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TEXTURE FEATURE EXTRACTION OF PATHOGEN MICROSCOPIC IMAGE USING DISCRETE WAVELET TRANSFORM

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Abstract

This study used a case study of Jabon leaves, and the pathogen is one of the causes of disease that attack the leaves of jabon, one of the leaf spots and leaf blight. Discovery of leaf spot disease in different pathogens and leaf blight. The pathogen was obtained from the leaf spot of Curvularia sp. 1 and Pestalotia sp., while the pathogen came from Curvularia sp. 2 and Botrytis sp. Identify the pathogen as soon as possible to minimize its effects. Improper handling can lead to increased virulence and resistance to the pathogen. Improper handling also can cause a disease outbreak (disease epidemic) in a region. This study is the first step in identifying the pathogens responsible for Jabon leaf disease. In this study, the Application of Koch's Postulates method to achieve the purification of pathogens and retrieve the microscopic pathogen image as the data acquisition stage. Furthermore, use of the segmentation stage to separate the object pathogen from the background, and one of the methods used is Otsu Thresholding. The extraction process of pathogen microscopic image using Discrete Wavelet Transform (DWT), DWT extraction results can be obtained using energy and entropy information.

Keywords: DWT; pathogen; extraction feature

Abstrak

Penelitian ini menggunakan studi kasus daun jabon, Patogen merupakan salah satu penyebab penyakit yang menyerang daun jabon, salah satunya bercak daun dan hawar daun. Penemuan penyakit bercak daun pada patogen yang berbeda begitu pula pada penyakit hawar daun. Patogen diperoleh dari bercak daun Culvularia sp. 1 dan Pestalotia sp., sedangkan patogen yang berasal dari hawar daun Culvularia sp. 2 dan Botrytis sp. Patogen harus diidentifikasi sesegera mungkin untuk meminimalkan efek yang ditimbulkannya. Penanganan yang tidak tepat dapat menyebabkan peningkatan virulensi dan resistensi patogen. Penanganan yang tidak tepat juga berpotensi menimbulkan wabah penyakit (wabah penyakit) di suatu wilayah. Tujuan dari penelitian ini adalah tahap awal untuk mengidentifikasi patogen yang ada pada penyakit daun jabon. Pada penelitian ini, metode Postulat Koch diterapkan untuk mendapatkan purifikasi patogen dan kemudian mengambil citra patogen mikroskopis sebagai tahap akuisisi data. Selanjutnya adalah tahap segmentasi yang digunakan untuk memisahkan objek patogen dengan backgroundnya, sedangkan salah satu metode yang digunakan adalah Otsu Thresholding. Proses ekstraksi citra mikroskopis patogen menggunakan Discrete Wavelet Transform (DWT), hasil ekstraksi DWT dapat diperoleh dengan menggunakan informasi energi dan entropi.

Kata kunci: DWT; pathogen; fitur ekstraksi

INTRODUCTION

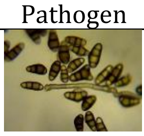
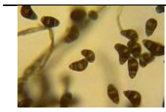
Jabon Merah (Neolamarckia Macrophylla (Wall.) as a timber plant has the potential to meet the national timber demand (Larekeng, Qalbi, Rachmat, Iswanto, & Restu, 2022). Several diseases attack the jabon, including root, stem, and leaf disease. Most jabon disease is caused by fungi (Warisno & Dahana K, 2011). The fungus that attacks the leaves of jabon causes spots, blight, and dead buds. The fungus has several properties, one of which is that it causes plant diseases. These fungi are categorized as pathogens (Agrios G, 2005). The spread of pathogens is very broad (Hadi S, 2001). Jabon seeds are among the most vulnerable to pathogen attacks (Aisah, 2014). It is necessary to handle this as early as possible, so the growth of jabon is not hampered.

