which being examined
r_i = range block element if range block is $R = \{r_1, r_2, .., r_n\}$
d_i = domain block element if domain block is $D = \{d_1, d_2, .., d_n\}$
RMS = root means square

2.4 Clustering Medicinal Plants with Fuzzy C-Means

The research carry out two experiment plans: clustering FCM based on fractal dimension value and fractal code value. Clustering has been done to 400 practice data. These are the following stages :

1. Input data matrix for mat n x m (n= amount of sample data, m = attribute data are fractal dimension value or fractal code
2. Setting a parameter which are need such as, Cluster amount *(c)* = 20, Degree *(w)* = 2, Maximum iteration (maxiter) = 100, Stopping criteria *(e)* = 10^{-5}, Former objective function *(P_0)* = 1, Former Iteration = 1.
3. Forming former partition matrix U (cluster member degree) randomly with 5 equations, Ref. [4].

$$U = \begin{bmatrix} \mu_{11(x_1)} & \mu_{12(x_2)} \cdots & \mu_{1n(x_n)} \\ \mu_{21(x_1)} & \mu_{22(x_2)} \cdots & \mu_{2n(x_n)} \\ \vdots & & \\ \mu_{c1(x_1)} & \mu_{c2(x_2)} \cdots & \mu_{cn(x_n)} \end{bmatrix} \quad (5)$$

With:

U = former partition matrix
$\mu_{11(x_1)}$ = data member degree to-x and cluster to $-c$

4. Counting cluster center with 6 equation, Ref. [4].

$$V_{ij} = \frac{\sum_{k=1}^{n} (\mu_{ik})^w . x_{kj}}{\sum_{k=1}^{n} (\mu_{ik})^w} \quad (6)$$

With:

V_{ij} = cluster center
μ_{ik} = nol member degree to-k and cluster to-i
w = quality ranking degree

x = input data to-k

5. Counting cluster center with 6 equation, Ref. [4].

$$P_t = \sum_{j=1}^{m}\sum_{k=1}^{n}\left(\left[\sum_{j=1}^{m}\left(x_{ij} - v_{kj}\right)^2\right](\mu_{ik})^w\right) \quad (7)$$

With:
P_t = objective function of iteration to-t
x_{kj} = sample data to-k, attribute to-j
v_{ij} = cluster center to-k for attribute to-j
μ_{ik} = nol member degree to-k in cluster to-i

6. Improving member degree to find the length between cluster center and data with 8 and 9 equation, Ref.[4]

$$\mu_{ik} = \left[\sum_{j=1}^{m}\left(\frac{d_{ik}}{d_{jk}}\right)^{\frac{2}{(w-1)}}\right]^{-1} \quad (8)$$

$$d_{ik} = \left[\sum_{j=1}^{m}\left(x_{kj} - v_{ij}\right)^2\right]^{1/2} \quad (9)$$

with:
x_{kj} = sample data to-k, attribute to-j
v_{ij} = cluster center to-k for attribute to-j
w = quality rank degree

Examine stopping condition if *(| Pt- Pt-1 | <ε)* or *(t> maxiter)* so that clustering process must be stopped, if not the process will be back to level 4.

3 DISCUSION AND RESULT

3.1 Feature Extraction Result with Fractal Dimension

Feature extraction with fractal dimension shows 5 fractal dimension values. The first value is formed by global image extraction.The four other values are formed by local region extraction. Fractal dimension value forms in fraction around one and two as it is shown in Pig.(2).

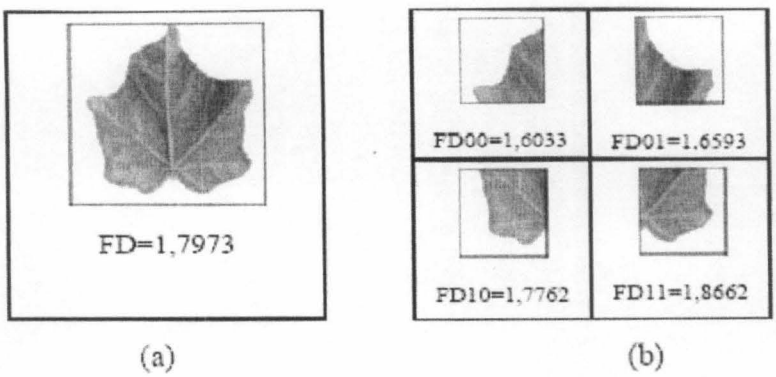

Figure 2: Fractal dimension of all Jarak Pagar leaf plants (a) and local region (b).

