A study on Image Classification based on Deep Learning and Tensorflow

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A study on Image Classification based on Deep Learning and Tensorflow

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Abstract

This research study about image classification by using the deep neural network (DNN) or also known as Deep Learning by using framework TensorFlow. Python is used as a programming language because it comes together with TensorFlow framework. The input data mainly focuses in flowers category which there are five (5) types of flowers that have been used in this paper. Deep neural network (DNN) has been choosing as the best option for the training process because it produced a high percentage of accuracy. Results are discussed in terms of the accuracy of the image classification in percentage. Roses get 90.585% and same goes to another type of flowers where the average of the result is up to 90% and above.

Keywords: Image classification, Deep Learning, Tensorflow

I. INTRODUCTION

Recently, image classification is growing and becoming a trend among technology developers especially with the growth of data in different parts of industry such as e-commerce, automotive, healthcare, and gaming. The most obvious example of this technology is applied to Facebook. Facebook now can detect up to 98% accuracy in order to identify your face with only a few tagged images and classified it into your Facebook's album. The technology itself almost beats the ability of human in image classification or recognition (What is the Working of Image Recognition and How it is Used, 2017).

One of the dominant approaches for this technology is deep learning. Deep learning falls under the category of Artificial Intelligence where it can act or think like a human. Normally, the system itself will be set with hundreds or maybe thousands of input data in order to make the 'training' session to be more efficient and fast. It starts by giving some sort of 'training' with all the input data (Faux & Luthon, 2012).

Machine learning is also the frequent systems that has been applied towards image classification. However, there are still parts that can be improved within machine learning. Therefore, image classification is going to be occupied with deep learning system.

Machine Vision has its own context when it comes with Image Classification. The ability of this technology is to recognize people, objects, places, action and writing in images. The combination of artificial intelligence software and machine vision technologies can achieve the outstanding result of image classification (Haughn M, 2017).

The fundamental task of image classification is to make sure all the images are categorized according to its specific sectors or groups (Xie, Hong, Zhang, & Tian, 2015). Classification is easy for humans but it has proved to be major problems for machines. It consists of unidentified patterns compared to detecting an object as it should be classified to the proper categories. The various applications such as vehicle navigation, robot navigation and remote sensing by using image classification technology. It is still undergoing challenging work and limited resources are needed to improve it (Xie et al., 2015).

Image classification has become a major challenge in machine vision and has a long history with it. The challenge includes a broad intra-class range of images caused by color, size, environmental conditions and shape. It is required big data of labelled training images and to prepare this big data, it consumes a lot of time and cost as for the training purpose only (X. Li & Guo, 2013).

In this paper, deep neural network, based on TensorFlow is used with Python as the programming language for image classification. Thousands of images are used as the input data in this project. The accuracy of each percentage of 'train' session will be studied and compared.

II. RELATED WORK

In [1], studied about Neural Network Architecture (NNA) as a method for the image classification. The framework consists of a combination between mimics of two pairs human eye and variation sequence auto-encoding. It involved many complex images but in the process of this study, the system slowly improves the MNIST models. The MNIST is the open source database to be used as the training set. It also tests with Street View House Numbers dataset where the result was improved because even the human eyes cannot distinguish it.

According to [2], the journal discussed on image classification system based on a structure of a Convolutional Neural Network (CNN). The training was performed such that a balanced number of face images and non-face images were used for training by deriving additional face images from the face images data. The image classification system employs the bi-scale CNN with 120 trained data and the auto-stage training achieves 81.6% detection rate with only six false positives on

Face Detection Data Set and Benchmark (FDDB), where the current state of the art achieves about 80% detection rate with 50 false positives.

From [3] the research used Decision Tree (DT) as the techniques in image classification. The DT has multiple datasets that are located under each of Hierarchical classifier. It must be done in order to calculate membership for each of the classes. The classifier allowed some rejection of the class on the intermediary stages. This method also required of three (3) parts which the first one is to find terminal nodes and second in the placement of class within it. The third one is partitioning of the nodes. This method is considered very simple and high rate of efficiency.

In the journal [4], this paper discusses on Support Vector Machine (SVM) active learning that was very actively growing interests during that time. It also proposed some new idea by combining spatial information from a sequential process in the trial process with spectral. It requires three strategy where the first one is Euclidean distance. It calculated some of the training samples from the main part of spatial. The second strategy is based on the Parzen window technique and finally, it includes spatial entropy. The result showed that two of the images have high resolution in terms of effectiveness of regularly.

