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Handwritten Digit Recognition using CNN

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Abstract

Handwritten digit recognition allows the computer to recognize the digits written by humans. In general, it is a hard task for the computers to recognize the digits because the handwriting varies with the person and there is no standard handwriting. In some languages the letters overlap making the computer hard to recognize the characters. So, Using Handwritten digit recognition technique we train the machine with different handwritten digits making the computer task easy. In this project a Convolutional Neural Network model was built. Inorder to train the model MNIST dataset is used as it consists of 60,000 training datasets. A graphical user interface is created which captures the image placed in front of the camera and passes the image as the input to the model so that the model predicts the output and the output is displayed in the result section of the graphical user interface.

Keywords: *MNIST, CNN, OpenCV, TensorFlow*

Introduction

In general, the common way for any human to master a skill could be accomplished by continuous practice. Continuous training of the neurons of the brain makes the man handle all sorts of things related to that skill. The same technique is applicable to deep learning. Handwritten digit recognition allows the computer to recognize the digits written by humans. In general, it is a hard task for the computers to recognize the digits because the handwriting varies with the person and there is no standard handwriting. In some languages the letters overlap making the computer hard to recognize the characters. So, Using Handwritten digit recognition technique we train the machine with different handwritten digits making the computer task easy.

For this project we are using MNIST dataset. So, in general MNIST dataset consists of sixty thousand training datasets and ten thousand test datasets. The MNIST dataset consists of 10 classes from class zero to class nine. These are represented as 28 x 28 matrices where each cell contains grayscale pixel values. For this project we are building a Convolutional Neural network model. For this project we are creating a graphical user interface that captures the image of the digit placed Infront of the front camera of the computer and the model recognizes the digit and displays the output on the same graphical user interface.

This project's main aim is to recognize the handwritten digits. For this project build a convolutional neural network model. We used MNIST dataset because it consists of sixty thousand training datasets and ten thousand test datasets with ten classes from 0-9. After loading the data, we preprocess the data like adding dimension and make data in handy for the model. Later we create and train the model. Finally, we create a

graphical user interface through which users can interact. The graphical user interface allows the user to place the handwritten digit in front of the camera of the computer so that it can capture and send it to the model so the model predicts the output and the output will be displayed on the result section of the graphical user interface.

Here for this project, we are building a Convolutional Neural Network model. Here the MNIST dataset dimension is (60000,28,28). But Convolutional neural networks require another dimension so reshaping of matrix is to be done. Now the new matrix can be used in Convolutional Neural Networks.

Lıterature Revıew And Related Work

Rohan Sethi, et. al, [1] proposed that the Handwritten digit recognition has been one of the highly sought-after problem statements in the area of pattern and image recognition. In this paper the author discussed usage of horizontal and vertical projections for segmentation. For recognition and classification SVM is used. for feature extraction Convex hull algorithm is used.The training of images was done with the aid of KNN Algorithm. Euclidean distance formula is used in KNN classification algorithm for distance calculation. Based on the data we select k parameters in this methodology.To quantify proximity between any two data points, a distance measure is necessary.From the IAM dataset, this proposed approach was able to correctly segment 92.56 percent of words and 95.65 percent of lines. fathmasiddique, et. al, [2] proposed that primary goal of this research is to investigate the relationship between accuracies and the number of concealed layers and epochs. The network stochastic gradient and back propagation algorithms are utilized for training, and the forward method is employed for testing.his approach takes an accuracy of 98% and loss range of 0.1% to 8.5%.The maximum accuracy is achieved only in specific epochs.The minimum error rate is also achieved in specific epochs based on the number of hidden layers. Anchit Shrivastava, et. al, [3] proposed that different features and conclusions can be extracted from classification of handwritten digit recognition. Different algorithms differ in their error rates. So after studying the faults of different algorithms we can reduce final error rate by covering those faults in the new algorithm proposed by the author of this paper. various types of feature extraction methods are ensembled to get a minimum error rate of 0.32%. As the number of layers increases, so does the accuracy and computing time. Yue Yin et. al, [4] proposed that optical character recognition has become one of the most important techniques in computer vision given that it can easily obtain digital information from various images from the internet of things(IoT). However, due to their low performance, present OCR systems provide a significant barrier in recognising Chinese uppercase characters. To address this issue, he developed a deep learning-assisted OCR technique that would improve recognition accuracy. Saleh Aly et.al, [5] proposed a new robust recognition system for numerical strings without the expensive work for segmentation algorithms. While the string length classification problem is distributed at every level of the cascade digit classifier, the suggested approach avoids the training of a separate length classifier. They employed the NIST SD19 dataset for this experiment, which contains mostly isolated digits.

