



HANDWRITTEN CHARACTER RECOGNITION USING CNN

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ABSTRACT:

Machine Learning comes under the field of computer science and technology that provides computers the ability to learn things without being programmed explicitly. Machine learning is used where it is not feasible to program and design algorithms with better performance; like a number of applications include filtering of emails, detection of malicious insiders working towards a data breach, optical character recognition (OCR) learning to rank, face recognition and computer vision. It became important to recognize handwriting as we start moving towards automated world. Deep learning is showing unbelievable results in the domain of visual and speech recognition. But still we lack in matching the accuracy of human vision and advancements will be continuing until we cross that limit. TensorFlow is one of the Google's open source machine learning as well as deep learning framework, which is convenient to build the standard deep learning model. Convolutional neural network is a unique model of deep learning; the advantage of using CNN is its powerful feature extraction capabilities of convolutional blocks. Based on the TensorFlow platform, a convolutional neural network model with five-convolution-layers has been created. The proposed system has been trained on samples of large collection of IAM database images and tested on sample images from user defines data set and in this experiment we found the highest recognition results.

Keywords: Handwritten Character Recognition, Convolutional Neural Network, Feature extraction, TensorFlow.

[1] INTRODUCTION

Handwritten Text Recognition is a technique that is much needed in this world these days. Before implementing this technique properly, we have relied on writing with our hands which can lead to

errors. Storing and accessing physical data efficiently is a difficult task [2]. Manual labor is required to maintain the correct organization of the data. Modern day technique is facilitating people to store the data over machines, where it is much easier to store, manage and access data. In addition, it also provides high security to the data. An example of Handwritten Text Recognition software is the Google Lens. Handwritten documents are easy for humans to understand because we have the power to learn [3]. The Machines can also be induced with the same ability by the using Deep Learning and Artificial Intelligence. The research that deals with such kind of problem is known as the OCR or also known as Optical Character Recognition.

It is a system that is used to convert electronic and image documents into digital text for machine readability. In the last few decades, some of the feature extraction technology has been proposed such as histogram of oriented gradients and many techniques such as image recognition, character recognition, face detection, etc. used as prominent feature extraction methods [1]. OCR is further of two variants, HCR (Handwritten Character Recognition) which is intelligent identification of the handwritten documents and PCR (Printed Character Recognition). Due to the different handwriting styles of humans, we need greater recognition power. Many times the writing style of single person is different as many times he writes. Additionally, OCR is characterized into two types as Offline and Online recognition systems on the basis of acquiring of the documents. Offline recognition system deals with the already written texts received through various input methods. Whereas in Online recognizing system, the writing is recognized at the same time it is written.

The Handwritten text system is commonly used system in various applications, and it is a technology that is a mandatory need in this world as of now. Before the correct implementation of this technology we have dependent on writing texts with our own hands that result in errors. It's difficult to store, access physical data and process the data in efficient manner. Manually it is needed to update, and labor is required in order to maintain proper organization of the data. Since for long time we have encountered a severe loss of data because of the traditional method of storing data.

Modern day technology is boon, and this technology is making people to store the data over machines, where the storage, organization and accessing of data is easier. Adoption of the Handwritten Text Recognition software is a practical idea and, it is easier to store and access data that was traditionally stored. Furthermore, it provides more security to the data. One such example of Handwritten text Recognition software is the Google Lens and example for hardware is OCR scanners. The aim of our project is to make an model for handwritten text recognition and convert them into speech for application in healthcare and personal care that can recognize the handwriting using concepts of deep learning. We approached our problem using Tensor Flow and OpenCV as they contain Pre-trained Models that are directly used to provide results accurately compared to other methods over such task. The model that developed in this paper is used to convert the text in different forms i.e., mainly Text document and Voice files. These files are stored in respective folder and information can be extracted. We mainly use Opensource models for the development of the project. The architecture of models that we have used are based on NLP. This NLP architecture has some basic components of data acquisition, processing and Query and visualization. This text is further converted into the voice.

