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Handwritten Digit Recognition using Double Convolution Neural Network

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Abstract: Because of the wide range of applications and ambiguity in learning approaches, character identification from handwritten images has gotten more interest in the pattern recognition research field. For handwritten digit recognition, two phases are required: character recognition and feature extraction based on a classification technique. Deep learning approaches are at the centre of handwriting recognition research, which has yielded breakthrough results in recent years. Nonetheless, the increasing development in the amount of handwritten data combined with the availability of vast computing capacity necessitates an increase in recognition accuracy and deserves additional exploration.

Index Terms **– Double Convolutional Neural Network, Keras, Tensorflow, Tkinter, MNIST Dataset.**

I. INTRODUCTION

Machine learning and deep learning are critical components of computer science and artificial intelligence. Machine learning, deep learning, and related principles have reduced the amount of human effort required in industry. From the beginning of machine learning and deep learning to an expert who has been practicing for years, handwritten digit identification has acquired a lot of attention. To successfully differentiate between distinct digits, a machine must have a thorough understanding of digit classification and the difference between minor and major points, which can only be achieved by adequate training and testing. Handwriting recognition (HWR) refers to a computer's capacity to recognize and understand comprehensible handwritten input from sources such as paper documents, user input touch screens, and other devices. Optical scanning (optical character recognition), intelligent word recognition, or user input can all be used to detect the image of written text on a piece of paper. Alternatively, the movements of the pen tip can be felt "on line," for example, by a pen-based computer screen surface, which is a more straightforward operation because there are more hints available. This paper shows how to detect handwritten numbers (0 to 9) from the well-known MNIST dataset using the Tensor Flow framework (library), Python as a programming language, and its libraries. When a user enters a digit, the computer recognizes it and displays the results with an accuracy %.

II. DOUBLE CONVOLUTION NEURAL NETWORKS

Artificial neural networks (NNs) are interconnected systems made up of several simple processing pieces (neurons) that operate in parallel and are controlled by a set of rules-

1) Network Structure
2) Connection Strengths
3) The Processing performed at Computing elements or nodes.

Convolution is a simple mathematical operation in which one matrix is multiplied by the other element by element and the sum of these multiplications is determined. Convolutions are used for a variety of reasons. -

- Convolutions allow for more accurate feature extraction.
- When compared to ANNs, they save a lot of time.
- When compared to pure fully connected layers, fewer parameters are created.
- Because there are fewer required parameters, fewer fully connected layers are required.

Images are pre-processed. Opencv, a python library, is used to perform image pre-processing. It offers some capabilities that can be used to make essential adjustments to images before sending them over the network. This model's architecture consists of three main parts, two convolutional blocks and one fully connected neural network layer. The inputs to this model are 28x28 images.

First Convolutional Block: A 28x28 image is taken as input to this block. A padding of 2 units is added to the image so as to retain its dimensions after a convolution operation on the image by 16 5x5 filters/kernels. The output of the convolution gives 16x28x28 volume, which is then input to a ReLU activation function followed by a MaxPool operation. ReLU activation is used to introduce some non-linearity. This block outputs a 16x14x14 volume.
Second Convolutional Block First step is again a convolution operation on 16x14x14 by 32 5x5kernels with padding of 2 units, obtaining a 32x14x14 volume. It is passed through a ReLU activation followed by a MaxPool operation. Second convolutional block outputs a 32x7x7 volume.
Fully connected Neural Layer: Here, a single hidden layer of 10 nodes is taken as the fully connected layer. Finally, the output of the fully connected layer is passed to a softmax function to obtain the output result of recognition.

The majority of the performance of deep convolutional neural networks can be attributed to the development of large models with parameter sharing (CNNs). By further exploring this concept, we propose doubly convolutional neural networks (DCNNs), which significantly boost the performance of CNNs. Instead of allocating a collection of independently trained convolutional filters, a DCNN maintains groups of filters, with filters within each category being translated copies of one another. In practice, most modern deep learning libraries support a two-step convolution protocol that can be used to implement a DCNN.

III. MNIST DATASET

Dataset MNIST (Modified National Institute of Standards and Technology) consists of samples of handwritten digits, they contain total 70,000 images us of which 60,000 are used in training set and 10,000 are used in testing set, both with appropriately labelled images 10 digits (0 to 9). Handwritten digits are images referring the form 28*28 gray scale intensities of images representing an image with the first column to be labelled as (0 to 9) for every image. Similarly, it has opted for the case of the testing set as 10,000 images with a label of 0 to 9 thus. MNIST is a computer science and vision database consisting of handwritten digits, with labels identifying the digits appropriately, International Journal of Information Sciences and Application (IJISA). ISSN 0974-2255, Vol.11, No.1, 2019, (Special Issue) © International Research Publication House. Every MNIST data point has two parts: an image of a handwritten digit and its corresponding label. To start with Tensor flow, we will be using the MNIST database to create an image identifying model based on simple feedforward neural network with no hidden layers respectively. The following figure represents the example sample of the MNIST dataset which is to be used using which the system will be trained and then tested for respected output.