Fuliang li et.al, [6] proposed a recognition algorithm based of back-propogation (BP) neural network. The classifier was divided into two categories: Chinese characters and English letters. The neural network architecture can help to simplify the network structure while also improving recognition accuracy and speed. The BP algorithm improved upon the shortcomings of the regular BP algorithm, which had delayed convergence and a proclivity for falling into local minimum points. Nishide Shun et.al. [7] proposed a recognition model which is based handwriting experience. The authors used self organizing map to train the model. This model is also designed to recognize handwriting sequences. Neuro-Dynamics learning model is used in this methodology. This model is tested using 10 japanese characters. The results were promising about the effectiveness of the model.

Desıgn And Methodology

For this project we decided to use MNIST dataset which consists of 60,000 images, with 10 labels which are used to train the model. All the MNIST images are 28 * 28-pixel gray level images and each image is associated with the label. The labels are from 0-9. We can access the MNIST dataset using keras library. So for this project we imported the keras library. All the images in the MNIST represent a single handwritten digit along with the label. This ready-to-use dataset is applied in the experiment below. The steps involved in the methodology are as follows:

a) Load all the libraries and datasets
b) Pre-processing the data
c) Creation of a Model
d) Model Training
e) Model Evaluation
f) GUI creation to capture the input image

3.1 Load all the libraries and datasets

This is the first step that to be performed. In this step MNIST dataset has to be loaded as it contains the necessary train datasets. Inorder to use or access this library we need to import Keras library. So, in this step we loaded MNIST dataset from keras library. Loading all the libraries and datasets is the primary prerequisite without which we cannot move forward to further steps of this methodology.

3.2 Pre-processing the data

Here we are using convolutional Neural Networks for this project in order to develop the model. Here the MNIST dataset dimension is (60000,28,28). But Convolutional neural networks require another dimension so reshaping of matrix is to be done. Now the new matrix can be used in Convolutional Neural Networks. Data in the MNIST dataset cannot be used directly as the dimensions and other features differ from the requirements of training of the model.

3.3 Creation of a Model

It's time for the creation of the Convolutional Neural Networks model. In general, we all know that the Convolutional Neural Networks model generally works better for the grid structured data. This is the main reason for selecting Convolutional Neural Network. We Compiled the model with the Adadelta optimizer. This step is key to creating the model after which in next step this created model is trained.

3.4 Model Training

For training the model we use the method model.fit () provided by the keras library. The inputs provided to model.fit () are training data, validation data, epochs and batch size. After training the model weights needed to be saved. Number of epochs to be set is dependent on our requirement of efficiency of the model. If we want more efficiency we have to set higher number of epochs.

3.5 Model Evaluation

For evaluation of the model, we can use the test dataset in the keras library. The test dataset consists of 10,000 images, with 10 labels which are used to test the model. All the MNIST images are 28 * 28-pixel

gray level images and each image is associated with the label. The labels are from 0-9. We can access the MNIST dataset using keras library. Along with it we can evaluate the model by creating our own input and testing the observed result with the actual result.