According to Herliyana, the fungi have an abundance of type, only known about 98.998 species, and which are a pathogen number of about 8000 species (Herliyana, 2013). Herliyana et al. obtained several types of pathogens from red jabon leaves, a pathogen found in spotting diseases, namely Pestalotia sp. and Rhizoctonia sp., in blight diseases, namely Lasiodiplodia Theobromae, Fusarium sp., Colletotrichum sp., Marsonia sp., Gleosporium sp. 1 and Gleosporium sp. 2 (Herliyana, Sakbani, Herdiyeni, & Munif, 2020). Disease control should be adjusted to consider the type of pathogen. One way to know the pathogen is by conducting the pathogen identification process, which is done by using the aid of microscope magnification (Streets, 1972).

Sudarsan et al. researched Microscope Image Processing (MIP) and developed a CWT-based computer vision algorithm to characterize soil particle size from digital images captured with a microscope. The wavelet technique's efficacy in detecting an image's particle size is promising, and the portability of the image acquisition device produces excellent proximate soil sensors (Sudarsan, Ji, Adamchuk, & Biswas, 2018). Santosh et al. also research MIP. The discrete wavelet transform (DWT) is comparable to a microscope because distinct signal components can be distinguished by simply adjusting the focus (Santosh & Barpanda, 2020).

This study, using primary data, collected a 2043 microscopic pathogen image of jabon leaf disease that is spotting and blight, then extracted using the Discrete Wavelet Transform (DWT) method.

Table 1. Morphological and texture features of the pathogen

Pathogen	Characteristic
	Culvularia sp 1. is a dark-colored Conidia with clear tip cells. 3-to-5-cell Conidia, characterized by curving and enlarged central cells. Culvularia sp one is derived from jabon leaf spot disease.
	Culvularia sp.2. The difference between Culvularia sp. one and Culvularia sp.2. In Culvularia sp.1, each cell constraint has a light black color, while Culvularia sp.2 has two cell boundaries in the center of wider black Conidia. The origin of the disease is the pathogen of jabon leaf blight.
	Pestalotia sp. has dark Conidia with some clear-colored cells. The tip of the cell is tapered, with two or more tails. Pestalotia sp. can cause leaf spot disease jabon.
	Botrytis sp. has long-shaped Mycelium features, cylindrical, clear color, and irregular branches. Conidia surround Conidiaphore. Color Conidia clear or grey, cell 1. Botrytis sp. is one of the causes of leaf blight Jabon

The number of pathogens is very high; therefore, to determine the type of pathogen, a researcher must manually examine the manual to determine the pathogen's characteristics and identify similar characteristics. Each image of a pathogen using computer vision can be identified because pathogens have different characteristics s, as shown in Table 1.

Bangun et al. conducted another study to identify the microscopic pathogen image of the white jabon leaf. That is pathogen Colletotrichum sp., Curvularia sp., and Fusarium sp. using morphological characteristic extraction methods and producing the best features of compactness and roundness for classification (Bangun, Herdiyeni, & Herliyana, 2016).

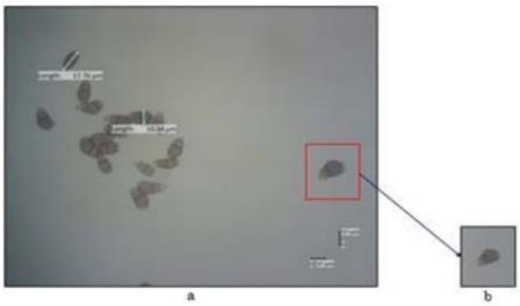


Figure 1. Cutting only one pathogen

In the study above by Bangun et al., the image's distinguishing features were obtained by cutting only the pathogenic image, as shown in Figure 1. However, the entire image cannot be extracted. In this study, we attempted to extract colony image pathogens from a full image without cutting them individually.

Other challenges of the microscopic image are complex images, objects that can be stacked, blurred images in part because the objects are stacked, and many other objects that become noise.

RESEARCH METHODS

The method proposed in this research includes three stages: data acquisition, preprocessing, and feature extraction.

Data Acquisition

This process was done in the forest pathology laboratory of the silviculture department of the IPB forestry faculty. The sample of jabon leaf studied is a jabon leaf from "persemain permanent IPB." The acquisition phase of this pathogen microscopic image data uses the Postulat Koch method to obtain pure pathogens (Streets, 1972) and then photographed using the Optilab camera with 400x. Magnification and a maximum resolution of 5 megapixels for the image produced under 1 megabyte.