IV. PROPOSED SYSTEM

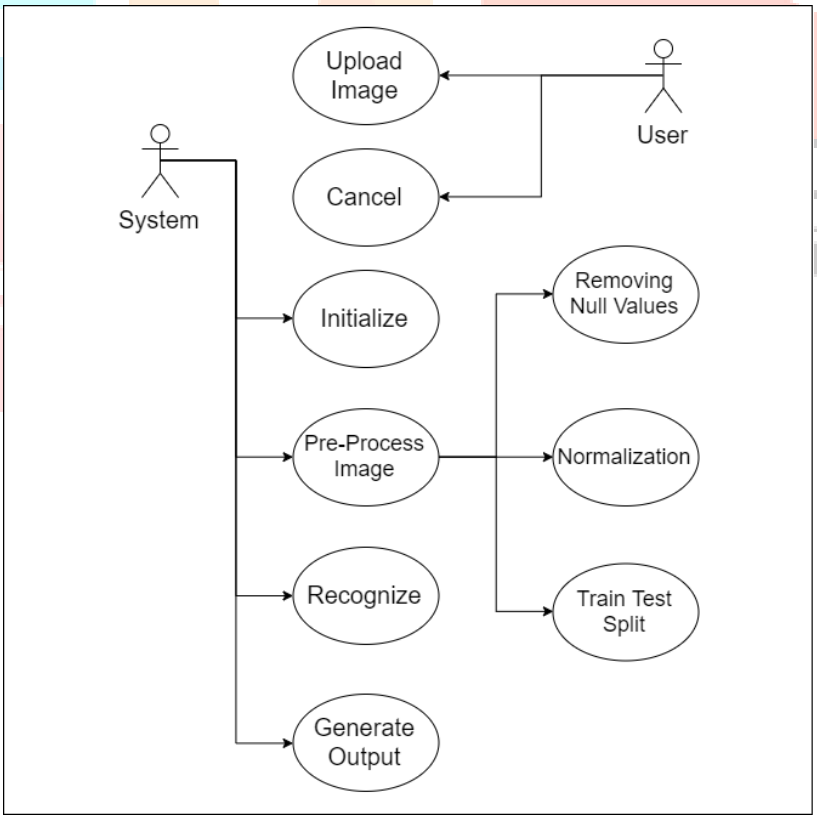

Fig.1 Steps involved in Digit Recognition

The Fig depicts the eight operations –

- Draw Image
- Initialize
- Pre-Process Image
- Removing Null Values
- Normalization
- Train Test Split
- Recognize
- Generate Output

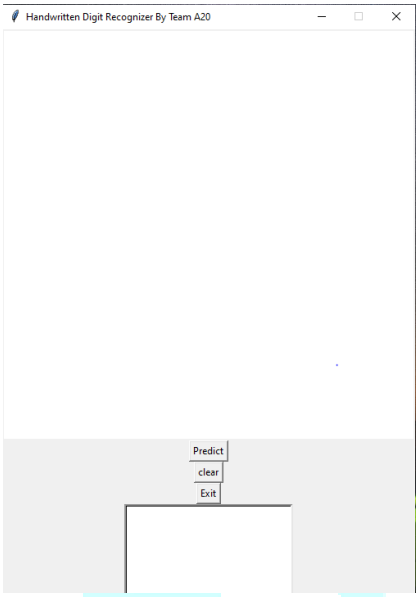

Fig.2 Interface for drawing image

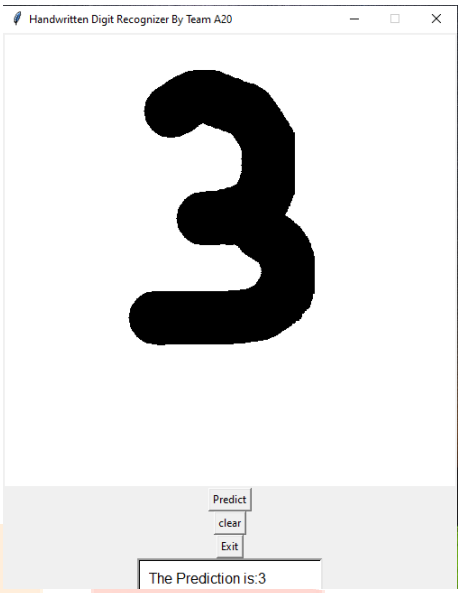

Fig.3 Sample Screenshot of digit 3

Fig.4 Sample Screenshot of digit 6

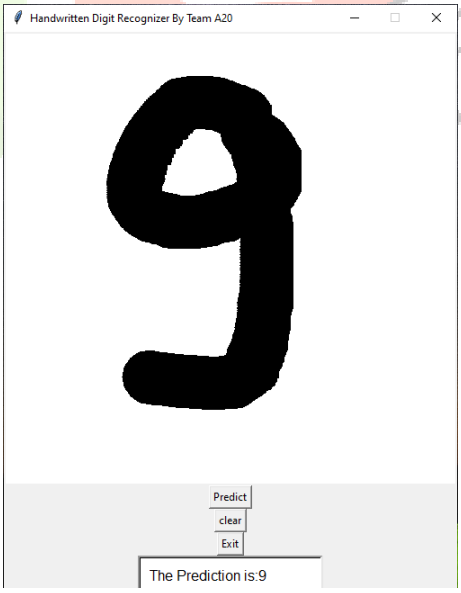

Fig.5 Sample Screenshot of digit 9

V. CONCLUSION AND FUTURE ENHANCEMENT

The effectiveness of handwritten digit recognition using a Double Convolutional Neural Network has been demonstrated to be quite high. It outperforms all other algorithms, even artificial neural networks. To acquire the appropriate digit recognition, this research used machine learning techniques such as Tensor flow and Keras. The researchers developed handwriting recognizers, tested them on the MNIST (Mixed National Institute of Standards and Technology) dataset, and then enhanced the training time and recognition performance. The accuracy rate is 99.5 percent, indicating a strong and promising performance. As a result of our practice, we were able to correctly detect the numbers drawn at various angles and correctly show the correct digit in a single turn. As a result, the system would be able to distinguish the introduced digit based on the shapes and values in the dataset.

Currently, our project's scope is limited to recognizing one digit at a time. We recommend that this functionality be expanded to allow for the correct prediction of multiple digits at the same time. In addition, we propose the ability to predict Characters.

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