3.2 Feature Extraction Result with Fractal Code

Feature Extraction Result with fractal code is taken from block domain pairs and block range which has the smallest value of RMS. Contrast scale value *(s)*, brightness factor *(g)*, average block range (Avgrange) and average block domain (Avgdomain) of those pairs which are fractal code. For example : feature extraction result with fractal code is shown in Table 1.

Table 1: Fractal Code value of Jarak Pagar leaf.

	Contrast scale	Brightness factor	average block range	average block domain
Jarak Pagar leaf	1,07	224	190,3	221,8

3.3 Fractal Dimension Characteristic Vector

One of each leaf image can be gained vector characteristic which has 5 fractal dimension values (FD). Each class makes distinctly fractal dimension vector pattern and each class has its own characteristic.

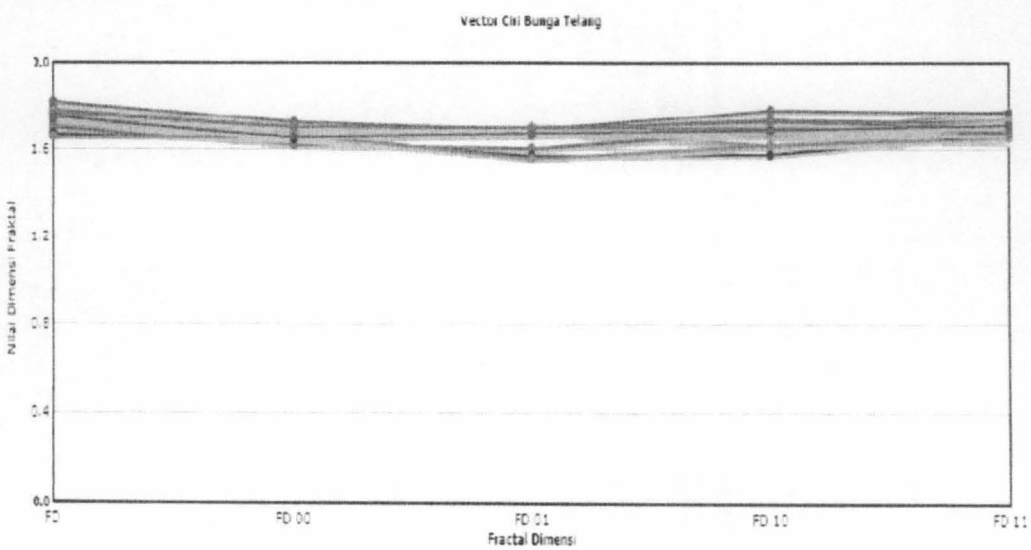

Figure 3: The class of fractal dimension vector pattern of Bunga Telang.

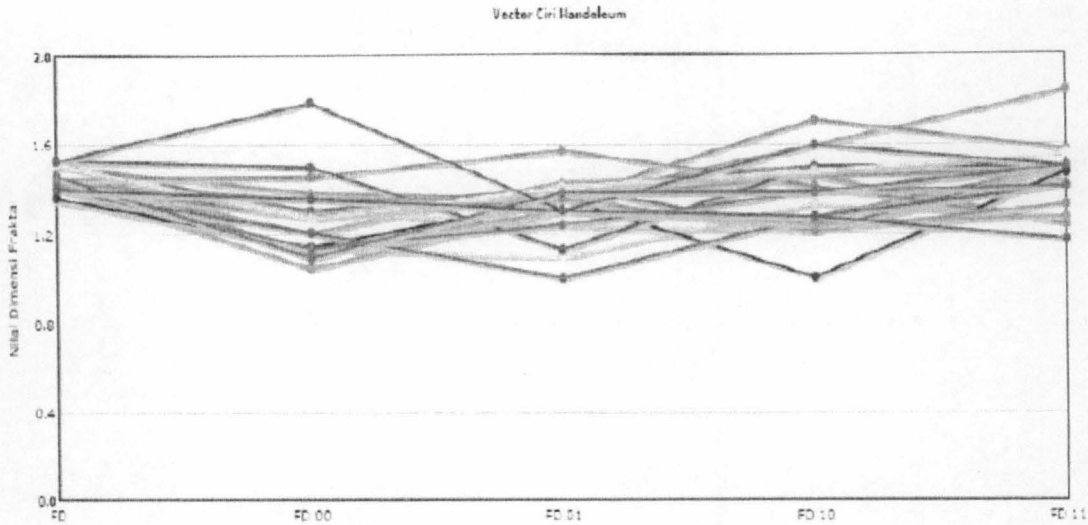

Figure 4: The class of fractal dimension vector pattern of Handeleum.

