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THE ACCURACY OF MAPE MODEL ON CNN TO CLASSIFICATION OF MOVING OBJECT

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ABSTRACT

Neural Network which is the adoption of the performance of the human brain based on various types of data that process into information and knowledge. There are many algorithms in neural networks such as Convolutional Neural Network (CNN). CNN is an algorithm that is able to provide knowledge based on image data and moving images. For example, moving images are traffic activities consisting of various vehicles and vehicle numbers. So there needs to be a classification in recognizing vehicle numbers from moving media for data center purposes in smart cities. Success in classification is of course the value of accuracy. However, CNN, which generally uses ordinary accuracy techniques, needs to be tested with other accuracy techniques such as Mean Absolute Percentage Error (MAPE) in order to obtain optimal accuracy models. From the accuracy model based on the usual formula, the highest 92% results from frame 2 while the MAPE accuracy model achieves 100% the highest from frame 4. And the last, his shows that CNN will be more optimal in moving image classification with the MAPE accuracy model.

Keywords: *CNN, MAPE, Moving Object, Vehicle Plate.*

1. INTRODUCTION

Classification is one of the techniques in data mining that involves the concept of neural networks [1][2]. Where, a neural network or what is often called an artificial neural network has a validation process in the form of training data and data testing. The neural network process by obtaining classification involves supervised [3]. The supervised process can be applied to various data in numeric, text, image, and moving images [4]. Various algorithms can be applied in the continuity of the neural network. Likes k-Nearest Neighbor (KNN)[5], *Multilayer perceptron* (MLP) [6], *Simple Evolving Connectionist System* (SECoS) [7], *Convolutional Neural Network* (CNN) [8] and so on with various advantages in data recognition. In accordance with the data received, the neural network can process data mining techniques such as classification in introducing data, prediction with data without time, forecasting with data in the form of time. References [9], detection in image data and moving images, and associations to obtain patterns from data which can be said to be computational techniques [10][11].

In doing classification with image data and moving image algorithms that are often found in various studies using CNN [12]. Where CNN is a technique inspired by mammalian and human vision patterns [13]. So that CNN performs a convolution process from the movement of a filter based on the size of the image [14]. CNN has been developed by various researchers in classifying moving images [15]. The moving image which is the data to be used in the neural network algorithm, of course, must have good pixels to support the algorithm process [16][17]. A lot of data can be referred to as moving images such as traffic videos [18]. Traffic that is traversed by various vehicles where each vehicle has a vehicle number can be introduced by neural network algorithms such as CNN [19].

However, the success of the neural network algorithm is measured by accuracy techniques [20]. Various accuracy techniques to get the percent accuracy of the classification algorithm [21]. CNN, which generally uses ordinary accuracy techniques, needs to develop an algorithm model where in getting accuracy it is tested with various accuracy techniques. One example of accuracy that has a percent calculation unit is the Mean Absolute Percentage Error (MAPE) [22]. So that in this study optimization was carried out in obtaining the MAPE accuracy model on CNN to classify motorized

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vehicle numbers based on moving image data. Where in the classification raised in this study is moving image data from human daily life. As the data tested in this study, which classified the number of motorized vehicles moving in traffic. However, CNN, which is a classification algorithm, was tested using the Mean Absolute Percentage Error (MAPE) accuracy technique compared to the usual accuracy technique. So that with the application of the model with the MAPE accuracy technique in CNN, it is able to provide optimal values in reading motorized vehicle numbers.

2. MATERIAL AND METHOD

2.1. Accuracy on CNN

CNN was first created by Kunihiko Fukushima by NeoCognitron from Japan and developed and can be used as a field as machine learning by researchers [23]. However, in a study that has been developed by the Indian Institute of Technology Patna, comparing the CNN algorithm with the SVC (Support Vector Classifier) algorithm for the classification of a fashion product which results in the CNN algorithm having a higher level of accuracy than SVC with each - yielding figures of 91.17% for CNN and 89.70% for SVC [24]. CNN has an architecture on an artificial neural network as shown in Figure 1.

