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Application of CNN in the Classification of Chili Varieties for Agricultural Efficiency

Febrian Trio Pamungkas[1*)], Irsyad Zainal Muttaqin[2]
[1]Informatics Engineering Study Program, Faculty of Informatics, Institut Teknologi Telkom Purwokerto
[2]Informatics Engineering Study Program, Faculty of Informatics, Institut Teknologi Telkom Purwokerto
Email: [1]21102140@ittelkom-pwt.ac.id, [2] 21102157@ittelkom-pwt.ac.id

Abstract – This research focuses on the problem of classifying chili harvests which is still done manually by farmers. This manual classification process will of course take a long time, require a lot of energy and will feel tedious. This research aims to develop a classification system for chili types using the Convolutional Neural Network (CNN) method. By utilizing CNN technology, it is hoped that the chili grouping process can be carried out automatically with a high level of accuracy, thereby increasing work efficiency and reducing errors in chili grouping. The data used in this research is primary data with a total of 500 images of chilies divided into 4 classes. These images were taken using a Samsung A7 smartphone camera under consistent conditions: all photos were captured during daylight hours with the same camera angle. The training and testing results of the CNN model in classifying types of chili showed an accuracy of 99.5% in the training stage and reached an accuracy of 94% in the testing stage. Based on these results, it shows that the application of the CNN method in classifying chili types can work very well and effectively.

Keywords – convolutional neural network, classification, type of chili.

I. INTRODUCTION

In Indonesia, chili is a very important food commodity and is needed by almost all levels of society [1]. The development of chili production in the next 5 years is estimated to be experienced an increase with a growth rate of 8.96%, namely from 2.59 million tons in 2019 to 3.97 million tons in 2024. Types of chilies vary greatly, In Indonesia itself there are various types of chilies that are usually cultivated by farmers, including large chilies consisting of large red chilies and curly red chilies, as well as cayenne pepper consisting of green cayenne pepper and red cayenne pepper [2]. When planting chilies, farmers usually do not only plant one type of chili but rather plant many varieties of chilies so that they can reduce the risk of crop failure caused by pest attacks, disease or unfavorable weather conditions [3]. Harvesting chilies takes around 70-75 days after planting [4]. After harvest, farmers usually classify the types of chilies that have been harvested. However, this classification process is still often done manually. This manual method is time consuming, requires a lot of labor and will cause boredom. Therefore, a more efficient and accurate solution is needed to classify the types of chilies that have been harvested. This research aims to develop a classification system for types of chilies using the Convolutional Neural Network (CNN) method. By utilizing CNN technology, it is hoped that the chili classification process can be carried out automatically with a high level of accuracy, thereby increasing work efficiency and reducing errors in chili classification. This will not only increase work efficiency and reduce errors in batching, but will also help farmers increase the productivity and quality of their crops.

In this study, the dataset used consists of 500 primary images of chilies, collected manually by photographing samples using a Samsung A7 smartphone under consistent conditions. The images were taken during daylight hours with a fixed camera angle to maintain uniformity. These images are divided into four classes: red curly chilies, green curly chilies, red cayenne peppers, and green cayenne peppers.

Convolutional neural networks are classification method carried out in research which is a neural network or a neural network that uses convolution as a replacement for multiplication general matrix, which is at least in each layer there is one convolution. Convolutional neural networks are capable analyzing features unsupervised, This makes this method different with other machine learning methods [5].

The Convolutional Neural Network (CNN) method has been widely used to solve the same problems in various fields, especially in image-based object classification. This method has proven to be effective in carrying out classification. For example, research conducted by Rangga and Toto showed that the results of applying the CNN method to classify chili seeds reached an accuracy level of 90% [6]. The CNN architecture was able to separate three types of seeds in chili plants by providing labels according to the input data. Other research conducted by Fani, Nila and Sri shows that the application of the CNN method is very effective in classifying eye diseases with very high accuracy, reaching 98.37% [7]. Apart from that, research from Apwabul and Herawan also proves that the CNN method is able to classify types of disease in rice plants with a high level of accuracy, namely 91.7% [8]. Ahmad, Irma and Andi's research shows that CNN is able to classify types of tomatoes with a high accuracy of up to 96,6% [9]. Subsequent research from Yoga and Indah showed that the CNN method was proven to work well in classifying types of Aglaonema plants, with an accuracy success rate of 96% from the 50 images tested [10]. Further research was carried out by Sandi and friends which showed that the CNN method could be applied to types of jellyfish and obtained quite high accuracy, namely 87% [11].

