Handwritten Character Recognition Using Images

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Abstract: Sometimes we don't have enough time to write some contents, article, etc in our notes, so at that time we can easily take all written data in the form of notes in our phones. So to do this firstly we have to detect the written letter/character and take same letter in our phones for taking the note. we have used convolutional neural network in our project to recognize character. Going through different processes like feature extraction, pre-processing, etc. out character is recognized. How our model works is described in the upcoming pages.

Index Terms - neural network, pre-processing, feature extraction and classification

1. INTRODUCTION

Handwritten character recognition involves both vision based and pattern recognition. There are statistical and geometric strategies to pattern recognition. In statistical methods, a collection of characteristics undergoing huge measurement process of input data is generated randomly and one of the unknown classes has been selected. The image's physical phase will focus on interrelationships between input data factor. The two systems are typically employed in pattern recognition.

Handwriting detection is now one of the most attractive and hard study fields in vision based and pattern recognition in past few years. It can improve the human-machine connection in a variety of applications and probably contributes to the advancement of an automated process. Several studies have focused to making of novel strategies and approach to reduce during time consumed while enhancing correctness of recognition. The two primary types of HRT are off-line and on-line. A sensor of the design in offline HR generally takes the finished writing visually, and the visual is available. The web-based HR, on other hand, displays the two-dimensional coordinates of succeeding locations in respect to time, as well as grouping of the writer's strokes. On-line techniques seemed found to upper-level to their off-line due to the chronological details given by the former in hand written signs. Neural networks, on other hand, have been successfully used in off-line systems to attain similar high amounts of precision. Then offline HR remains a viable option of a hot topic of experimentation, with scientists inspecting at different ways to boost detection quality. Every HRS begins with initialization, followed by division and image retrieval. Initialization relates to the process of transferring an image together into file that can be separated. During division, the picture selected is separated to distinct letters, and then every letter is then scaled to (m x n) pixels for the teaching network.

Choosing correct trait production strategy is major element in generating great recognition result. Some approaches to trait production for letter identification have been reported in report. Unitary Image, Template Matching, Deformable Templates some of the most often used feature extraction methods are evolution, chart representation, calculation bar chart, shape figure, etc. A simulated NN is employed as the software for jobs that involve sorting and detection. For detecting offline handwritten digits in six important Indian scripts, U. Pal and colleagues proposed a modified quadratic classifier-based approach. A multilayer perceptron was used to distinguish written English letters.

1.1 Approaches:

In this theme, machine learning is nearly linked to computational statistics, so having a background in statistics can help you better understand and apply machine learning techniques. For individuals who are unfamiliar with statistics, a definition of correlation and regression, two often used approaches for exploring the relationship between quantitative variables, is a good place to start. The calculation of the relationship within two different variables that aren't dependent or independent of one another is known as Correlation. Regression can be applied to study the association between dependent and independent variable at its most basic level.

2.1 Literature review:

(Sumedha B. Hallale, Geeta D. Salunke)Vol 2, Issue 9, September 2013: The paper describes a deep learning method for detecting handwritten letters or numerals. An image of a handwritten character was used as input for character detection, and a pre-trained model based on the CNN approach was used. The four main steps of this approach were as follows:

2.1.1 Data pre-processing: The optical scanner captures the image that is recognized in an offline character recognition system. If we scanned the pictures of letters and preprocessed it then the organization of input information analysis can be improved. T. Although such distortion is not possible to eliminate, it can be reduced using a variety of noise reduction techniques. Three of the most common techniques include convolutional filtering, morphological procedures with logical operations, and noise modeling. When a picture is acquired, it is in greyscale format, which means it is represented by pixel density values ranging from 0 to 255. Binarization involves thresholding and converting a greyscale image into a binary image with 0 and 1 values Skeletonization is the technique of removing superfluous pixels from a character that aren't part of the image's backbone. The technique of transforming an image of any size into the same size is known as normalization.

