

Dog Breed Classification using Convolutional Neural Networks and Transfer Learning

¹Mansi Chalawari, ²Manasi Koli, ³Mrunal Deshmukh, ⁴Poonam R.Pathak

^{1,2,3}Students, ⁴Assistant Professor
Information Technology Department
PHCET, Rasayani, India

Abstract: Convolution Neural Networks (CNN) with the help of transfer learning the system used for dog breed classification and detection. It also considers the combination of multiple basic CNN models for dog breed can be classified and give immense improved performances. This model supports the classification of 133 dog breeds whereas capital punishment the model. CNN may be a structure designed to method real-world user-defined pictures. Consider, a dog image is chosen the model can classify Associate in Nursing establish an analysis of the dog breeds, this model is used as a neighborhood of mobile or net app for the real-world and user-definition image. Once the image is given to the model for execution, it analyzes if a dog is a gift and returns the estimated breed. During this model, we tend to use a pair of datasets that are dog and human. Whereas we tend to execute our scratch model it's impossible to induce high accuracy therefore we tend to come up with the Resnet50 model that has high accuracy share up to eighty-six and higher than roughly that processes information at intervals less time with the assistance of GPU (Graphical Process Unit). The result that occurred has shown Brobdingnagian improvement of accuracy as compared to the scratch model.

Keywords: Convolutional Neural Network, Transfer learning, ResNet50, Dog Breed Classification, Deep Convolutional Neural Networks.

I. INTRODUCTION

Convolution Neural Network, typically written as CNN. A CNN (i.e. Convolutional Neural Network) may be a category of DNN (i.e. deep neural networks), most often wont to notice the visual image. It's a kind of artificial neural network utilized in image detection and process that's specifically designed to method totally different sizes of information, or pictures. It's a Deep Learning algorithmic program that considers taking input pictures and compares them to various aspects within the image and is ready to builds variations one from another. All over the globe, their area unit quite 800 dog breeds area unit found, that varies region to region and per the climate in addition. So, it's troublesome to classify all therefore can|we'll|we are going to think about 133 dog breeds for coaching our model, whereas, one will choose image online/ webpage and may notice the dog breed or lost dog if someone does not grasp what class dog belongs to the current model will provide them the acceptable results. Excluding that, it is not troublesome to estimate the dog breed image. That is why the associate degree initiative is taken into account to make this project differentiate between dog breed and lots of attention-grabbing future scopes which is able to result in associate degree correct time period answer.

II. RELATED WORK

In 2018, Minori Uno, Xian-Hua Han and Yen-Wei Chen in "Comprehensive Study of Multiple CNNs Fusion for Fine-Grained Dog Breed Categorization" have proposed to fusion multiple basic CNN models for dog breed categorization. They compressively study the fusion of different layers such as FC6, Relu6, FC7, Relu7 and FC8 in AlexNet and VGG16. According to this they manifested 2.88% improvement over fusion architecture. This system gives accuracy rate of VGG16 from 81.2% to 84.08%. [1]

In 2018, R. O. Sinnott, F. Wu and W. Chen, in "A Mobile Application for Dog Breed Detection and Recognition based on Deep Learning" proposed a dog breed image classification application supporting object detection which utilized deep learning. This deep learning recognition model gives the classification of 120 dog breeds. The system gives 85% of accuracy for 50 classes of dogs and 64% for 120 classes of dog types. [2]

In 2019, S. Divya meena and I. Agilandeewari in "An Efficient Framework for Animal Breeds Classification Using Semi-Supervised Learning and Multi-Part Convolutional Neural Network (MP-CNN)" have built a semi-supervised learning based Multi-part Convolutional Neural Network with classifying 27 classes of animals with 35,992 training images. [3]

In 2019, P. Borwarnginn, K. Thongkanchorn, S. Kanchanapreechakorn, W. Kusakunniran in "Breakthrough Conventional Based Approach for Dog Breed Classification Using CNN with Transfer Learning" proposed the classification methods for dog breed classification where they used two image processing approaches that are 1) conventional based approaches by Local Binary Pattern (LBP) and Histogram of Oriented Gradient (HOG) and 2) the deep learning-based approach by using convolutional neural networks (CNN) with transfer learning. This study proves that CNN could be used on dog breed classification.

