

Handwritten Character Recognition using Machine Learning

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Abstract—In this paper we present an innovative method for Handwritten Character Recognition using deep learning. Deep Learning is one of the important and fast growing technology and has made it easy for training in the field of AI. Handwritten Character Recognition is the process that provides machine to recognize human written character. We have used various algorithm for the implementation of this model. Implementation of this model includes input(Read Data Set), pre-processing, Training, CNN, save and load the model and recognized character. Convolutional Neural Network is mainly used for the further working of this model. In our system we have made use of Google Colab and made use of TensorFlow for training. We have developed this system using python programming language.

Keywords—CNN, Machine Learning, Accuracy, Recognition

I. INTRODUCTION

Recognition of handwritten character is easy for human it is a complex task when it comes to computers. It is the capability of the computer. The given input might be in online or offline. Optical Character Recognition(OCR) is one of the important technique used to scan the page and convert them into basic text. Though there are many new technologies Deep Learning and Machine Learning are the understandable algorithms. These algorithms helps us to predict and recognize different kinds of handwritten character(ENGLISH). In this project we have used Convolutional Neural Network algorithm It is the extended version of Artificial Neural Network(ANN) which is predominantly used to extract the feature from the grid-like matrix dataset. For example visual datasets like images or videos where data patterns play an extensive role.

Convolutional neural networks are distinguished from other neural networks by their superior performance with image, speech, or audio signal inputs. The Convolutional Neural Network's main concept is to use predefined convertible filters to distinguish patterns in image edges, parts of objects, and expand on this information to detect complete objects. A neural network trained for classification is designed to take inputs and classify them into groups. These groups may be fuzzy, without clearly defined boundaries. This project concerns detecting online handwritten characters.

Deep Learning is a subdivision pertaining to Machine Learning, which is also a subdivision pertaining to Artificial Intelligence. Artificial intelligence is an approach which empowers the system to mirror human behaviors. Machine Learning is an approach to attain Artificial Intelligence using algorithms trained along datasets and lastly Deep Learning is a kind of Machine Learning influenced by the complexion of the human brain. Deep Learning is a Machine Learning approach that grasps features and tasks directly from data. Data can be images, text, or sound. Deep Learning is generally indicated as end to end learning with Deep Learning features picked up with Neural Network without human intervention. Deep Neural Networks requires hours or even

months to train. The training time increases with the amount of data and the number of layers in the network.

II. LITERATURE SURVEY

Mrunalini Pimpale *et al.*, [1] in proposed model an innovative method for offline handwritten character detection using deep neural networks. They have mainly designed a image segmentation based Handwritten character recognition system. OpenCV is used for image processing and have used Tensor flow for training a neural network. Python programming language is mainly used for developing this system. The implementation of this model includes pre-processing, conversion of gray-scale, thresholding, image segmentation.

Anchit Shrivatsav. *et al.*, [2] in this model the number of 60000 images were used as training sets of images with pixel size 28×28. The image or training sets are matched with original image. It was found out after complete analysis and review that classifier ensemble system has the least error rate of just 0.32%. In the proposed model review of different methods handwritten digits were observed and analyzed . In this model for hand written digits recognition were a pretrained CNN is used is used in combination with the SVM classifier ..

Nikitha A .*et al.*, [3] deep learning algorithm is used in the proposed model. In this paper the have first collected the data for training the hand written text, later feature have been extracted from the text dataset and performed the training of this model using deep learning approach. LSTM deep model is used to achieve more accuracy. Two approaches have been compared in this paper on IAM handwritten data set, and found that 2DLSTM based approach outperform the other approach. The main steps involved are first, give upload the image, next recognize the text present in the image lastly display the recognized text.

Vaibhav.V.Manikar *et al.*, [4] in the proposed model the information is stored in image format and then Optical Character Recognition is used to transform the images to digital format. The implementation of this system includes preprocessing, segmentation, feature extraction, post processing and image acquisition. To capture the image various methods can be used and even upload from the gallery. The accuracy of the model is 90.

YuWeng *et al.*, [5] convolutional neural network is mainly used in this proposed system. The implementation of this system includes the following steps, image collecting in the form of photos , third image detection includes image detection API, third image preprocessing includes image location, image cutting and gray processing, next is feature extraction involves load CNN model and feature extraction, and last step is image matching involves calculating similarities and then it will return the results. They have used 50000 images to train and obtained 93.3% accuracy.

Prof. Vaibhav V Manikar *et al.*, [6] In this model they have developed an android application for recognizing the character. It involves several steps including pre-processing, segmentation, feature extraction and post-processing. Were the image is captured

by the camera and loaded into the android app and choice is provided to the user to select a part of an image which is to be converted. Further processing is done by OCR engine and produces the converted text on the screen. The method to transform handwritten data into electronic format is 'Optical Character Recognition'. The converted text is saved as a text file, which can be edited in future whenever required. The advantage of our system is that no internet connectivity is required for character recognition. This system offers 90% accuracy for handwritten documents and gives the easiest way to edit or share the recognized data.