These results indicate that CNN is a very potential and reliable method for classification tasks, including the classification of chili types in this study. In this study, we will classify 4 types of chilies, namely red curly chilies, green curly chilies, red cayenne peppers and green cayenne peppers.

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II. RESEARCH METHODOLOGY

This research is to classify types of chilies using the Convolutional Neural Network method. The flow of this research can be seen in Figure 1.

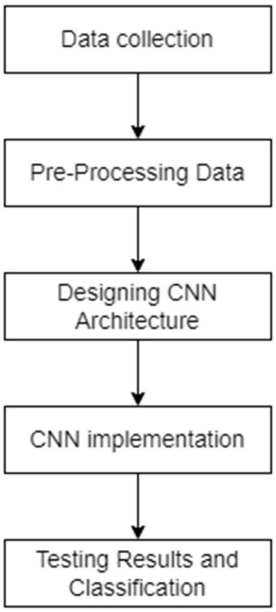

Figure 1 Research flow

Below is a further explanation of each step from journals, books and so on.

A. Data collection

Data collection is a stage research process where researchers apply methods and certain scientific techniques in order to collect data systematically for analysis purposes [12]. The data used in this research are pictures of chili peppers of various types. The data used is primary data obtained directly by researchers through chili sellers in the market who were photographed directly using the Oppo Reno 4 smartphone. The total data collected reached 500 images consisting of 4 different types of chilies, namely red curly chilies, green curly chilies, red cayenne peppers and green cayenne peppers, each class consists of 150 images. Each picture is labeled according to the type of chili present. One example The images used are listed below figure 2.

Figure 2 Sampel green curly chilies

Figure 3 Sampel red curly chilies

Figure 4 Sampel green cayenne pepper

Figure 5 Sampel red cayenne pepper

B. Pre-preprocessing Data

After the data collection process then data preprocessing is carried out to prepare pictures of chilies before use in model training and testing. In this stage, there are several images that contain a collection of chili images or background parts which is undesirable. To overcome this cropping the image manually with the aim of ensuring that the image is ready to be used in training. The image cropping process is carried out to delete the parts that are not desired in every image. After the next image cropping process, dividing or splitting data into data train, validation data and test data [13].

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C. Designed the CNN architecture

At this stage, architectural design is carried out CNN model. CNN is a deep learning algorithm designed to process data in the form of images, determine the importance of various aspects in the image through weights and biases that can be learned, and serves to differentiate one object from another [14]. CNN consists of two architectural layers, namely the feature learning layer and the classification layer [15], as shown in Figure 6.

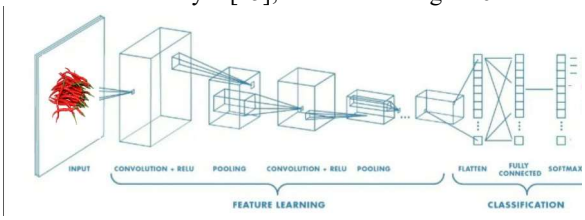

Figure 6 CNN architecture[16]

During the feature learning stage, there is a layer that directly takes image input and processes it into output data. This process involves convolution and pooling layers. Each step in these layers produces a feature map consisting of numbers representing the image, which is then passed to the classification layer. In the classification layer, there are several layers of neurons that are fully connected to each other. This layer receives input from the results of feature learning, then processes it through a flattening process and several fully connected hidden layers, to produce output in the form of classification accuracy for each class. [16].

D. CNN implementation

At this stage, clay chili data is implemented using the Convolutional Neural Network (CNN) method. Data that has passed the previous stages will be analyzed according to the stages in the CNN architecture which will be created using the Python programming language.

E. Testing Results and Classification

Accuracy is a metric used to assess the performance of a classification model. Accuracy is obtained by dividing the number of correct predictions from the model by the total number of predictions made, defined as follows [16].

$$Accuracy = \frac{correct\ prediction}{total\ predictions} \times 100\% \qquad (1)$$

III. RESULTS AND DISCUSSION

A. Dataset

The data used is in the form of images of types of chilies consisting of 500 images divided into 4 data classes. The author stipulates the data comparison is 80%: 20%, the data comparison is based on on the Pareto principle which is generally used in data mining, where the principle states that 80% of events result from the remaining 20%. The dataset distribution scenario can be seen in table 1.

