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A Novel Dog Breed Identification using Convolutional Neural Network

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Abstract

ML has grown in popularity over the previous decade as a result of strong computers that can process large amounts of data in a reasonable length of time. A well-known problem in Machine Learning is the Dog breed classifier. The issue is determining a dog's breed. The input can be a dog or a human image, and the proposed algorithm should be able to forecast the dog's breed or, if the human is a dog, which breeds it belongs to. For human face detection, OpenCV is utilised, while for dog face detection, the VGG16 model is employed. With the ResNet101 architecture, a convolutional neural network is utilized for classification. On test data, the final model had an accuracy of 81 percent.

Keywords: Face Recognition; Face Detection; Security; Authentication

Introduction

Dogs are the most common pets in people's homes. Currently, there are around 470 million puppies in the world, with 75 percent to 85 percent of them being stray dogs and wild puppies. According to the World Health Organization, over 200 million puppies will be unowned by 2021. Due to the large number of dogs, there are a number of issues, including population control, rabies outbreaks, vaccination control, and felony ownership [6]. According to the American Kennel Club there are currently over a hundred and ninety breeds [18]. Each dog breed has its own set of features and fitness requirements. It is critical to identify a canine breed in order to provide appropriate treatments and training. Dog breed identification has always been done with the help of professionals. However, evaluating each dog should take some time. For the classification of dog breeds, many photo processing algorithms have been investigated.

Chanvichitkul et al. [5] proposed using canine face pictures to classify canine breeds. They compared a contour-based totally classifier to a Principle Component Analysis (PCA)-based totally classifier. According to [15], Italy has 14 internationally recognised dog breeds as well as other regionally recognised varieties. wang et al. [17] used deep learning to classify different breeds of puppies into distinct groups.

The suggested scheme compares the results of two image processing approaches in dog breed categorization.

1. Traditional primarily based strategies by using Local Binary Pattern (LBP [11]) and Histogram of Oriented Gradient (HOG) [13].
2. Deep gaining knowledge of primarily based strategy with the aid of the usage of pre-trained convolutional neural networks (CNN) with switch learning.

The final result shows that our retrained CNN mannequin does a better job of classifying dog breeds. It has a precision of 96.75 percent, compared to 79.25 percent when using the HOG descriptor.

A well-known problem in Machine Learning is the Dog breed classifier. The issue is determining a dog's breed. An image of a dog or a human can be used as the input, and the proposed scheme predicts the dog's breed, or which breeds that human would belong to if it were a dog. The goal is to create a pipeline that can process real-world user-supplied photos and determine a canine's breed estimation. This is a multi-class classification problem that was solved using supervised machine learning in the proposed scheme.

The remainder of this paper is written as follows: Section II discusses traditional techniques, whereas Section III discusses deep learning-based approaches. In Section IV, we go over our experimental setup. The observations and analysis are found in Section V. Finally, the conclusion is reached in Section VI.

Conventional Based Approach

Approach based on tradition The traditional based approaches are detailed in this section.

Convolutional Neural Network

A Convolutional Neural Network (CNN) is a Deep Learning algorithm that can take an input image, give relevance (learnable weights and biases) to various aspects/objects in the image, and distinguish between them [12, 10]. The accuracy of the CNN model constructed from scratch must be at least 10%. Because a random guess will produce a correct response around 1 in 133 times, which translates to an accuracy of less than 1%, this can show that the model is working. There are three convolutional layers in the model [7].

Kernel size 3 and stride 1 are used in all convolutional layers. The 224 × 224 input picture is taken by the first Conv layer (conv1), and the final Conv layer (conv3) provides an output image size of 128.

Here, the ReLU activation function is applied [16]. The pooling layer (2,2) is used, resulting in a 2x reduction in input size. The two fully connected layers that result in a 133-dimensional output in the end. To prevent overfitting, a 0.25 dropout is added [4].

The suggested scheme's purpose is to create a machine learning model that can analyse real-world, user-provided photos. Two tasks must be completed by the algorithm:

1. *Dogface detector*: Given an image of a dog, the algorithm will determine a breed classification
2. *Human face detector*: Given a human photograph, the code will identify the dog breed that most closely resembles it.

The problem can be solved using a CNN [9]. A CNN is a Deep Learning system that can take an input image, assign significance and to various aspects/objects in the image using CNN3 (learnable weights and biases), and distinguish one from the other [4, 8].

There are three steps to the solution. To begin, methods such as OpenCV's implementation of Haar feature-based cascade classifiers are used to detect human images [14]. Second, a pre-trained VGG16 model is utilised to recognise dog photos [2]. Finally, after the image has been classified as dog or human, it is sent to a CNN model, which analyses it and predicts the breed that best matches the image out of 133 breeds.

