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Optimization of Image Classification Using the Convolutional Neural Network (CNN) Algorithm for Cirebon Batik Image Indonesian

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Abstract

Batik is an artistic culture in Indonesia that is well known to the world. Cirebon is one of Indonesia's batik-producing areas which has characteristic motifs and colours. On the other hand, the rapid development of technology has made the current generation of people forget the cultural heritage of their respective regions. To introduce Cirebon batik, researchers created an image recognition program for Cirebon batik using the Convolutional Neural Network algorithm, which is a convolution activity by combining several layers of preparation, by utilizing several components that move together and are motivated by a biological sensory system. The batik images used are Lion Barong, Naga Liman, Mega Mendung, Kraton Cirebon, Banjar Balong. The implementation of Cirebon batik image recognition is carried out using a test model, namely the Sequential model that runs on the Google Collaboratory application, and Keras. The test data in this study were 175 training data images and 55 test data images which resulted in an evaluation value with an accuracy value of 98.18% and a loss value of 0.117 in the Sequential model.

Keywords *– Convolutional Neural Network* (CNN)*, Image Classification,* Cirebon Batik, *Hard*

1. Introduction

Indonesia has various kinds of cultural arts in the form of batik art which are spread in almost all islands in Indonesia. Batik is an image produced using a canting tool or the like with wax material as a barrier to the entry of colour and has been recognized by the world as a UNESCO world heritage on October 2, 2009 as a human heritage for oral and non-material culture.[1], [2]. Cirebon is the site of the development of a well-known Islamic sultanate in West Java, so that there are many historical relics of Islamic culture. This can be seen from one of the relics of Islamic culture found in Cirebon, namely the Kasepuhan Palace[3]. Each region in Indonesia has its own batik characteristics that contain its own meaning, Cirebon batik is one of the batik arts that still exists today and many people really like Cirebon batik but don't know about the motifs in the cloth.[4]. The number of batik motifs in Indonesia makes people confused in determining Cirebon batik with other batik.

Research by [2]with the title "Classification of Riau Batik Using Convolutional Neural Networks (CNN)", to classify Riau batik. The total data used are 160 images divided into 68 images of Riau batik and 100 images of non-Riau batik which produce an accuracy value of 65%.

Research by [5]entitled "The Strength of Cirebon Batik Motif Design as a Space for Indonesian Geographical Indications of Identity,". The uniqueness and characteristics of Cirebon batik are part of the identity space for the people of Cirebon and deserve Geographical Indications to provide economic values that have an impact on the preservation of Indonesian batik traditions in general.

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Research by [6] entitled "Classification of typical batik fabrics and typical Sasirangan fabrics using the convolutional neural network method," the results of the accuracy of 91.84% when trained by doing random data with 20 epochs and when testing data with 10 random data, we get the results of the accuracy as much as 99.73%.

Research by [7]entitled "Analysis and Implementation of Palm Disease Diagnosis with the Convolutional Neural Network (CNN) Method," From the test, 2490 oil palm images were labelled with 11 disease categories. The highest accuracy result is 0.89 and the lowest is 0.83 and the average accuracy is 0.87. This shows that the results of oil palm image classification with CNN are quite good.

Based on the problems and previous research, researchers are interested in conducting research in the classification of Cirebon batik using the Convolutional Neural Networks (CNN) algorithm. This research is expected to be able to contribute to the preservation of Cirebon batik culture.

1.1 Pre-processing

Pre-processing is the initial stage of the face recognition process by processing the original data before the data is processed for recognition. This stage is carried out with the aim of preparing images and changing images according to system requirements so that the information contained in them is suitable for processing in the next process. In addition, pre-processing is also carried out to prepare training data and data testing. The pre-processing stages carried out are scaling, grey scaling, and thresholding.[8].

1.2 Deep Learning

Artificial Neural Network (ANN) is a branch of machine learning [9]. Machine learning is a computational algorithm that works based on historical data to improve accuracy in making predictions*[10]*. *Deep Learning*s a learning method that utilizes a multi-layered artificial neural network. This Artificial Neural Network is made similar to the human brain, where neurons are connected to each other to form a very complex network of neurons.[11].

1.3 *Convolutional Neural Network* (CNN)

Convolutional Neural Network(CNN) is a deep neural network algorithm, which is most commonly applied to analyse visual images. CNN is a multilayer perceptron in which each neuron is connected to all neurons in the next layer. However, CNN is able to find hierarchical patterns in the data and collect more complex pixels from smaller, simpler pixels. Therefore, CNN's performance in terms of connectivity and pixel complexity of the image is very good[7].