3.6 GUI Creation to capture input images

This is the last step of the entire process where we create a Graphical User interface which captures the images placed Infront the camera and after capturing the image, the image is sent as an input to the model created and model predicts the input and the output is displayed in the same Graphical User Interface. We can make N number of changes to our GUI based on our requirements.

Results And Dıscussıon

After training the model with MNIST dataset, the model is now ready to recognize the handwritten digits through webcam activated in the GUI. Fig.1 explains the way in which the dataset size increases fourfold. MNIST dataset is used for this project. Fig.3 represents the dataset present in the MNIST. The MNIST dataset consists of 10 classes from class zero to class nine. These are represented as 28 x 28 matrices where each cell contains grayscale pixel values. Fig.2 represents the input data that a user can pass to the model. The graphical user interface captures the image and feed it to the model. Now the model predicts the digit present in the image and the result will be displayed in the resultant section of graphical user interface as represented by the Fig.4.

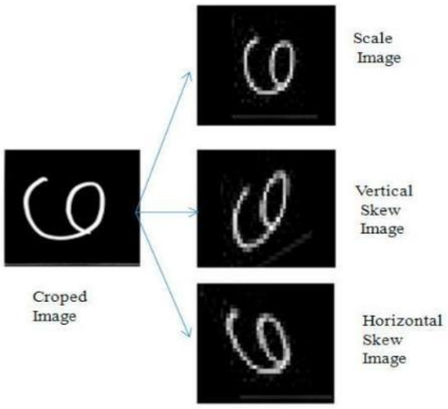

FIG-1 Conversation that Increases the Dataset Fourfold

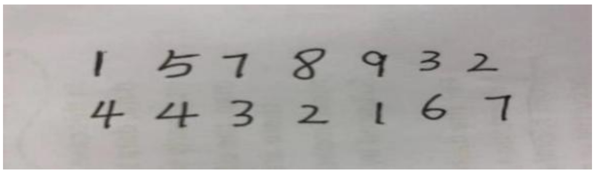

FIG-2 Input handwritten digits to our model

FIG-3 Data present in the training set

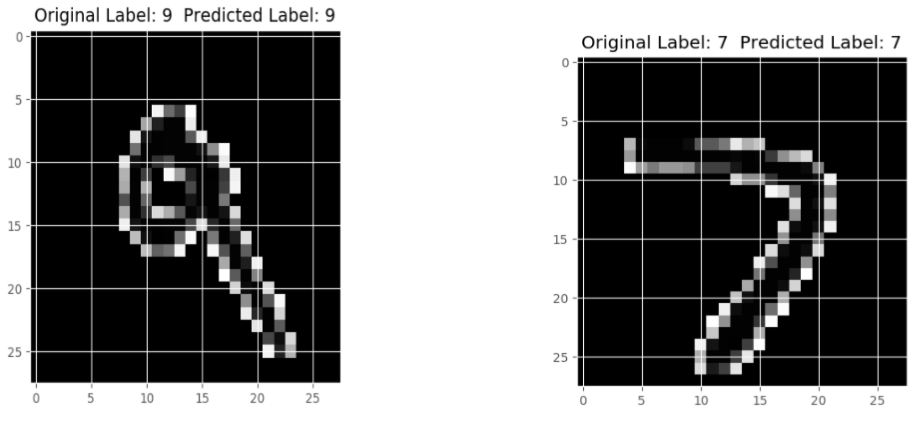

FIG- 4Output figures

Conclusıon And Future Work

Through this project we have successfully built a convolutional model which recognizes the handwritten digit present in the image uploaded. For this project we used MNIST dataset inorder to train the model. A graphical user interface is created to capture the image and to feed the image to the model so the model predicts the output number present in the image and the output will be displayed on the result section of the graphical user interface.

The proposed model obtained 98% accuracy in correctly identifying the number present in the real-world images.

In future this project can be extended to recognize multi-digit numbers and characters.

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