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# Implementation of deep learning for handwriting imagery of sundanese script using convolutional neural network algorithm (CNN)

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**Abstract**

Aksara Sunda, Sundanese writing system, is one of the cultures of Sundanese land that needs to be preserved. Currently, not all people know Aksara Sunda because of the shift in cultural values and there is a presumption that Aksara Sunda is difficult to learn because it has a unique and complicated shape. The use of deep learning has been widely used, especially in the field of computer vision to classify images, one of the commonly used algorithms is the Convolutional Neural Network (CNN). The application of The Convolutional Neural Network (CNN) algorithm on Sundanese handwriting imagery can make it easier for people to learn Sundanese script, this study aims to find out how accurate the neural network convolutional algorithm is in classifying Aksara Sunda imagery. Data collection techniques were done by distributing questionnaires to respondents. System testing using accuracy tests, testing on CNN models using data testing get 97.5% accuracy and model testing using applications get 98% accuracy. So based on the results of the trial, the implementation of deep learning methods using neural network convolution algorithms was able to classify the handwriting image of Aksara Sunda well.

**Keywords:** deep learning; convolutional neural network; computer vision; aksara sunda; classification of images.

## Introduction

Sundanese script is one of the cultures of Sundanese land that needs to be preserved, especially by the people of West Java [1]. Currently, not all West Java people understand Aksara Sunda due to a shift in cultural values that cause more interest in foreign cultures, especially there is an assumption that Aksara Sunda is difficult to learn because it has a unique and complicated form [2].

Deep learning is a part of artificial intelligence that is currently widely used in various fields such as to predict opportunities, recognize objects to diagnose diseases [3]. One of the uses of deep learning is in the field of computer vision to classify images, by using deep learning it can make it easier for humans to recognize objects precisely and quickly, CNN's are successfully and efficaciously used in many sample and image reputation packages [4][5]. Feature extraction is a key step of such set of rules. Function extraction from photo entails extracting a minimal set of features containing a high amount of object or scene data from low-degree photo pixel fee, therefor, taking pictures the differences a few of the item classes concerned [5].

There are several algorithms that can complete the classification of images in deep learning, namely Multi-Layer Perceptron (MLP) and Convolutional Neural Network (CNN). MLP is a model of artificial neural networks [6]. MLP can be used for speech recognition, patterns, characters or others, but has disadvantages when the input used is in the form of images [7]. CNN is a development of machine learning algorithms that can be used to process image data. [8]. The use of CNN algorithm can cover the shortcomings that exist in the MLP algorithm in solving input problems in the form of images.

This study employed CNN algorithm in classifying Sundanese handwriting imagery and analyze the level of accuracy in performing Aksara Sunda image recognition using accuracy tests. Image data used was the result of

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scanning Aksara Sunda handwriting from respondents, there are 10 types of Sundanese handwriting studied consisting of Aksara Sunda, Aksara Ngalagena and Sundanese numbers. System testing used accuracy tests.

## Method

### *A. Aksara Sunda*

Aksara Sunda is a letter derived from Sunda land that has been used since the 14th century, evidenced by various historical relics in the form of inscriptions, charters, and ancient manuscripts that are quite a lot [9]. The script known by the public today is the basic of Aksara Sunda [10] that is divided into two main types, namely Aksara Swara (a, é, i, o, u, e, dan eu) and Ngalagena (ka, ga, nga, ca, ja, nya, ta, da, na, pa, ba, ma, ya, ra, la, wa, sa, ha, fa, va, qa, xa, za, kha, sya) [11]. In general, Aksara Sunda is arranged into several groups or types, namely Aksara Swara, Aksara Ngalagena, Rarangkèn and Numbers.

### *B. Classification of Imagery*

Image classification is the process of grouping image pixels and assigning them to a category. The purpose of image classification is to duplicate the human ability to understand information in digital imagery [12].

### *C. Deep Learning*

Deep learning is part of machine learning that aims to solve more complex problems such as recognizing objects, recognizing sounds, recognizing text by replicating the workings of the human brain [13]. Deep learning algorithms have a unique feature that can act automatically so that they are able to capture relevant features as a need to solve problems [14].

