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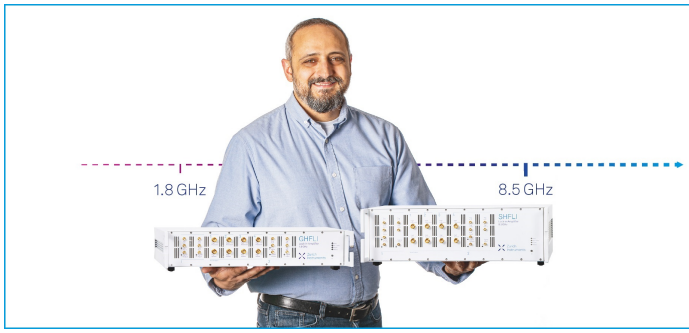

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Herbal Leaf Authentication Using Convolutional Neural Network on Raspberry Pi 3

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Abstract. Currently, there are many methods for classifying herbal plants based on leaf authentication. Basically, the method of leaf authentication is a visual comparison of images taken by a camera with a reference visual image. This paper aims to identify herbal leaves using the artificial intelligence method i.e. the convolutional neural network (CNN) applied to the Raspberry Pi. The advantage of CNN is that it does not need feature extraction because it contains an automatic feature extraction process. In this paper, there are 10 types of leaves from different herbal plants which are divided into two-third training data and one-third testing data. The results of the identification system using CNN will be validated with other data that are not included in training and testing. Furthermore, it will be tested with different types of leaves that are outside ten types of leaves in the experiment. The accuracy using this CNN method is above 90%. These results indicate that the CNN method is more accurate in herbal leaf authentication.

INTRODUCTION

Herbal plants are plants that can be used for alternatives to cure diseases naturally. About 80% of people Min the world still depend on traditional medicine [1]. Meanwhile, according to [2] herbal plants are plants whose plant parts (leaves, stems, or roots) have properties that can be used as raw materials in making modern medicines or traditional medicines. These medicinal plants are often found in the forest. There are various types of herbal plants that we can know through the identification of these herbs, one of which is using identification through the leaves. Methods for identifying leaves have been carried out by researchers, including the introduction of leaf types automatically for classification purposes. This study uses the Probabilistic Neural Network method (PNN) [3]. The disadvantage of probabilistic neural networks is that there is an increase in the use of computer memory space and computational time when the use of training data increases because all training data must be entered into the PNN algorithm. The application of image processing for identification of medicinal plant leaves is implemented on 10 different types of medicinal plants. The identified leaf image will be processed using image processing to determine the type of medicinal plant [4]. The implementation of artificial neural networks for the identification is, for example, in Philippine medicinal plant leaves. In identification process, feature extraction is needed for the leaf image of the plant [5]. The method of recognition and classification of plant leaves uses convolutional neural networks. The CNN method is considered more practical in image processing [6]. The research is only focused on finding out the type of plants based on the identification of plant leaves.

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Based on the paper, the writer wants to improve the existing system. In this paper, the author wants to identify the herbal leaves using an artificial intelligence method, the convolutional neural network (CNN), which is applied to the Raspberry Pi. One of the advantages of this method is that there is no need for feature extraction because there is an automatic feature extraction process. CNN is more efficient in the identification and classification process because CNN assumes input in the form of an image matrix [7]. Leaf images of a plant will be processed in Raspberry Pi in which Convolutional Neural Network (CNN) has been installed. The results of the identification process will be validated with other data excluded in training and testing as well as leaf data other than the type of leaf that is identified. This paper is expected to make it easier for people to find out the types of herbal plants through identified leaves.

SYSTEM OVERVIEW

The authentication process will be carried out on ten different types of herbal leaves. The authentication process is done via an integrated smartphone Camera with Raspberry pi. Raspberry pi functions as the main controller in processing image data through a convolutional neural network (CNN) and provides output data in the form of image prediction by the authenticated image data. Afterward, the output will be displayed via the application display on the smartphone.

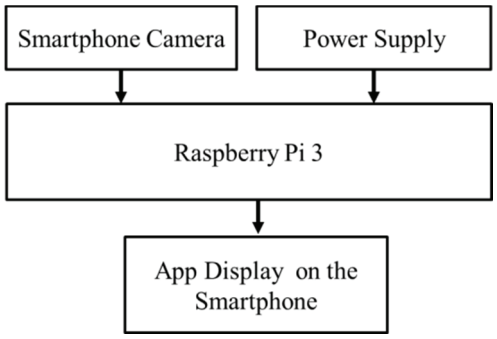

FIGURE 1. Block Diagram Of System

Convolutional Neural Network (CNN) is a development of the Multilayer Perceptron (MLP) which is designed to process two-dimensional data. CNN uses a combination of various multilayer perceptrons so that the learning algorithm only requires a little preprocessing [7]. CNN is an artificial neural network architecture that is effective in image processing. The architecture of CNN is very good at filtering images sent in communication information systems [8]. Actually, CNN itself is a type of deep neural network because it is widely used in image applications and has a high network depth. MLP itself began to be replaced by CNN in its use because it does not store spatial information from image data. Within CNN itself there is the main underlying process, namely the convolutional layer which aims to extract features from the input image. This will result in a linear transformation of the input data according to the spatial information in the data.