Table 1 Dataset sharing scenario

class	Total Image	Data training	Data test
		80%	20%
Green Curly Chilies	125	100	25
Red Curly Chilies	125	100	25
Green Cayenne Pepper	125	100	25
Red Cayenne Pepper	125	100	25

B. Training Results

Training is carried out to create a model that will be implemented in system classification. Below are the results of the training.

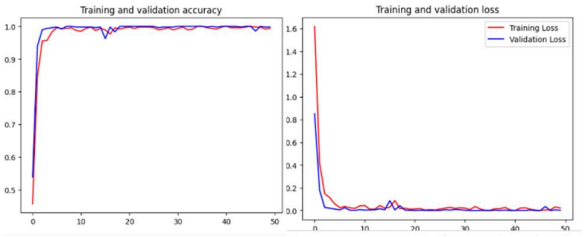

Figure 7 Training Results Graph

Figure 7 shows that the trained CNN model has a very high level of accuracy, almost reaching 100% and has low loss, indicating that the model is able to recognize and classify chili images very well without significant overfitting.

C. Test result

Testing uses test image data of 100 images. Does the image of the chili being tested match its class, an example of the test can be seen in the image

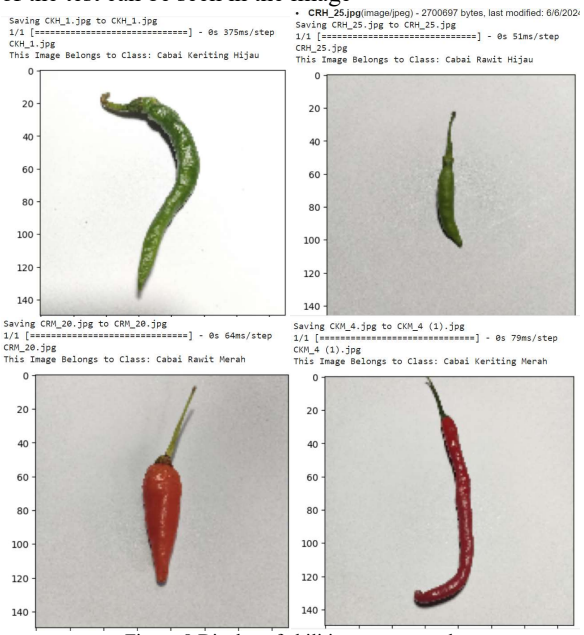

Figure 8 Display of chili image test results

It can be seen in Figure 8 that the CNN model can classify the types of chilies well. For each image entered, the CNN model can classify it according to its class. For more detailed results, see table 2

Table 2 CNN Model testing results

Class	Correct Prediction	Wrong Prediction
Green Curly Chilies	25	-
Red Curly Chilies	25	-
Green Cayenne Pepper	25	-

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Red Cayenne Pepper	19	6

Table 2 shows the results of testing the CNN model in classifying chilies. The test was carried out using 100 test data from various types of chilies. CNN accuracy level in classifying chili types can be calculated with the equation:

$$Accuracy = \frac{correct\ prediction}{total\ predictions} \times 100\%$$

$$Accuracy = \frac{94}{100} \times 100\% = 94\%$$

Convolutional Neural Network (CNN) model in classification types of chilies achieved an accuracy of 94%. This accuracy proves that CNN can classify the types of chilies very well.

IV. CONCLUSION

Based on several stages of testing that have been carried out, it can be concluded that the Convolutional Neural method Network (CNN) is able to classify chili types very well. The research results show that the model achieved 99.5% accuracy, indicating the model's ability to recognize patterns in the data very well. In testing using 100 images of chilies from the 4 types of chilies tested, the CNN model was able to recognize the types of chilies correctly with an accuracy of 94%. For future research, it is recommended to use a larger and more diverse dataset with more types of chilies, as well as exploring other classification methods such as Transfer Learning, Random Forest, Support Vector Machine, k-Nearest Neighbors, and YOLO (You Only Look Once) to improve and strengthen the results that have been achieved.

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