Figure 2. Stage of image capture and sick leaf selection

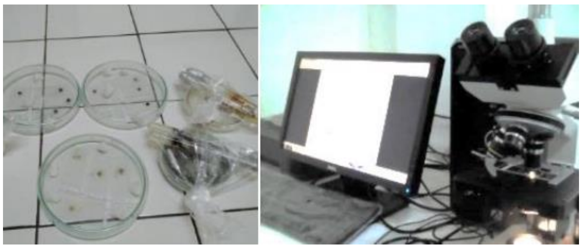


Figure 3. purification of pathogen isolation and pathogen image capture

Figures 2 and 3 depict the various stages of Postulate Koch's method for identifying foliar disease-causing pathogens.

Preprocessing

The preprocessing step is to select the image to be extracted, some images with good pathogen image quality are selected, and the next process is to crop the selected image of good quality to remove the overly dominant noise.

Figure 3. Cropping Culvularia sp. 1 to remove the dominant noise

During Postulate Koch's, dominant noise occurs due to shooting and several other factors. So as in Figure 4, noise that is too dominant must be removed because it will greatly affect the value of the feature extraction of pathogen image features.

The image is segmented to get the object of a microscopic pathogen image separated from its background, and the separator of the pathogen microscopic image with its background is one of them using the Otsu thresholding method, Otsu thresholding is the optimum method of global Thresholding (Rafael C. Gonzalez & Woods, 2008). This method maximizes the differences between the two regions using discriminant analysis (Otsu & N., 1996) (Naga Kiran D & Kanchana V, 2019). In this part, Otsu Thresholding will generate a mask to get the microscopic object of the pathogen with black/white background, as in Figure 5.

Figure 5. Segmentation stages, create a mask using Otsu Thresholding

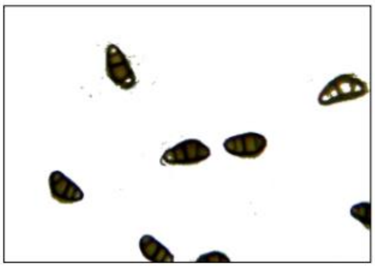


Figure 6. result of pathogen segmentation

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The method of Otsu Thresholding is a rapid method of computation. It very well separates microscopic objects of pathogens against the background with the condition that the intensity of the pixel of a pathogen microscope object with its background has a pixel intensity value that is not too close. Figure 6 depicts the results of Otsu segmentation, which produces a pathogen object image with greater prominence for the subsequent extraction procedure.

Feature Extraction DWT

DWT is used to extract image texture characteristics using the Scaling function and Wavelet function (Madhu & Kumar, 2022). An image can be extracted to produce four coefficients.

$$W_{\varphi}(j_0, m, n) = \frac{1}{\sqrt{MN}} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) * \varphi_{j0,m,n}(x,y) \quad \text{...(1)}$$

$$W_{\psi}^{i}(j, m, n) = \frac{1}{\sqrt{MN}} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) * {\psi^{i}}_{j,m,n}(x,y), \quad i = \{H, V, D\} \quad \text{...(2)}$$

Four coefficients from DWT extraction can be analyzed: LL, LH, HL, and HH. DWT can analyze the information of an object in the image with the method of multiresolution analysis (MRA), which was introduced by Stephane Mallat (Rafael C. Gonzalez & Woods, 2008). MRA is used to analyze the depth of information contained in an image. At this stage, the image is processed using DWT with levels 1 – 4 of decomposition (multiresolution).

Some extraction images using DWT can be seen from the different spectrums of each image, showing that each pathogen has different texture characteristics when extracted using DWT. The LL coefficient shows the approximation of the original image. As for the other results of the LL coefficient, it can reduce or eliminate small noises in the image so that the LL coefficient gives the value of a cleaner image that is close to the pure value of an image. The higher the DWT decomposition level of an image, the LL coefficient is reduced in size and approximates the image approximation.