Based on the journal [5], it proposed fast image classification by boosting the Fuzzy Classifiers. It was a simple way to differentiate between known and unknown category. This method is simply boosting Meta knowledge where local characteristic can be mostly found. It was tested with some big data of images and compared with the bag-of-features image model. The result gave much better classification accuracy as it was a testing process that gave a short period of time where it produced 30% shorter compared to the previous one. Table 2 shows the summary of the related works of classification systems.

Table 1. Summary of the related works of classification systems

Research No	Name/Year	Title of project	Purpose	Method Used	Result
Research 1	Gregor, Danihelka, Graves, Rezende, & Wierstra (2015)	DRAW: A Recurrent Neural Network for Image Generation	➢ Train neural network for image classification ➢ Trained complex images with MNIST models	Artificial Neural Network (ANN)	Classification improved even naked eye cannot distinguish it with main data
Research 2	Rastegari, Ordonez, Redmon, & Farhadi (2016)	XNOR-Net: ImageNet Classification Using Binary Convolutional Neural Networks	➢ Balanced number of face images and non-face images are used for training ➢ Employing the bi-scale CNN 120 trained with the auto-stage training	Convolutional Neural Network	Current state of the art achieves about 80% detection rate with 50 false positives.
Research 3	Kamavisdar, Saluja, & Agrawal (2013)	A Survey On Image Classification Application Techniques	➢ Multiple dataset that being located under each of Hierarchical classifier ➢ Rejection of the class on the intermediary stage	Decision Tree	Considered very simple and high rate of efficiency
Research 4	Pasolli, Melgani, Tuia, Pacifici, & Emery (2014)	SVM Active Learning Approach for Image Classification Using Spatial Information	➢ Combining spatial information from sequential process of trial process with spectral	Support Vector Machine (SVM)	Two (2) of the images have high resolution in terms of effectiveness of regularly.
Research 5	Korytkowski, Rutkowski, & Scherer (2016)	Fast Image Classication by Boosting Fuzzy Classifiers	➢ Simply boosting Meta knowledge where local characteristic can be mostly found	Fuzzy Classifiers	Testing process give short period of time where it produce 30% shorter compared to the previous one.

III. METHOD

Based on Figure 1, it is the framework of image classification where deep neural networks are also applied. There are four (4) phases throughout this process and each of the phases will be discussed. Each of the phases are included on TensorFlow as the open source software and Python as its programming language. Then, the process is continued to collect some of the images (inputs), by applying DNN and lastly all images will be classified into their groups.

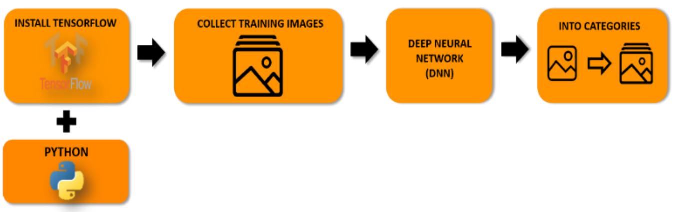

Fig. 1. The block diagram of Image Classification

III.I Training Images

Input data for this paper mainly uses thousands of images. All of these images are taken from ImageNet. ImageNet also was known as Large Scale Visual Recognition Challenge where it is a competition about detecting and classified thousands of object into its categories. This is an annual competition since 2010 until today. This is a benchmarking or starting of revolution on 'big data'.

In this paper, thousands of images of flowers were obtained through this ImageNet website as shown in Figure 2 and it is free. It meant to be used by the researcher or engineers. This research paper solely focuses on classify flowers into each of its categories. There are thousands of flower images and it has five types of flowers here. Each type of flowers contains hundreds of images with different side and also colors. The total number for all of this flower is 3670 images as shown in Table 2.

Fig. 2. The block diagram of Image Classification

Table 2. Number of images according to the type of flowers

No.	Type of Flowers	No of Images
1.	Daisy	633
2.	Dandelion	898
3.	Roses	641
4.	Sunflower	699
5.	Tulips	799
Total of flower images		3670

III.II Implementation Deep Neural Network (DNN)

As shown in Figure 3, it consists of five (5) data inputs (five type of different flowers) and undergoes training with multiple hidden layers. The inputs are also set with fixed-size of the 224x224 RGB image. The convolution process is configured with MobileNet as it produces an efficient convolution neural networks.

