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Jatropha Curcas Disease Identification With Extreme Learning Machine

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ABSTRACT

Jatropha is a plant that has many functions, but this plant can be attacked by various diseases. Expert systems can be applied in identifying so that can help both farmers and extension workers to identify the disease. one of method that can be used is Extreme Learning Machine. Extreme Learning Machine is a method of learning in Neural Network which has a one-time iteration concept in each process. In this study get a maximum accuracy of 66.67% with an average accuracy of 60.61%. This proves the identification using Extreme Learning Machine is better than the comparison method that has been done before.

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1. INTRODUCTION

Jatropha plant is a plant that can grow well in dry lowland with a height of 0-500 mdpl, rainfall of 300-1000 mm per year and temperatures between 20-26oC(1). This plant originally came from America (2), but can also be found in Southeast Asia, southern and central Africa, southern India (3), and Indonesia(1). This plant has many benefits such as biodiesel replacement, and its seed oil can be used as an additive to candle making, soap, cosmetics, and detergents (2). Moreover, Jatropha oil content reaches 63% compared to soybean oil, sunflower and palm oil (3).

Not apart from that, jatropha cultivation can suffer diseases that attack leaves, stems, roots, flowers, and seeds. Diseases of Jatropha plants are a threat to farmers because they can cause death(1) and resulted in decreased yields. According to the results of interviews with experts, in recognizing jatropha diseases of the farmers are still experiencing difficulties due to lack of extension counseling time so that knowledge of farmers about Jatropha curcas and disease is still lacking. To help farmers in identifying the disease, it takes a method that can utilize the knowledge of experts who will be inserted into the computer then the computer can give the results of identification like an expert, this system is called expert system(4).

The system model that will be designed in this paper is using quantitative data from experts who are used as basic knowledge in the system. Data from the expert is data from 9 diseases and 30 symptoms. In doing identification of Jatropha plant disease required the appropriate method, so it can identify well. In some studies of disease identification, especially for Jatropha curcas with the same data have been done by using Fuzzy Neural Network method (5) which get a fairly low accuracy of about 11.2%. It is considered necessary to be improved by means of optimization using the Simulated Annealing method(6) which results promise to

improve results. The results obtained after the optimization, which is equal to 32.5%. Increased by 21.3% than using Fuzzy Neural Network only.

To provide deeper learning to make decisions on the detection system are known some learning methods in neural network, one of which is Extreme Learning Machine (ELM). The study used the Extreme Learning Network (ELM) method conducted by Rahma et al (7) to classify stroke level from Electrocephalogram analysis (EEG signal) which resulted in accuracy above 72%. Further research was conducted by Zhang, who performed early detection of the risk of heart failure with basic information, demographics and patient disease data as the primary input. By using ELM the result obtained is quite high that is equal to 93%. Based on previous research used ELM, in this research method used is Extreme Learning Network (ELM) to detect Jatropha plant disease type.

2. JATROPHA CURCAS DISEASE

The cause of jatropha disease is pathogen(1). There are many kinds of pathogenic fungi that attack the Jatropha plant, Helminthosporium tetramera, Pestalotiopsis paraguarensis, P. Vesicolor, Cercospora jatrophaecurces, Phutophthora spp., Pythium spp., Fusarium spp., Dothiorella sp., Colletotrichum sp., Oidium sp., Alternaria sp., Fusarium sp., Xanthomonas sp., J. Gossypiella (8), and Armillaria tabescens(9). Based on the above types of pathogens cause various diseases such as patches of leaves, root rot and others (1). For more details, jatropha diseases and their symptoms can be seen in Table 1 below.

