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Store product classification using convolutional neural network

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ABSTRACT

Stores sells consumer goods, mainly food products and other household products at retail. The products sold in stores vary greatly, in order to be time efficient in the fast-paced era and the current technological era requires artificial intelligence technology. In the artificial intelligence branch, there is a specific or detailed learning process known as deep learning. One of the branches of deep learning is the convolutional neural network (CNN). This research intends to employ a CNN architecture to facilitate and streamline the time and cost of the store's product sorting process. The test is conducted with 1,050 product images divided into 35 labels and divided into three data, namely 80% data training 10% data validation and 10% data test. The image used is preprocessed with a size of 256×256 pixels. The data was trained with six convolution layers and an epoch of 50 with an execution time of 33 minutes so as to achieve an accuracy of 91.37%.

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1. INTRODUCTION

Trading activity is one of the ways people can meet their diverse needs of life. Presidential decree 112 of 2007 explains that the market is an area where traders and buyers carry out buying and selling activities or a place where traders and buyers meet. The traditional market is the market with the main characteristics of bargaining prices in the buying and selling process, while the modern market is a buying and selling area that has a fixed price. Modern markets are distinguished into modern shopping centers and shops.

A modern store is a one-stop shop that sells various types of goods at retail. Ultramodern stores are divided into stores, minimarkets, wholesalers, supermarkets, department stores, and hypermarkets. The differences of ultramodern stores are based on the bottom area and the range of goods. Wholesale sells non-commercial consumer goods. Department stores sell consumer goods mainly clothing products and equipment at retail. Minimarkets, supermarkets and hypermarkets sell consumer goods, mainly food products and other household products [1].

The products sold in stores are very varied, in order to be time efficient in the fast-paced era and the current technological era requires artificial intelligence technology by adopting human processes and ways of thinking capable of classifying these products. In the artificial intelligence branch, there is a specific or detailed

learning process known as deep learning. Deep learning permits machines to unravel advanced issues even from numerous and unstructured information [2]. The deep learning approach is a breakthrough algorithm in solving the problems of human life today [3]. Deep learning has proven to excel in image processing [4].

One of the uses of deep learning is the field of image processing. The existence of an image processing system is intended to help humans in recognizing or classifying objects efficiently, namely fast, precise, and able to process with a lot of data at once. Algorithms contained in image processing, including support vector machine, Naıve Bayes, and neural network. One of the algorithms that is often used is neural network. Neural networks are developed based on how neural networks work in the human brain.

One of the most common deep learning applications in the field of image classification is convolutional neural network (CNN) [5]. CNN could be a special variety of multi-layer neural network impressed by the mechanisms of the optical system of living beings [6]. CNN is a deep learning model consisting of several layers : convolutional, pooling and fully connected layers [7]. CNN is widely used in many fields, applications, and problems in computer vision such as image recognition, segmentation, detection, and classification [8], [9].

Therefore, this study intends to employ a CNN best solution that uses image objects of 35 types of products. The CNN architecture employs in this study is expected to be able to classify images of store products and produce the best accuracy. Section 2 presents research on the development of CNNs that have been carried out previously and used as a reference.

2. RELATED WORKS

CNN is an algorithm that already exists but is widely developed by several researchers in the field of deep learning. This study is inseparable from previous research as a reference. Several studies have focused on the development of CNNs across various objects.

Lu *et al.* [10], classifies fruits using CNNs. author designed six layers of CNN consisting of a convolution layer, a pooling layer and a fully connected layer. The results of the experiment achieved promising performance with an accuracy of 91.44%, better than three advanced approaches : vector engine voting-based support, wavelet entropy, and genetic algorithms.

Liu *et al.* [11], built a large data set of wide flower images with 79 classes and planned a brand new framework supported CNNs to classify flowers. The neural network consists of five convolutional layers during which the receptive planes square measure adopted little, a number of that square measure followed by a max-pooling layer, and three layers that are fully connected with the last 79-way softmax. The author's approach reached 76.54% brackets in the author's laborious flower dataset. additionally, the algorithmic rule of the check authors on the Oxford 102 flowers dataset. It outperformed the antecedently proverbial vogue and achieved the delicacy of the 84.02% bracket.

Attokaren *et al.* [12], classifies food images using CNNs. The author additionally uses the max-pooling function for data, and the features extracted from this function are used to train the network. Accuracy 86.97% for food class-101 recognized datasets using the proposed implementation.