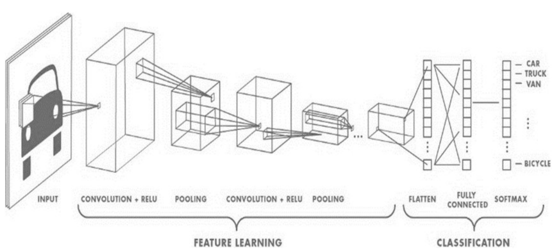

Figure 1: Convolutional Neural Network Architecture

In doing the classification, of course, it has good and bad results, optimal or not optimal which is very dependent on the confusion matrix such as recall accuracy, and precision so that the higher the confusion matrix, the better or optimally an algorithm is run [25]. In the case of multiclass classification, the performance calculation uses the macro and micro averages. Macro-average treats all classes equally while micro-average favours larger classes. The macro average is indicated by the index *M*, while the micro average is indicated by the index μ [26].

$$Precision\ M = \frac{\sum_{i=1}^{l} \frac{tp_i}{tp_i + fp_i}}{l} \quad (1)$$

$$Recall\ M = \frac{\sum_{i=1}^{l} \frac{tp_i}{tp_i + fn_i}}{l} \quad (2)$$

$$FScore\ M = \frac{2(PrecisionM\ x\ RecallM)}{PrecisionM + RecallM} \quad (3)$$

$$Precision\ \mu = \frac{\sum_{i=1}^{l} tp_i}{\sum_{i=1}^{l} (tp_i + fp_i)} \quad (4)$$

$$Recall\ \mu = \frac{\sum_{i=1}^{l} tp_i}{\sum_{i=1}^{l} (tp_i + fn_i)} \quad (5)$$

$$FScore\ \mu = \frac{2(Precision\mu\ x\ Recall\mu)}{Precision\mu + Recall} \quad (6)$$

$$Accuracy_{Average} = \frac{\frac{TP+}{P+N}}{l} \quad (7)$$

CNN is one of the algorithms that is very well known and capable of classifying various data, both numeric, images, and moving images as developed [27] conducted research in classifying EEG signals on CNN structures and obtained accuracy results with an average of 69.57% and trials were also carried out with 7 humans in 7 geometric figures obtaining accuracy with an average of 35.14% in the time span domain. Besides [28] do forecasting with CNN and compare it with KDE so as to conclude that CNN provides a very good indicator and uses accuracy techniques to get the optimal value.

Some methods are more specified for summarizing errors generated by facts and information in forecasting, classification, and detection techniques. [29]. Most of these measurements involve averaging some function of the difference between the actual value and the forecast value [9]. The difference between the observed value and the forecast value is often referred to as the residual. Various techniques in measuring accuracy both in numbers and in percent such as MAPE [30]. Calculations with MAPE are carried out with absolutes in the form of a percent divided by a lot of data to be measured by period [31]. The MAPE equation is shown in equation (8).

$$MAPE = \frac{\sum_{t=1}^{n} \left| \frac{x-y}{x} \right|}{n} \times 100\% \quad (8)$$

Where:
x = actual data
y = classification data
n = amount of data.

Measuring accuracy is very important in validation tests on neural network algorithms such as what is done [32] In his research, he compared the

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accuracy technique in one of the neural network algorithms where the very accurate results used MAPE as the accuracy technique. Besides that, [31] In this research, we conduct optimal testing with MAPE accuracy to get forecasting on CPO prices. This makes the need for MAPE testing in getting the model on the CNN algorithm.

2.2. Dataset

The dataset used in this paper is a moving image taken by traffic data, namely recording traffic activities that are directed at the number of motorized vehicles. The dataset process that is taken is the traffic activity in the city of Medan which is recorded so that later the algorithm tested by applying MAPE accuracy in CNN is able to recognize the number of motorized vehicles that move in a video.

2.3. General Architecture

General architecture is the most important part of the research so that the scheduled research is in accordance with the rules that have been set in obtaining the optimal model in MAPE accuracy on the CNN method for classifying moving images. The general architecture in this study can be seen in Figure 2.

