



Detection of Palm Fruit Maturity Using Convolutional Neural Network Method

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Abstract

Palm oil has an important role as a source of foreign exchange in the economy in Indonesia. Oil palm is one of the vegetable oil-producing plants that has the highest economic value compared to other crops such as soybeans, olives, coconuts or sunflowers. Palm oil quality is also influenced by water content, dirt content, free fatty acid content and the level of maturity of the palm fruit. Maturity of palm fruit is a very important factor in determining the quality of crude oil produced by palm fruit. In determining the maturity of oil palm, sorting is necessary to get quality palm fruit with the appropriate level of maturity. The use of image processing technology (ImageProcessing) can facilitate the process of analyzing objects. Meanwhile, the implementation of deep learning using the Convolutional Neural Network method can help identify the maturity level of oil palm fruit with a high level of accuracy. The results showed a very good effectiveness with an accuracy reaching 99% and a precision level reaching 99.8%.

1. Introduction

Palm oil is one of the most efficient vegetable oil-producing plants among several vegetable oil sources that have other high economic value, such as soybeans, olives, coconuts and sunflowers. The part of oil palm that has high economic value is the part of the fruit which is arranged in a bunch, commonly called FFB (fresh fruit bunches).

In practice, in general, the determination of fruit maturity is still done visually by experienced oil palm farmers based on the number of fruits that fall from the bunch or the color of the fruit. Such identification techniques and processes have several weaknesses, including the relatively long time required, humans also tend to feel tired and bored easily when carrying out monotonous activities, differences in perceptions of fruit quality, various product results are also obtained due to human visual limitations, and is greatly influenced by the psychological condition of the observer. This can also result in inconsistency in the selection process.

To select the level of maturity of oil palm fruit can be done by utilizing computer technology, one of which uses image processing techniques. The Convolutional Neural Network (CNN) method is one of the algorithms in image processing techniques that is quite good for use in object recognition and image detection.

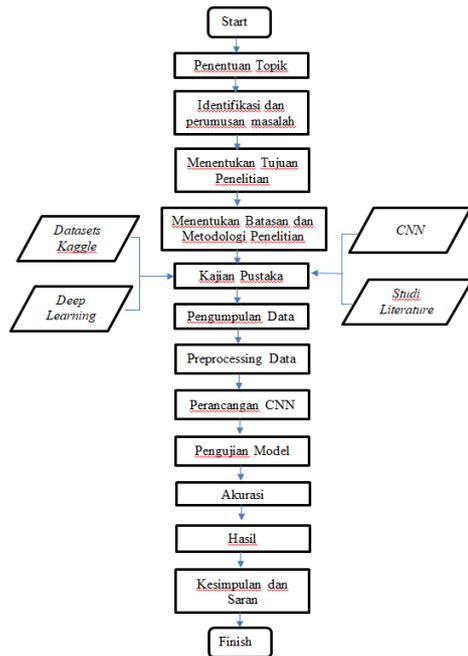
Several previous studies have been completed, for example Oil Palm Detection via Deep Transfer Learning (Isis Bonet et al., 2020) and Oil Palm Fruit Image Ripeness Classification with Computer Vision using Deep Learning and Visual Attention (Herman et al., 2020). However, from previous research that has been done, there has been no similar research using the Convolutional Neural Network algorithm. Researchers wish to conduct a similar study using the CNN algorithm. The Deep Learning method that currently has the most

significant results in image recognition is the Convolutional Neural Network. Because the Convolutional Neural Network method tries to imitate the image recognition system in the human visual cortex so that it has the ability to process image information like humans (Maulana & Rochmawati, 2019). The challenge of using the CNN method is how to produce high accuracy with relatively low computational costs. Of course, many things can affect this, some of which are the number of training datasets, the dimensions of the data, and the selection of the right training rate (Sahrul et al., 2018). Another technique is to use a transfer learning architecture that is capable of imitating or duplicating previous models that have been initiated by machines (Prathivi et al., 2019). Based on the above background, this research applies the implementation of the deep learning method using CNN to help identify and produce the best accuracy in determining the maturity level of oil palm fruit.