[2] LITERATURE SURVEY

In 1959, Research from Grimsdale in the field of word recognition, is soonest endeavor to perceive the handwritten character. This research exhibited the utilization of examination by combination strategy being proposed by Eden. He demonstrates that the role of individual handwriting is limited to number of schematic highlight. This hypothesis was later used as a part of almost all strategies to support the methodologies in the field of text recognition. Amit Choudhary [6] demonstrated an Off-Line Handwritten Character Recognition using Features Extracted by using Binarization Technique. It helps to extract features obtained by Binarisation technique for recognition of English language handwritten characters. This algorithm delivers outstanding classification accuracy of 85.62 %. Sonu Varghese Ketal. [7] demonstrated Tri-Stage Recognition Scheme for Handwritten Malayalam Character Recognition. In the first step we will start setting up character groups in different classes based on the number of corners, loops, bifurcations and endings. In the second step we identify exact character in the class based on the various feature extraction technique. In the final step we are checking the probability of occurrence of the character in the given position on the basis of defined rules for the making of words. Recognition conducted in different stages improves the efficiency, rate of recognition and accuracy of the system. Parshuram M. Kamble [8] Demonstrated handwritten Marathi character recognition using R-HOG Feature. The system has been tested with a large quantity of handwritten Marathi characters. From the results it can be concluded that the use of R-HOG based feature extraction method and FFANN based classification with high processing speed and accuracy is more accurate.

[3] ALGORITHM

In Deep Learning the word ‘deep’ points to the number of hidden layers present in the Neural Network. Recognition of Handwritten Text is based on Deep Learning technique i.e., Convolutional Neural Network (CNN) which uses five hidden layers. It includes four main phases- Convolution, Pooling, Flattening and Fully-Connected Layer.

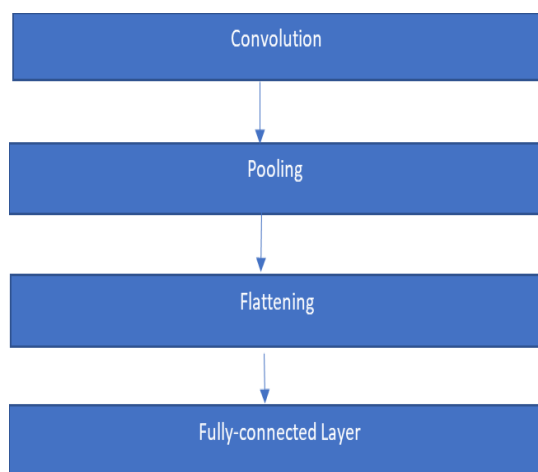


Figure: 1.Algorithm

Convolution

Convolutional layer is the important building block of the whole Convolutional Neural Network (CNN) model. Convolutional layer creates a feature map by doing the Filtering process to

the input images. The images are taken from the IAM dataset and then sent to the very first layer that is the Convolutional Layer. There is no separate preprocessing step for the input images from the dataset in Deep Learning model. The images are filtered using a convolutional filter and after that sent to the next layer for pooling.

Pooling

Pooling layer decreases the spatial dimensions of the image that makes it easy to lowers the number of parameters which both reduces the training time and combats overfitting [9]. There are two important pooling layers known as max-pooling and min pooling. In the max-pooling, it takes the maximum values from the selected region and in the min pooling, it takes the minimum values from the selected region. The main advantages of reducing the spatial dimensions are:

- When the spatial information decreases, computational performance increases.
- Also, when the spatial information decreases simultaneously the parameters which are used to train the model gets reduced, thus it decreases the chances of overfitting.



Figure: 2.Max Pooling

Flattening

The last part of convolutional neural network (CNN) is a classifier that is the artificial neural network (ANN). For ANN we require input layer as a 1D feature vector. The process of conversion to 1D feature vector is known as flattening [9]. It takes the output of the convolutional layers, flattens all its structure to create a single long feature vector which is later used by the dense layer for the final classification process.

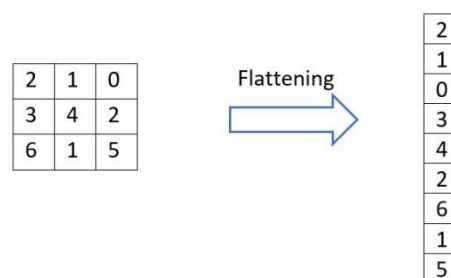


Figure: 3.Flattening

Fully-Connected Layer

In a Convolutional Neural Network (CNN), the output layer is the Fully-Connected layer where the inputs from the various layers are flattened and are sent to transform the output into number of classes in the Neural Network. In this model, the activation function used is Rectified Linear Unit (ReLU). The activation function squashes the values into a range of value. Softmax is the last layer that predicts the accurate output among all the classes.