Ahmed Mahi Obaid et al.,[7] This paper proposes an efficient approach towards the development of handwritten text recognition systems. 3-layer Artificial Neural Network (ANN) is utilized in this Paper using supervised learning approach. Algorithms used in this model are Resilient Back-propagation, Scaled conjugate gradient, ANN Train and Test. Implementation of this system involves pre processing, segmentation, feature extraction. Handwritten Character Recognition system was tested on several different scanned handwritten images is proposed with different styles and has achieved 95% accuracy and is advantageous as it uses fewer features to train the neural network, which results into faster convergence (less time for training).

III. IMPLEMENTATION

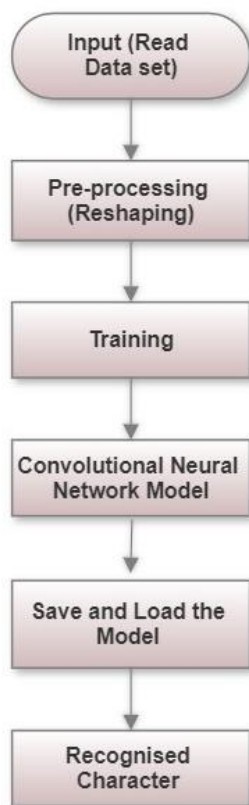


Fig 1: Workflow of Handwritten Character Recognition

A. DATASET USED

In this project, we have used the dataset from Kaggle platform. The dataset used is A_Z Handwritten Data in .csv format. This dataset consists of 9312 images, which includes different handwritten characters.

B. DATA PREPROCESSING

Data preprocessing is a step in the data mining and data analysis process that takes raw data and transforms it into a format that can be understood and analyzed by computers and machine learning. Raw, real-world data in the form of text, images, video, etc., is messy. Not only may it contain errors and inconsistencies, but it is often incomplete, and doesn't have a regular, uniform design. Machines like to process nice and tidy information – they read data as 1s and 0s. So calculating structured data, like whole numbers and percentages is easy. However, unstructured data, in the form of text and images must first be cleaned and formatted before analysis. After importing the dataset consisting of handwritten characters the necessary data analysis is performed.

C. TRAINING

Training of handwritten characters dataset is done by splitting the dataset in the ratio of 80:20. We are splitting the data into training & testing dataset using `train_test_split()` function and reshaping the train and test images data so that they can be displayed as an image, as initially in csv file they were present as 784 columns of pixel data. So we have converted it to 28x28 pixels. After reshaping, shuffling is done for some of the images of train set by using `shuffle()` function.

D. CNN MODEL

A convolutional neural network (CNN) is used to extract the features of several layers of filters. The convolution layers are generally followed by maxpool layers that are used to reduce the number of features extracted and ultimately the output of the maxpool and layers and convolution layers are flattened into a vector of single dimension and are given as an output to the Dense Layer. Followed by feature extraction, we create a CNN model for training the model over training dataset. We then compile the CNN model, where we define the optimizing function & the loss function used for fitting. The dataset is quite large so we are training for 5 epochs, however we can even train it for multiple epochs which is recommended for character recognition for better accuracy.

E. SAVE AND LOAD THE MODEL

After compiling the model, we get the model summary that tells us what were the different layers defined in the model. The summary of the model is obtained using `model.summary()` function. We then save the model using `model.save()` function. We also print the training & validation accuracies along with training and validation losses for character recognition. After saving the model, we load the model for further process i.e. prediction.

F. RECOGNISED CHARACTER

In this step we create 9 subplots of (3,3) shape & visualize some of the test dataset characters along with their predictions by using the `model.predict()` function. Then we read an external image of any online handwritten character & we make a copy of it that is to go through some processing to be fed to the model for the prediction. The image is then converted from BGR representation to RGB for displaying the image, and is resized to our required dimensions that we want to display the image. Then the image is resized using `cv2.resize()` function into the dimensions that the model takes as input, along with reshaping the image using `np.reshape()` function which can be used as model input. Now we make a prediction using the processed image. Using `np.argmax()` function we get to know the exact character through the `word_dict` dictionary. The predicted character is then displayed on the frame.

IV.RESULTS

The handwritten characters are analyzed, pre-processed and reshaped for recognition process. The dataset is split into training and test sets. Followed by the implementation of CNN model. The character prediction is evaluated using accuracy metrics. For the present dataset we were able to achieve 98.16% test accuracy, 98.67% training accuracy, 4.99% training loss, 8.04% test loss respectively. According to accuracy plot, the accuracy is increasing after each epoch evaluation and in loss plot, the loss is decreasing after each epoch evaluation.