Table 1. Jatropha Curcas Disease

No	Diseases	Pathogen	Effects	Causes
1	Bacterial Wilt	*Ralstonia solanacearum* Bacteria	Infected plants become withered.	- Rot at the base of the stem and roots. - The other side of the plant withers. - Experiencing decay at the base of the branch. - The main stem base sometimes rots.
2	Charcoal Rot	*Rhiczoctonia bataticola* Fungi	May cause sprouts to die before or after surface.	- The leaves wither in all parts of the plant suddenly. - The leaves wither yellowing at the bottom of the plant and fall out. - Root looks blackish.
3	Powdery Mildew	*Pseudoidium jatrophae* Fungi	- Leaf fall or shoot does not develop and die. - Young fruits usually change shape and fall.	- The presence of white powdery mildew on the leaves, fruit, and stems when they are still young or shoot.
4	Antraknosa	*Colletotrichum gloeosporioides* Fungi	- Leaves or fruit become damaged. - Sprout shoots off.	- Brown round spots are restricted yellow halo. - If attacking the edge of the leaves are irregular spots. - Blackish brown spots on the fruit surface
5	Bacterial Blight	*Xanthomonas campestris*.		- Aqueous spots bordering leaf repeats to form angled spots. - Blackish spots on the leaves. - Under the surface, leaves look shiny
6	Fusarium Wilt	*Fusarium spp*. Fungi	Plants become dead	- Plant withered with yellowish leaves. - If the stem is defended will look the part of the woody brown ribbed.
7	Dieback	Not yet known		- The rot starts from the tip/top of the plant. - Leaves fall and stems look bare. - Side shoots cannot grow because the branches rot. - The rotten part is usually watery and the shoots dry out. - If the split part will be seen the vessels and brown pith.
8	Cercospora Leaf Blight	*Cercospora jatrophicola* Fungi		- Irregular brown color on leaves.
9	Altenaria Leaf Blight	*Altenaria* Fungi		- Spots ring rounded leaves

3. DATASET

In this research are grouped into two that is training data and test data. The training data was obtained from experts of Jatropha plant disease at Indonesian Crops and Fiber Crops Research Institute. Data obtained from the results of direct interviews conducted in 2015 in the form of 9 diseases and 30

symptoms with the value of each symptom is worth between 0-1. The test data were obtained from direct observation data at Jatropha plantation in Situbondo. The test data obtained amounted to 166 data. The obtained data will be the limitations in this study.

4. NEURAL NETWORK

Neural network is a modeling of a cognitive way of thinking that is capable of learning. The learning process is a process where the necessary knowledge will be stored in the nodes and weighted(10). The process of adding knowledge to the neural network is done continuously so that knowledge will be maximally exploited to recognize an object(11). The type of learning undertaken by the neural network is based on historical data. Neural network methods use non-linear interconnected calculation elements called neurons. Neurons adapted from biological neural network systems have "foult tolerant" properties meaning neurons can recognize input signals that are somewhat different from those ever received and if a neuron is damaged, other neurons can be trained to replace the function of the damaged neuron. Neural network is a programmed system, meaning that all output or decision taken by the network is based on experience during the learning process or training. The purpose of neural network training is to achieve equality between the ability of memorization and generalization. The ability to memorize is the ability of neural networks to recapture a perfectly learned pattern, while generalization is the ability of neural networks to provide action or response from similar input patterns (slightly different patterns) to previously received input patterns(12). The way of learning conducted by the neural network is divided into two, namely supervised learning and unsupervised learning. The way supervised learning is supervised learning so that the expected outputs have been previously known by using existing data. One input pattern will be assigned to a neuron in the input layer and forwarded to the neuron in the output layer. The neurons in the output layer will generate results and are matched to the target output pattern. If there is a difference between the learning outcomes with the target output pattern then the error will appear. If the error obtained is too large, further learning is required. Extreme learning machine is a neural network method that had a concept about used a single hidden layer feedforward network(13). Some of neural network algorithms was used in classification are backpropogation(14), extreme learning machine (7,15), hybrid extreme learning machine(16–19), and ANFIS(20)

5. NEURAL NETWORK

There is a deeper study of the neural network, one of which is the first Extreme Learning Machine performed by Huang in 2006(13). ELM is one of the learning methods in Neural Network which has the concept of Single Hidden Layer Feed Forward. ELM was created with the aim to overcome the weaknesses of previous Neural Network methods. This method has a very fast computation concept because it only performs one iteration process and gives better result from other Neural Network method(15). Bobot input pada ELM biasanya ditentukan secara acak, sedangkan untuk bobot output ditentukan secara analitik sehingga output pada hasil ELM hanya satu. The weight inputs on the ELM are usually determined randomly, whereas for the output weight is determined analytically so that the output on the ELM result is only one(21).

In the ELM uses two types of data, namely training data and testing data(13). The training data is aimed at obtaining the best input weight based on the best accuracy results on the training data used. Testing data aims to test the best input weights that were obtained in the process of testing train data by using test data. To calculate the final accuracy is using the average between the training data and the testing data.

Model of ELM can be seen in Figure 1.

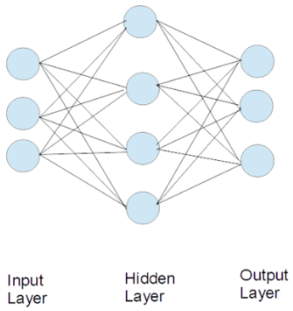

Figure 1. ELM architecture model

In Figure 1 the ELM architecture has similarities as the architecture of other Neural Networks that use the concept of Backpropogation learning. The difference between ELM and Backpropogation learning is on weight calculation and ELM uses only one iteration. Pseuocode of ELM can be seen on Figure 2.