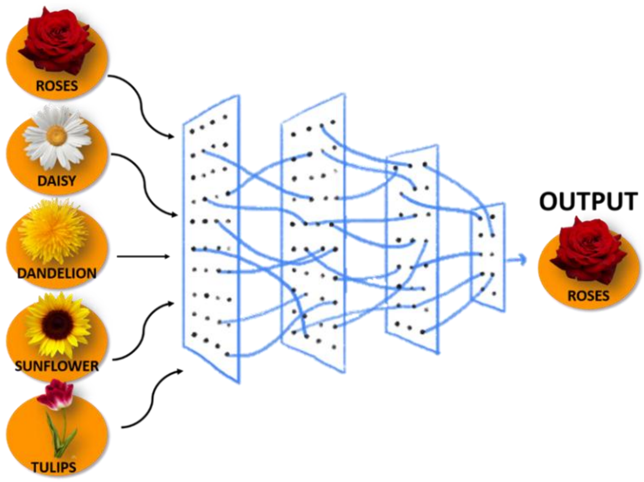

Fig. 3. DNN process towards flower images

III.III MobileNet Performance

In this paper, MobileNet is used as the 'trainer' as it consists of small efficient of deep neural networks (DNN). It has two (2) ways to configure this MobileNet which is the first one is input image resolution and the size of the model within MobileNet. As for this research, it was set as shown in Figure 4 where Input Image Resolution is set as 224 and Size of the model is set as 0.50.

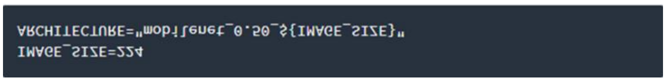

Fig. 4. Script configuration of MobileNet

III.IV Flowchart of the classification systems

Based on Figure 5, the flowchart of image classification that will be implemented using TensorFlow. The programming language that will be used in the software in Python. The flowchart shows that the systems will be started by collecting images of the flowers. After that, DNN is applied to train the model. Running for validation or testing and if it is not the image of a particular flower that supposedly acts as output then it needs to start over again from DNN. The process ends after the output is classified into the right type of flowers.

The flowchart starts with inserting sets of flower images as an input in this research. It has five (5) types of the flower which is Roses, Daisy, Dandelion, Sunflowers, and Tulips. After that, all of these input images undergo 'training' with the deep neural network (DNN).

The deep neural network (DNN) had to train all of these sets of data until the systems recognize each of these 3670 images. Then, each of the classifications occurred when one of the images being tested whether it belongs to any of these five (5) type of flowers.

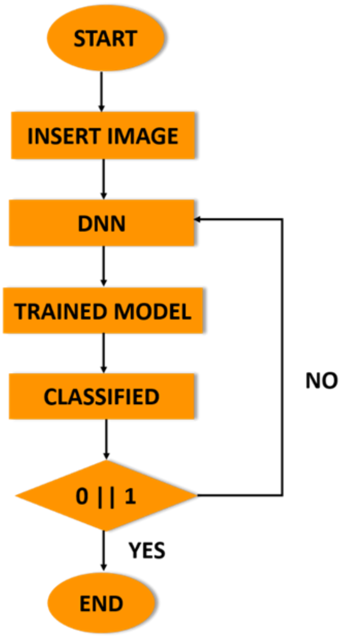

Fig. 5. The flowchart of image classification system

IV. RESULT

IV.I The Accuracy of the Roses

The results for type flowers of Roses are shown in Figure 6 and Table 3. It is shown that the accuracy of the image classification for Roses is 90.585% when it was simulated and compared to other types of flowers.

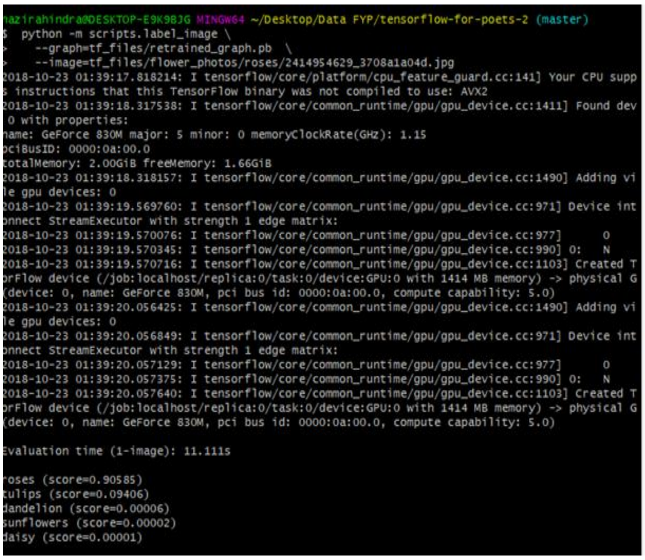

Fig. 6. The result of classification for Roses image

Table 3. The result of classification for Roses image in percentage

NO	FLOWERS	ACCURACY
1.	ROSES	90.585%
2.	DAISY	0.001%
3.	DANDELION	0.006%
4.	SUNFLOWERS	0.002%
5.	TULIPS	9.406%

IV.II The Accuracy of the Daisy

The results for type flowers of Daisy are shown in Figure 6 and Table 4. It is shown that the accuracy of the image classification for Daisy is 99.626% when it was simulated] and compared to other types of flowers.