[4] PROGRAM

For handwriting text recognition we use functions like:

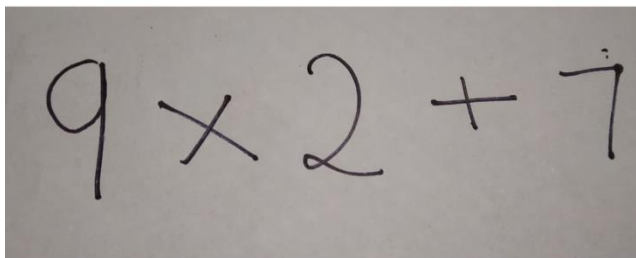
Scan_file(): here we use pytesseract to scan the input image.

Result(): where we get the output on the webpage.

For equation solving we use functions like:

Here we use CV2 module .From this CV2 module we use method like thresh hold which is used to change the background of the image and remove all the noise.

For mathematical equations the recognition of numbers and symbols are shown as above.



From the above equation 9,2,7 are recognized as number and * ,+ are recognized as symbols.

Input for Handwritten recognition:

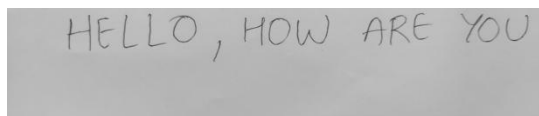


Figure: 4.Input 1

Output For the above input is:

Information

Words: 5

Scan time: 2.390353 seconds

Extracted text

HELLO , HOW ARE YOU

Figure: 5.Output1

Input for the equation recognition is:

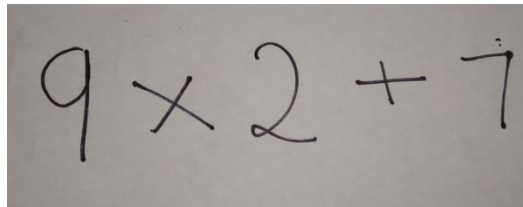


Figure: 6.Input2

Output for the above image is:

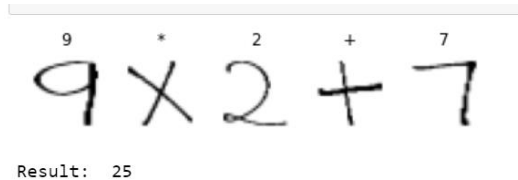


Figure: 7.Output2

[5] CONCLUSION

This paper gives a detailed review of text recognition in the English language using TensorFlow and studies so many algorithms for recognition. The accuracy of text recognition fully depends on the quality and the nature of the image to be read. Current research does not deal with the cursive handwriting because it needs a high supervised system. In this paper, we have studied numerous papers with different algorithms to increase the accuracy of the result. Apart from these, we have concluded that Recognition of Handwritten Characters based on Deep Learning with TensorFlow

gives the most accurate classification and prediction values which can be taken for further researches. The training time taken by the Convolutional Neural Network (CNN) model is very less as compared with any other model. The error rate is also less as compared with the previous models. Convolutional Neural Network (CNN) is not a lot different from other machine learning models but it tries to find patterns in the dataset. And for solving mathematical equations we have trained data containing 0 to 9 digits and symbols like +, -, /, *. For further we can extend this project for solving linear equations and some other integral equations.

[6] FUTURE SCOPE

In the future, we need to improve the current performance of our project. For a better accuracy we will work on the following ideas:

• By increasing dataset-size and by applying various (random) transformations to the input images.

- By Removing all the cursive handwriting style images from the input images.
- By Increasing the input size.
- By adding more layers of CNN.
- Replacing LSTM by two-dimensional LSTM.
- By using Adam optimizer because it gives more accurate results.
- If the recognized word is not present in a dictionary, then search for the most similar word.

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