III. LIMITATION OF EXISTING SYSTEM

The VGG16 and Alexnet gives less accuracy compare to other algorithm for classifications problems. VGG16 offers more training time and deals with vanishing gradient problem. The obtained accuracy for VGG16 is between 81.20% to 84.08% [1].

Dog breed image classification application supporting object detection that utilized deep learning. The dog breed recognition model supports the classification of 120 dog breeds. The results are higher because it was trained on less breeds of dogs.[2]

The system was trained on only 27 dog breeds but in real world there are more than 27 breeds of dogs to classify so the model will not become more generalized.[3]

IV. PROBLEM STATEMENT

The existing system model follows on a solely restricted variety of dog breeds that were troublesome to find and differentiate them once their area unit close to 133 dog breeds on the market therefore generally varied dog categories wander away.

The VGG16 model uses weight parameter of information set that cause serious model except that coaching time is a lot of and creates vanishing gradient drawback.

Their area unit several drawbacks of VGG16 like it creates a lot of heavier models, and a lot of coaches' time.

Machine Learning Algorithms don't work well on unbalanced dataset kinds of issues that end up in provide correct predictions.

Hence, we've introduced a ResNet50 design that is healthier and economical than VGG16.

V. PROPOSED SYSTEM

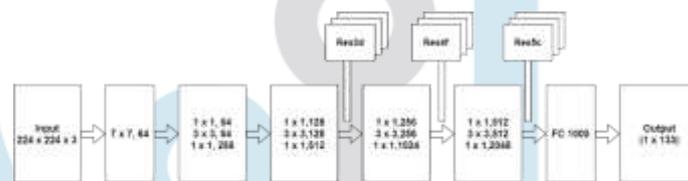


Fig 1. ResNet50 Architecture

The Proposed system will be trained on 133 breeds of dogs, so our model will become more generalized in the Real-World dog breed classification scenario. The proposed model classifies the animals on both generic and fine-grained levels. The animal breeds are accurately classified using Multi-part Convolutional Neural Network. We'll do information pre-processing so pictures the photographs from the dataset are trained victimization animals' varied positions and human images for higher results. Here, during this project, we'll contemplate two varieties of the dataset such as dog and human where the total number of dog breeds is 8351 and the total number of human images is 13243. Dataset used in Existing System is imbalanced i.e., the number of images of some breeds of dogs is higher than other, imbalanced problem will confuse the deep learning algorithms which results in a decrease inaccuracy.

Transfer learning is also used to increase the accuracy between breeds which uses models such as VGG16. By using VGG16 the accuracy they got is between 81.20% to 84.08%. The proposed model classifies the animals on both generic and fine-grained levels. The animal breeds are accurately classified using Multi-part Convolutional Neural Network.

We used VGG16 to classify the dogs from dogs and human images folder from 1st 100 images but the results we get is not accurate. But our main aim is to accurately detect the different breeds of dogs which is not possible using VGG16 apart from them it's heavier, takes more training time, and also with vanishing gradient problem as well, so we come up with ResNet50 architecture.

Conv layers and Max-Pooling layers are also called Hidden Layers. The first Image is given as an to the ResNet50 model, then the image is passed to the 1st Conv layer of ResNet50 then the output of 1 Conv layers goes as an input to the 2nd Conv layer then the output of 2nd Conv layer goes as an input to 3rd Conv layer then the output of 3rd Conv layer goes as an input to 4th Conv layer then the output of 4th Conv layer goes as an input to 5th Conv layer then the output of 5th Conv layer goes to the output layer than at the output layer we get our predictions of the given input image. The Max-Pooling layers are used to reduce the dimensionality of Images. At the Output layers, we will be using Softmax Activation Functions. Activation Functions are used to find the non-linear functionality. We will get predictions from the 133 breeds of dogs.