### *D. Convolutional Neural Network(CNN)*

Convolutional Neural Network is the development of a multi-layer perceptron designed to process image data [8]. CNN was inspired by the visual cortex, one of the parts of the human brain that is useful for processing information in visual form [15].

This research applied CNN's algorithm in classifying handwriting images of Sundanese script. There are several stages in the training process in determining the characteristics or patterns in the image as shown in **Figure 1**.

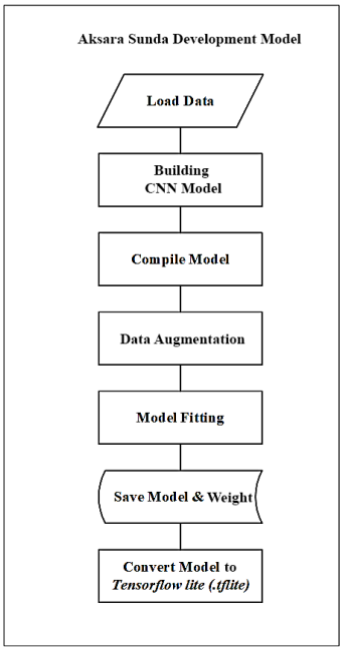


**Figure 1.** Stages of Training Process

The training process started from load data, build CNN model, compile model, data augmentation, model fitting, save model and weight and finally convert model to Tensorflow lite. The process of creating a training model was done using Keras library and Tensorflow. The architectural design of CNN's algorithm in this study was shown in **Figure 2**.

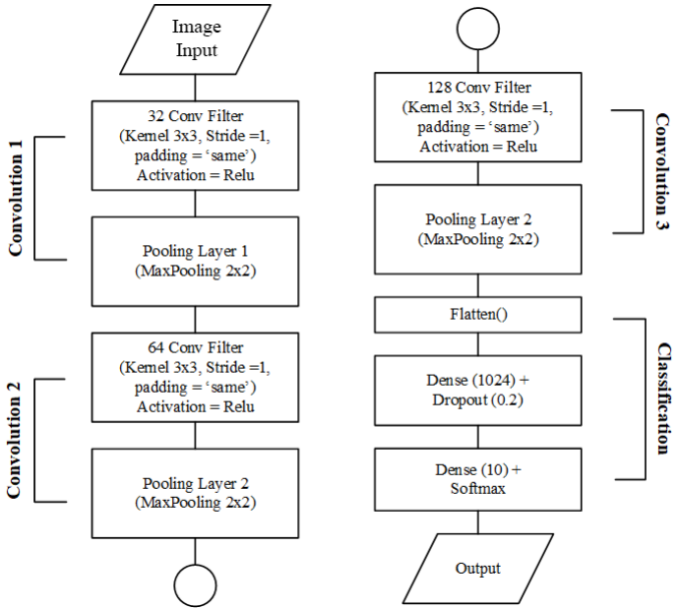


**Figure 2.** CNN Architecture Design

The CNN architecture of the study had 3 layers of convolution with a filter count of 32, 64 and 128 units added ReLu and MaxPooling functions to reduce the matrix size. In the classification process used 1 hidden layer that had 1024 kernel. The activation function used in the classification process was softmax.

### *E. Preprocessing Data*

Preprocessing data was the process of preparing raw data to be ready for the learning process. At this stage, the process of resize and grayscale was carried out.

1. Resize

   Resize was to change the size of the data to a certain size, in this study the original image data was resized to a size of 64x64. The goal of the resize process was to speed up the learning process and made the data one of the same sizes. Illustration of the resize process shown in **Figure 3**.

