

Convolutional Neural Network (CNN) Method for Classification of Images by Age

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Abstract

Image classification is one of the studies that is currently being developed. The details of the characteristics that must be captured make researchers compete to find the most suitable method for classifying. The Convolutional Neural Network (CNN) algorithm is one of the most superior algorithms in the field of object classification and identification today. With the help of several packages contained in Google Colab for classification, this algorithm is easier to use. In this study, the target case is the age of a person who will be classified using photos or images taken from the internet which are then stored in the form of Google Drive. The research data used is divided into 2 parts, namely for training data as many as 23,440 images, and 10,046 for testing data. Then to facilitate the extraction of features from the features to be identified, the researchers carried out the preprocessing stage, namely grayscale images, and data augmentation. The purpose of this study is to implement the concept of Deep Learning with Convolutional Neural Networks (CNN) in image classification and to determine the level of accuracy of the CNN model in classifying images. After the algorithm is run and the model has been formed, an accuracy of 78.5% is obtained. It can be concluded that the Convolutional Neural Network (CNN) method is good at classifying images

Keywords: image classification, convolutional neural network, preprocessing.

1. Introduction

Artificial intelligence is a study of how to make computers do things that humans currently do better (Rasywir et al, 2020). Artificial Intelligence (AI) aims to find out or model human thought processes and design machines so they can mimic human behavior (Putra et al, 2020).

Machine learning and deep learning are parts of AI that are increasingly developing in solving human problems (Sandag et al, 2021). DL and ML are hot topics because of their significant capabilities in modeling complex data such as image and sound data (Cahya, 2020). Image classification is a process of grouping training image features that have been stored with test image features. The part of image recognition that has been developed at this time is age recognition (Asmara et al, 2018).

The Deep Learning method which currently has the most significant results in image recognition is the Convolutional Neural Network (CNN). This is because CNN tries to imitate the image recognition system in the human visual cortex so that it can process image information (Akita et al., 2016). The CNN method is used because it has effectiveness in recognition, can extract features, and classify automatically (Nugroho, 2019).

2. Literature Review

2.1. Machine Learning

Machine Learning is a set of techniques that function to handle and predict a set of data by representing the data with algorithms for learning. With machine learning, computers can learn independently from the data that has been provided (Danukusumo, 2017).

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2.2. Deep Learning

Deep learning (DL) is also known as deep structured learning which means deep hierarchical learning (Wang et al, 2019). DL is part of a machine learning method based on deeper artificial neural networks. Machine learning can be supervised (semi supervised learning), semi-supervised (semi supervised learning), or unsupervised (unsupervised learning) (Kamilaris et al, 2018).

2.3. Convolutional Neural Networks

Convolutional Neural Network (CNN) is a convolution operation that combines several layers of processing, using several elements that operate in parallel and are inspired by biological nervous systems (Hu et al, 2015). Architecture in the form of images (Maggiori et al, 2016). The extraction process in CNN consists of several hidden layers, namely the convolution layer, activation function (ReLU), and pooling. CNN works hierarchically so that the output in the first convolution layer is used as input in the next convolution layer. The classification process consists of a fully connected activation function (softmax) whose output is a result, of classification (Katole et al, 2015)

Here is the ReLU activation function:

$$f(x) = \max(0, x) \quad (1)$$

The softmax activation function is used to get the classification results. The activation function produces values that are interpreted as probabilities that have not been normalized for each class. Class values are calculated using the softmax function (Vedaldi & Lenc, 2015).

$$\sigma(\vec{z})_i = \frac{e^{z_i}}{\sum_{j=1}^K e^{z_j}} \quad (2)$$

2.4. Classification

A classification is a form of data analysis that extracts a model to describe the categorization or class of data. In classification, classifiers or models are built to predict class labels (categorical), for example, a rainy or sunny weather (Coates et al., 2011). Accuracy is a matrix for evaluating the results of a classification model. Accuracy is the division of the model predictions that are considered correct by the total number predicted, the calculation is defined as follows (Fonda et al., 2020):

$$Accuracy = \frac{\text{Number of correct predictions}}{\text{Total number of predictions}} \times 100\%$$

3. Research Method

This research is explorative research. Explorative research is research that wants to explore something new, which is not widely known by the public, so it wants to be studied more deeply, usually regarding contemporary or recent phenomena. In this case, the researcher wants to classify images using the CNN method to detect a person's age.

