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Implementation of Deep Learning for Aksara Sunda Handwriting Imagery Using Convolutional Neural Network Algorithm (CNN)

Arif Purnama^{1,2}; Saeful Bahri^{3,2}; Gunawan^{4,2}; Taufik Hidayatulloh^{5,6}; Satis Suhada^{6,5}
¹Universitas Bina Sarana Informatika, Jl. Cendekia No. 8, Subang 41115, Indonesia
²Universitas Negeri Maulana, Jl. Jembermanggala Raya, Kelurahan Cipanas, Mojokerto, Jawa Timur 60601, Indonesia
³arifpurnama@gmail.com; ⁴saeful.bahri@gmail.com; ⁵gunawan.gunawan@gmail.com; ⁶taufik.hidayatulloh@gmail.com; ⁷satis.suhada@gmail.com
⁸Corresponding author

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Abstract
Aksara Sunda becomes 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 are done by distributing questionnaires to respondents. System testing using accuracy tests, testing on CNN models using data testing got 97.7% accuracy and model testing using applications got 99% accuracy. So based on the results of the trial, the implementation of deep learning methods using neural network convolutional algorithm 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 know 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.
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 [4]. MLP can be used for speech recognition, patterns, characters or others, but has disadvantages when the input used is in the form of images [5]. CNN is a development of machine learning algorithms that can be used to process image data [6]. The use of CNN algorithm can cover the shortcomings that exist in the MLP algorithm in solving input problems in the form of images.
In this study will apply 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 is the result of scanning Aksara Sunda handwriting from respondents, Aksara Sunda studied there are 10 types of sundanese handwriting consisting of Aksara Sunda, Aksara Ngagame and sundanese numbers. System testing uses accuracy tests.

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^a Universitas Bina Sarana Informatika, Jl. Cemerlang No.8, Sukabumi 43135, Indonesia

^b Universitas Nusa Mandiri, Jl. Jatiwaringin Raya Kelurahan Cipinang Melayu, Kecamatan Makassar Jakarta Timur 13680, Indonesia

¹ arifpurnama6@gmail.com; ² saeful.sel@nusamandiri.ac.id; ³ gunawan.gnz@bsi.ac.id; ⁴ taufik.tho@bsi.ac.id; ⁵ satia.shq@nusamandiri.ac.id

* Corresponding author

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Abstract

Aksara Sunda becomes 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 are 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.

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Introduction

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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 [7]. The script known by the public today is the basic of Aksara Sunda [8]. Basic of Aksara sunda is divided into two main, 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) [9]. In general, Aksara Sunda is arranged into several groups or types, namely Aksara Swara, Aksara Ngalagena, Rarangken 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 [10].

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 mimicking the workings of the human brain [11]. 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 [12].

D. Convolutional Neural Network(CNN)

Convolutinal Neural Network is the development of a multi-layer perceptron designed to process image data [6]. CNN was inspired by the visual cortex, one of the parts of the human brain that is useful for processing information in visual form [13].

This research will apply 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.

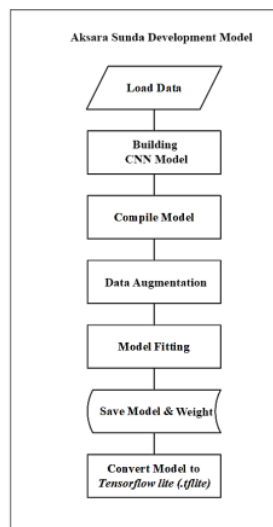


Figure 1. Stages of Training Process

The training process starts 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 is done using Keras library and Tensorflow. The architectural design of CNN's algorithm in this study was shown in figure 2.

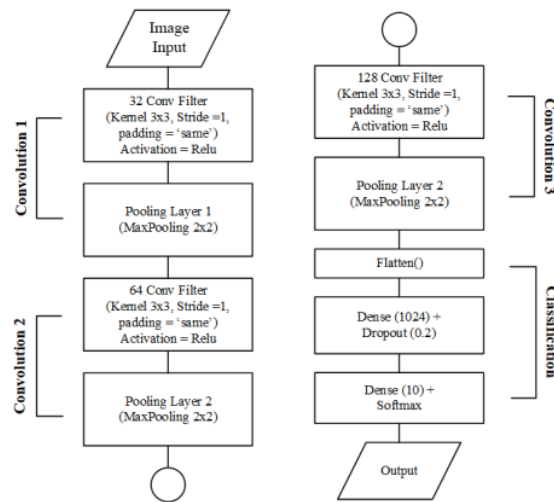


Figure 2. CNN Architecture Design

The CNN architecture of the study has 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 has 1024 kernel. The activation function used in the classification process is softmax.