The coefficients of LH, HL, and HH can each show the texture value of an image and the edge of an image based on horizontal, vertical, and diagonal orientation. LH, HL, and HH coefficients at DWT levels increasingly show an edge and image characteristic. As for DWT extraction can be used some family wavelet that is Daubechies, Symlet, and Coiflet. Wavelet family is different only on the value of high filter and low filter just in processing an image but can show different results in any retrieval of information contained in the image. Figures 7, 8, 9, and 10 display examples of the spectrum images of each pathogen studied. We can see that each studied pathogen has a unique spectrum.

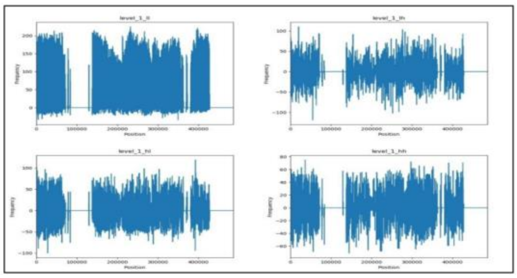

Figure 7. DWT extraction results from the pathogen coefficients LL, LH, HL, and HH in the Culvularia sp. 1 spectrum

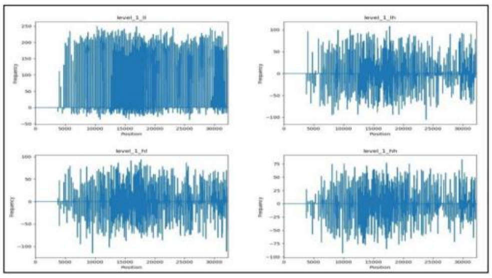

Figure 8. DWT extraction results from the pathogen coefficients LL, LH, HL, and HH in the Botrytis sp. Spectrum

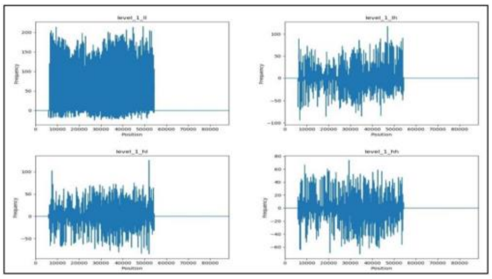

Figure 9. DWT extraction results from a pathogen, coefficients LL, LH, HL, and HH in the Culvularia sp. 2 spectrum

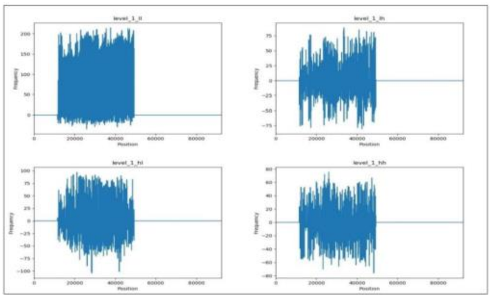

Figure 10. DWT extraction results from the pathogen coefficients LL, LH, HL, and HH in the Pestalotia sp. spectrum

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Image extraction results using DWT then calculated the information contained therein using entropy and energy. Energy is the sum of the absolute value of data. The energy can present the texture image characteristic, and the energy can be used to obtain the image character extracted with DWT (Tan et al., 2014) (Tampinongkol, Herdiyeni, & Herliyana, 2020).

$$E = \sum_{n=1}^{N} |f(n)|$$

Where E represents energy, N represents the amount of data, and f (n) represents the position of data to n.

Entropy is used to measure pixel diversity in an image to generalize the uncertainty that appears in an image (Wang et al., 2015) (Widiyanto, Sukra, Madenda, Wardani, & Wibowo, 2018).

$$S = -\int_{n=1}^{G} h_n \log_2(h_n)$$

Where n is the gray level of some subband, h_e is the n-probability of the gray level, and G is the total of the gray level.

RESULTS AND DISCUSSION

Extract results using the DWT with symlet family wavelet, which measured information using energy and entropy. Energy is used to calculate the coefficients of LH, HL, and HH since that coefficient can represent the texture contained in an image. Whereas the LL coefficient is computed using entropy to measure the uniformity of the texture in the approximation image.