Dyrmann *et al.* [13], presents a method capable of recognizing plant species in pictures coloured during a CNN way. The network was engineered from scratch by being trained and tested on a complete of 10,413 pictures containing 22 weeds and plant species within the early stages of growth. For these 22 species, this network is in a position to realize a classification accuracy of 86.2%.

Rathi *et al.* [14], recommends a way for automatic classification of fish species, is needed for greater understanding of fish behavior in zoological science and by marine biologists. This methodology uses new techniques supported by CNNs, deep image learning and processing to achieve 96.29% accuracy. This system ensures vastly demarcation delicacy advancements than the preliminarily proposed styles.

Prasad *et al.* [15], classifying flower images using CNNs. The dataset used is in the style of 9,500 flower images categorized into four related ones. The CNN coaching is initiated in five batches and therefore the testing is disbursed on all the for datasets and achieves an accuracy of 97.78%.

Gustisyaf and Sinaga [16], the way toward distinguishing fingerprints is one of the significant, simple to do multifariousness strategies, the cost is cheap, and a dactyloscopy authority does the particular outgrowth. Classified gender by fingerprint using the CNN method, and three models were created to determine sex, with a complete of 49,270 image data that included test data and training data by classifying two classes, male and female. Of the three models, the very best accuracy was taken at 99.9667%.

Khaing *et al.* [17], developed a system of objection management recognition supported CNNs is

considered. CNN applied to fruit discovery tasks and recognition through parameter optimization. Results from the take a look at has associate degree accuracy within the classification getting ready to 94% to 30 class 971 drawings.

Liew *et al.* [18], an approach using CNNs is proposed for real-time gender classifications based on the image of the face. Liew *et al.* deliver the goods classification accuracy 98.75% and 99.38% on sums and AT&T databases, severally. The image is 32×32 at a speed of 0.27 ms which means it reaches 3,700 images per second. Training among but 20 epochs.

Elhoseiny *et al.* [19], weather classification of images using CNNs. Approach outperforming the state of art by a huge margin in weather classification tasks. Approach reaches 82.2% normalized classification accuracy, not 53.1% for state of the art (i.e., 54.8% relative improvement). In section 3, we will explain the CNN method that will be developed and the processing of the dataset to be used.

3. METHOD

Deep learning has emerged as a major tool for self-perception problems such as understanding images, sounds from humans, robots exploring the world. CNN it consists of 1 or a more convolutional layer and so continued with one or additional utterly connected layers as in a very customary multilayer neural network [20]. Understanding CNN and applying it to image recognition systems is the target of the projected model. CNN extracts feature maps from the second image with a victimization filter. CNNs consider mapping image pixels with environmental areas instead of having entirely layers of neurons connected. CNNs have been tried to be very dominant and potential tools in the image process. Even at intervals the areas of pc vision such as handwriting recognition, physical object classification, and segmentation, CNN has become a far higher tool compared to all or any or any different tools antecedently enacted [21]. CNNs are used with the Keras framework as well as Google Collaboratory and back-end TensorFlow.

3.1. Dataset

The imagery data is taken manually, i.e. shooting using the phone's camera, also taken from Google images. The image data collected is 1,050 product images divided into 35 classes as labels with different pixel resolution sizes and different formats. At the data preprocessing stage, change the pixel resolution size to 256×256, and formatting is also done into joint photographic experts group (JPG). The purpose of the data preprocessing stage for the input used is equal. The image is divided into three parts, namely 80% training, 10% validation, and 10% testing. The Image data will not be displayed all only 6 products randomly displayed as shown in Figure 1.

Figure 1(a) is Ultra Milk Strawberry which includes dairy products, in addition to Ultra Milk Strawberry there are also other dairy products such as Frisian flag Strawberry and Ultra Milk Cokelat. Figure 1(b) is Samyang which includes instant noodle products. Figure 1(c) is Amidis and Figure 1(d) is Aqua which include mineral water products, besides that there are also other mineral water products including Crystalline, Le Minerale, and Vit. Figure 1(e) is Lemonilo Mie Goreng which includes instant noodle products, in addition to Samyang and Lemonilo Mie Goreng there are also other instant noodle products, namely Indomie Goreng, Lemonilo Ayam Bawang, Lemonilo Kari Ayam, and Mie Sedap Goreng. Figure 1(f) is Bodrex Extra which include medicinal products, in addition to Bodrex Extra there are also other medicinal products, namely Antimo, Bodrex Flu dan Batuk Berdahak, Bodrex flu Dan Batuk PE, Bodrex Migraine, Promag, Tolak Angin, and Kayu Putih Cap Lang.