E. Preprocessing Data

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

1. Resize

Resize is to change the size of the data to a certain size, in this study the original image data will be resized to a size of 64x64. The goal of the resize process is to speed up the learning process and make the data one of the same size.



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 is 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)

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

Results and Discussion

A. Sample Data

The data used in this study is a written image taken from respondents by writing on the data collection questionnaire, then the scanning and cropping process is carried out to get image data that will be used as datasets.

The data sample used in this study is 10 Aksara Sunda out of a total of 42 Aksara Sunda, sampling using systematic random sampling techniques with equations.

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

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

Based on the equation above, then 10 sample data that will be used are at intervals 4, that is Aksara O, KA, JA, NA, YA, SA, QA, SYA, 4 and 8. Figure 4 shows the illustration of sampling.

1	2	3	4	5	6	7	8	9	10
a	é	í	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. Ilustrasi of Sampling

Table 1. Aksara Sunda Sample

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

10	<i>U</i>	Number	8
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B. Application Deployment

In testing the handwriting 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 begins with the user taking input data in the form of handwriting using a mobile phone camera, when the input data is successfully retrieved, the user then presses the detection button, then the classification process will be done by matching the pattern between the input data and the model that has been created. The output of the classification process will be displayed in the form of labels of the detected Aksara Sunda. The following is the flow of the classification process using mobile-based applications.

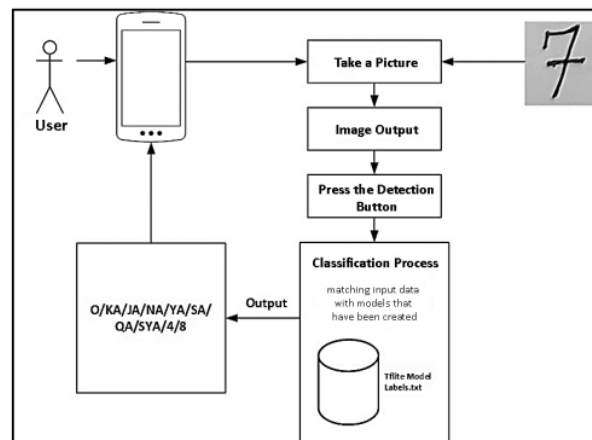


Figure 6. Application Usage Flow

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 to see the performance of the CNN model that has been created.

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
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:

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

Jadi, akurasi yang dihasilkan oleh model CNN didapatkan nilai sebesar 97.5%.

D. Pengujian Model Menggunakan Aplikasi

Pengujian model menggunakan aplikasi dilakukan terhadap 10 kelas aksara sunda, data input yang digunakan pada pengujian ini berasal dari tulisan tangan aksara sunda yang ditulis diatas kertas HVS berjumlah 50 aksara kemudian dilakukan deteksi melalui kamera smartphone, dimana tiap kelas terdiri dari 5 aksara sunda. Tujuan dari pengujian untuk melihat akurasi model yang dihasilkan oleh aplikasi.

Table 3. Hasil Pengujian Model Menggunakan Aplikasi

No	Kelas Aksara Sunda	Jumlah Data Uji	Jumlah Data Benar	Jumlah Data Salah
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

Berdasarkan pengujian diatas, dari 50 data citra sebanyak 49 data berhasil diklasifikasi dengan benar dan terdapat kesalahan mendeteksi dari data citra kelas SA sebanyak 1. Maka berdasarkan perhitungan aksara dari pengujian diatas adalah sebagai berikut:

$$\text{Akurasi} = \frac{49}{50} \times 100 = 98\%$$

So, the accuracy generated by testing the model using the application is obtained a value of 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, which is expected to add the type of Aksara Sunda, is expected to add the amount of image data, is expected to develop a system to be able to classify more than one Aksara Sunda simultaneously, expected to use different methods so as to compare classification results.

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