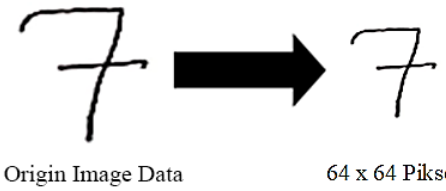


**Figure 3.** Illustration of the Resize Process

2. Grayscale

   Grayscale is the process of converting image colors from RGB to grayscale or gray with the aim of speeding up the learning process. Mathematically the grayscale process can be done with equations (1).

$$Grayscale = 0.299R + 0.587G + 0.144B \quad (1)$$

### *F. Calculation of Accuracy*

Accuracy calculation was a process used to test the performance of the CNN model that has been created in performing image classification. Equations used in calculating accuracy are shown in equations (2).

$$\text{Accuracy} = \frac{\text{Coorect Number of Test Data}}{\text{Total Ammount of Data}} x\ 100 \quad (2)$$

## Results and Discussion

### *A. Sample Data*

The data used in this study was a written image taken from respondents by writing on the data collection questionnaire, then the scanning and cropping process was carried out to get image data that was used as datasets. The data sample used in this study were 10 Aksara Sunda out of a total of 42 Aksara Sunda, sampling using systematic random sampling techniques with equations (3).

$$systematic\ random\ sampling = \frac{\text{Population}}{\text{Number of Sample Needed}} \tag{3}$$

$$systematic\ random\ sampling = \frac{42}{10} = 4.2 \approx 4$$

Based on the equation above, then 10 sample data used were at intervals 4, that was Aksara O, KA, JA, NA, YA, SA, QA, SYA, 4 and 8. **Figure 4** shows the illustration of sampling and sundanese script sample shown in **Table 1**.

**Table 1.** Sundanese Script Sample

| No | Sundanese Script | Type of Aksara | Latin Script |
|---|---|---|---|
| 1 |  | Swara | O |
| 2 |  | Ngalagèna | Ka |
| 3 |  | Ngalagèna | Ja |
| 4 |  | Ngalagèna | Na |
| 5 |  | Ngalagèna | Ya |
| 6 |  | Ngalagèna | Sa |
| 7 |  | Ngalagèna | Qa |
| 8 |  | Ngalagèna | Sya |
| 9 |  | Number | 4 |
| 10 |  | Number | 8 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| *a* | *é* | *i* | *o* | *u* | *e* | *eu* | *ka* | *ga* | *nga* |
| | | | ✓ | | | | ✓ | | |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| *ca* | *ja* | *nya* | *ta* | *da* | *na* | *pa* | *ba* | *ma* | *ya* |
| | ✓ | | | | ✓ | | | | ✓ |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| *ra* | *la* | *wa* | *sa* | *ha* | *fa* | *va* | *qa* | *xa* | *za* |
| | | | ✓ | | | | ✓ | | |
| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| kha | sya | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | ✓ | | | | ✓ | | | | ✓ |
| 41 | 42 | | | | | | | | |
| 9 | 0 | | | | | | | | |

**Figure 4.** Illustration of Sampling

### *B. Application Deployment*

In testing the handwriting of Aksara Sunda's image classification system, it was created a mobile-based application using Android Studio.


**Figure 5.** Application View

**Figure 5** is a display of the application used to classify Aksara Sunda imagery. The classification process began with the user taking input data in the form of handwriting using a mobile phone camera, when the input data was successfully retrieved, the user then presses the detection button, then the classification process were done by matching the pattern between the input data and the model that has been created. Then, the output of the classification process was displayed in the form of labels of the detected Aksara Sunda. **Figure 6** is the flow of the classification process using mobile-based applications.

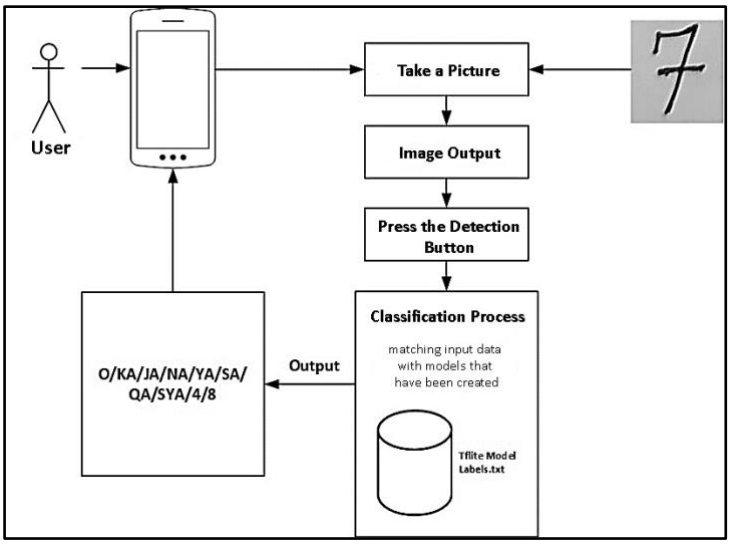


**Figure 6.** Application Usage Flow

### *C. CNN Model Testing*

Testing on the CNN model was conducted on 10 classes of Aksara Sunda, input data derived from data testing amounting to 40 image data, the purpose of this test was to see the performance of the CNN model that has been created. CNN model test result shown in **Table 2**.