2.1.2 Feature Extraction: Because many classifiers struggle to handle raw images or data effectively, it's necessary to extract the material's relevant information. The goal of feature extraction is to extract useful information by lowering the data's dimension. The quality of the features gathered from the information is used to determined the execution of the classifier. The frame of digit is necessary for pulling out the quality and completing the identification processes after they have been restricted. This stand contains the crucial information of input numbers, while not needed data of a picture is ejected. To get the narrower stand of letters, the points of pixels in the forefront on the farthest every sides are discovered. In a classic quality ejection idea, as if a line crosses between a pixel (forefront), the pixel is assigned with same value.

2.1.3 Classification and Recognition: Neural network means the neurons connected to make a circuit like/same as biological neurons. The neural network consists of three main phase. Training phase in which data is trained, validating phase in which data will validate and lastly testing phase in which the final phase is tested to give required output.
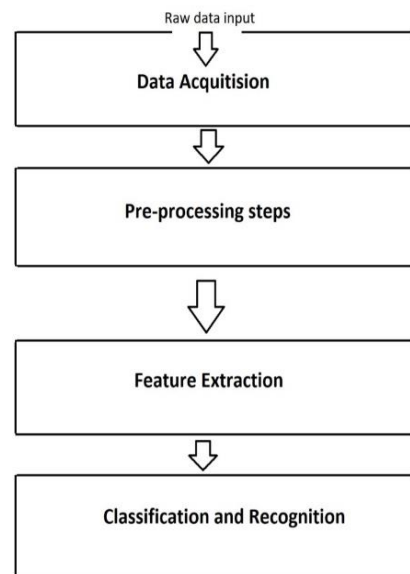
2.2 METHODOLOGY:

- First we have gone through data processing.
- In data processing we have given a label name, drop a top label, merge two dataset Kaggle and minist in one and form one data label and target.
- Then we build a Convolutional Neural Network and take 20% of data as test data and 80% data as training data.
- Then we trained the data using history.fit().
- Then we build a confusion matrix.
- At last we have created a whiteboard interface using open cv and there our cnn model is used to predicted the written character in whiteboard.

3.1 Tools and Libraries Used:

The following tools have been used in project:

- **CUDA**: CUDA is a software that connects our program and GPU if required. For installation of this software we have to download nvidia cuda and cudnn for supported version and install it accordingly the main features of cuda is that It directly connects our program to GPU because if our program runs on GPU it takes less time to compile, i.e. faster output.

- **CUDNN:**GPU-accelerated primitives for deep neural networks are available in the (CUDNN) collection. It contains fine-tuned versions of routines that are commonly used in DNN applications.

- **Concepts of Python Programming language:** we have used python for writing out codes as most of the ML codes are written in Python because it has less code, easy to write, and faster execution.

- **Tensorflow:** TensorFlow is a software package created by google that allows you to swiftly implement ML and DL techniques. Many mathematical equations are made simple to calculate using a combination of computational algebra and optimization techniques.

- **Numpy:** It is the package in python we can directly download in pycharm going in interpreter. Main features of this is to import numpy libraries for program execution. Such as we can import numpy as np.

- **Pandas**: An open-source Python library that provides Python programmers with simple data structures and data analysis tools.

- **Sklearn:** An open ended question sklearn is library that is widely used in ML, DL python. This provides a mathematical modeling methods.

- **Matplotlib:** It is mainly used to plot graphs in in python. We can see any data graphical representation from this library.

- **Pycharm :** Pycharm is a software in which we can write codes and compile it to get required output in any language. We can download any interpreter within the software if required.

3.2 Proposed work:

We present the whiteboard based model with the CNN based object detection model. The CNN is mostly used for image processing, image segmentation, and other data that is auto-correlated. The CNN is used to identity the Character from the give input using the CNN algorithm and taking a A_Z Handwriten_character dataset which contains many character images as classes with their labels.

