Optimization of the CNN model for smart agriculture

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Abstract. Artificial intelligence is a branch of computer science that has advanced quite rapidly and is very useful in helping to alleviate human tasks. One of the models or algorithms part of artificial intelligence is the Convolutional Neural Network (CNN). This model is proven to be very accurate in image data processing. CNN has been used for facial recognition and image data detection systems. In this study, researchers will optimize CNN to obtain a faster and more accurate model for processing plant disease image data in this study using oil palm plant sample data. With the Research and Development method and FGD (Focus Group Discussion) with various experts, this research is expected to produce a CNN model that is faster and more accurate.

Keyword: Optimization, Model, CNN, Smart, Agriculture

1. Introduction

According to the United Nations Food and Agriculture Organization (FAO), human food needs will continue to increase while the availability of agricultural land is decreasing. The United Nations Food and Agriculture Organization (FAO) estimates that the global population will reach 8 billion people by 2025 and 9.6 billion people by 2050. To keep pace, food production must increase by 70 percent by 2050 [1]. So humans are looking for new ways in agriculture that are not dependent on land. Researchers carry out various kinds of research related to smart agriculture in an effort to increase crop yields. Climate conditions that continue to experience unpredictable changes greatly affect the conventional agricultural sector. Quite a drastic change in seasons sometimes causes crop failure. Climate change fundamentally causes development changes in agriculture [2].

1.1. Formulation of the problem

The formulation of the research problem is as follows:

a. Difficulty in monitoring plant conditions and real-time. So it is difficult to take care of plants to grow properly.

b. The difficulty of conventional detection of pests and plant diseases. Pests and plant diseases that can be detected early can prevent and avoid attack by these pests and plant diseases.
1.2. Research purposes
This study aims to obtain a new smart agriculture modeling by optimizing the Artificial Intelligence Model, namely the Convolution Neural Network (CNN) in order to produce a better, faster and more accurate model.

1.3. Benefits of Research
Produce a new model in the field of computer science, especially artificial intelligence, by optimizing the Convolution Neural Network (CNN) algorithm.

2. Literature Review
2.1. Smart Agriculture
One of the implementations of the internet of thing is smart agriculture. Smart agriculture is a development of a smart system that is implemented in agriculture. Internet of Things-based Smart Agriculture is a concept where agricultural equipment that usually uses traditional methods is replaced by equipment equipped with instruments and connected via the internet [3]. Agriculture has an important role for a country to meet the food and economic needs of its citizens. Especially countries where most of its citizens work as farmers [4].

2.2. Convolution Neural Network (CNN)
Neural convolution networks (CNN) have an inference process for recognition and a back propagation process for training. Because CNN training takes a lot of time, the complete CNN training application is usually carried out off-line, and then uses a trained CNN in the terminal to carry out the process [5].

The mathematical model of the Convolution Neural Network (CNN) algorithm in this study is as follows:
\[ s(t) = (x . t) (t) = \sum_{a=-\infty}^{\infty} x(a) \cdot w(t-a) \]  

Where:
- \( s(t) \) = Function resulting from convolutional operations
- \( x \) = Input
- \( w \) = weight (kernel)

The function \( s(t) \) provides a single output in the form of a feature map.

3. Method
This study uses a method known as the WBL RoTer Model or Integrated Rolling WBL with FGD (Focus Group Discussion) activities, Delphi techniques, and experiments. The development method in this study refers to the R&D stage model recommended by Borg & Gall[6] or Plomp[7].

![Figure 1. CNN model](image-url)
• Input: Enter the image data into CNN, in this case the image data to be studied is the leaves of the oil palm plant.

• Feature Extraction, including Convolution, Relu or layer activation functions and the pooling layer. This process is repeated several times to obtain sufficient maps to proceed to the Classification process.

• Classification You will get the classification results in the form of information on healthy plant leaves or plant leaves that are attacked by diseases or pests.