Pig.(3) shows the class of Bunga Telang leaf which has a nearly similarity of fractal dimension vector pattern. Because this leaf shaped pattern in that class is similar. Otherwise Pig.(4) shows the class of Handeleum leaf which does not have similarity of fractal dimension vector pattern. Because the leaf shaped pattern of each class is different.

3.4 Fractal Code Characteristic Vector

One of leaf image can be gained characteristic vector consists of 4 fractal code value such as : contrast scale *(s)*, brightness factor *(g)*, average block range (Avgrange) and average block domain (Avgdomain). Each class forms fractal code vector pattern which distinctly characterize the classes.

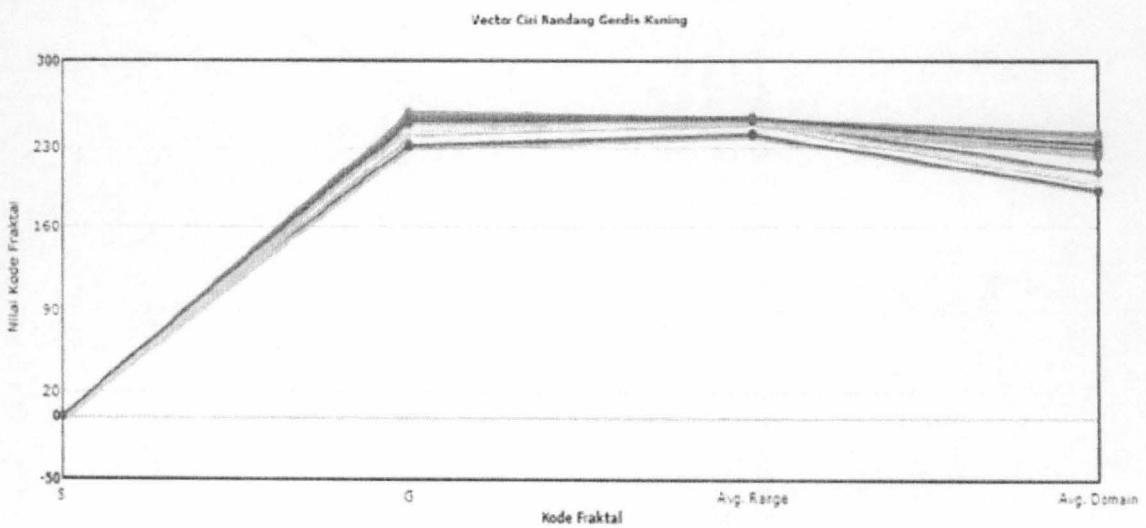

Figure 5: The class of fractal code vector pattern of Nandang Gendis Kuning.

Pig.(5) shows the class of Nandang Gendis Kuning which has nearly similarity of fractal code vector pattern. Because the leaf texture pattern of this class is similar.While Pig.(6) shows the class of Kemangi, which does not have fractal code vector pattern, but it has a different fractal code vector pattern. Because the leaf texture pattern of it is different.

