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IC3INA

2013 International Conference on Computer, Control, Informatics, and Its Application

LIPI KOMINFO IEEE INDONESIA SECTION

ISBN : 978-1-4799-1076-2

Jakarta, Indonesia, 19-20 November 2013

- Computer Tracks
- Control Tracks
- Informatics Tracks
- Applications Tracks

2013 International Conference on Computer, Control, Informatics and Its Applications (IC3INA)

19-21 November 2013
Jakarta, Indonesia

IEEE Catalog Number	:	CFP13YAD-ART
ISBN	:	978-1-4799-1078-6

Editor	:	Rifki Sadikin, Agus Subekti
Publisher	:	IEEE
Secretariat	:	Research Center for Informatics, Indonesian Institute of Sciences Bandung, West Java, Indonesia

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2013 International Conference on Computer, Control, Informatics and Its Applications (IC3INA)

"Recent Challenges in Computer, Control and Informatics "

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Paddy Diseases Identification with Texture Analysis using Fractal Descriptors Based on Fourier Spectrum

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***Abstract*—The efforts to increasing the quantity and quality of rice production are obstructed by the paddy disease. This research attempted to identify the four major paddy diseases in Indonesia (leaf blast, brown spot, bacterial leaf blight, and tungro) using fractal descriptors to analyze the texture of the lesions. The lesion images were extracted manually. The descriptors of 'S' component of each lesion images then used in classification process using probabilistic neural networks. This techniques achieved at least 83.00% accuracy when identifying the diseases. This method has a potential to be used as one of the feature if it combined with other features, especially when two diseases with relatively same color involved.**

Keywords—paddy disease; fractal descriptors; texture analysis.

I. INTRODUCTION

The efforts to increase the quantity and quality of rice production to satisfy the increasing needs of rice in Indonesia experienced several obstacles, one of which is the attack of the diseases on paddy fields. Indonesian Directorate General of Food Crops [4] stated that during the period of October 2011 to March 2012, 80,096 hectares of paddy fields exposed to attach by three major paddy diseases in Indonesia: tungro, leaf blast, and leaf blight. To control these diseases and to minimize the impacts of the attacks, the diseases must be identified quickly. Unfortunately, experts who are able to identify the diseases are often unavailable in some region [13].

Computer vision is a potential solution to tackles this problem. One way to identify the diseases in plants is by observing the physical changes (diseases spots or lesions) caused by chemical changes in the sick plants [10]. The images of these spots can be processed and used to recognize the diseases quickly, easily, and inexpensively [13]. This method also nondestructive [2] and the results are consistent. This method involves the extraction the features of the said disease lesion.

The common paddy lesion features are the texture, the color, the position, or the size of spots or lesions [7]. Some research combined more than one of these features. For example, [1] used the texture, color, and shape to recognize blast, sheath blight, and brown spot, the three major rice diseases in Sri Lanka, with 70% accuracy. [15] used a color features (e.g. boundary color and spot color) to recognize blast, brown spot, and narrow brown spot diseases and achieved 87.5% accuracy.

[6] proposed a new technique to analyze the texture using fractal descriptors based on image Fourier spectrum. When tested to four different datasets (Brodatz, USPTex, OuTex, and plant leaves), this method is more accurate and faster than any other fractal descriptor estimation techniques.

This research attempted to identify the four major paddy diseases in Indonesia using fractal descriptors proposed by [6] and assess the performance of said method. The four diseases are leaf blast (*Pyricularia orizae*), brown spot (*Helminthosporium oryzae*), bacterial leaf blight (*Xanthomonas oryzae*), dan tungro (tungro bacilliform virus). Probabilistic Neural Networks (PNN) was chosen as the classifier because its good results in classifying plant diseases [14] and its fast process [11] which is necessary in mobile environment that will be used when the system is ready to implemented.