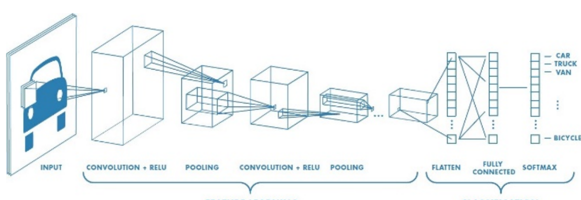


Figure 1 CNN Architecture

A. Convolution Layer

*Filter*top extract objects from the input image where the filter has a weight that functions as character detection from an object that can be edges, curves or colours is a convolution layer process on CNN. This convolution layer will produce a linear transformation originating from the input image that adjusts to the spatial information in the data. Repeated filter processes can produce a series of receptive fields. The parameters used to be able to modify the properties of each layer are by changing the filter size, controlling the filter by determining the input data that moves along the pixels or can be called stride control,[6]. The mathematical equation of the convolution operation can be seen in the following equation[10]:

$$s(t) = (x \times y)(t) \tag{1}$$

Where s(t) is the convolution function, x is the input, and w is the filter.

B. Pool

*Pool*er subsampling is a reduction in the size of the matrix. There are two types of pooling that are often used, namely average pooling and max pooling. The value taken in average pooling is the average value while in max pooling is the maximum value[12][13].

C. Rectified Linear Units (ReLu)

Rectified Linear Unit(ReLu) is a linear activation function that is widely used in CNNs. This activation function has the task of determining whether a neuron should be active or not based on the weight value entered[14]. The mathematical equation of the RelU activation function can be seen in the following equation[10].

$$relu(x) = \max(0, x) \tag{2}$$

Where relu(x) is a RelU function of the value of x, x is the input, and max(0, x) is a function of the max values of 0 and x.

D. Fully Connected Layer

Feature map generated by the previous stage in the form of a multidimensional array. So, before entering the Fully Connected Layer stage, the Feature Map will go through a "flatten" or reshape process. The flatten process generates a vector that will be used as input from the Fully Connected Layer. Fully Connected Layer has several Hidden Layers, Action Functions, Output Layers and Loss Functions[11].

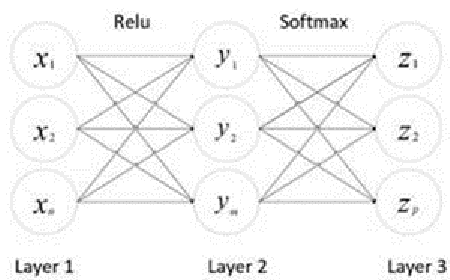


Figure 2 Fully Connected Layer

From Figure 4 above, where layer 1 will be carried out the feed forwarding process to layer 2 using the RelU activation function. In the layer 2 section, the classification process will be carried out using softmax[15]. The equation formula for the fully connected layer can be written as follows[16]:

$$z_r = \sum_{c=1}^{J} x_c W_{cr} + b_r \tag{3}$$

Where r is 1,2,3,…,R, R is the number of outgoing neurons, J is the number of incoming neurons, zr is the output of the r-th neuron, xc is the input of the c-th neuron, Wcr is the weight between neurons the c-th input goes to the r-th output neuron, and br is the bias for the r-th output neuron.

E. SoftMax

*SoftMax Activation*s another form of Logistic Regression that functions in the classification process of more than two classes. SoftMax is used to convert the output of the last layer into its basic probability distribution. The following is the SoftMax activation equation[17]:

$$fi(\vec{x}) = \frac{e^{xi}}{\sum_{j=1}^{k} e^{xj}} \tag{4}$$

In the above equation there is the notation fi which is the result of the function for each i-th element in the class vector output. While x is a vector that has a value obtained from the results of the last fully connected layer. SoftMax can calculate the probabilities of all classes then a vector with real value will be taken and converted into a value with a range of zero to one which if added up all will be worth one.[17].

2. METHOD

The research methodology used in this study uses Convolutional Neural Network (CNN) with Keras framework on Google Collaboratory and back-end Tensor Flow. The general description carried out in this research process is described in Figure 5 below.

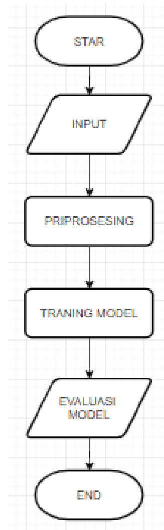


Figure 3 Test Framework

From Figure 3 above, the initial stage is carried out by entering an image in the form of a dataset that has been prepared in advance and is divided into 2, namely train data and test data. Most of the image data in this study are downloaded from the internet which of course have different sizes. Therefore, image pre-processing is carried out to prepare images which are then processed further, both for feature extraction needs and data classification needs. The process is carried out using several steps of data pre-processing that can be classified using the CNN method.

