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Deep Learning Implementation to Determine Vehicle Groups at Halim Toll Gate

[1]Yedizha Afif Farhani, [2]Fauziah, [3]Nurhayati

Program Studi Teknik Informatika,
Fakultas Teknologi Komunikasi dan Informatika, Universitas Nasional, Jl. Sawo Manila, Pasar Minggu, Kota Jakarta Selatan, Daerah Khusus Ibukota Jakarta 12520

Email: [1]yedizhaa21@gmail.com, [2]fauziah@civitas.unas.ac.id, [3]nurhayati@civitas.unas.ac.id

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ABSTRACT

One of the solutions for the smooth flow of vehicles in big cities is to build toll road infrastructure. The toll road is a freeway with a paid system that can only be passed by four or more wheeled vehicles. There is often a buildup of vehicles when making payment transactions because the vehicle classification system is still manual or a wrong class occurs when payment transactions. To improve service quality, the use of deep learning to determine the class of vehicles or to correct transaction results is deemed effective. CNN method will classify vehicles based on two-dimensional image data. Vehicle data collection is done at the Halim Toll Gate..

1. Introdcution

Machine Learning is a technique for inferring data with a mathematical approach. The essence of machine learning is to create a model (mathematical) that reflects data patterns. (Jan Wira Gotama Putra, 2019: 5). Deep learning is an implementation or a derivative of machine learning that aims to mimic the workings of the human brain using artificial reasoning networks. Deep learning has excellent skills in computer vision. One of them is in the case of object classification in images. By implementing one of the machine learning methods that can be used for object image classification, namely Convolution Neural Network (CNN). This method also has a modification in the form of Deep Convolution Neural Network which is the beginning of deep learning. (Krizhevsky, 2012). One way to classify vehicles from previous research is to use Automatic Vehicle Classification (AVC).

Yudo Asmoro, et al (2016) in his research "Design of Prototype Automatic Vehicle Classification (AVC) on Toll Road Vehicles" uses infrared light to classify vehicles. This method has accurate results of 85% and an error of 15%. Nadiya Shvai, et al (2019) in his research "Accurate classification for Automatic Vehicle Type Recognition Based on Ensemble Classifiers" combines AVC with the length of time the sensor reads objects and vehicle weight and then combines them with deep learning using the CNN method. The result obtained is an accuracy rate of 99.03% in determining the type of vehicle whether including minibuses, trucks, buses, or motorcycles. The drawback of this method is that it uses a large number of infrared sensors so that the costs incurred are large. International scale research is not focused on the number of truck axles. This research will discuss the implementation of Deep Learning to determine vehicle classes based on two-dimensional imagery. The author takes samples of vehicles that pass through the Halim Toll Gate. The author will test whether deep learning can determine the class of vehicles based on two-dimensional imagery and how many results are obtained.

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2. Literature Review

I Wayan Suartika EP (2016) in "Image Classification Using Convolutional Neural Network (CNN) on Caltech 101" examines more specifically about CNN. In his research examined how much CNN can recognize animals. Comparison data is divided into poultry and reptile categories. The results of the study obtained an accuracy of 20% for poultry and 50% for reptiles.

Bagus Pribadi and Muchammad Naseer (2014) in the "Vehicle Type Classification System through Digital Image Processing Techniques" uses image smoothing processes to select data in the form of vehicles. Data is taken from CCTV server with the format. MP4. Testing is carried out for 1 minute 10 seconds. Selecting image data using Gaussian Smoothing. The method will select the image and will blur an unneeded area, the way is by looking at the surrounding area of the area, which region is more dominant then the disturbance area will be blended so that the area resembles the area around it. The results of this study obtained an error of between 2% -26%. This is influenced by the distance of the object and the size of the object. The smaller the object and the finer the image selection, the higher the accuracy value. The position of the CCTV camera also affects the results. The higher the CCTV, the distance between objects with each other becomes clearer.

Rama Adistya and M. Aziz Muslim (2016) in "Vehicle Detection and Classification using Backpropagation and Sobel Algorithms". In his research, combining sobel filters with training using backpropagation. Examine the detection accuracy of moving objects (vehicles) by comparing detection using applications and detection manually. Video sampling was taken at three stages, namely morning, afternoon and night. Each sample has a duration of 4 hours. The results of this study, accuracy in detecting moving images in the morning, afternoon, and night was 94.63%, 93.85%, and 68.32%. In this study, the type or class of vehicle cannot be determined yet. The error occurred due to lack of light intensity at night and traffic density during the day.