Algorithm:

Step 1: Start step

Step 2: Importing the Dataset using Data Loaders of PyTorch step

Step 3: Input the dataset to the first layer of neural networks

Step 4: - Detect Humans using Haar Cascade Classifier

Step 5: - Detect Dogs in the dataset using a pre-trained VGG16 model

Step 6: Create a CNN to Classify Dog Breeds (from Scratch) using the below steps:

- i) Do Forward Propagation i.e. go from left to right of the architecture using the relu activation function
 - ii) Differentiation of value that we got in (i) by doing forward propagation with the authentic value. Estimate the error which is generated by using the Loss Function.
 - iii) Do Back Propagation i.e. go from right to left of the architecture. Update weights and bias of your input layer simultaneously until your model leads to convergence
 - iv) Perform the steps from (i) to (iii) again, but updates the parameters after a certain amount of observations.
- Step7: - Create a CNN to Classify Dog Breeds (using Transfer Learning) using the below steps: -
- i) Downloading the weights of the ResNet50 pre-trained model and then putting it in the first layer of the neural network
 - ii) Removing the last fully-connected layer of the pre-trained model and then replace it with 133 classes of Dog Breed.
- Step 8: Training the model
 Step 9: Testing the model and Algorithm
 Step 10: Stop

We have enforced this technique victimization PyTorch, which could be a Deep Learning Framework. The prediction results that we tend to get at the tip will then be displayed on the online Page victimization Flask, which could be a python net development library. we've deployed this project as an online Application on our native system victimization Python and Flask

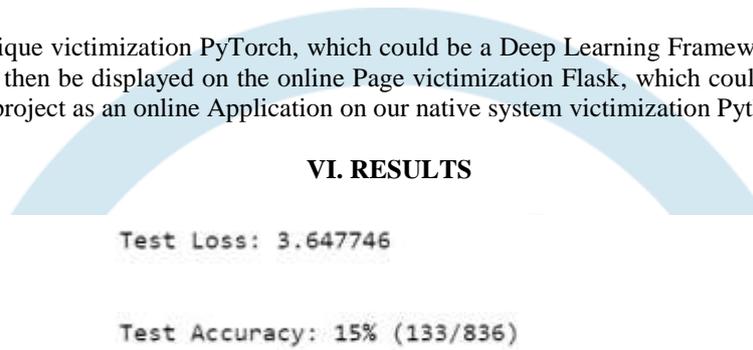


Fig 2. Accuracy of CNN model from Scratch

The accuracy we get by training our CNN model from scratch with 40 epochs is only 15%. We have used GPU to train our CNN from the scratch model.

```
# (IMPLEMENTATION) Test the Model
test(loader_transfer, model_transfer, criterion_transfer, use_cuda)

Test Loss: 0.442989

Test Accuracy: 86% (719/836)
```



Fig 3. Accuracy of CNN model using Transfer Learning

In the above figure, we get an accuracy of 86% by using the ResNet50 transfer learning model. We trained this model on 40 epochs with GPU Support.

It clearly shows that we get the better and best performance by using ResNet50 Transfer Learning even with the same number of epochs.

By using the ResNet50 pre-trained model, the results we get on our test images are outstanding.



Fig 4. ResNet50 accurately detected the above dog breed as German shorthaired pointer.



Fig 5. ResNet50 accurately detected above dog breed as Pointer.



It took 10 hours with GPU (Graphical Processing Unit) to trained our whole model (CNN from scratch + ResNet50).

We have trained our model on Google Colab, which provides free access to computing resources including GPUs. We even deployed this model as a Web Application with the help of Flask (which is Python Web Development Framework), JSON, and Python.

Future Scope

The model can then be deployed on the Google Play Store as an App, where anyone can download it and then can be used at the dog's shop. At the dog shop, if any pet lover wants to know the dog breed without even asking the shop owner, he/she can use this app to identify the dog breed. Knowing Dog Breed will help the individuals to get information about the dog, whether the detected types of the dog breed as any history of diseases, whether the detected dog eats more or eat less, whether the dog behaves good or bad. All these things and information will help. We can even use this model to identify the lost dog through Cameras and CCTV. With the help of this model, we will search dogs only on the detected breed types rather than identifying the whole dog breeds data.