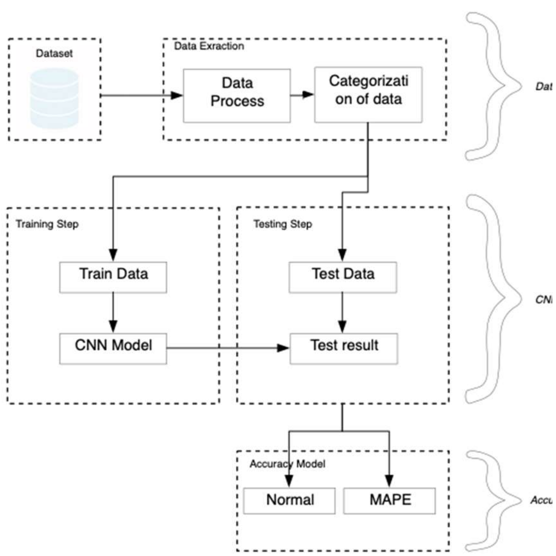

Figure 2: General Architecture

The explanation in Figure 2 is explained based on the following steps:

1. Collecting data by recording videos of traffic activities aimed at vehicle plates.
2. Perform data processing, namely resizing the image to a size of 300 pixels x 300 pixels.
3. Categorizing the data by dividing it into training data and test data. The sample data divides the training test data and test data with a statistical approach, namely the Slovin approach which is calculated based on equation (9).

$$n = \frac{N}{1+Ne^2} \quad (9)$$

Dimana:
n is the number of datasets to search
N is dataset size
e is the margin of error value of the dataset size

4. Classifying with CNN on training data
   a. Input *neuron*
   b. Performing a convolution layer by combining two series of numbers to produce a third number series
   c. Measuring activation function with ReLu $f(x) = \max(x, 0)$.
5. Classifying with CNN on testing data
   a. Input *neuron*
   b. Performing a convolution layer by combining two series of numbers to produce a third number series
   c. Measuring activation function with ReLu $f(x) = \max(x, 0)$.
6. Measurement accuracy
   a. Measured by the usual accuracy technique based on equation (7)
   b. Measured by MAPE accuracy technique based on equation (8)

3. RESULTS AND DISCUSSION

The model that will be built as a system design is the main stage. Where, the process has 3 parts, namely recording video while the car is running as input and then in the process, namely cutting the frame on the moving image with several parts that are forwarded to classification with CNN, and the output is the introduction of vehicle plate numbers generated based on accuracy with the usual calculation method and the accuracy is based on the calculation with MAPE. The main stages can be seen in Figure 3.

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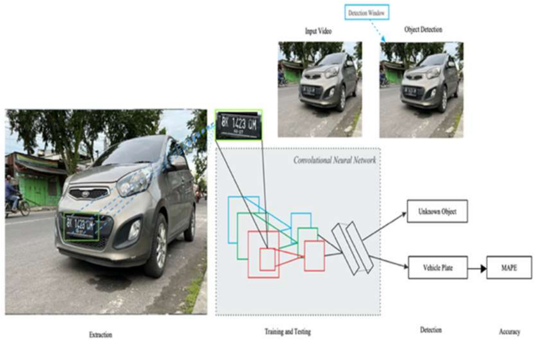

Figure 3: System Design

In Figure 3 it is clear that the input from the system design as the main stage based on the recorded moving image is cut based on several frames to make a collection of images with a pixel size of 300x300 using a camera to classify the moving image, namely the vehicle plate number. Area extraction and computation of features in the area using a convolutional neural network algorithm. The output or output of the system design in this study is the classification of images whether in an image area on the streaming media it is a Motorized Vehicle Number Sign or not and the resulting accuracy is based on the usual formula and MAPE.

From the research flow that has been designed based on the general architecture of Figures 2 and 3, to facilitate the visualization of the output, in this paper, the output interface design is carried out. Output design is used to display the results of object detection in the image. The research output design was made by visualizing the area of Motorized Vehicle Number Signs in light green colour accompanied by a label description of the image on the streaming media and the level of accuracy given to the system on the image on the detected streaming media.

Convolutional Neural Network algorithm requires architectural design in the training process. This architectural design consists of several parts of the network, namely Image for detection, Input Neuron, Convolution + Activation (ReLU) + Pooling layer, Fully connected layer, Classification and Detection output. The following is a visualization of the network architecture of the Convolutional Neural Network in Figure 4.