Raspberry Pi is a low-cost single-board computer with a processor speed ranging from 700 MHz to 1.2 GHz for Pi 3. On-board memory ranges from 256MB to 1GB RAM. The board supports up to 4 USB ports with an HDMI port. In addition, Raspberry Pi has a GPIO pin that supports protocols such as I²C as well as supporting Wi-Fi and Bluetooth facilities which makes the device very compatible with other devices. Raspberry pi supports Scratch and the Python programming language [9].

Raspberry Pi is used because it has several advantages such as using a micro SD card to store data, be it operating system data or long-term data storage. Also, Raspberry Pi 3 excels at 3D graphics and supports overvolting by editing its config.txt file.

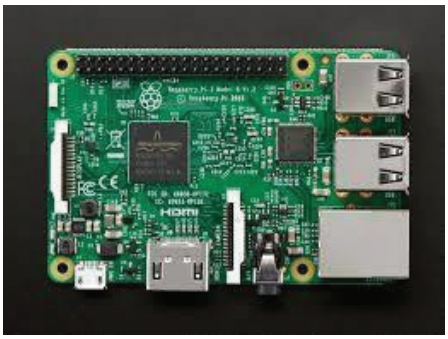

FIGURE 2. Raspberry Pi 3[9]

RESEARCH METHODS

The research method in this paper employs the convolutional neural network (CNN) method. Convolutional Neural Network is one of the machine learning methods of developing Multi-Layer Perceptron (MLP) designed to process two-dimensional data. In this paper, there are ten types of leaves from different herbal plants. The identification process uses a smartphone camera to take pictures of the leaf of herbal plants. Leaf image of a plant will be processed in a Raspberry Pi which has already been installed a Convolutional Neural Network (CNN). Then, the output in the form of a prediction image will be shown on a display application.

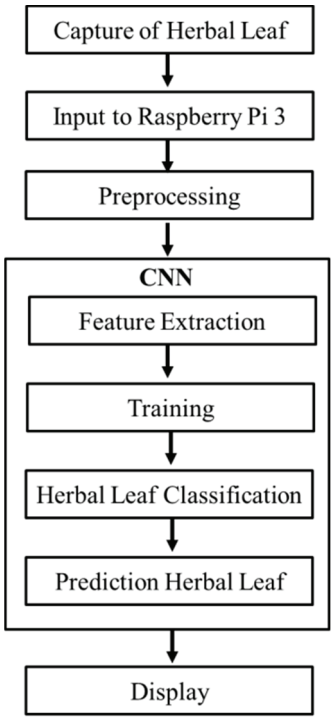

FIGURE 3. Proposed Methodology Flow chart

Classifier Leaf Image Using Convolutional Neural Network

Ten types of herbal leaves will be identified, namely: Alpinia galanga leaf, Annona muricata leaf, Anredera cordifolia leaf, Betel leaf, Centella Asiatica leaf, Guava leaf, Marsh fleabane leaf, Morinda citrifolia leaf, Papaya leaf, and Syzygium polyanthum leaf. The convolutional process uses three convolutional layers and three pooling layers. The results of convolutional and pooling are in the form of ten predictions according to the input provided.

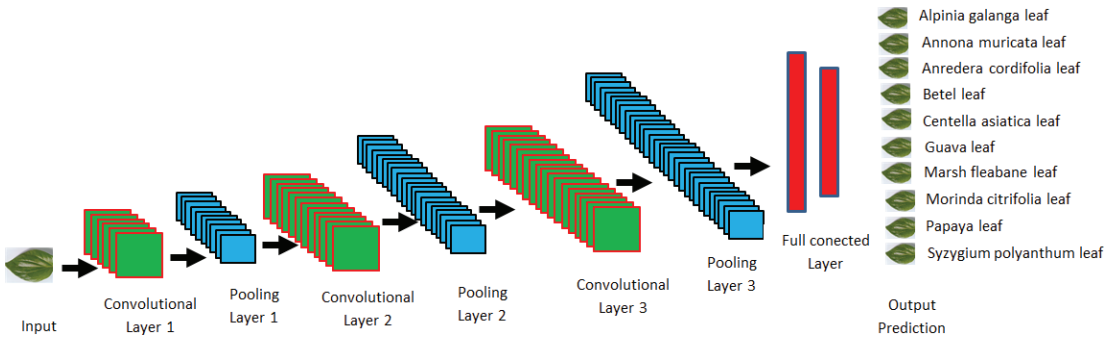

FIGURE 4. The basic structure of a convolutional neural network

The following is a convolutional neural network modeling at each layer:

a. Convolutional layer

$$FM_{(i,j)}^{(m)} = tanh\left(b^{(m)}\right) + \sum_{C_1}^{n} C_{(r_1,C_1)}^{(m)} \times I_{\left((r_{1+i}),(c_{i+j})\right)} \quad (1)$$