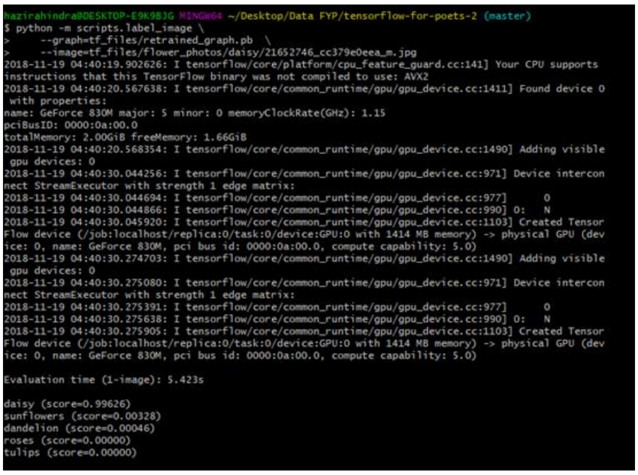

Fig. 7. The result of classification for Daisy image

Table 4. The result of classification for Daisy image in percentage

NO	FLOWERS	ACCURACY
1.	ROSES	0.000%
2.	DAISY	99.626%
3.	DANDELION	0.046%
4.	SUNFLOWERS	0.328%
5.	TULIPS	0.000%

IV.III The Accuracy of the Dandelion

The results for type flowers of Dandelion are shown in Figure 8 and Table 5. It is shown that the accuracy of the image classification for Dandelion is 99.823% when it was simulated and compared to other types of flowers.

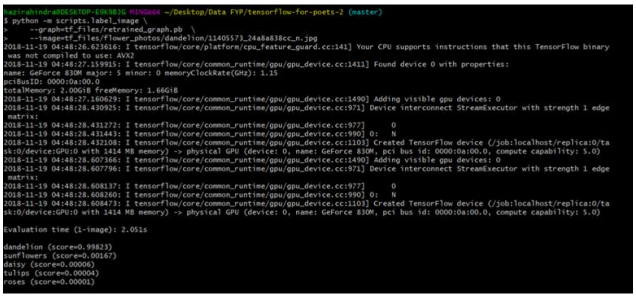

Fig. 8. The result of classification for Dandelion image

Table 5. The result of classification for Dandelion image in percentage

NO	FLOWERS	ACCURACY
1.	ROSES	0.001%
2.	DAISY	0.006%
3.	DANDELION	99.823%
4.	SUNFLOWERS	0.167%
5.	TULIPS	0.004%

IV.IV The Accuracy of the Sunflowers

The results for type flowers of Sunflowers are shown in Figure 9 and Table 6. It is shown that the accuracy of the image classification for Sunflowers is 99.982% when it was simulated and compared to other types of flowers.

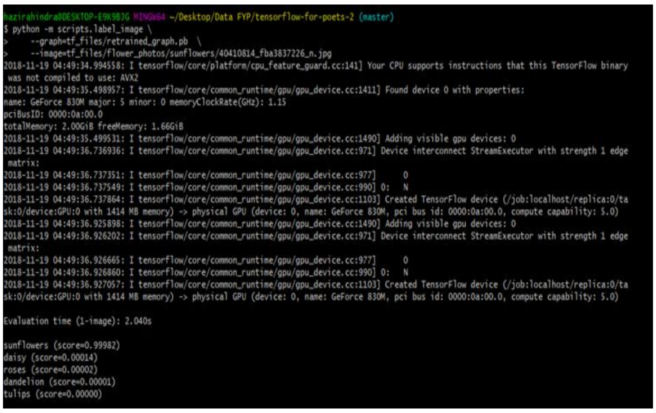

Fig. 9. The result of classification for Sunflowers image

Table 6. The result of classification for Sunflowers image in percentage

NO	FLOWERS	ACCURACY
1.	ROSES	0.002%
2.	DAISY	0.014%
3.	DANDELION	0.001%
4.	SUNFLOWERS	99.982%
5.	TULIPS	0.000%

IV.V The Accuracy of the Tulips

The results for type flowers of Tulips are shown in Figure 10 and Table 7. It is shown that the accuracy of the image classification for Tulips is 100.0% when it was simulated and compared to other types of flowers.

