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HERBAL PLANT DETECTION BASED ON LEAVES IMAGE USING CONVOLUTIONAL NEURAL NETWORK WITH MOBILE NET ARCHITECTURE

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Abstract— *Indonesia is a country with a variety of flora/plant diversity. One type of flora wealth is herbal plants. Herbal plants are plants that have uses to treat a disease. The diversity of herbs often makes our mistakes in recognizing the type. Therefore we need a system that can recognize the types of herbs automatically with their use. In this study, the CNN (Convolutional Neural Network) algorithm is used. This algorithm is a deep learning method that can recognize and classify an object. In this study, we use 500 images for 5 types of leaves of herbal plants. Mobilenet architecture is used on an Android-based system so that it has the thickness of the convex filter that matches the image thus saving the size of the learning model. Based on the test results on 30 new images obtained an accuracy rate of 86.7%. So it can be concluded that the use of the CNN algorithm is quite good at detecting herbal plants based on the training data used.*

Keywords*:* Convolutional Neural Network, Tanaman herbal, Android, Deep learning, Mobile net

Abstrak— Indonesia merupakan negara dengan berbagai macam keanekaragaman flora/tumbuhan. Salah satu jenis kekayaan floranya yakni tanaman herbal. Tanaman herbal merupakan tanaman yang mempunyai kegunaan untuk mengobati suatu penyakit. Beraneka-ragamnya tanaman herbal ini sering membuat kesalahan kita dalam mengenali jenisnya. Oleh karena itu diperlukan sebuah sistem yang mampu mengenali jenis tanaman herbal secara otomatis dengan kegunaannya. Pada penelitian ini digunakan algoritma CNN(Convolutional Neural Network). Algoritma ini merupakan metode deep learning yang maampu mengenali dan mengklasifikasikan suatu objek. Pada penelitian ini menggunakan 500 citra untuk 5 jenis daun tanaman herbal. Arsitektur mobilenet digunakan pada sistem berbasis Android sehingga memilki ketebalan filter konvulusi yang sesuai dengan gambar sehingga menghemat ukuran dari model pembelajaran yang digunakan. Berdasarkan hasil pengujian pada 30 citra baru didapatkan tingkat akurasi sebesar 86,7%. Sehingga dapat disimpulkan penggunaan algoritma CNN cukup baik dalam mendeteksi tanaman herbal berdasarkan data latih yang digunakan.

Kata Kunci*:* Convolutional Neural Network, Tanaman herbal, Android, Deep learning, mobile net

INTRODUCTION

Indonesia is a country rich in biodiversity. One of the biological wealth that can be found in various regions of Indonesia is herbal plants. Herbal plants can be used as a natural alternative treatment besides chemicals[1]. Herbal plants have used as a provider of oxygen, food ingredients, medicines, and cosmetics. Due to a lack of public knowledge of herbal plants, so many people prefer to use chemical drugs that are more practical and clear [2]. Indonesia has more than 38,000 plant species with 2039 herbal plants [3]. Therefore we need documentation that contains information related to medicinal plants used. To find out or detect these herbs can be done by identifying the shape of the leaf image. An application is needed to be able to recognize herbal plants through leaf images taken. The introduction of herbal plants is done with a series of characteristics. These characteristics include leaf shape, leaf size, leaf color, and leaf texture.

The development of artificial intelligence technology to process images is developing very rapidly. Often the image used during the classification process is in a state that is not ideal. Like the many distractions in the form of shadows, photographs, blurred images, and unclear objects used. So we need a technique that can process and carry out the classification process in less than ideal image conditions. One technique that can be used is the deep learning method that can recognize and detect an object in a digital image[4]. One method of deep learning that can recognize and detect objects in an image is Convolutional Neural Network (CNN). CNN capability is claimed

as the best method in terms of object detection and object recognition[4]. The methods that CNN has been the same as those of neurons, usually the weight, bias, and activation functions. It's just that CNN is done with a convolutional filter. The CNN method also has a weakness that other deep learning methods have, that is, the training process requires quite a long time.