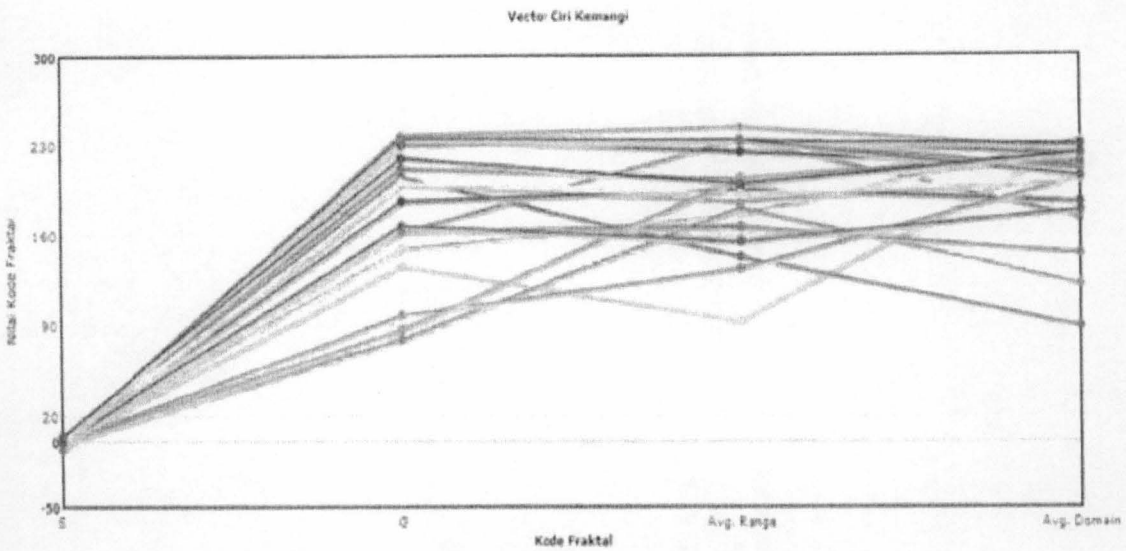

Figure 6: The class of fractal code vector pattern of Kemangi..

3.5 Evaluation System

Evaluation system is conducted to clustering model and the image identification result of medicinal leaf plant.

Clustering FCM Result Based on Fractal Dimension

The result image of clustering medicinal leaf plant with FCM based on fractal dimension is accurately gained by the level of 85,04 %. There are 3 classes which has clustering result above 80 % such as class 7 (Bunga Telang) is clusterred by 100 %, class 20 (Pegagan) is clustered by 90 % and class 17 (Tabat Barito) is clustered by 85%. Mean while two classes are below 20 % such as class 5 (Lilin) and class 14 (Handeleum) each of them is clustered by 10 %. The class that is generally clustered above 80 % has a shaped pattern and the characteristic of its vector is nearly similar as it shown on Pig.(3) for Bunga Telang class. However, the class that is clustered below 10 % has a shaped pattern and its characteristic vector pattern is different as it shown at Pig.(4) for Handeleum class.

Clustering Result with FCM Based on Fractal Code

The result of clustering image of medicinal leaf plant by FCM based on Fractal code is got at the accusation 79,94 %. There is a class which has a clustering result of 80 % such as class 16 (Nandang Gendis). Mean while the two classes are below 20 % such as class 13 (Kemangi) and class 18 (Gadung Cina). The class which is clusterred by 80 % is generally has a texture pattern and a characteristic vector pattern which is similar and shown on Pig.(5) for Nandang Gendis Kuning. However, the class which is clustered

below 10 % has a texture pattern and characteristic vector pattern which does not have similarity as it is shown on Pig.(6) for Kemangi class.

Identification Result with FCM Based on Fractal Dimension

After having identification of 200 testing data image of leaf medicinal plant, it is accurately gained those data for each class as it is shown at Pig.(7).

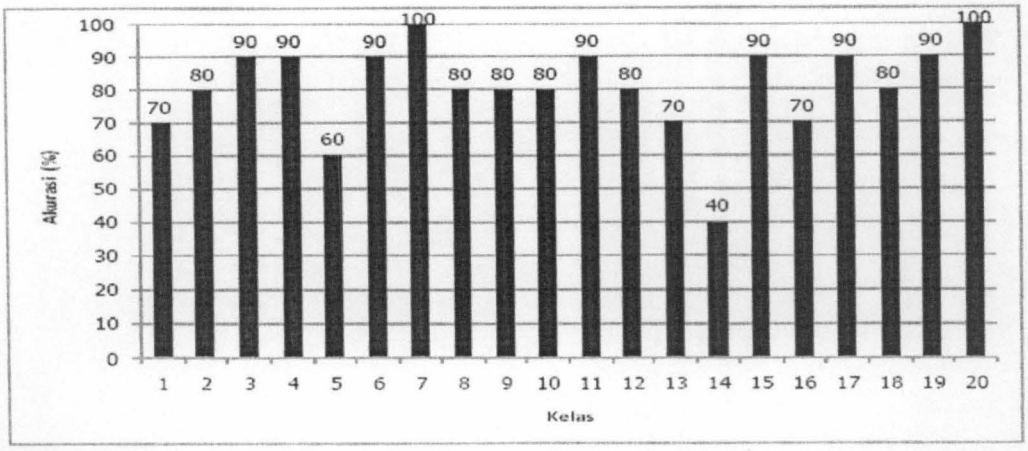

Figure 7: Graphic is accurately identified every image class of each medicinal plant based on fractal dimension.