Pre-processing is the stage that is carried out before training or testing the model by carrying out the resizing process, RGB image conversion and VGG16 feature extraction. Resize is changing the size of the image used to adjust the image so that it can be trained or tested. RGB image conversion is the process of changing colour images to grayscale. Feature extraction is an object recognition technique by looking at the special characteristics of the object which aims to perform calculations and comparisons to classify an image.

The image classification process of Cirebon batik is tested using a sequential model, namely by making a simple test model by randomly determining parameters in order to get the maximum accuracy value.

2.1 Dataset

Dataset The test used is 175 images on the train data and 55 images on the test data with 30 test data for each image character taken using the scraping method from various sources on the internet, namely google image by downloading images related to the object in this study. . Here are 5 Cirebon batik used.

Table 1. Research variable

No	Variable	train	Test	Definition
1	Lion Barong	30	9	The image in the form of Cirebon Batik Singa Barong
2	Dragon Liman	33	11	Image in the form of batik Cirebon Naga Liman
3	Mega Cloudy	48	16	Image in the form of Mega Cloudy Cirebon batik
4	Cirebon Palace	30	9	Image in the form of Cirebon Kraton Batik Cirebon
5	Banjar Balong	30	10	Image in the form of Cirebon batik Banjar Balong

2.2 Test Design

In this study, the following CNN architectural model was used.

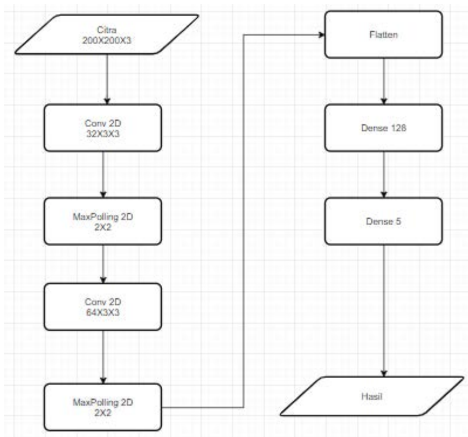


Figure 4 Sequential Model

In Figure 4 above, it is *flow* sequential test model. From the image above, the input image is 200x200x3 pixels and converted to grayscale and then convoluted with two convolution layers with 32 and 64 filters each measuring 3x3. In the pooling layer, the max pooling operation is used with a max pooling size of 2x2, which will divide each image size by two when passing through this process. The flatten process is used to change the 2d to 1d image format with a predetermined value of 200x200x3 pixels. Then we use two dense layers, with the first layer functioning as an activation ReLu (rectified linear unit) measuring 128 neurons and the second SoftMax layer having 5 neurons according to the number of data classes taken from the dataset.

3. Results and Discussion

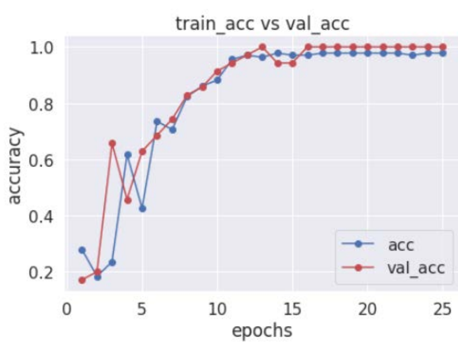
The testing phase is carried out by training the shadow puppet image data into a fit model using 25 epochs, batch size=128, and validation split=0.2 which means 80% training and 20% validation. Epoch can be defined as the number of neurons that can see all the data that has been collected, while batch size is the number of training examples in one forward/backward pass.