II. COMMON PADDY DISEASES IN INDONESIA

The Directorate General of Food Crops, Ministry of Agriculture of the Republic of Indonesia, routinely monitors some dangerous diseases on paddy crop. Table 1 presents the data on the size of the six major pests attacks on the rice fields. Three diseases that are on the table along with a brown spot disease were used in this study. The sample image of the infected leaves and lesions are presented in Fig 1.

TABLE I. THE MAJOR PADDY PESTS IN INDONESIA AND THEIR AREA OF ATTACK

No	Pest	Area of Attack (ha)
1	Rice Stem Borers	57,875
2	Brown Planthopper	11,351
3	Rats	54,300
4	Tungro	4,994
5	Leaf Blast	31,383
6	Bacterial leaf blight	43,719

Source: Directorate General of Food Crops, Indonesia [4]

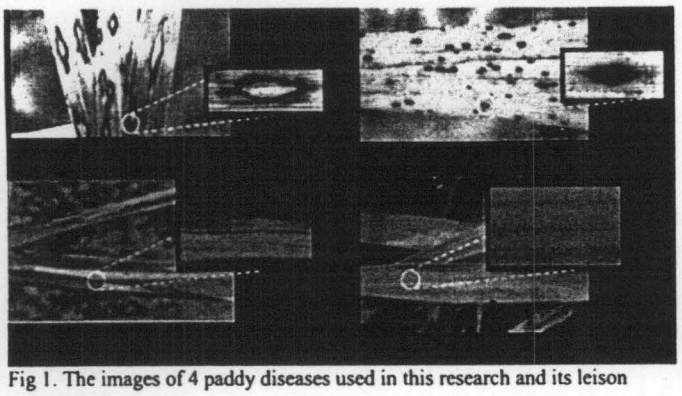

Fig 1. The images of 4 paddy diseases used in this research and its leison

Leaf Blast (*Pyricularia grisae*)

Leaf blast (LB) caused by *Pyricularia grisae*, a fungal pathogen. A blackish, rhombus-shaped, brown spot with a white colored central patches will appears at the leaves of the sick plan. Leaf blast is difficult to control because it's ability to forms pathogen strains quickly [12].

Brown Spot (*Helminthosporium oryzae*)

Brown spot (BS) caused by the fungus *Helminthosporium oryzae*. This disease can cause death in young rice plants and reduces grain quality. Leaves of the rice plants affected by this disease will have an oval shaped or round shaped brown colored patches about the size of sesame seeds [12].

Bacterial Leaf Blight (*Xanthomonas campestris*)

Bacterial leaf blight (BLB) is a disease caused by the bacterium *Xanthomonas campestris*. This disease is widespread and lowering the yield to 36%. HBD disease produces two characteristic symptoms: the crackle and blight. Crackle is a symptom that occurs in old plants <30 days. Leaves becomes grayish, folded, and rolled. In severe circumstances, the entire leaf curl, wilt, and die. Symptoms begin with a speckling of gray (yellow) on the edge of the leaf. During its development, the symptoms will be expanded, forming blight, and finally dried leaves [12].

Tungro (Tungro Bacilliform Virus)

Tungro (TG) is one of the important diseases in rice. It is very destructive. It caused by tungro bacilliform virus (RTBV). Depends on the phase of the infected plants, tungro can cause 5-70% yield loss. The younger the plants is, he loss caused by tungro will be greater. Tungro attacks prominent symptom is discoloration of leaves and stunted plant growth. Diseased plant leaf color varies from slightly yellow to orange. The typical symptoms are determined by the level of resistance of varieties, environmental conditions, and the growth stage when the plants infected [12].

From above description, we already seen the general characteristic of each disease. In practice, diagnosing a disease visually involves more than one lesion characteristic i.e. the location of the symptoms, the spots or lesions shape, the size of the spots or lesions, and the color of the spots or lesions [18]. In this research, we only focused on descripting the color texture of the disease lesions. This, however, does not mean that color texture is enough to differentiate the diseases. Some diseases may have a similar color and can only be differentiate by using the shape. The most obvious example of this kind of disease are brown spot (*Helminthosporium oryzae*) and narrow brown spot (*Cercospora janseana*).