In developing mobile / smartphone-based applications, an appropriate architecture is needed so that the training process can run faster. One architecture that has optimal performance is MobileNets. MobileNets is a CNN architecture that can be used to overcome the need for excess computing resources so that it can be used on devices with limited resources such as mobile devices. With the latest version, MobileNetV2, new features have been developed, so the object recognition process becomes more accurate.

Research on the detection of herbal plants with the title "Identification of Herbal Medicinal Plants Based on Leaf Image Using the Gray Level Co-occurrence Matrix and K-Nearest Neighbor" Algorithm conducted by Fittria Shofrotun Ni' mah and friends. This research uses the GLCM algorithm to analyze the texture and K-Nearest Neighbor for the classification process[3]. The results of this study indicate the classification process produces an accuracy rate of 83.3% using 9 subsets.

Another study was carried out by Zaki Imaduddin and colleagues under the title "Mobile Applications for Leaf Detection and Classification in Real-Time". In this study, the process of leaf detection and classification is done using the Android system. The methods used to detect leaves are Adaboost and SVM for the classification process. From the research results obtained an accuracy rate of 66.91%. The leaf samples used were Flavia[5].

The application of the CNN method can also be implemented in the Caltech 101 image classification as done by I Wayan Suartika E.P and friends with the title "Image Classification Using Convolutional Neural Network (CNN) on Caltech 101". In this study, the Caltech 101 image classified using the Convolutional Neural Network method produces an accuracy rate of 20-50%[6].

Another study was carried out by Febri Liantoni with the title "Classification of Leaves with Image Improvement Features Using the K-Nearest Neighbor Method". In this study the process of leaf classification using the K-Nearest Neighbor method. KNN is used because of its speed in the training process and is effective for large amounts of data and is easy to learn. The results of this study indicate an accuracy rate of 86.67%. In this study, image repairs were also performed using median filters and erosion [7].

Research on the detection of medicinal plants was conducted by M. Aria Dayanti with the title "Introduction of Medicinal Plant Leaves Using Backpropagation Artificial Neural Networks"[2]. In this research the process of processing the leaf image using 21 feature extraction and backpropagation neural network methods. based on the experimental results obtained an optimal accuracy value of 92%. Where are the results used with the input architecture 21 features and 1 hidden layer and 55 neurons.

Research with the title "Identification of Wood Types using Convolutional Neural Networks with Mobilenet Architecture" was conducted by Hendriyana and Yazid Hilman Maulana. In this study, one of the deep learning methods is used, namely the Convolutional Neural Network with mobile nets architecture. In this study, 1000 images were used for 10 types of wood. The results of testing with 30 new image data, obtained an accuracy of 98% training, 93.3% testing, 28% for recall, and 93% for precision [4].

Another research on CNN deep learning method is entitled "Introduction of Gringsing Woven Fabric Motif Using the Convolutional Neural Network Method with the Alexnet Architectural Model". This study aims to automatically detect the type of motif from Gringsing woven cloth using deep learning. In this research, CNN is used with Alexnet architecture. Based on the results of testing the model built can complete 100 epoch training with 19.33 hours, and has an accuracy value of 76%, 74.1% precision, 72.3% recall, and F-measure of 0.73[8].

Based on this background, this research will develop an introduction to herbal leaf plants using the Convolutional Neural Network method with the architecture of mobile nets. So that it can be measured how much their accuracy.

MATERIALS AND METHODS

In this study an experimental research method was carried out with the following stages :

A. Data collection

The data used in this study is a digital image. Digital images are collected from various sources, then called datasets. The dataset was collected from direct capture using a smartphone camera and images obtained from searches on internet media. The image used in this study is the image of the leaves of herbal plants or medicinal plants consisting of 5 types namely: the image of the leaves of the ginger plant, cat's whiskers, aloe vera, basil, and starfruit Wuluh. Before this data is used, it is first processed by grouping each image in the corresponding folder.