Description:
FM = feature map
C = Convolution layer filter
b = Convolution bias layer
I = Image input
m = Index number of feature patterns
n = the number of convolutional layers
i = The feature map layer row index
j = Index feature layer layer index
r1 = Convolution filter line length index layer
c1 = Convolution filter column length index layer

b. Pooling layer

$$FM_{(i,j)}^{(m_1)} = tanh\left(b^{(m_1)}\right) + \sum_{i=3I}^{3n_i+2} \sum_{j=3J}^{3n_j+2} p^{(m_1)} \times FM_{(i,j)}^{(m_1)} \quad (2)$$

Description
B = Pooling layer filter bias
P = Filter pooling layer
I = The feature map line index
J = Index feature map index

c. Output layer

$$O^{(i)} = tanh\left(b^{i} + \sum_{k=0}^{n_k-1} W_{(k)}^{(i)} \times N_{(k)}\right) \quad (3)$$

Description
O = Neuron output layer
b = Output layer bias
w = Output layer weight
i = Index number of output layer neurons
N = Number of output layer neurons

RESULT & DISCUSSIONS

Based on the proposed method, the herbal leaves used in this study were ten types of herbal leaves. Each type of herbal leaf is taken 60 leaves for the needs of training data and testing data, which is two thirds for training data and one third for testing data. The data amount of herbal leaf image is 600 data. Based on the results of the training conducted, the accuracy of authentication of herbal leaves using CNN is shown in the following graph.

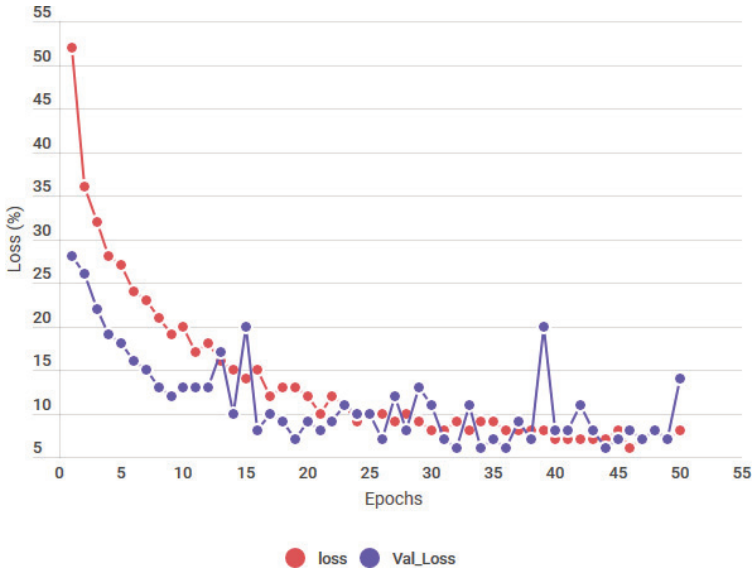

FIGURE 5. Graph training loss and validation loss

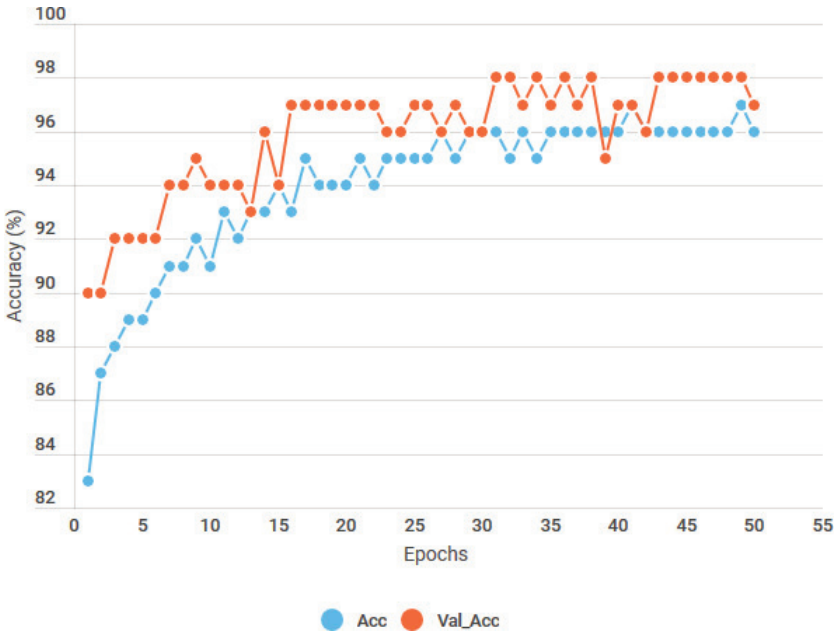

FIGURE 6. Graph training accuracy and validation accuracy

CONCLUSION

In this paper, the authors develop previous research that is authentication on plant leaves using the convolutional neural network (CNN) method. In this study, the authors developed herbal leaves. Ten types of herbal leaves will be authenticated using the convolutional neural network (CNN) model. By using CNN, there is no need to do feature extraction because there is already an automatic feature extraction process. From the results of tests carried out, the level of accuracy using this CNN model is above 90%. The accuracy is influenced by the amount of data as well as epochs in training. Hence, the CNN method is more accurate in herbal leaf authentication.

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