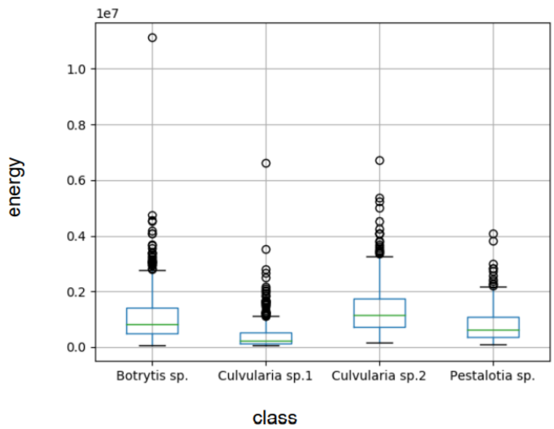

Figure 11. Distribution of data of each pathogen (energy)

Figure 11, The distribution of extracts calculated using wavelet energy, shows an overlap in Botrytis sp. and Culvularia sp. 2. The largest standard deviation is found in Botrytis sp. with values ranging from 925 to 647.2. Extreme outliers influence the value with a value of 11121374. As for Culvularia sp. 2., the data distribution is heavily piled into other classes of pathogens, which can cause many errors in the class Culvularia sp.2. at the same time, the largest outlier is shown in Culvularia sp.1.

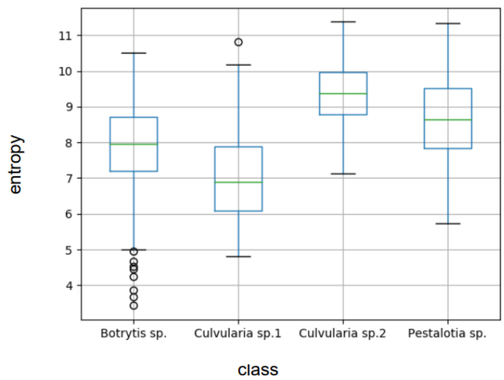

Figure 12. Distribution of data of each pathogen (entropy)

Figure 12 shows the distribution of entropy values for the four pathogens and highly stacked data, with the highest distribution seen in Botrytis sp. and the largest outliers. There is also the main data distribution between quartile one to quartile third largest Culvularia sp. 1 with a range of 1.78 605 greater than the others.

CONCLUSIONS AND SUGGESTIONS

Conclusion

After DWT image feature extraction, the four pathogens (Botrytis sp., Culvularia sp.1, Culvularia sp.2, and Pestalotia sp.) exhibited distinctive characteristics.

Additional findings from this study, Object Culvularia sp. 1 and Culvularia sp. 2. have a pixel intensity that is much different from the pixel background intensity of the image. Segmentation using the Otsu Thresholding method is perfect for such image types. The tail and the tip of Pestalotia sp. have a pixel intensity that is not much different from the pixel intensity of the background image, so the Otsu Thresholding method is not suitable for detecting the tail and the tip of Pestalotia sp.

Suggestion

The image used has an image resolution of under 1 megabyte. Higher quality is expected to capture more of the texture of a pathogen so that it can capture more accurate images.

REFERENCES

Agrios G. (2005). *Plant Pathology* (5th ed.). New York: Elsevier Academic.

Aisah, A. R. (2014). *Identifikasi dan Patogenisitas Cendawan Penyebab Primer Penyakit Mati Pucuk pada Bibit Jabon (Anthocephalus cadamba (Roxb.) Miq)*. IPB, Bogor.

Bangun, M. B., Herdiyeni, Y., & Herliyana, E. N. (2016). Morphological Feature Extraction of Jabon's Leaf Seedling Pathogen using Microscopic Image. *TELKOMNIKA (Telecommunication Computing Electronics and Control)*, *14*(1). https://doi.org/10.12928/telkomnika.v14i1.2486

Hadi S. (2001). Masalah Dalam Perlindungan Hutan Terhadap Ganguan oleh Penyakit. In *Patologi Hutan Perkembangannya di Indonesia*. Bogor: Fakultas Kehutanan IPB.