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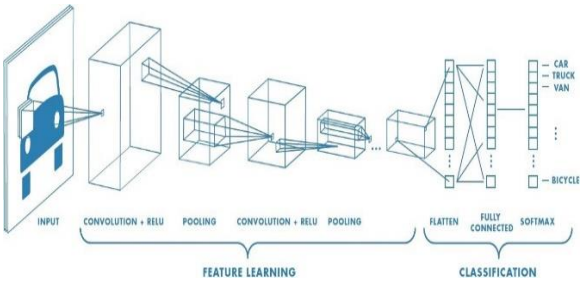
B. The method used

Deep learning can solve problems with large amounts of data. By using deep learning, it allows us to create systems that are capable of learning with the desired speed and accuracy. One example of the deep learning method used in this study is the Convolutional Neural Network. This algorithm is an efficient recognition algorithm and is widely used in image processing[4]. CNN is no different from other neural networks such as artificial neural networks where they have a bias, weight, and activation function. But what distinguishes CNN from other neural networks is CNN has a special layer called the Convolutional Layer. Leaf image processing is done using the kernel feature. This feature is used to get fractions (strides) from an image. This process is called convolution.



Source: [4]

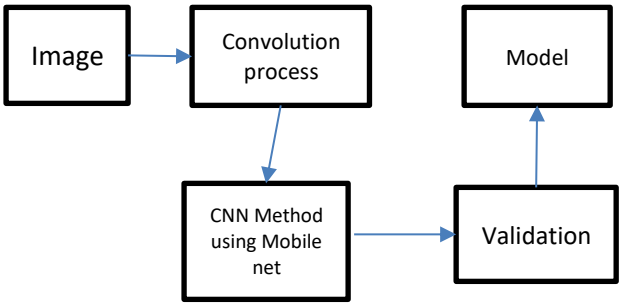
Figure 1. Process in Convolutional Neural Networks

MobileNet is one of the many CNN architectures that can be used on mobile applications. Some of the advantages of this CNN architecture are the thickness of the convolution filter according to the picture[9]. So that it can save the size of the model made, in addition to the bottleneck layer contained in the input and output, making the training process more accurate and faster.

C. Experiment, evaluate and validate results

This research uses the Tensorflow framework, which was developed by Google to develop machine learning. One feature found in Tensorflow is image recognition. Tensorflow uses CNN and mobile net v2 architecture. The measurement methods used are precision and recall. Precision is the level of accuracy between the information requested by users with the answers given by the system. Whereas recall is the success rate of the system in rediscovering information [7]

The following model diagram from this research:



Source: [10]

Figure 2. Research diagram

RESULTS AND DISCUSSION

A. Data preparation

There are 5 images of leaves of herbal plants that will be classified in this study, namely the image of the leaves of the ginger plant, cat's whiskers, aloe vera, basil, and starfruit Wuluh. This image data is then called a dataset. The classification process is carried out using the Convolutional Neural Network method and the Mobile Net architecture. The main process of this system is the training process, which will form a model used in the testing process. To measure the results of the test used precision and recall methods. Broadly speaking, the process of this herbal plant detection system is illustrated in Figure 2.

The dataset collected was 500 images for 5 types of leaves of herbal plants, each dataset for each leaf type was divided into 90 images for training/training and 10 images for validation. The first process carried out in the image that is put into the convolution layer.

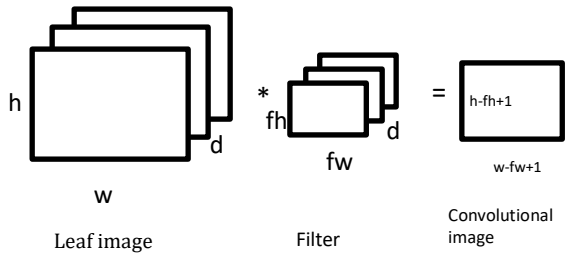
Source: [10]

Figure 3. Dataset of leaves of herbal plants taken from various sources

B. CNN Process

The convulsion process will maintain the relationship between the image pixels by studying image features using some input data. In this study, the size of the image used is a color image with a size of 150x150x3. Where 3 is an image that has 3 channels namely Red, Green, and Blue (RGB). This matrix is then multiplied by different filters, resulting in operations such as edge detection, blur, and sharpen.