4. Result and Discussion
This section describes the results of the research that has been carried out from the collection of datasets in the form of training data, validation data, and data testing. The following is the dataset used in this study:

Figure 2. The sample train dataset is for palm leaves that are attacked by diseases / pests

Figure 3. The sample train dataset for healthy palm leaves

Figure 4. Dataset of tested samples
In this study, using the Python programming language with the addition of other tools imported into python. The steps for obtaining research results are as follows:

a) Install all the necessary tools, namely:
   - Python
   - Jupyter notebook
   - Tensorflow Module
   - Hard Module

b) Declaration of all modules used

c) Creating a Dataset Image or image on the Desktop directory with 3 subfolders, namely
   - Train
   - Validation
   - Test

d) Declare train and validate the image

e) Run Instructions to view classification results

Coding to compile the model

```python
model.compile (loss = 'binary_crossentropy',
               optimizer = RMSprop (lr = 0.001),
               metrics = ['accuracy'])
```

```
# coding to see the results of accuracy and speed
model.fit = model.fit (train_dataset,
                      steps_per_epoch = 3,
                      epochs = 30,
                      validation_data = validation_dataset)
```

| No. | Dataset          | affected by pests | healthy |
|-----|------------------|-------------------|---------|
| 1   | Training data    | 20                | 10      |
| 2   | Data Validation  | 20                | 10      |
| 3   | Data Testing     | 4                 | 5       |

Table 1. Dataset for training data for healthy palm leaves

| Epoch | Time/step | Loss  | Accuracy | Validation Loss | Validation Accuracy |
|-------|-----------|-------|----------|-----------------|---------------------|
| 1/30  | 2s 554ms  | 26.2618 | 0.3333   | 0.7974          | 0.6667              |
| 5/30  | 1s 451ms  | 0.7449  | 0.5556   | 0.4801          | 0.8333              |
| 10/30 | 1s 488ms  | 0.7893  | 0.7778   | 0.6043          | 0.6333              |
| 15/30 | 1s 489ms  | 0.1797  | 1.0000   | 1.0433          | 0.7333              |
| 20/30 | 2s 516ms  | 0.2243  | 0.8889   | 0.4609          | 0.7667              |
| 25/30 | 2s 574ms  | 0.4272  | 0.7778   | 0.3808          | 0.9000              |
| 30/30 | 1s 492ms  | 0.0718  | 1.0000   | 0.0683          | 1.0000              |

Table 2. Result of model compilation

From the compilation of the model, the accuracy and loss graph is obtained as follows:
5. Conclusion
From the accuracy and loss graph, the model under study still shows unstable accuracy and loss, this is probably due to the lack of a large number of datasets used. The results of the compilation of the model show that it has shown 100% accuracy at the 30th iteration (epoch) and the image data test results show the same results.
References

[1] Beecham, “Towards Smart Farming: Agriculture Embracing the IoT Vision,” Beechham Res., 2014.

[2] J. W. Kruize, J. Wolfert, H. Scholten, C. N. Verdouw, A. Kassahun, and A. J. M. Beulens, “A reference architecture for Farm Software Ecosystems,” Comput. Electron. Agric., 2016, doi: 10.1016/j.compag.2016.04.011.

[3] P. D. R. S. K. Nikesh Gondchawar, “IoT based Smart Agriculture,” Int. J. Adv. Res. Comput. Commun. Eng., 2016, doi: 10.17148/IJARCCE.2016.56188.

[4] G. Gunawan, M. Sari, B. Surbakti, and A. Ginting, “Design of Automatic Plant Areas Using Humidity Sensor Based on Internet of Thing,” in Journal of Physics: Conference Series, 2019, vol. 1361, no. 1, doi: 10.1088/1742-6596/1361/1/012063.

[5] M. Alwani, H. Chen, M. Ferdman, and P. Milder, “Fused-layer CNN accelerators,” 2016, doi: 10.1109/MICRO.2016.7783725.

[6] M. D. Gall, W. R. Borg, and J. P. Gall, “Educational research: an introduction,” in Educational research: an introduction, 2006, p. 788.

[7] T. Plomp, “Educational Design Research: an Introduction,” in An Introduction to Educational Research, 2010, pp. 9–35.