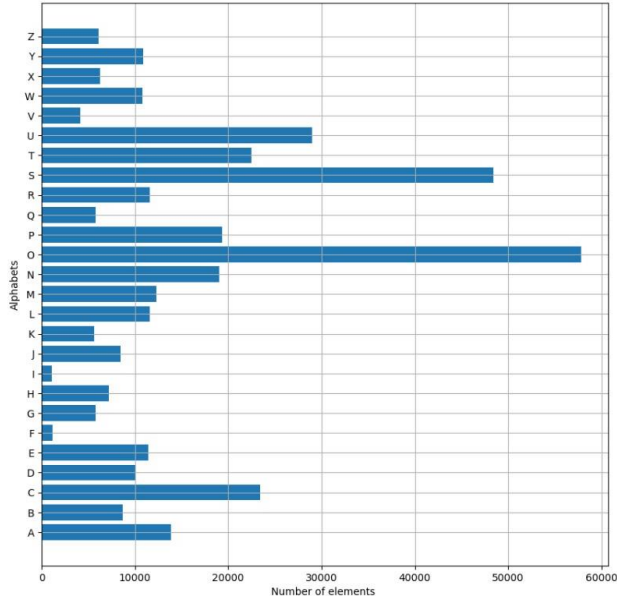


Fig 2: Number Of Alphabets Plot In The Dataset

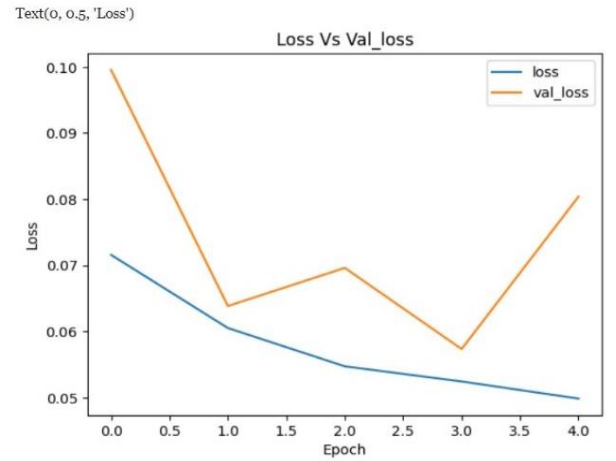


Fig 4: Loss Plot

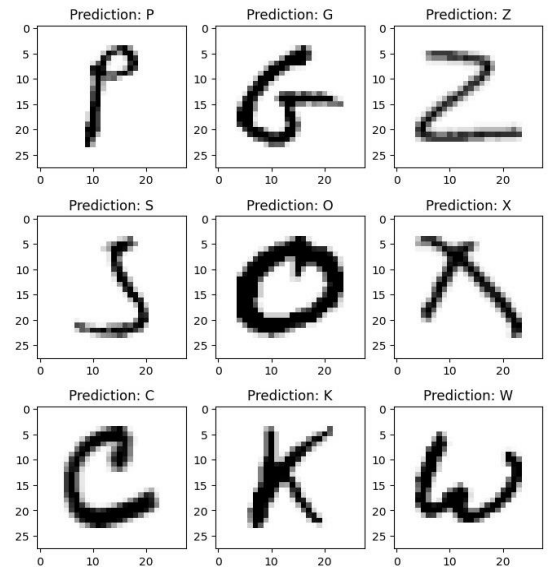


Fig 5: Subplots of Test Prediction

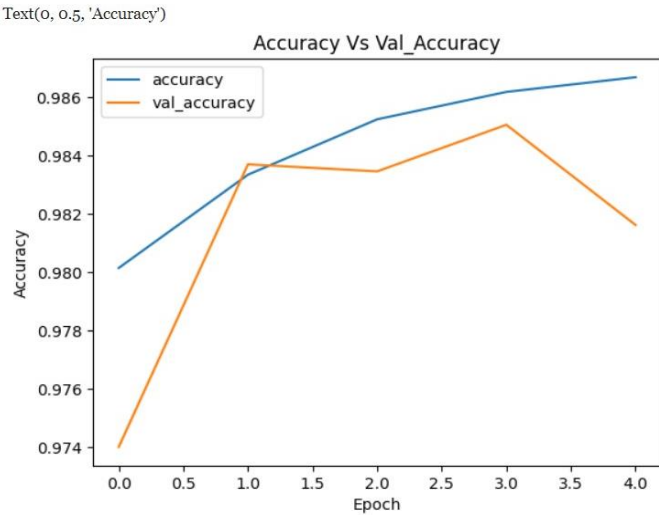


Fig 3: Accuracy Plot

1/1 [=====] - os 130ms/step

Prediction:A



Fig 6: Results of proposed model

V.CONCLUSION

In our proposed system, we have applied CNN and supervised learning to classify the images of handwritten characters separately and analysed recognition and got 98.16% of accuracy which is achieved by training the model. The variations of accuracies for handwritten characters were observed for various characters from dataset. The accuracy of prediction will increase and result in the decrease of error rate by having more training examples and epochs. We found out that this CNN approach is more effective than random forest classifier and K nearest neighbour. The CNN approach gave better results because of the use of multiple layers and filters which helped in reduction of error in classification.

In future, we can implement this system to different kinds of language by training them as same as the proposed model. By employing the same strategy with digits, we may use it full-fledge to rely on a similar index checker of handwritten documents along with their digital conversion.

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