3.1 Sequential Model

Table 2. Sequential Model Fit Results

epoch	Train Data		Data Validation	
	loss	Accuracy	loss	Accuracy
1	1.781915665	0.279411763	19.74918556	0.1714285761
2	18.02768898	0.1838235259	8.714849472	0.20000003
3	7.802925587	0.2352941185	2.030090094	0.6571428776
4	1.94068396	0.6176470518	1.340774	0.4571428597
5	1.272222281	0.4264705777	1.085587859	0.6285714507
6	0.992358923	0.7352941036	1.0170753	0.6857143044
7	0.8877596855	0.7058823705	0.8312000632	0.7428571582
8	0.6971838474	0.8235294223	0.6311178803	0.8285714388
9	0.5311122537	0.8602941036	0.4414956272	0.8571428657
10	0.3830477595	0.8823529482	0.3542631865	0.9142857194
11	0.2909376621	0.9558823705	0.2443846315	0.9428571463
12	0.1872066408	0.9705882072	0.1439020634	0.9714285731
13	0.1238235161	0.9632353187	0.1021680832	1
14	0.09022752941	0.9779411554	0.09671391547	0.9428571463
15	0.1021449417	0.9705882072	0.1458256245	0.9428571463
16	0.1066573411	0.9705882072	0.04903816432	1
17	0.08235959709	0.9779411554	0.02706898935	1
18	0.0988009721	0.9779411554	0.02035484277	1
19	0.07023841143	0.9779411554	0.01475755312	1
20	0.04592490196	0.9779411554	0.0164608676	1
21	0.06485889107	0.9779411554	0.01171034668	1
22	0.05928806588	0.9779411554	0.01364079304	1
23	0.03920879215	0.9705882072	0.01087800041	1
24	0.05145004392	0.9779411554	0.008379948325	1
25	0.1188511029	0.9779411554	0.008374610916	1
20	0.013241	0.995946	0.142919	0.972973

The table above is the result of training data train and test data using epochs 25 times. It can be seen that iteration produces accuracy and loss values from train data and validation data. The accuracy value is a value that can be used as a reference in determining the level of success/feasibility of the model that has been made and the loss value is a measure of the failure/error made by networks that aims to minimize it. In the train data, the highest accuracy value is 0.9779411554 at the 14th, 17th, 18th, 19th, 20th, 21st, 22nd, 24th and 25th epochs while the lowest loss value is 0.03920879215 at the 23rd epoch, then the validation data obtained the highest accuracy value of 1 in the 13th, 16th, 17th, 18th, 19th, 20th, 21st, 22nd, 23rd, 24th, and 25th epochs, while the lowest loss value is 0.008374610916 at the 25th epoch.



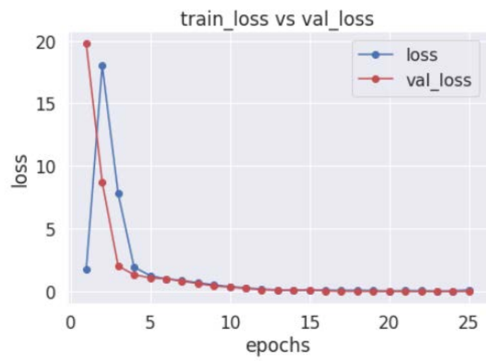


Figure 5 Plot Accuracy vs Loss Model Sequential

From Figure 5 above, it can be seen that the relationship between the accuracy value and the loss value in the train data and validation data is with the number of epochs/iterations. The correlation/relationship that occurs in the accuracy value shows a positive correlation which has a unidirectional relationship with the provision that the more the number of epochs used, the higher the accuracy of data train and data validation. Inversely proportional to the accuracy value, the relationship between the number of epochs and the loss value is a negative correlation where the number of epochs used will affect the value. *Ge*nerated in the training data is getting smaller. Based on these results, it can be concluded that to reduce the expected loss value, it can be done by increasing the number of epochs in the training process.

After we train the model, then we evaluate the performance of the model on the test set. Evaluation is carried out to see the possibility of failure of the image object that is read in the classification process, it will also obtain the accuracy value and loss value with the highest probability that will be obtained from the entire test model.

3.2 Evaluation

Evaluation of the results of the test model, namely the Sequential model that was trained using the data train as many as 175 images, obtained the evaluation value generated from the test data as many as 55 images by testing 25 times, batch size=128, validation split=0.2 obtained accuracy value and loss value as following.

Table 3. Evaluation of Accuracy Value and Loss Value

Sequential Model	
Accuracy	**loss**
98.18%	0.117

4. Conclusion

Based on research and the results of the implementation of the Convolutional Neural Network (CNN) method in the Cirebon batik image classification process, it can be concluded that to be able to pass the pre-processing process properly, the dimensions can be changed to 200x200x3 pixels and the colour is converted to grayscale in the Sequential model. This is evidenced by testing the amount of training data as much as 80% and validation data as much as 20% in each test model. By evaluating the sequential epoch model testing 25 times, batch size=128, and validation split=0.2 (80% training and 20% validation) the accuracy value and the model loss value based on the test data are 98.18% accuracy value and 0.117 loss value in the Sequential model.

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