The results of the convulsion between the image matrix and filter are then called feature maps.



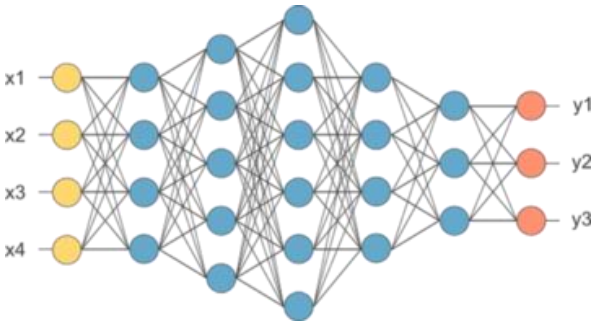
Source: [10]

Figure 4. The process of convulsing the image of herbal plants with its filter

Before proceeding to the Pooling layer process, to eliminate negative values on results, the network architecture uses ReLU (Rectified Linear Unit) activation. This activation function will "threshold" from 0 to infinity. The pooling layer will reduce the number of parameters if the image is too large. The process commonly used is max pooling, where we will take the largest value from each pooling kernel so that important information in the image. Repetition of the pooling and convulsion processes in CNN makes the process of image recognition well and reduces the overfitting that is common in Multilayer perceptron networks. Overfitting is a condition where the machine considers the data we entered to be wrong, even though the data is correct.

The use of Mobilenets architecture on CNN will reduce the need for excess computing so that it is suitable for use on mobile devices/smartphones. Mobilenet will divide 2 convulsive layers into depthwise convolution and pointwise convolution. Then a process is used to change the feature map pooling layer results into vector shapes. This process is then called the fully connected layer.

A fully connected layer is a layer in MLP that aims to transform data dimensions so that data can be classified linearly. FC layer is the layer where the Neural Network process occurs. The softening process occurs after the FC layer. The softening process uses activation functions such as softmax/sigmoid to classify the object so that it can output a string in the form of what image we are looking for.

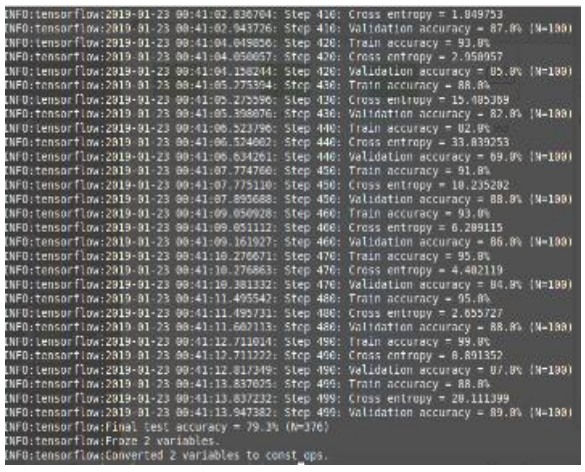


Source [10]

Figure 5. Fully Connected layer used in making the system

C. Training result

In this study, the Python programming language is used to carry out the training process. After going through the CNN algorithm process the training results are obtained. Where in this process is set the value of learning rate = 0.001, number epoch = 1000. Based on the results of the training conducted, the accuracy value for the training model is 79.4%. In training, the resulting model will be changed to Tensor flow lite (tf lite). Tf lite is what will be used as a model for testing. The results of this training process will produce 2 files namely graph lite and labels.txt both of these files will be compiled with a testing application using Android Studio.