Figures 1(a) to 1(f) is part of the image data that has been collected manually shooting using the phone's camera, also taken from google image with pixel resolution that has been adjusted to 256×256 and image format to JPG. The dataset that is displayed randomly, there are only 6 products, in addition to those in the picture there are also several snacks including Chitato Sapi Panggang, Garuda Rosta Bawang, Lays Classic. Kopi Kapal Api, and Luwak White Coffee are coffee. Paseo is a tissue. Pepsodent, and Pepsodent Herbal are toothpastes. Teh Sariwangi is tea. Zen Body Wash Pink is a shower gel. There are several types of sauces including Saus ABC Extra Pedas, Saus Dua Belibis, and Saus Jawara.

(a) (b) (c)

(d) (e) (f)

Figure 1. Dataset for (a) Ultra Milk Strawberry, (b) Samyang, (c) Amidis, (d) Aqua, (e) Lemonilo, and (f) Bodrex Extra

3.2. Proposed Convolutional Neural Network

The convolutional layer is that the central a part of CNN. Pictures area unit usually stationary. Meaning that the formation of one half the image is that the same because the remainder of the half. The features studied in one region will match similar patterns in another. The filter area unit is then designed to support the rear propagation technique [6].

CNNs are currently the most numerous efficient models for classifying images [22]. CNN continue to increase its computing speed because hardware progress, and the range of applications have has developed gradually because it has proven its superiority performance [23]. CNN showed good performance in the classification of objects [24]. Almost all CNN architectures follow identical general style principles of in turn applying convolutional layers to the input, sporadically downsampling the spatial dimensions whereas increasing the quantity of feature maps. Moreover, there also are totally connected layers, activation operates and loss function. However, among all the operations of CNN, convolutional layers, pooling layers, and absolutely connected layers are the foremost vital ones.

The convolutional layer is that the terribly initial layer wherever it will extract options from the pictures as a result of pixels area unit solely associated with the adjacent and shut pixels, convolution permits to preserve the connection between completely different components of a picture. Convolution is filtering the image with a smaller picture element filter to decrease the dimensions of the image while not losing the link between pixels. When applying convolution to a 7×7 image by employing a 3×3 size filter with a 1×1 step can find yourself with a 5×5 output.

When constructing CNN, it's common to insert pooling layers once every convolution layer, in order that we will cut back the abstraction size of the illustration. Layers reduce parameters and reduce complexity. Also, pooling layers facilitate with the overfitting downside. The totally connected network is in any design wherever every parameter is connected to every different to see the link and impact of every parameter on the label. The complexness of space-time continuum is reduced by victimisation convolution and pooling layers.

In general, CNN has 2 stages, namely the stage of learning features and classification. Feature learning is a technique that permits a system to run mechanically to see the illustration of a picture into options in the variety of numbers that gift the image. The bracket stage is the stage where the results of point literacy is used for the next process which is based on the intended sorting. Image input on the CNN model uses an image that is 256×256 in size. Feature learning consists of two layers: the convolutional layer and the pooling layer [25]. The input image is then be processed first through a convolution process and a pooling process at the feature

learning stage. Each convolution has a different number of filters and kernel sizes. Then the alignment process or the process of changing the feature map resulting from the pooling layer is carried out. The built CNN model is depicted in Figure 2.