Data analysis techniques in this study can be described as follows:

- a) Retrieve data on the internet and then save it in the form of Google Drive
- b) Dividing training data and testing data
- c) Perform data pre-processing which consists of 2 steps:
 - a. Grayscale image, converts the image to grayscale
 - b. Image augmentation, a technique used to increase the amount of data by adding slightly modified copies of existing data.
- d) Implementation of the CNN method to see the accuracy of the model
- e) Conduct evaluation and testing of CNN
- f) Make age predictions on existing image data
- g) Perform interpretation of research results.

4. Results and Discussion

4.1. Collecting Data

In this study, for identification purposes, it is necessary to identify objects in the form of facial photos. As explained in the background, in this research the case study used is a photo of a person's face taken from skillcate.com which is stored in the form of a Google Drive. Where in the folder it is divided into 2 data, namely, testing data which totals 10,046 images, and training data of 23,440 images. The age categories used in the data are the age groups of toddlerhood, childhood, adolescence, adulthood, elderly, and old age.

4.2. Pre-processing Process

There are 2 stages of data pre-processing that are carried out before the data is processed by the CNN algorithm, namely the grayscale image and image augmentation stages.

a. Grayscale Image

For the CNN algorithm to find it easier to get the characteristics of the image being trained, the training data that will be used as input will later be corrected on the color features. Improvements to the color features that will be carried out are by converting the RGB image to a grayscale image. That way the computation of the CNN algorithm that is performed is less than the features in each image, and it's easier to get.

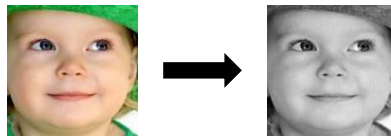


Figure 1. Grayscale Image

b. Image Augmentation

After the image is converted into a grayscale image, then the data augmentation process is carried out. As you know, to get optimal performance, deep learning requires large amounts of data. Because the variety of objects in the research location and the ability to collect data is quite limited, data augmentation was carried out to increase the variety of data. Data augmentation is the manipulation of data without losing the essence or essence of the data.

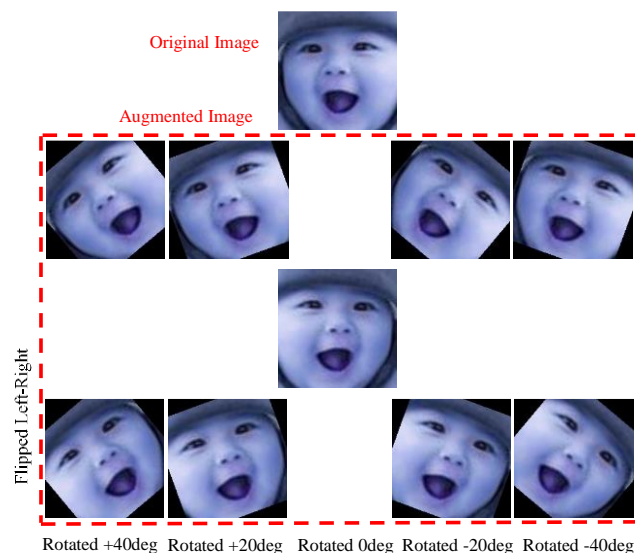


Figure 2. Result of Augmented Image

4.3. Convolutional Neural Network Implementation

Next, training the image data into a model with a fit model. In carrying out the fit model, iteration (epoch) = 35, batch size = 512 are used. Iteration (epoch) means the number of times the network will see the entire data set, while the

batch size is the number of data samples that will be distributed to the neural network in one epoch. The accuracy results obtained are Table 3.