Source: [10]

Figure6. The training process to produce the tf-lite model in python

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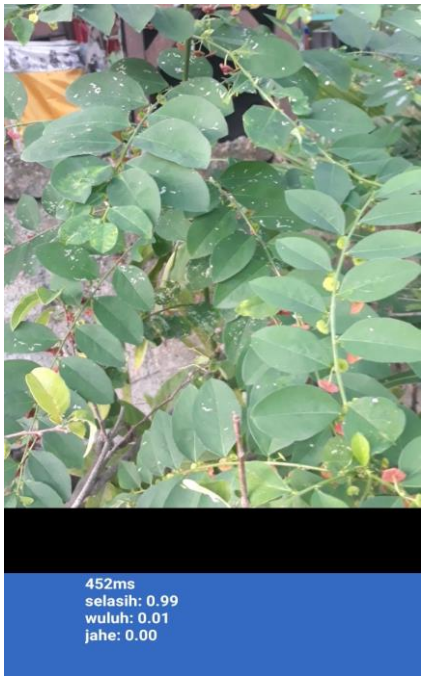
D. Testing result

CNN algorithm requires training and testing processes. In the training process described earlier, a process is carried out to train the CNN algorithm in recognizing the dataset and forming a model based on the results of the training. The testing process will test the model that was formed earlier. In this research, the Java programming language based on Android studio is used. The image that will be used first is resized to 150x150 pixel size. The following interface is the application interface for identifying herbal plants.



Source : [10]

Figure 7. Android application interface for herbal plant detection

Figure 7 shows the results of the process of identifying the leaves of an herbal plant with the output of the plant name and its accuracy value. In this application, the introduction results are generated from the application. The results of this introduction are then sorted by their accuracy value. The greatest accuracy value is the result of the identification of the best herbal plants. The application can detect images in realtime, without having to upload image data to the system. In this study, testing 5 images with 30 images per species. The following table shows the results of this application.

Table 1 System classification results

Category	Classification result				Succeed			Fail	
	Ginger	cat whiskers	Aloe vera	Starfruit Wulus	Basil	Total	Percentage	Total	Percentage
Ginger	30	0	0	0	0	30	100%	0	0%
cat whiskers	2	26	0	2	0	26	86%	4	14%
Aloe vera	2	0	28	0	0	28	93%	2	7%
Starfruit wuluh	0	2	0	26	2	26	86%	4	14%
Basil	0	5	0	5	20	20	66%	10	34%

Source : [10]

Based on the results for the classification in Table 1 above, it can be seen that this herbal plant detection system can classify all ginger leaf images. As for the image of Aloe vera leaves, 28 images were classified successfully and 2 were wrong. The image of Wuluh starfruit leaves and cat's whiskers can be classified correctly is 26 and 4 incorrectly. While the basil imagery only gets a success rate of 20 and 10 misidentifications. The following is the calculation of the recall and precision of each leaf image.

Table 2. Calculation of the precision value of the classification results

Kategori	Relevant (a)	Not Relevant (b)	Total (a+b)	Not found (c)	Total (a+c)	Recall [a/(a+c)] x100%	Precission [a/(a+b)] x100%]
Ginger	30	0	30	70	100	30%	100%
cat whiskers	26	4	30	74	100	26%	86%
Aloe vera	28	2	30	72	100	28%	93%
Belimbing wuluh	26	4	30	74	100	26%	86%
Basil	20	10	30	80	100	20%	67%
		Average				26%	86.4%

Source : [10]

Based on the calculation value of precision and recall in table 2 above, the best precision value is obtained in the ginger plant, while the smallest precision value is the basil leaf. If averaged the precision value from the results of the classification of this system is equal to 86.4%. while the accuracy value can be calculated by the following formula:

Accuracy= $\frac{130}{150} x100\% = 86{,}7\%$

CONCLUSION

Based on research conducted with a dataset of 500 images for 5 types of leaves. Where 90 images are used for training and 10 images for dataset validation. Then in the testing process used 30 images taken randomly as testing data for each image of the leaves of herbal plants.

After the training process is obtained the best accuracy value with 400 images for training data and 100 images for testing data is 79.4%. The dataset training process is done with Python-based applications. Whereas the testing part was carried out on an android-based mobile application using Android studio and the Tensor flow framework. The architecture used in this tensor flow is mobileNet version 2. In this study, the accuracy value was 86.7%. The precision value was 86.4% and recall was 26%. The results of the detection of types of herbal plants with the Convolutional Neural Network method produce a pretty good accuracy value.

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