2. Research Methods

2.2. Research Method

The Convolutional Neural Network (CNN) method is one of the AI methods that is specifically applied to visual or image data. In this study, in selecting the maturity level of oil palm fruit using the Deep Learning method with the Convolutional Neural Network Algorithm with the research flow as described in the flowchart below.



There are 5 basic steps used as a solution to problems in deep learning:

- A. Collecting data: this step is formed from saving in several files containing data that can be learned by the computer, and after that it is separated between input and output features.
- B. Preparing data: determining data quality in data preprocessing so that the results obtained are also optimal/good.
- C. Train a model: this step is done by selecting the right algorithm and data representation in the form of a model.
- D. Evaluating the model: testing the accuracy of the results based on the test dataset section.
- E. Improve performance: this step involves selecting hyperparameters to increase efficiency and usually using cross-validation.

2.2. Dataset

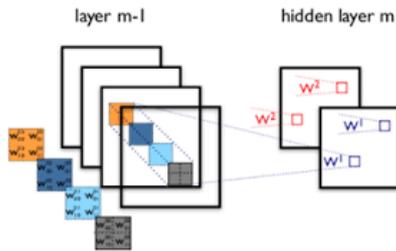
The dataset used is in the form of image data, consisting of test data and training data sourced from kaggle (<https://www.kaggle.com/datasets/ahmadfath>

an/kematangansawit), with a total of 205 images for each test data and 206 images for training data. The training data is used to train the image data, then the prediction results of the image data will be entered into the test data, to be submitted and assessed by the Kaggle competition platform. The total test and training data used in this study were 411 images.

2.3. Convolutional Neural Network

Convolutional Neural Network (CNN) is the development of Multilayer Perceptron (MLP) which is designed to process two-dimensional data. CNN is included in the type of Deep Neural Network because of its high network depth and widely applied to image data. In the case of image classification, MLP is not suitable for use because it does not store spatial information from image data and considers each pixel as an independent feature, resulting in poor results. CNN was first developed under the name NeoCognitron by Kunihiko Fukushima, a researcher from the NHK Broadcasting Science Research Laboratories, Kinuta, Setagaya, Tokyo, Japan. The concept was then finalized by Yann LeChun, a researcher from AT&T Bell Laboratories in Holmdel, New Jersey, USA. The CNN model with the name LeNet was successfully applied by LeChun in his research on number and handwriting recognition. In 2012, Alex Krizhevsky with his CNN application won the ImageNet Large Scale Visual Recognition Challenge 2012. This achievement became a moment to prove that the Deep Learning method, especially CNN. The CNN method has proven to be successful in outperforming other Machine Learning methods such as SVM in the case of object classification in images. The way CNN works is similar to MLP, but in CNN each neuron is represented in two dimensions, unlike MLP where each neuron is only one dimension.

Due to the nature of the convolution process, CNN can only be used on data that has a two-dimensional structure such as images and sounds.



2.4. Preprocessing Data

At this stage, data collection (gathering), image data labeling and image augmentation will be carried out from the entire training image data. This study uses preprocessing data with image segmentation and produces a model that is able to learn from the input data in the form of images of palm fruit and is able to produce predictions of palm maturity.

2.5. Test

At this stage the Convolutional Neural Network Algorithm requires a training and testing process. This training process aims to train the CNN algorithm in recognizing the dataset and forming a model based on the training. The testing process aims to test a model that was formed during the training process.

3. Results and Discussion

The testing process uses the Convolutional Neural Network method, at this stage the data collected in the form of images. The testing phase is carried out by running applications that have been made on a laptop or computer with a camera. This stage will determine that the application or program is successfully created.

This section contains a complete and detailed flowchart of the research steps including the reflected algorithms, routes,

models, designs, which are related to aspects of system design.

4. Conclusion

In conclusion, the system that the researcher made is very effective, with the following considerations:

- A. The use of the CNN method is very well achieved by using it without having to make any modifications to the structured algorithm
- B. Besides being very accurate, the proposed approach is very flexible because it can be directly used to identify the same plant species, or different varieties for training and validation.
- C. The classification method used has high potential, due to the impact that this technology can have on larger plantations.

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