Fig. 10. The result of classification for Tulip image

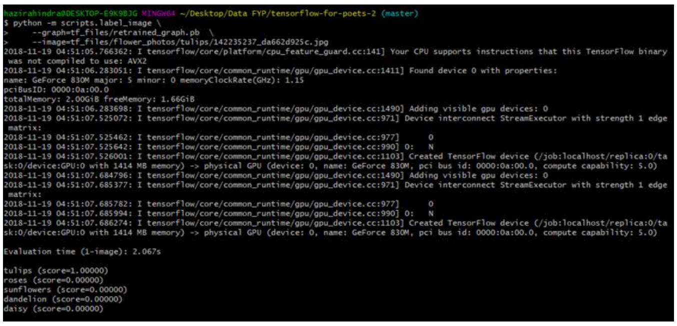

Table 7. The result of classification for Tulip image in percentage

NO	FLOWERS	ACCURACY
1.	ROSES	0.000%
2.	DAISY	0.000%
3.	DANDELION	0.000%
4.	SUNFLOWERS	0.000%
5.	TULIPS	1.000%

IV.VI Comparison of two Different Size Model MobileNet

This shows the graph of MobileNet with two different size models. The size model was one of the parameters that can be adjusted or changed. From Figure 11, it can be seen that training session of MobileNet 0.50 was much faster as it only required 51 seconds while MobileNet 1.00 took more time with 6 minutes 44 seconds to complete the training session. However, MobileNet 1.00 had a higher rate of accuracy compared to MobileNet 0.50. It can be concluded that as the size of the model is bigger it is going to take more time to finish the training session but despite that, it produces higher accuracy compared to the smaller model of MobileNet.

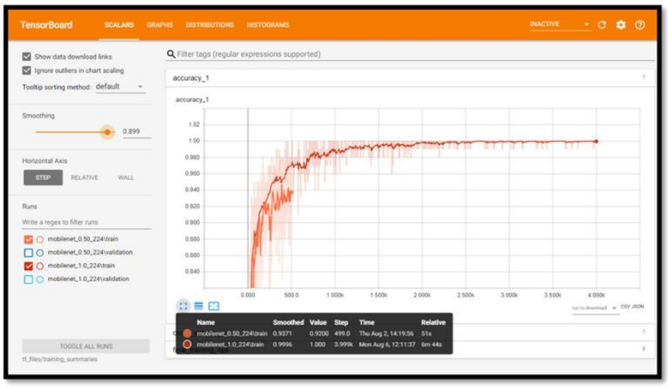

Fig. 11. Graph of 0.50 vs 1.00 MobileNet

V. DISCUSSION

The result of this paper depends on the objectives that need to be achieved. Other than that, certain parameters also played its roles to determine the accuracy of the image classification by using the deep neural network (DNN).

The first result of this research was tested by conducting classification for each of the types of flowers. It can be seen all of the five (5) types of flowers showed up to 90% accuracy in terms of implementation of the system of image classification by using DNN. This happened due to the abundantly set of data that was being used in order to train the model and of course DNN worked excellent when there were lots of data.

Then, the system was tested with an image of cow.jpg where actually this images were not included during the training model. The images also were not one of the categories of flowers instead it fell under animals. There were some errors after doing the classification. The errors state that ‘Not Found Error’ which meant that the images cannot be recognized by the systems as it was not trained so that model trained can recognize it as an animal named as cow.

Lastly, the results of the graph that showed some changes when one of the parameters of MobileNet was changed. The size of the model was set into two (2) different sizes and it affected the systems. As the size of the model become smaller, the training session took short time to be completed,but the percentage of the accuracy might be slightly low compared to the big size of the training model.

VI. CONCLUSION

In conclusion, this research is about image classification by using deep learning via framework TensorFlow. It has three (3) objectives that have achieved throughout this research. The objectives are linked directly with conclusions because it can determine whether all objectives are successfully achieved or not. It can be concluded that all results that have been obtained, showed quite impressive outcomes. The deep neural network (DNN) becomes the main agenda for this research, especially in image classification technology. DNN technique was studied in more details starting from assembling, training model and to classify images into categories. The roles of epochs in DNN was able to control accuracy and also prevent any problems such as overfitting. Implementation of deep learning by using framework TensorFlow also gave good results as it is able to simulate, train and classified with up to 90% percent of accuracy towards five (5) different types of flowers that have become a trained model. Lastly, Python have been used as the programming language throughout this research since it comes together with framework TensorFlow which leads to designing of the system involved Python from start until ends.

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