III. Fractal Descriptors

Mandelbrot [8] stated that many objects in nature has a fractal properties: self-similarity and complexity. The complexity of the value, which is usually expressed by the fractal dimension, can be taken from any objects that exist in nature and this value can be used to describes a natural object [9]. In fractal dimension, an object can have a fractional dimension, not only 1 like a line or 2 like a plane.

According to [9], the fractal dimension is not affected by the distortion due to projection and can provide information about the anisotropy and estimate the gradient of the surface texture of the object. There are several methods to estimate the fractal dimension, like Bouligand-Minowski, Brownian Motion, box-counting, multifractal spectrum, lacunarity measure, regularization dimension, and a dimension variation.

The fractal dimension, however, only consists of one number. In many case, identifying things by only one number is not enough. To overcome this limitation, the concept of fractal dimension then expanded into fractal descriptor, which contains a set of values derived from fractal dimension calculation process to become an image features. Bruno *et al.* [3] suggested that the fractal descriptors can be used to characterize the image of the main characteristics, such as texture, contour, and shape.

This research used fractal descriptor method developed by [6]. [6] proposed a method for applying texture analysis using fractal descriptors based on Fourier spectrum. A Fourier transformation applied to the image, and then the power spectrum of each frequency ring are computed. When presented in bilog form, the slope of this curve are the fractal dimension of the image.

One more process required to get the fractal descriptors from the image. In order to get richer descriptors of the image, [3] and [6] used a multiscale analysis to the whole curve. Based on empirical results, [6] opted to use scale-space analysis developed by Witkin [16] by using various scale of k, where k is the standard variation of the Gaussian kernel used in scale-space analysis. As showed in [6], these descriptors are able to differentiate textures in various database with better results than other fractal descriptors techniques.

IV. Probabilistic Neural Networks

Probabilistic neural networks (PNN) is a nonparametric classifiers that introduced by [11]. Some advantages of PNN is the class boundaries that can be made complex depending on the value of smoothing parameter, insensitive to outliers, and a sparse sample are enough to get a good performance. PNN work faster than the backpropagation neural network,