Royani Darma Nurfita, et al (2018) in "Implementation of Tensorflow Based Deep Learning for Fingerprint Recognition" using the CNN method with the Tensorflow library testing the number of epochs and learning rates. Based on these studies, the greater the epoch and the smaller the learning rate, the better the results obtained. The results obtained in these studies up to 100% accuracy.

Renjie Xie, et al (2016) in his research "Resource-Constrained Implementation and Optimization of a Deep Neural Network for Vehicle Classification" using the DNN method to compare the speed of computers from various cores to analyze data. They analyze passing vehicles and classify them whether they are minibuses or trucks. The research gets increasingly resultsthe higher the number of cores, the faster the results are obtained.

Based on the results of the analysis from previous studies, the deep learning method is used to solve the problem of data classification because of its use which has a relatively fast computational process, so that this study can produce a classification of vehicles based on image processing.

The resnet model introduces new blocks known as residual blocks. Characteristics of residual neural networks use skip connections, or shortcuts to jump over several layers. So that these layers can copy their input to the next layer. These typical models of ResNet are implemented by leaps and boundsone layer (He, et al, 2016).

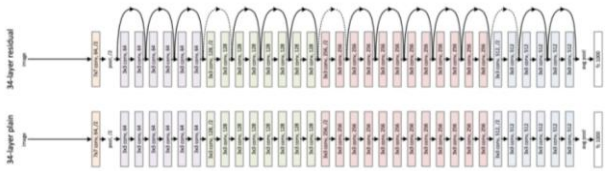

Fig 1. How it works from the 34th*ResNet layer*.

ResNet uses stepping for each layer connection, the connection will facilitate the training process. The motivation to skip or skip one layer is to avoid the problem of loss of gradient, by re-using the activation of the previous layer until the adjacent layer can learn its weight (Danang Setiaji and Herintaka, 2019).

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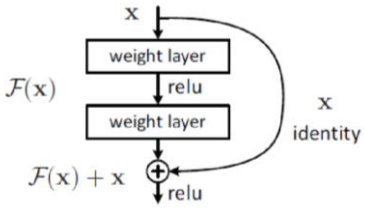

Fig 2. Leap layer on ResNet

3. Research methods

This study classifies vehicles that pass the toll road at Halim Toll Gate using CNN method. This classification is by looking at the results of capture captured on CCTV gate cameras and images taken directly with the back camera of the Oppo F1s cellphone during the observation. The picture is captured by the camera with the position of the car or vehicle on the side view or slightly sloped, so that the axle is visible in the picture.

Vehicle classifications are based on Ministry of Public Works Decree No. 370 / KPTS / M / 2007. This regulation is the basis used to classify vehicle classes in Indonesia

Table 1.
Classification of Vehicle Groups in Indonesia

Golongan	Jenis Kendaraan
Golongan I	Sedan, Jip, Pick Up/Truk Kecil, dan Bus
Golongan II	Truk dengan 2 (dua) gandar
Golongan III	Truk dengan 3 (tiga) gandar
Golongan IV	Truk dengan 4 (empat) gandar
Golongan V	Truk dengan 5 (lima) gandar
Golongan VI	Kendaraan bermotor roda 2 (dua)

Fig 3. Vehicle group 1

Fig 4. Vehicle group 2

Fig 5. Vehicle group 3

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Fig 6. Vehicle group 4

Fig 7. Vehicle group 5.

This study is in accordance with Figure 8 which has several stages. After the data is collected and labeled according to the classification manually, then the program design is done where the program must be in accordance with needs. After that, make a program that uses Matlab software. The design of the CNN program in this study uses ResNet-50. It starts with a pre-processing stage that equalizes the number of images to be trained, resizes the image pixels and equalizes the color scale to gray. This process is called ReLU (Rectified Linear Units). The next process is to do the training process or making training data models. The results of this training process will produce an image called pre-trained. The image will be material or data from the CNN network. If no errors occur, no CNN network evaluation is performed. The pre-trained image data earlier is also used as image data in the validation process. Next do the testing program or testing process. Test data in the testing process, obtained from data sets. The test is done by taking a random sample of images from each class of vehicle. If the accuracy of the program is still not good, improvements are made to the program code to get high accuracy. Looking at the results coming out of the program, a deeper analysis is carried out so that it can produce better accuracy. obtained from the data set. The test is done by taking a random sample of images from each class of vehicle. If the accuracy of the program is still not good, improvements are made to the program code to get high accuracy. Looking at the results coming out of the program, a deeper analysis is carried out so that it can produce better accuracy. obtained from the data set. The test is done by taking a random sample of images from each class of vehicle. If the accuracy of the program is still not good, improvements are made to the program code to get high accuracy. Looking at the results coming out of the program, a deeper analysis is carried out so that it can produce better accuracy.