Steps in the proposed scheme

The proposed scheme detail step by step process is describe in this section. The architecture is provided in Fig. 1.

- Import the necessary dataset and libraries, pre-process the data, and create training, testing, and validation dataset. Perform Image augmentation on the training data.
- Detect human faces using OpenCV's implementation of Haar feature-basedcascade classifiers.
- Create a dog face detector using the pre-trained VGG16 Model.

- Create a CNN from the ground up to classify dog breeds, then train, validate, and test the model.
- Using Transfer Learning, create a CNN to classify dog breeds with resnet101 architecture. Train and test the model.
- Write an algorithm to combine the dog detector and human detector.
- Return the anticipated breed if a dog is detected in the image.
- If a human is seen in the image, return the dog breed that most closely resembles it.
- Provide the output that shows the error if neither is identified.

Experimental Results

Dog images dataset: The dog image dataset has 8351 total images that are sorted into the train (6,680 Images), test (836 Images), and valid (835 Images) directories. Each of these directories (train, test, valid) has 133 folders corresponding to dog breeds. The images are of different sizes and different backgrounds, some images are not full-sized. The data is not balanced because the number of images provided for each breed varies. Few have 4 images while some have 8 images. The sample dog breed images are given in Fig. 2 and human faces in Fig. 3.

Human images dataset: The human dataset contains 13233 total human images which are sorted by names of humans. All images are of size 250 × 250.

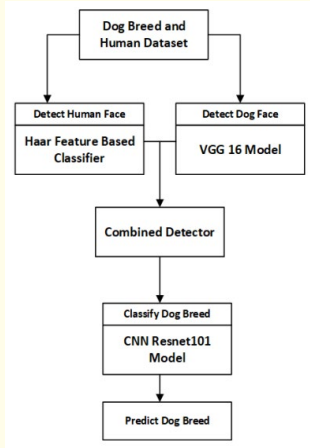

Figure 1: Proposed Dog Breed Prediction Architecture.

Images have different backgrounds and different angles. The data is not balanced because it have 1 image for some people and many images for some other people.

The data is divided into three categories: training, testing, and validation. The training dataset is used to train the model. The testing data is used to forecast the model's performance on new data. The accuracy measure is used to assess the model's performance on test data [1, 3].

$$Accuracy = \frac{Number\ of\ items\ correctly\ classified}{All\ classified\ items} \qquad (1)$$

During model training, the test data prediction is compared to the validation dataset, and Multi-class log loss is calculated to choose the best performing model. Log loss accounts for the uncertainty of prediction depending on how much it differs from the real label, which aids in model evaluation.

Figure 2: Sample Dog Breeds.

Figure 3: Sample Human Faces.

Figure 4: Sample Prediction of Dog Breed for Input Dog and Human Images.

Although the CNN developed from scratch has a 16 percent accuracy, the model can be greatly enhanced by employing transfer learning. The Resnet101 architecture, which is pre-trained on the ImageNet dataset and has 101 layers, is chosen to develop CNN with transfer learning. The suggested model is fed the final convolutional output of Resnet101. To obtain a 133-dimensional output, a completely connected layer is added (one for each dog category). When compared to CNN created from scratch, the model performed exceptionally well. The model had an accuracy of 81 percent after only 5 epochs.

Human Face Detector: OpenCV's implementation of Haar feature-based cascade classifiers was used to construct the human face detector function. In the first 100 photographs of the human face dataset, 98 percent of human faces were detected, while 17 percent of human faces were discovered in the first 100 images of the dog dataset.

Dog Face detector: The dog detector function was created using a pre-trained VGG16 model. 100% of dog faces were detected in the first 100 images of the dog dataset and 1% of dog faces detected in the first 100 images of the human dataset.

The CNN model constructed utilising transfer learning with the ResNet101 architecture was trained for 5 epochs, and the final model produced an accuracy of 81% on test data. Out of 836 total photos, the algorithm correctly predicted breeds for 680 of them.

Conclusion

Using opencv and the VGG16 model, the suggested approach effectively detected human and dog faces and determined which class of dog breed it belongs to using CNN and ResNet101 architecture. The model's performance exceeds expectations. The model constructed via transfer learning has an accuracy of 81 percent, compared to only 13 percent for the CNN model created from scratch. The model can be enhanced by adding more training and test data; currently, only 133 dog breeds are used in the model. The method can also minimise overfitting and increase accuracy by undertaking additional picture augmentation.

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