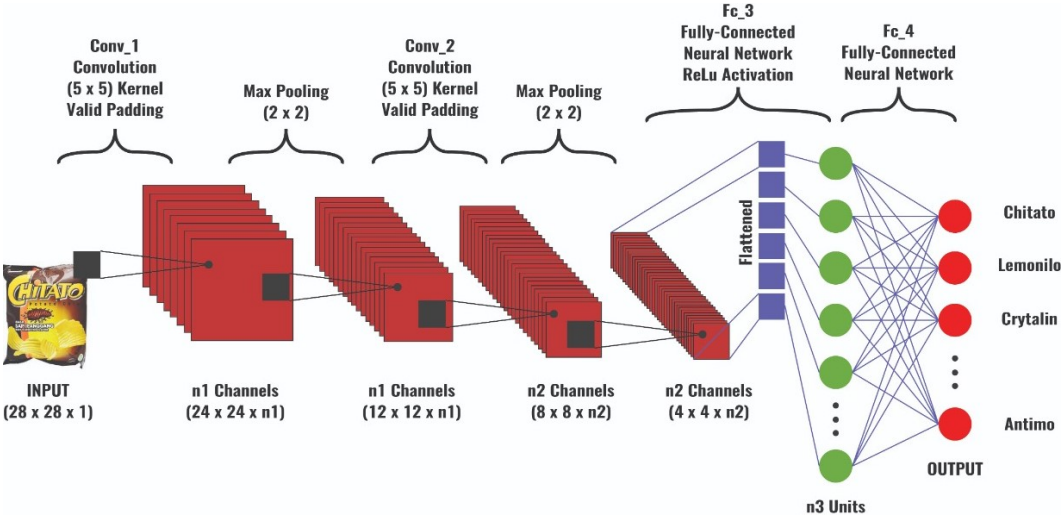

Figure 2. Segmentation model convolutional neural network

The structure of the CNN consists of inputs, feature extraction, classification, and outputs [26]. The CNN model is build consists of 6 convolution layers with features measuring 3×3 and using the rectified linear unit (ReLU) activation function and max pooling used at a size of 2×2, then a flattening process is carried out, namely changing the output of the convolution process in the form of a matrix into a vector which is then be continued in the classification process using a multi-layer perceptron with the number of neurons on the predetermined hidden layer. The image class is then classified based on the values of the neurons in the hidden layer by using the softmax activation function. The output of the connected end layer is fully fed to the softmax function [27]. In section 4 is explained the results of the application of the method in section 3.

4. RESULTS AND DISCUSSION

The CNN model training process is performed out as many as 50 epochs. The test is performed using test data for each CNN model class that had been created using the Adam optimizer. The results of the training data and validation accuracy data is depicted in Figure 3. The graph show training and validation accuracy in the chart.

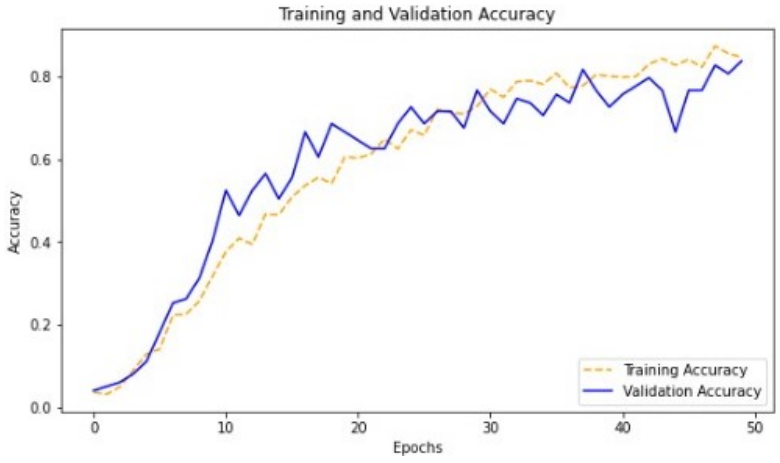

Figure 3. Accuracy chart

Figure 3 explained for the graph of accuracy in training and validation it can be seen that the higher the epoch or train is done, the closer the accuracy is to perfect. In Figure 3, it is depicted that the graph shows almost equal and ascending movements of training and validation, where if the accuracy chart goes up, the better. However, it still needs additions to improve accuracy, meanwhile, in Figure 4. Explaining graphs of training accuracy and validation for data loss where when the epoch gets bigger, the accuracy decreases and it can be concluded that there is less data loss than valid data.