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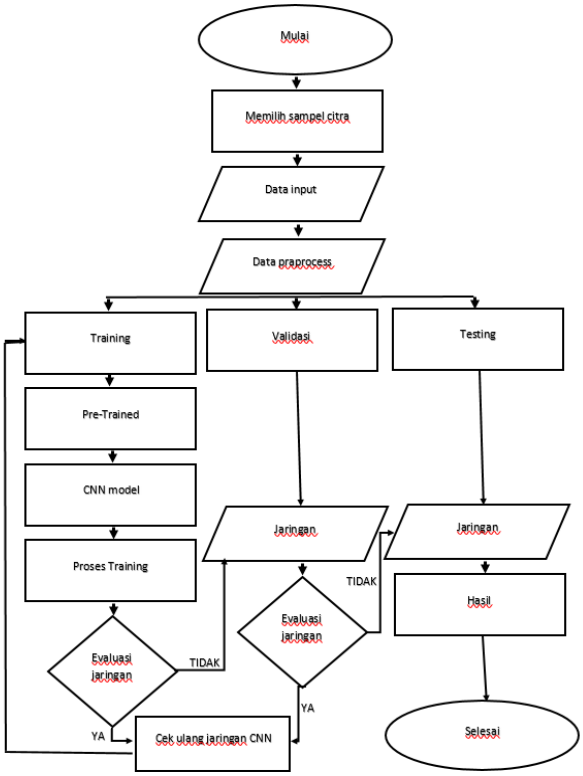

Fig 8. Image processing process flowchart

4. Results and Discussion

4.1. Results of Making Data Sets

The size of the image that was originally various sizes changed to 224 x 224 pixels with the greyscale format. This is done with the intention of equalizing the pixel size and color scale.

Table 1.
Number of data sets used. 208 total images.

Label	Count
golongan1	82
golongan2	56
golongan3	30
golongan4	21
golongan5	19

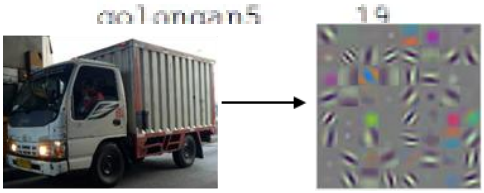

Fig 9. Pixel size selection results and *greyscale.*

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4.2. Results of Making Training Data

The results of making training data for 95 sets of images are used for the training and validation process (each group consists of 19 images and is chosen randomly based on the data set). The number 19 is the prune of the overall data, because 19 is the smallest amount obtained from the number of dataset in group 5. This is done so that the percentage results are objective from each group. Making training data using ResNet-50. The results of the training process are called pre-trainned.

4.3. Test result

A total of 5 sets of images were used for testing, each group was taken as much as 1 sample image. Tests are carried out randomly using data from data sets. Obtained results:

Table 3.
Image test results.

	Command Window ans = 0.5846 ans = 'Gambar yang dimuat adalah kelas golongan1.'
	Command Window ans = 0.5846 ans = 'Gambar yang dimuat adalah kelas golongan2.'
	Command Window ans = 0.6462 ans = 'Gambar yang dimuat adalah kelas golongan3.'
	Command Window ans = 0.5846 ans = 'Gambar yang dimuat adalah kelas golongan4.'
	Command Window ans = 0.6308 ans = 'Gambar yang dimuat adalah kelas golongan5.'

a. Can detect group 1 with 58% accuracy.
b. Can detect class 2 with an accuracy of 58%.
c. Can detect class 3 with an accuracy of 64%.
d. Can detect class 4 with an accuracy of 58%.
e. Can detect class 5 with an accuracy of 63%.

5. Conclusion

The results of the study to determine vehicle classes based on two-dimensional images show that deep learning can detect groups 1, 2, 3, 4, and 5 with an accuracy of 58%, 58%, 64%, 58%, and 63%.

In this study the error results obtained in the testing process due to the effects of light. Incorrect results of shooting also affect the final result. Examples between group 1 and group 2 differences are in the rear wheels, where for group 2 there are 2 axles (double rear wheels). If the picture is on the side, the

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system is less accurate in processing the test data because the physical shape is almost the same and the rear wheel only looks 1 axle. As a result, the percentage of yield decreases.

The effects of light from the sun in the morning to noon conditions and the effect of light from lights during night conditions can affect the quality of the image affected by noise. This picture affects the accuracy of the final results when we use it as training data and test data.

The amount of training data can affect network accuracy. The more training data the network will learn more so that accuracy will be better. However, large computing equipment is needed to carry out network training processes on a lot of data.

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