Herliyana, E. N. (2013). *Biodiversitas dan potensi cendawan di indonesia*. Bogor: IPB Press.

Herliyana, E. N., Sakbani, L., Herdiyeni, Y., & Munif, A. (2020). Identifikasi Cendawan Patogen Penyebab Penyakit pada Daun Jabon Merah (Anthocephalus macrophyllus (Roxb.) Havil). *Journal of Tropical Silviculture*, *11*(3), 154–162. https://doi.org/10.29244/j-siltrop.11.3.154-162

Larekeng, S. H., Qalbi, N., Rachmat, A., Iswanto, I., & Restu, M. (2022). Effect of gamma iradiated seeds of Jabon Merah (Neolamarckia macrophylla (Wall.) Bosser) to genetic diversity. *IOP Conference Series: Earth and Environmental Science*, *1115*(1), 012027. https://doi.org/10.1088/1755-1315/1115/1/012027

Madhu, & Kumar, R. (2022). A hybrid feature extraction technique for content based medical image retrieval using segmentation and clustering techniques. *Multimedia Tools and Applications*, *81*(6). https://doi.org/10.1007/s11042-022-11901-8

Naga Kiran D, & Kanchana V. (2019). Recognition of glaucoma using otsu segmentation method. *International Journal of Research in Pharmaceutical Sciences*, *10*(3), 1988–1996. https://doi.org/10.26452/ijrps.v10i3.1407

Otsu, & N. (1996). A threshold selection method from gray-level histograms. *IEEE Trans. on Systems, Man and Cybernetics*, *9*(1), 62–66. Retrieved from https://cw.fel.cvut.cz/b201/_media/courses/a6m33bio/otsu.pdf

Rafael C. Gonzalez, & Woods, R. E. (2008). *Digital Image Processing*. Hoboken, New Jersey: Prentice Hall.

Santosh, N. K., & Barpanda, S. S. (2020). 4. Wavelet applications in medical image processing. In *Predictive Intelligence in Biomedical and Health Informatics* (pp. 63–90). De Gruyter. https://doi.org/10.1515/9783110676129-004

Streets, R. B. (1972). *The Diagnosis of Plant Diseases: A Field and Laboratory Manual Emphasizing the Most Practical Methods for Rapid Identification*. Tucson, Arizona: University of Arizona Press.

Sudarsan, B., Ji, W., Adamchuk, V., & Biswas, A. (2018). Characterizing soil particle sizes using wavelet analysis of microscope images. *Computers and Electronics in Agriculture*, *148*, 217–225. https://doi.org/10.1016/j.compag.2018.03.019

Tampinongkol, F. F., Herdiyeni, Y., & Herliyana, E. N. (2020). Feature extraction of Jabon (Anthocephalus sp) leaf disease using discrete wavelet transform. *TELKOMNIKA (Telecommunication Computing Electronics and Control)*, *18*(2), 740. https://doi.org/10.12928/telkomnika.v18i2.10714

Tan, C., Wang, Y., Zhou, X., Wang, Z., Zhang, L., & Liu, X. (2014). An Integrated Denoising Method for Sensor Mixed Noises Based on Wavelet Packet Transform and Energy-Correlation Analysis. *Journal of Sensors*, *2014*. https://doi.org/10.1155/2014/650891

Wang, S., Yang, X., Zhang, Y., Phillips, P., Yang, J., & Yuan, T.-F. (2015). Identification of Green, Oolong and Black Teas in China via Wavelet Packet Entropy and Fuzzy Support Vector Machine. *Entropy*, *17*(12). https://doi.org/10.3390/e17106663

Warisno, & Dahana K. (2011). *Peluang Investasi: Jabon Tanaman Kayu Masa Depan*. Jakarta: Gramedia Pustaka Utama.

Widiyanto, S., Sukra, Y., Madenda, S., Wardani, D. T., & Wibowo, E. P. (2018). Texture Feature Extraction Based On GLCM and DWT for Beef Tenderness Classification. *2018 Third International Conference on Informatics and Computing (ICIC)*, 1–4. IEEE. https://doi.org/10.1109/IAC.2018.8780569