**Table 2.** CNN Model Test Result

| No | Aksara Sunda's Class | Number of Test Data | Amount of Correct Data | Amount of Incorrect Data |
|---|---|---|---|---|
| 1 | 4 | 4 | 4 | 0 |
| 2 | 8 | 4 | 4 | 0 |

| No | Aksara Sunda's Class | Number of Test Data | Amount of Correct Data | Amount of Incorrect Data |
|---|---|---|---|---|
| 3 | JA | 4 | 4 | 0 |
| 4 | KA | 4 | 3 | 1 |
| 5 | NA | 4 | 4 | 0 |
| 6 | O | 4 | 4 | 0 |
| 7 | QA | 4 | 4 | 0 |
| 8 | SA | 4 | 4 | 0 |
| 9 | SYA | 4 | 4 | 0 |
| 10 | YA | 4 | 4 | 0 |
| Total | | 40 | 39 | 1 |

Based on the results of the above test, from a total of 40 image data as many as 39 data were correctly classified and there was a detecting error from the input of class KA as much as 1 data, based on the equation (2) then the calculation of accuracy from the above test is as follows:

$$\text{Accuracy} = \frac{40}{39}\ x\ 100\ =\ 97.5\%$$

Accuracy score of CNN model is 97.5%.

### *D. Model Testing Using Application*

Testing on the CNN model was conducted on 10 classes of Aksara Sunda, the input data used in this test came from the handwriting of Aksara Sunda that written on HVS paper amounting to 50 characters and then detected through a smartphone camera, each class consists of 5 Aksara Sunda. The purpose of the test was to see the accuracy of the model produced by the application. Model test results using the application shown in **Table 3**.

**Table 3.** Model Test Results Using the Application

| No | Aksara Sunda's Class | Number of Test Data | Amount of Correct Data | Amount of Incorrect Data |
|---|---|---|---|---|
| 1 | 4 | 5 | 5 | 0 |
| 2 | 8 | 5 | 5 | 0 |
| 3 | JA | 5 | 5 | 0 |
| 4 | KA | 5 | 5 | 0 |
| 5 | NA | 5 | 5 | 0 |
| 6 | O | 5 | 5 | 0 |
| 7 | QA | 5 | 5 | 0 |
| 8 | SA | 5 | 4 | 1 |
| 9 | SYA | 5 | 5 | 0 |
| 10 | YA | 5 | 5 | 0 |
| Total | | 50 | 49 | 1 |

Based on the above tests, from 50 image data as many as 49 data was correctly classified and there was an error detecting from SA class image data as much as 1. So based on the calculation of the script from the test which results are shown in **Table 3**. So, the accuracy generated by testing the model using the application was obtained a value of 98%.

$$\text{Accuracy} = \frac{49}{50}\ x\ 100\ =\ 98\%$$

## Conclusion

The conclusion of this study is the implementation of the CNN algorithm in classifying Aksara Sunda's handwriting imagery using a combination of 3 convolutional layers, 3 pooling layers, 1 flatten layer and 1 dropout layer. The number of filters used in the implementation process is 32, 64 and 128 units with a 3x3 kernel number as well as ReLU and Softmax activation functions. In testing the CNN model using data testing amounted to 40 image data to get an accuracy of 97.5%, while in testing the model using applications by way of imagery derived from handwriting on HVS paper amounted to 50 image data getting accuracy of 98%. In the development of the system, it takes some improvements following some suggestions that can be done to develop the system in previous research. They are adding the type of Aksara Sunda, adding the amount of image data, developing a system to be able to classify more than one Aksara Sunda simultaneously, using different methods to compare classification results.

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