On Pig.(7), class 7 (Bunga Telang) and class 20 (Pegagan) have an accuracy of 100 %. Whereas class 14 (Handeleum) has the lowest accuracy of 40 %. These accuracy levels are created by fractal dimension vector pattern of each class. Class 7 (Bunga Telang) and 20 (Pegagan) have almost a similar fractal dimension vector pattern. The fractal dimension vector pattern similarity is formed by those classes which have the same leaf shaped pattern and they are easily identified as it's shown on Pig.(8) and Pig.(9). But class 14 tends to have different leaf shaped pattern as it's shown on Pig.(10). Until the fractal dimension vector pattern is not similarly formed. The difference of it causes the difficulty in identifying the class.

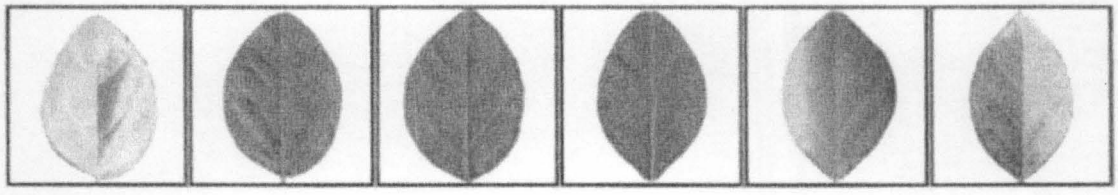

Figure 8: The leaf shaped pattern of Bunga Telang class.

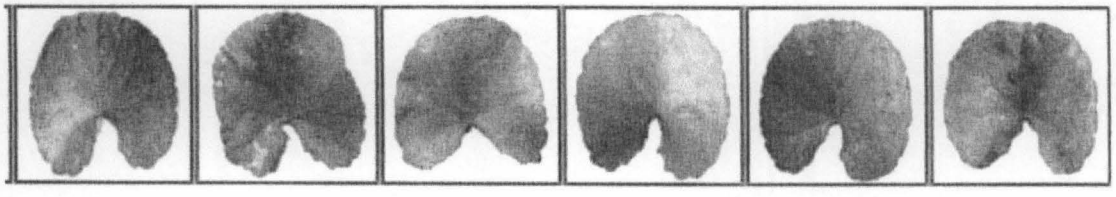

Figure 9: The leaf shaped pattern of Pegagan class.

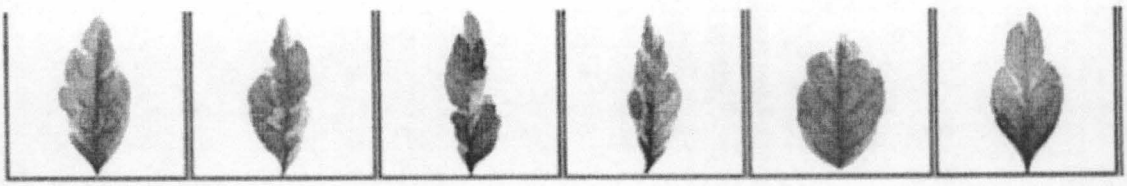

Figure 10: The leaf shaped pattern of Handeuleum class.

Identification Result of FCM Based on Fractal Code

After identifying 200 data of testing leaf image medicinal plant, it is obtained an accuracy of each class as it's shown on Pig. (11).