Algorithm ELM: Given a training set $\aleph = \{(\mathbf{x}_i, \mathbf{t}_i) | \mathbf{x}_i \in \mathbf{R}^n, \mathbf{t}_i \in \mathbf{R}^m, i = 1, \ldots, N\}$, activation function $g(x)$, and hidden node number $\tilde{N}$,

Step 1: Randomly assign input weight $\mathbf{w}_i$ and bias b_i, $i = 1, \ldots, \tilde{N}$.

Step 2: Calculate the hidden layer output matrix $\mathbf{H}$.

Step 3: Calculate the output weight β

$$\beta = \mathbf{H}^{\dagger}\mathbf{T},$$

where $\mathbf{T} = [\mathbf{t}_1, \ldots, \mathbf{t}_N]^{\mathrm{T}}$.

Figure 2. ELM Pseudocode(13)

The process of ELM algorithm actually has similarities with the concept of feedforward learning. The difference is in the number of layers used because ELM uses single layer. In the test of training data and testing data using the same algorithm flow. The difference is only in the determination of the input weights, where the test of training data using random input weights, while test the testing data using the best input weights in the training data testing. The flowchart of ELM algorithm can be seen in Figure 3.

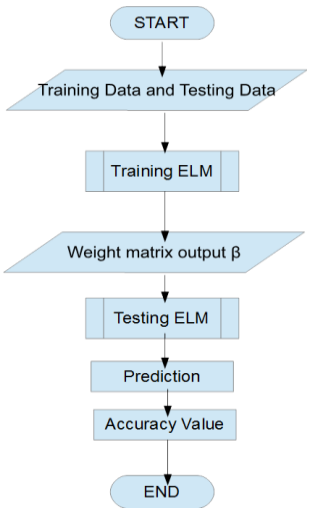

Figure 3. ELM Flowchart

6. RESULT AND DISCUSSION

In the ELM test Neuron testing is performed to see how many neurons are required in the ELM process to get the best accuracy. This test is performed from 1 to 25. The following is a result of neuron testing on ELM using 135 training data and 31 test data. Figure 4 shows the results of neuron testing.

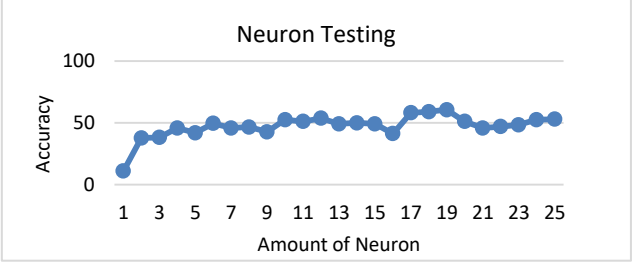

Figure 4. Neuron testing

In neuron testing, the best neurons are present in 19 neurons. In this test the best average accuracy is 60.61 and the best accuracy is 66.67%. Too much neurons that used for ELM can affect the time processing of ELM, but small amount of neurons can affect low accuration to identifty because neurons in input layer is more than neurons in hidden layer.

Previous research has been done using Fuzzy Neural Network (FNN) and Fuzzy Neural Network-Simulated Annealing (FNN-SA). Identification of Jatropha Curcas by FNN used FIS Tsukamoto's membership function on Jatropha Curcas symptoms and disease. FNN-SA used SA to optimize membership function of Jatropha Curcas symptoms and diseases. Based on ELM testing then compared with other methods such as FNN, FNN-SA and Backpropogation can be seen in Table 2.

Table 2. Test results of several methods

Method	Best Average Accuracy	Best Max Accuracy
FNN (5)	11,2%	30%
FNN-SA (7)	19.5%	32.5%
Backpropogation	9,1%	12,12%
ELM	60,61%	66,67%

We use 10 experiments using the best parameters in each method. Based on comparative results with previously applied methods, ELM has much better accuracy results compared with the previous method. ELM can give best accuracy than other method because ELM determined the weights between hidden neurons and the output of neurons from a single hidden layer analytically. This proves that ELM is good enough for the identification of jatropha curcas diseases compared to previous methods

7. CONCLUSION

The use of the ELM method provides a maximum accuracy of 66.67% and an average accuracy of 60.61%. These results prove that ELM is better than the previous comparison method for identification of rare fence disease. Accuracy results that are still below 70% prove still need further development for this ELM method. Modifying the ELM using other methods such as Neural Network Other methods or with optimization methods is expected to provide better results than ever before.

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