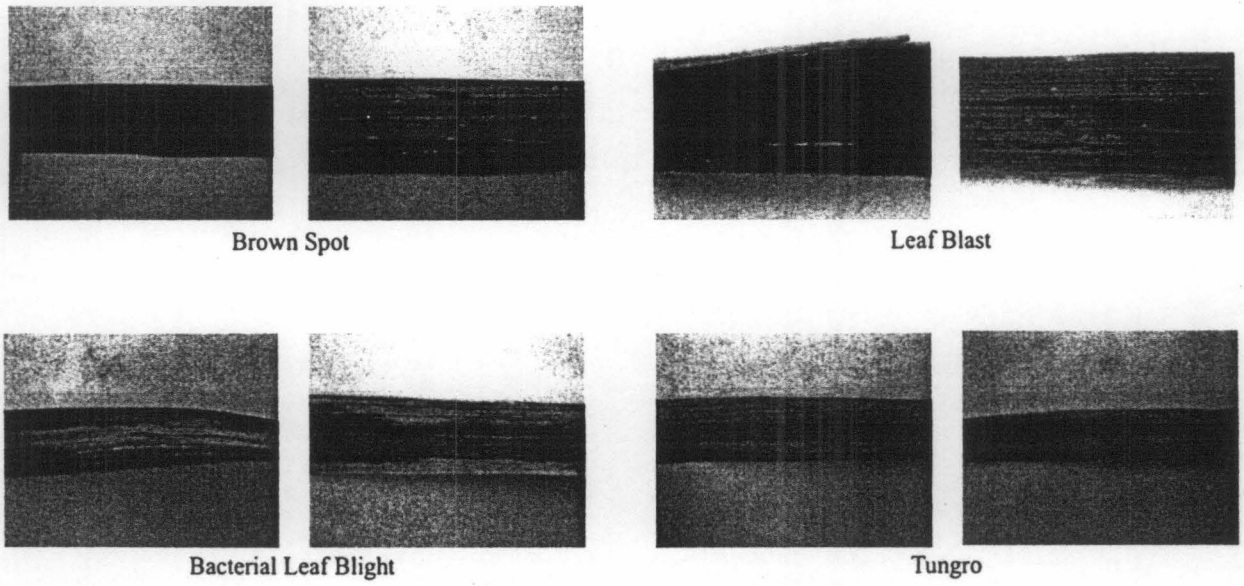

Fig 2. Some of the images of sick leaves used in the research

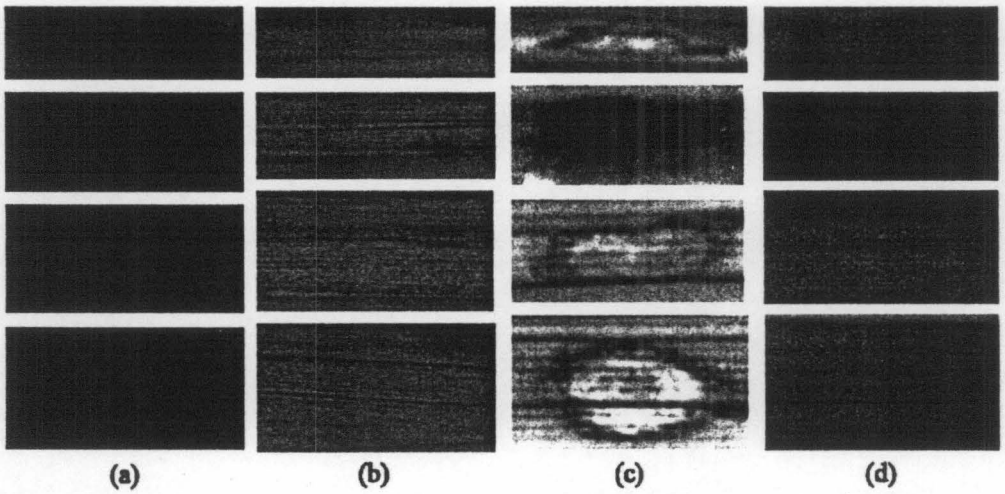

Fig 3. The extracted lesion images. (a) brown spot, (b) bacterial leaf blight, (c) leaf blast, and (d) tungro

even up to 200,000 times faster [11] as it only needs one iteration of training process [5]. [14] used PNN to classify plant diseases with accuracy over 95%.

V. Research Method

First, the images of leaves for each disease were collected. Then, the lesions were cropped manually. Each of these lesion images then converted to HSV color space. We extracted the saturation components from the images. Because of the differences on lighting condition, we done histogram equalization [17] first to the images. Then, we sharpened the images using Laplacian filters.

The fractal descriptors then extracted from each lesion images using method proposed by [6]. These values then used in diseases classification process using PNN. The training and testing data were splitted using 5-fold cross validation. The results were presented using confusion matrix for further analysis.

VI. Results and Discussion

In this research, 40 JPEG images of sick paddy leaves were obtained with each disease has 10 images. Some of these images were taken in paddy field in Laladon and Cipanas, West Java, Indonesia. Unfortunately, there are only few samples available for leaf blast diseases. To compensate this condition, we took some other images from the Internet that have different size and quality than our images.

Fig. 2 shows the samples leaves images used in this research. The lesions then extracted manually. We obtained 27 brown spot, 80, bacterial leaf blight, 100 leaf blast, and 98 tungro lesion (Fig. 3). The height and width of these images are around 100-200 pixels.