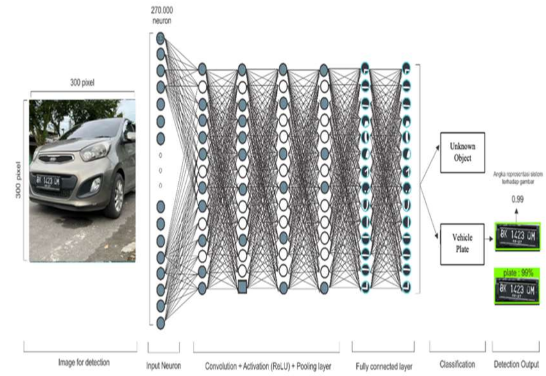

Figure 4: Network Architecture

In Figure 4 it can be seen that several parts of them are Image for detection, which is the image that will be detected. In the picture the size for training is 300x300 pixels with RGB (Red, Green, Blue) colours, which are 3 channels so that those that enter the first layer or the Input neuron section are 270,000 neurons obtained from 300x300x3 calculations. Each neuron has a parameter value where the parameters used in the network range from 0 to 225. Convolution is a technique in combining 2 sets into 3 sets of states. As in this paper, it is merging 2 sets into the kernel input into 2 sets in the output. From the input and the kernel which has a set of numbers poured in a matrix. The merging process can be seen based on Figure 5 below

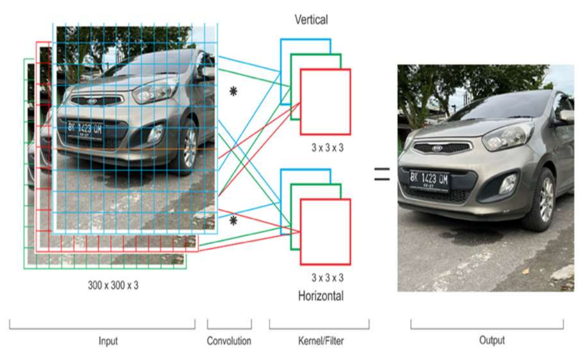

Figure 5: Convolution Layer

In the input area in Figure 5, the image has a height of 300 and a width of 300. Figure 4 also has a depth of 3 in the convolution layer formed with the filter above it. Where the Filter is a cube shape with height and width cropped in the original image. The filter is used to get the pattern to be convoluted and multiplied by the matrix on the input. For example, the mode for input in this paper uses a sequence with an input value of size 6x6 and a kernel with a vertical size of 3x3 and the calculation method is based on Figure 6 below.

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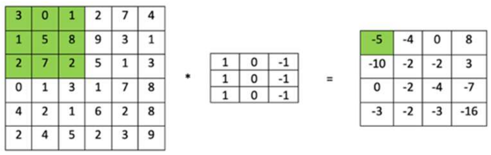

Figure 6: Convolution Process

If a 3x3 filter with a step size is used, or if the step used in the convolution calculation is 1, then the convolution process computing process starts with a 3x3 filter size in the upper left corner and moves the window to the lower left corner. The filter used by the researcher in Figure 6 only consists of one set of weights. So that 3 x 3 x 3 = 9 + 1 bias = 10 weights. At each position, the number of pixels is calculated using the equation $\sum_i^n = Wi\, Xi + b$. Then calculate the value with the Activation Function which is used to find non-linear values in the convoluted value. The Activation Function used in the detection of this Motor Vehicle plate uses ReLu. The ReLu formula used is $f(x) = \max(x, 0)$. Where x is the input neuron or input node. The 0 in the ReLU expression is a corrected linear unit if the input is less than 0. The ReLU calculation is exemplified as shown in Figure 7.