3.3 Algorithm:

- CNN algorithm is an algorithm that uses neural networks to provide real-time character recognition . CNN algorithm employs CNN model to detect the characters in real-time. The algorithm works using twelve techniques:
- Select a dataset to work with.
- Prepare the dataset for training, then create the training data and shuffle it.
- Labels and features are assigned.
- translating labels to categorical data and normalizing X
- X and Y must be split for CNN to work. Define, assemble, and train the CNN model. Model precision and score
- In choosing the dataset we choosed A_Z Handwritten_recognition and Minist 0-9 Dataset.
- We prepared dataset for training and created a training dataset.
- We shuffled all the dataset to randomly pick the images of the character
- We assigned labels and features to our dataset
- Then we normalize the data and convert the labels to categorical data.
- After that, we separated X and Y for CNN.
- Then we build our CNN model and train it till 10 epochs. Then we check our accuracy and score of model to predict the output.

3.4 Algorithm Steps:

Step 1: Initialize pre-processed dataset or data-along with the user provided input.

Step 2: Get the vectorized output of each object from the given input using the CNN which contains bounding box center, width, height, and class.

Step 3: Every images is resize to 28x28 pixels and randomly picked 200 images out there

Step 4: Then user input is converted into 28x28 pixels images and comapared with every randomly picked 200 samples.

Step 5: Then it check which image features is same with the input user images features.

Step 6: Return the output.

4.1 Architecture:

- **Data:** Initially the data is of the required classes and the weight required by the class is taken from the datasets.
- **Data pre-processing:** The CNN is trained using dataset and the required algorithm to get the information about the object and highlight the object and using the boundary box with the labels and weight which needs to be identified.
- **Feature extraction:** The feature from the input which is given to data pre-processing is extracted from the CNN in a form of vectorized output which contains the various information about the required character which must be detected.
- **User input:** The input should be given by user by drawing a character on whiteboard.
- **CNN:** It refers to the Convolutional neural network. It takes the information from preprocessed data and use the information to detect the character from the user input data.
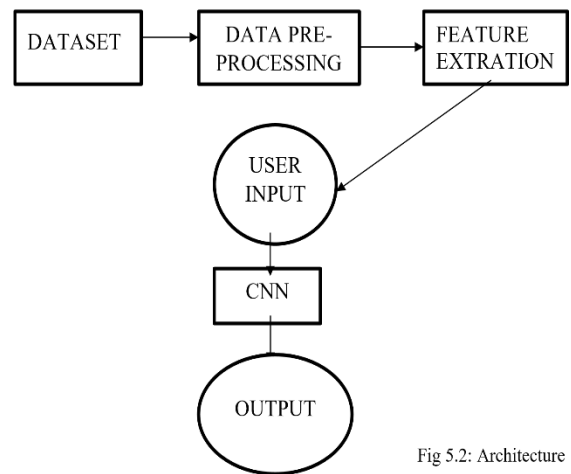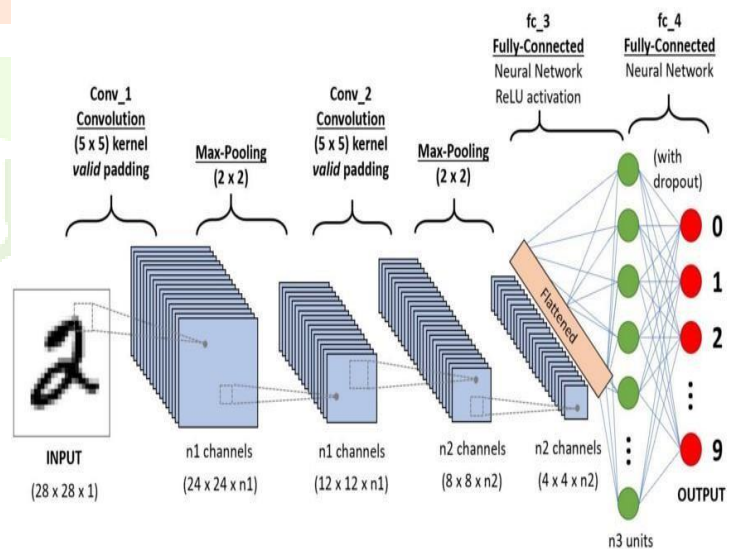- **Output:** Output will be in the form of the character and accuracy.