Fig. 4. depicts the averaged values of the descriptors of each class. The descriptors then used in classification process using PNN and 5-fold cross validation. The classification results are presented in confusion matrix (Table 2). The overall accuracy are 91.80% with classes accuracy as follows:

Brown spots accuracy : 92.31%
Bacterial leaf blight accuracy : 96.25%
Leaf blast accuracy : 83.00%
Tungro accuracy : 97.96%

TABLE II. CONFUSION MATRIX OF THE CLASSIFICATION RESULT

		Prediction			
		BS	BLB	*LB*	TG
Actual	BS	24	1	1	1
	BLB	0	77	2	1
	LB	0	5	83	12
	TG	0	1	1	96

Notes:
BS : Brown spot BLB : Bacterial leaf blight
LB : Leaf blast TG : Tungro

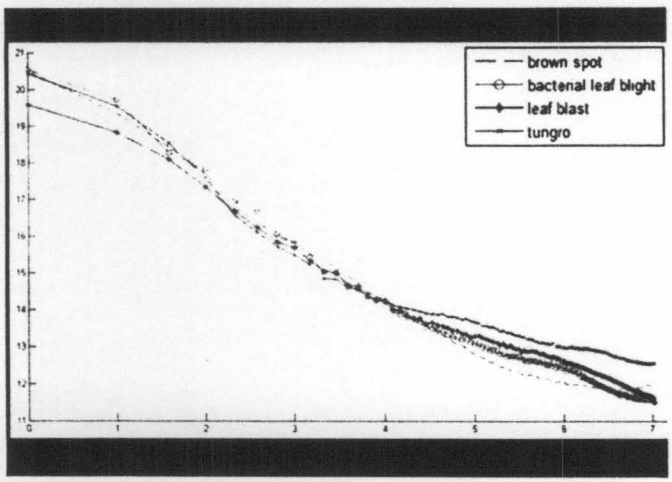

Fig 4. The average value of fractal descriptors of each disease class.

Three of four classes already has more than 90% accuracy. Leaf blast accuracy, however, only stand at 83.00%. The reasons why the leaf blast often misclassified is probably the variation of their lesion color (Fig. 5). Some lesions has a color that lighter, similar to bacterial leaf blight, while others has a darker color, similar to tungro. As the results of these 5 instances of leaf blast are misclassified as bacterial leaf blight and 12 instances are misclassified as tungro, making it's accuracy the poorest at 83.00%.

In this case, another feature are needed to differentiate the leaf blast lesion from other diseases lesions. In this case, we have to consider another feature of the lesions the shape. A leaf blast lesions are elliptical or spindle shaped [19], different than bacterial leaf blight and tungro that has elongated shape.

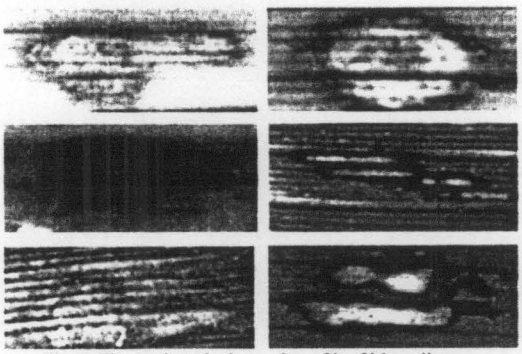

Fig 5. The various lesion color of leaf blast disease.

VII. CONCLUSION

We have already used the fractal descriptors method developed Bay [6] to identify 4 common paddy diseases in Indonesia with at least 83.00% accuracy. This method has a potential to be used as one of the feature if it combined with other features, especially when two diseases with relatively same color involved.

REFERENCES

[1] Anthonys G, Wickramarachchi N. 2009. An image recognition system for crop disease identification of paddy fields in Sri Lanka. In: *2009 International Conference on Industrial and Information Systems (ICIIS)*; 2009 Dec 28-31; Sri Langka. pp 403-407. doi. 10.1109/ICIINFS.2009.5429828.