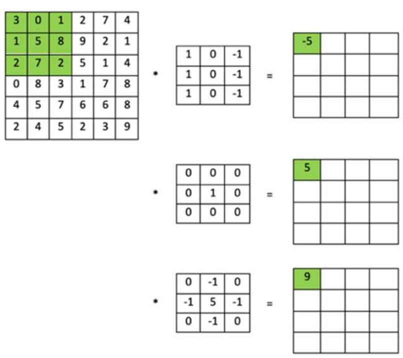

Figure 7: Activation Function (ReLU)

Figure 7 For the first kernel is the highest value obtained using three kernels, then the number 9 is used in the next output, and so on for other columns and rows. And the pooling layer is a layer that helps reduce the image size. The pooling layer usually appears after the convolutional layer. The pooling layer basically consists of filters of a certain size and increments that sweep across an area of the feature map. The size of the max pooling method layer pooling layer is 6x6. At the end of the convolutional and pooling layers, the network usually uses a fully connected layer where each pixel is considered as a separate neuron, just like an ordinary neural network is called a fully connected layer. The fully connected layer is the last fully connected layer containing as many neurons as the predicted class.

Figure 8: Fully Connected Layer

Figure 8 above is a visualization of the full connected layering process. In this process, each pixel is assumed to be the number plate of the car. A feature of the car number plate is the edge of the white car number plate which contains the letters. The edge of the output vehicle number plate consists of a class plate, or car plate. The recognition output is the final result of the vehicle number plate recognition. In accordance with the output design, this paper shows that the detection results are 0 to 100% based on ordinary accuracy and MAPE accuracy.

3.1. Vehicle Plate Detection Results (Testing)

From the training process that has been carried out, the next step is to conduct testing to test the success of the CNN algorithm that has been developed. With the process carried out on video recording of moving vehicles, then cutting the frame into several images that are carried out training and testing with the CNN algorithm. The results of the testing can be seen in table 1 below:

Table 1. Vehicle Plate Detection Results

Frames	Result	Accuracy	
		General	MAPE
1		90%	95%
2		92%	99%

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3		81%	99%
4		63%	100 %

From table 1, it can be seen in 1 video which is then broken down based on 4 frames. Of course, irregular frame cuts can be between 1 to 10 depending on the resolution of the resulting image for training with the detected object, namely BK 1423 QM. In the application that has been designed there is an accuracy that has been poured in the programming language. So seen from table 1 there is a comparison with using. Usual accuracy and accuracy using MAPE. As for the discrepancy in the accuracy model that is poured into the CNN algorithm in Figure 9 below.

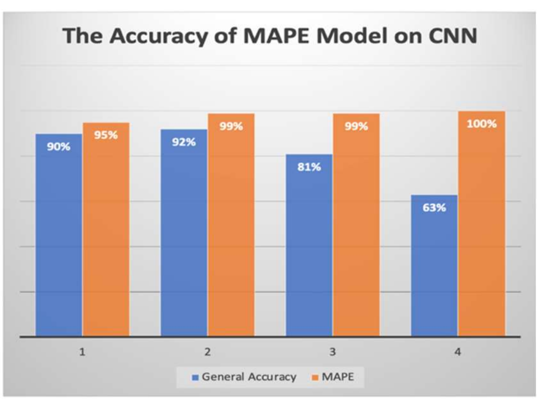

Figure 9: Model Accuracy

In Figure 9 it can be seen that the MAPE accuracy is superior to using the usual accuracy of the CNN algorithm. From frame 1 it can be seen that 90% on the usual accuracy and 95% on the accuracy using MAPE, then from frame 2 also on the usual accuracy of 92% and 99% MAPE accuracy. While in frame 3, 81% accuracy is seen in the usual and 99% in MAPE. And on frame 4, it looks 63% on the usual accuracy and 100% on the MAPE accuracy. From each frame, of course, MAPE is superior. However, based on the MAPE frame, the highest accuracy is 100% on frame 4 and the highest usual accuracy is 92% on frame 2.

4. CONCLUSION

In summary, this paper shows that the accuracy model has been running optimally by using MAPE on the CNN algorithm to detect moving objects. The moving object being tested is a vehicle plate that has many uses and can be implemented in traffic lights to find out traffic violations in order to develop the smart city concept in various cities in the world. The process of the video that the vehicle is cut based on an indefinite number of frames is then carried out training and testing with CNN then comparisons are made to the accuracy measurements commonly used on CNN and MAPE. From the observations MAPE is superior and achieves 100% accuracy the highest in the fourth frame and with a general accuracy of 92% in the second frame.

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