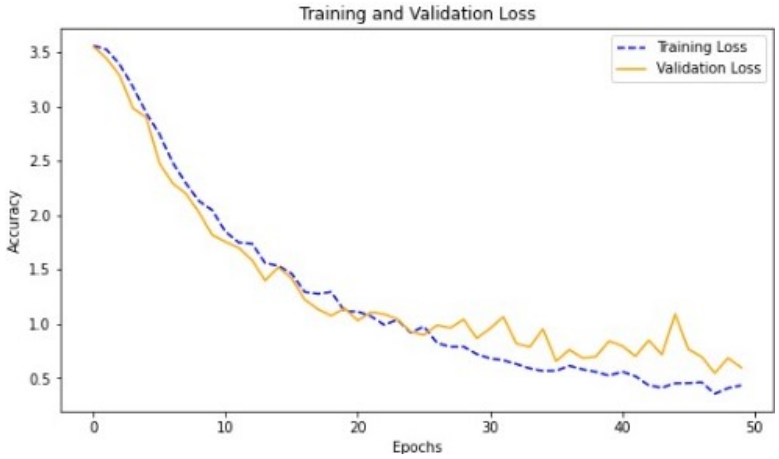

Figure 4. Loss chart

In Figure 4, it is depicted that the chart shows training and validation movements that are almost in line and decreasing, where if the loss chart decreases, the better and the accuracy and loss are in the opposite direction which indicates that the data tested has run optimally. After testing with training data and validation data, testing is carried out using test data in Figure 4. That data loss and near-perfect accuracy can be produced. Can be proven in the test results and data validation described in Figure 5.

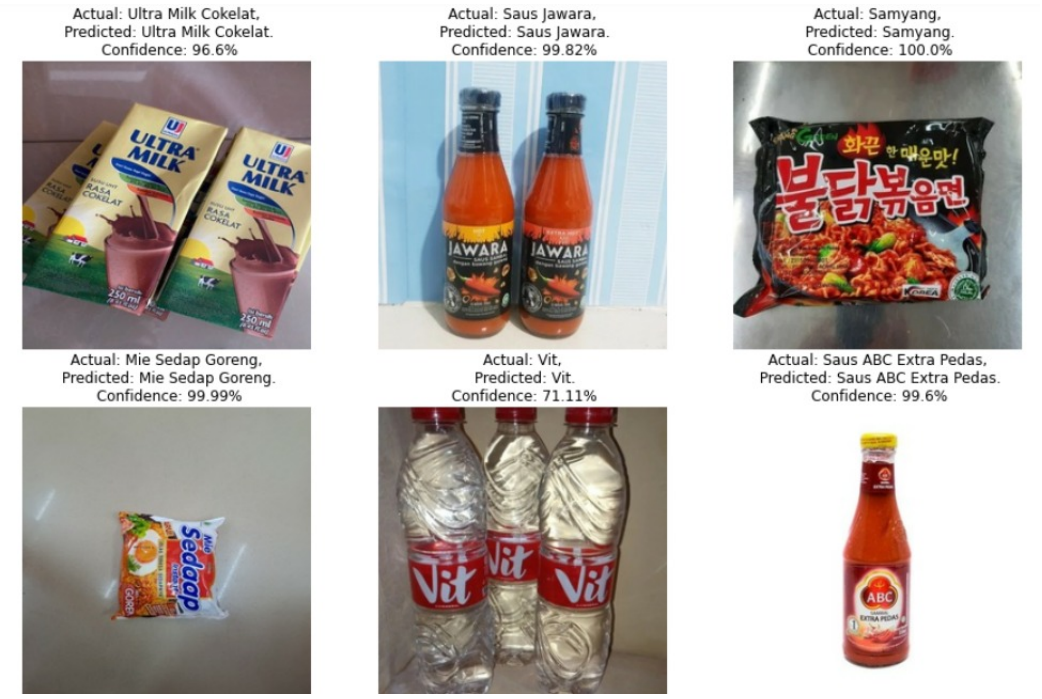

Figure 5. Results

From the test results it can be seen in Figure 5 that the make proposal succeeded in developing Ultra Milk Chocolate with an accuracy of 96.6%, Jawara Sauce with an accuracy of 99.82%, Samyang with an accuracy of 100%, Delicious Fried Noodles with an accuracy of 99.99%, Vit Mineral Water with an accuracy 71.11%, Extra Spicy ABC Sauce with 99.6% accuracy and achieves very good and appropriate accuracy, obtaining a final accuracy of 91.37% with an execution time of 33 minutes. By combining the created CNN methods, very good accuracy can be obtained for classifying mini-market products. And it is hoped that in this study the methods used can be used in real terms to facilitate work in sorting goods in mini markets. In section 5 are the final conclusions and things that can be done for further research.

5. CONCLUSION

This study classified products using the CNN method, which has been successfully carried out with an accuracy rate of 91.37%. The CNN model used consists of 6 convolution layers with a filter size of 3×3, ReLU activation function, and softmax, also using 2×2 layer pooling. The images used are 1,050 images divided into 35 labels with an image size of 256×256 pixels on a sequential model, with an epoch process of 50. From this research, it can be developed again such as the data augmentation that does not yet exist.

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