[2] Brosnan T, Sun D. 2004. Improving quality inspection of food products by computer vision-a review. *Journal of Food Engineering*. 61:3-16.

[3] Bruno OM, Plotze RD, Falvo M, de Castro M. 2008. Fractal dimension applied to plant identification. *Information Sciences*. 178(12):2722-2733.

[4] Directorate General of Food Crops, Ministry of Agriculture, Republic of Indonesia. 2012. Evaluasi prakiraan serangan OPT utama tanaman padi, jagung, kedelan MT. 2011/2012 terhadap angka kejadian selama bulan Oktober 2011-Maret 2012. http://tanamanpangan.deptan.go.id/index.php/folder/detail/3/3/131 [2013 March 25].

[5] Duda RO, Hart PE, Stork DG. 2000. *Pattern Classification*. 2nd edition. New York(US): John Wiley & Sons.

[6] Florindo JB, Bruno OM. 2012. Fractal descriptors based on Fourier spectrum applied to texture analysis. *Physica A*. 391:4909-4922.

[7] [IRRI] International Rice Research Institute. 2009. *Crop Health: Diagnostic of Common Diseases of Rice*. http://www.knowledge bank.irri .org/ipm/terms-and-definitions.html [20 August 2013].

[8] Mandelbrot BB. 1968. *The Fractal Geometry of Nature*. New York(US): Freeman.

[9] Pentland AP. 1984. Fractal-based description of natural scene. *IEEE Trans Patt Recog and Mach Intell*. 6(6):661-674.

[10] Qin Z, Zhang M. 2005. Detection of rice sheat blight for in-season disease management using multispectral remote sensing. *International Journal of Applied Earth Observation and Geoinformation* 7:115-128.

[11] Specht DF. 1990. Probabilistic neural networks. Neural Networks. 3:109-118.

[12] Syam M, Suparyono, Hermanto, Diah WS. 2011. *Masalah Lapang Hama, Penyakit, dan Hara pada Padi*. Bogor: Pusat Penelitian dan Pengembangan Tanaman Pangan.

[13] Vibhute A, Bodhe SK. 2012. Applications of image processing in agriculture: a survey. *International Journal of Computer Applications*. 52(2):34-40.

[14] Wang H, Li G, Ma Z, Li X. 2012. Application of neural networks to image recognition of plant diseases. In: *2012 International Conference on Systems and Informatics (ICSAI)*; Yantai, Cina; 2012 May 19-20. pp 2159-2164. doi.10.1109/ICSAI.2012.6223479.

[15] Kurniawati NN, Abdullah SNHS, Abdullah S, Abdullah S. 2009. Investigation on image processing techniques for diagnosing paddy diseases. In: International Conference of Soft Computing and Pattern Recognition; 2009 Dec 4-7, Malacca. pp 272-277.

[16] Witkin AP. 1984. Scale-space filtering: a new approach to multi-scale description. In *Acoustics, Speech, and Signal Processing, IEEE International Conference on ICASSP'84*. (Vol. 9, pp. 150-153). IEEE.

[17] Pizer SM, Amburn EP, Austin JD, Cromartie R, Geselowitz A, Greer T, Romeny BH, Zimmerman JB, Zuiderveld K. 1987. Adaptive histogram equalization and its variation. *Computer Vision, Graphics, and Image Processing*. Vol. 39. pp 355-368.

[18] International Rice Research Institute. *Rice Doctor*. http://www.knowledgebank.irri.org/RiceDoctor [last access 23 Sep 2013].

[19] International Rice Research Institute. IRRI Knowledge Bank. http://www.knowledgebank.irri.org/ipm/fungal-diseases/rice-blast-pyricularia-grisea-cooke-sacc.html [last access 23 Sep 2013].