Conclusion

So, in the model, we have used Convolutional Neural Network (CNN) along with Transfer Learning of ResNet50, which gives us the accuracy of around 86% on 133 breeds of dog. The Transfer Learning and Convolutional Neural Network techniques an area unit still within the analysis space. We have used transfer Learning which gives higher accuracy. World Health Organization can even use this model to separate the dangerous dogs who have disease problems and who can spread diseases from other less harmful dogs.

REFERENCES

- [1] M. Uno, X. Han and Y. Chen, "Comprehensive Study of Multiple CNNs Fusion for Fine-Grained Dog Breed Categorization," 2018 IEEE International Symposium on Multimedia (ISM), Taichung, 2018, pp. 198-203.
- [2] R. O. Sinnott, F. Wu and W. Chen, "A Mobile Application for Dog Breed Detection and Recognition Based on Deep Learning," 2018 IEEE/ACM 5th International Conference on Big Data Computing Applications and Technologies (BDCAT), Zurich, 2018, pp. 87-96.
- [3] S. Divya meena and Agilandeewari, "An Efficient Framework for Animal Breeds Classification Using Semi-Supervised Learning and Multi-Part Convolutional Neural Network (MP-CNN)" 2019 [IEEE Access](#).
- [4] Changqing Wang; Jiayang Wang; Quancheng Du; Xiangyu Yang, "Dog Breed Classification Based on Deep Learning", 2020 13th International Symposium on Computational Intelligence and Design (ISCID), Hangzhou.
- [5] Xinyuan Tu; Kenneth Lai; Svetlana Yanushkevich, "Transfer Learning on Convolutional Neural Networks for Dog Identification", 2018 IEEE 9th International Conference on Software Engineering and Service Science (ICSESS), Beijing
- [6] Wenbo Li; Chuan Ke, "Ensemble deep neural networks for domain-specific Image Recognition", 2016 IEEE International Conference on Multimedia & Expo Workshops (ICMEW), Seattle
- [7] Cristian Iorga; Victor-Emil Neagoe, "A Deep CNN Approach with Transfer Learning for Image Recognition", 2019 11th International Conference on Electronics, Computers and Artificial Intelligence (ECAI), Pitesti.
- [8] Punyanuch Borwarnginn; Kittikhun Thongkanchorn; Sarattha Kanchanapreechakorn; Worapan Kusakunniran, "Breakthrough Conventional Based Approach for Dog Breed Classification Using CNN with Transfer Learning", 2019 11th International Conference on Information Technology and Electrical Engineering (ICITEE), Pattaya.
- [9] Bulbul Bamne; Neha Shrivastava; Lokesh Parashar; Upendra Singh, "Transfer learning-based Object Detection by using Convolutional Neural Networks", 2020 International Conference on Electronics and Sustainable Communication Systems (ICESC), Coimbatore.
- [10] Xiaolong Wang; Vincent Ly; Scott Sorensen; Chandra Kambhamettu, "Dog breed classification via landmarks", 2014 IEEE International Conference on Image Processing (ICIP), Paris.
- [11] Zalán Ráduly; Csaba Sulyok; Zsolt Vadász; Attila Zölde, "Dog Breed Identification Using Deep Learning", 2018 IEEE 16th International Symposium on Intelligent Systems and Informatics (SISY), Subotica.
- [12] Mahardi; I-Hung Wang; Kuang-Chyi Lee; Shinn-Liang Chang, "Images Classification of Dogs and Cats using Fine-Tuned VGG Models", 2020 IEEE Eurasia Conference on IOT, Communication and Engineering (ECICE), Yunlin.
- [13] S. C. Dubey, K. S. Mundhe and A. A. Kadam, "Credit Card Fraud Detection using Artificial Neural Network and BackPropagation," 2020 4th International Conference on Intelligent Computing and Control Systems (ICICCS), Madurai, India, 2020, pp. 268-273, doi: 10.1109/ICICCS48265.2020.9120957.