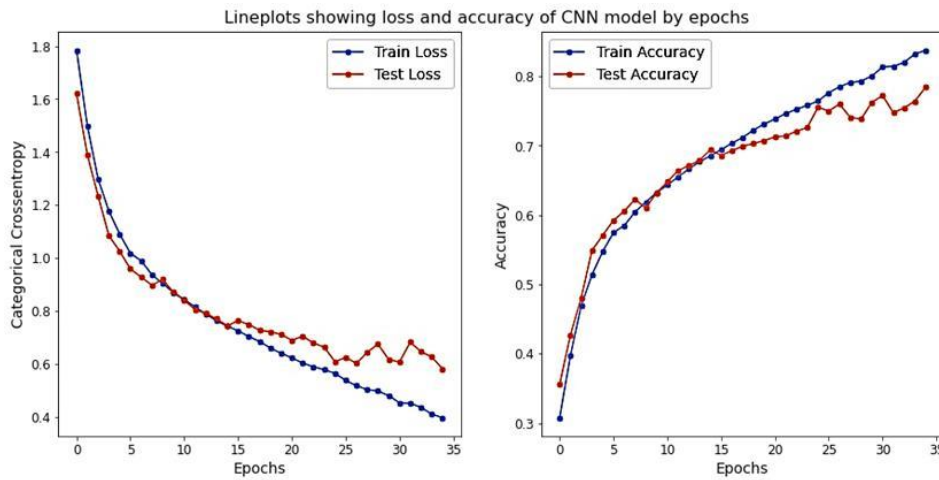


Figure 3. Line plots of Loss and Accuracy of CNN Model by Epoch

The figure 3 shows a graph of the movement of accuracy values and loss values for training data and testing data generated at each iteration (epoch). Based on the figure, the red line shows the movement of the testing data, while the blue line shows the movement of the accuracy and loss values for the training data. The graph on the left shows the loss for both data, it can be seen that for the training data, the loss value obtained continues to fall until the 35th epoch, and the loss value for the testing data initially decreases at a point the loss value increases until the 35th epoch. While the graph on the right shows the accuracy value of the two data. Based on the picture above it can be seen that the accuracy value of the iteration results produced both for the training data went up to the 35th epoch, while for the testing data, it fluctuated up to the 35th epoch. The accuracy value obtained is 78.5% for the CNN model. It can be concluded that the CNN method used is in a good category for age classification.

4.4. Image Classification and Testing

In classifying images, researchers use a confusion matrix, where the function of the confusion matrix is to see how many times the data has been misinterpreted or mispredicted. The picture above shows the calculation of the accuracy of the confusion matrix for 7 age classes, where the age class that has the lowest accuracy is the 46-65-year-old class with an accuracy of 0.71, and the highest accuracy is obtained in the 1-2-year-old class with an accuracy of 0.96. By looking at the output above, it can be concluded that each predetermined age class is already a good accuracy category for age classification.

The results of image predictions according to a predetermined age class, where the output is shown in Table 1.

Table 1. Age Prediction Results

Class Label	0	1	2	3	4	5	6
Age Ranges (class)	1-2	3-9	10-20	21-27	28-45	46-65	66-116
Example Picture							

5. Conclusion

The implementation of the Convolutional Neural Network (CNN) method for image classification is done using the Keras package, TensorFlow, and several other supporting packages on Google Colab. The CNN algorithm is an algorithm that is capable of classifying objects without the need for additional feature extraction. Because the algorithm already has a feature learning process. However, during this research, the limited capabilities of the devices used and

the image data used were not homogeneous, making the researchers add additional feature extraction to make it easier for the algorithm to perform features on the images to be processed. By changing the image to a grayscale image. With this, the researchers succeeded in sharpening the image to simplify the extraction process. The level of accuracy obtained from the model formed is equal to 78.5%. This has entered into the category of good accuracy in classifying images according to the specified age class.

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