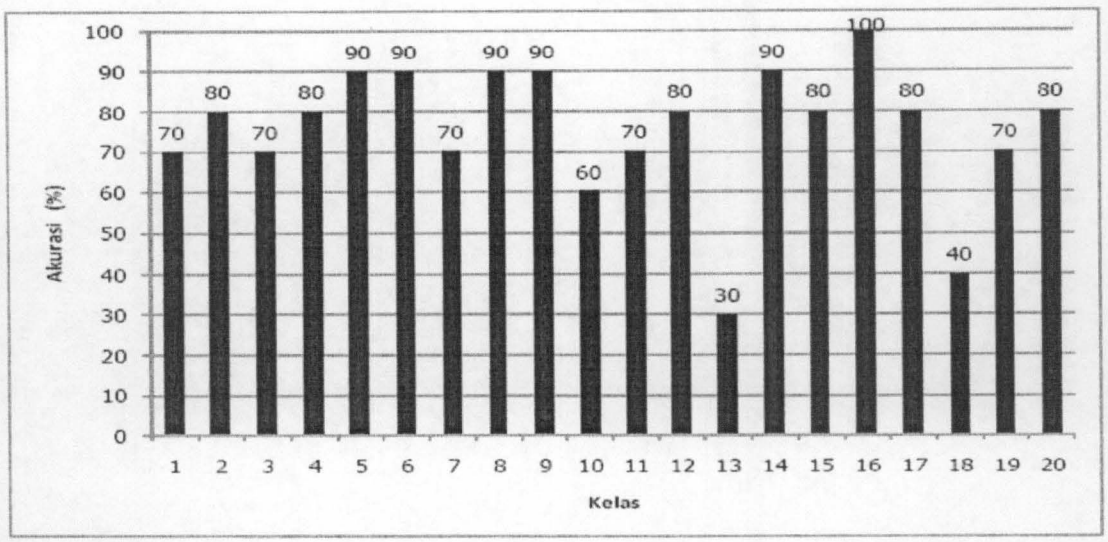

Figure 11: Bina Darma Crest. Graphic can accurately identify each image class of medicinal plant based on fractal code.

On Pig.(11), class 16 (Nandang Gendis Kuning) has the highest accuracy of 100 %. Whereas class 13 (Kemangi) has the lowest accuracy of 30 %. Class 16 (Nandang Gendis Kuning) has nearly the same fractal code vector pattern. The similarity is formed because the class has texture pattern and lightning which are easily identified as it's shown on Pig.(12). Butclass 13 (Kemangi) does not have the same fractal code vector pattern. The difference of it is formed because the class has a different texture patterns and lightning, so it is difficult to identified as it's shown on Pig.(13).

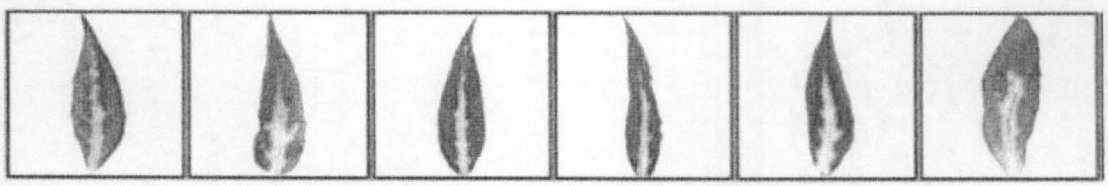

Figure 13: The leaf shaped pattern of Nandang Gendis Kuning class.

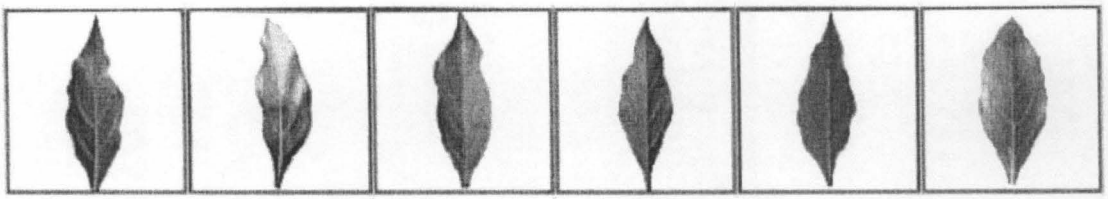

Figure 13: The leaf shaped pattern of Kemangi class.

4 CONCLUSIONS

Based on the research above, it is concluded that :

1. Fractal method and clustering FCM can be implemented to develop identification system of medicinal plant.
2. Extraction result of fractal method create different vector pattern at each class which does or does not influence it easily at the time of identification.
3. The extraction result of fractal dimension is more influenced by leaf image shaped pattern of medicinal pattern, but its result of fractal dimension is more influenced by texture pattern of medicinal leaf image.
4. The classification result of medicinal leaf image use FCM based on fractal dimension reach an accuracy of 85,04% and based on fractal code get an accuracy of 79,94%.

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