Fig 5.2: Architecture

4.2 Convolutional Neural Network

Going through all the types of machine learning CNN is one of it. We can also called CNN as ConvNet. It is a DL mathematical calculations which takes pictures as input in specified pixels and going through all the features of the pictures it will be able to separate picture from another. CNN works as human brain neurons. In mobile phones now a days we can see face recognition this all are based in CNN. Let us consider, we have to recognize the pictures of tiger whether it is tiger or not so during the identification process the pixels of the image is converted to arrays. CNN hidden layers such as convolution layer, RELU layer and pooling layer perform different feature extraction whether the given image is tiger or not and at last we have fully connected layer that helps to identify the object in the image tiger or anything else. Same things is applied in character recognition also we will draw a character in whiteboard and crop it. It will get converted into 28*28 pixels then after going all the process it will recognize which character we have given input . Deep CNN is a multilayer perceptron neural network deep learning system that consists of many convolutional layers, subsampling layers, and fully coupled layers. Following that, the dataset is used to train the weights in the network's full layers for each item categorization. The CNN module is supervised feature learning approaches that are durable in recognizing the character in many contexts, and it is one of the categories in deep learning for handwritten character recognition. It acquired exceptional success in high scale picture classification tasks in Handwritten character recognition thanks to the new high-speed computer system. Deep learning's effectiveness in character identification is due to its neural network topology, which can self-construct object descriptors and learn high-level properties that aren't directly provided in the dataset.

4.2.1 Working:

Here, convolutional neural network which is made by combining huge layers of unnatural neurons. Unnatural neurons can be consider as mathematical function, like biological neurons of human brain which calculate the sum of various inputs taking weight only and give a activation value. Every layers in CNN model creates activation function and passed to the others when we give input image. The earliest layer usually extracts basic information including parallel or orthogonal sides. This data is forwarded to another layer, that is responsible for identifying huge advanced characteristics like corners and combinational edges. As we delve deeper into the network, we discover that it is capable of recognizing increasingly advanced items like device, items, and so on. Based on the activation layer of the final convnet, the identification layer generates a set of confidence ratings (values from 0 and 1) that show how often the vision is to belong to a "classified." For example, if a ConvNet recognizes tiger, elephant, and lion, the end layer's outcome is the probability that the digital image includes any of the above animals.
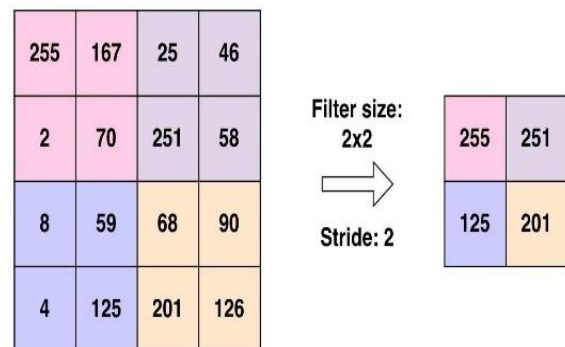
Pooling layer: pooling layer is a layer of CNN model. The main features of this layer is to remove unnecessary features from the pictures. This layer operates different quality map independently. One of the familiar approach is max pooling. another features of max pooling is it helps in reducing the size of quality maps. In this process brighter pictures is selected.

5.1 Conclusion and Future works:

In this paper we have made a model using Convolutional Neural Network that is used to recognize any kind by characters that is written by hand. Going through all the four steps at last our model was able to recognize a character and a digits single at a time. This algorithm can be used in any kind of picture detection such as face detection, fingerprint identification. By using this we can easily find the single mistakes in any article and correct it accordingly. Example: if some words has repeated letters then we can remove that repeated letter in a short period of time.

5.2 References:

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