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Mini project report submitted in partial fulfillment of curriculum prescribed for Neural Networks and Fuzzy Logic(CS620) for the award of the degree of

Bachelor of Engineering
in
Computer Science and Engineering
By

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CERTIFICATE

This is to certify that the work entitled **“Handwritten Character Recognition”** is a bonafied work carried out **by Anirudh D Pai, Eeshaan Achar & Navneet Gajanan Hosmane** in partial fulfillment of the award of the degree of **Bachelor of Engineering in Computer Science and Engineering of JSS Science and Technology, Mysuru during the year 2020**. It is certified that all corrections / suggestions indicated during CIE have been incorporated in the report. The mini project report has been approved as it satisfies the academic requirements in respect of mini project work prescribed for the Neural Networks and Fuzzy Logic(CS620) course.

Course In Charge and Guide

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Abstract

Handwriting recognition is the ability of a machine to receive and interpret handwritten input from multiple sources like paper documents, photographs, touch screen devices etc. Recognition of handwritten and machine characters is an emerging area of research and finds extensive applications in banks, offices and industries. This project is about devising an algorithm for recognition of hand written characters also known as HCR (Handwritten Character Recognition). A novel technique is proposed for recognition English language characters using Convolutional Neural Network including the schemes of feature extraction of the characters and implemented.

Acknowledgements

We have put a lot of effort in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. we would like to extend our sincere thanks to all of them.

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We would like to express our gratitude towards our parents for their kind co-operation and encouragement which helped us in completion of this project.

Our thanks and appreciations also go to our team in developing the project and people who have willingly helped us out with their abilities.

Contents

1 Implementation

Convolutional Neural Network (CNN) is one of the most widely used methods for handwriting recognition. To implement CNN in our project we have used TensorFlow, which is an end-to-end open source platform for machine learning. Specifically, we have used an inbuilt library of TensorFlow called “Keras” to build our model. The stages of CNN for image recognition are as follows:

1.1 Datasets

The EMNIST(Extended Modified NIST) dataset is a set of handwritten character digits derived from the NIST Special Database 19 and converted to a 28x28 pixel image format and dataset structure that directly matches the MNIST dataset. There are many models of datasets available. The one which we chose is EMNIST Balanced, which consists of 47 balanced classes with around 130K samples. The samples are divided as 112K training set and 18K testing set.

1.2 Pre-Processing

An image data consists of three basic colors: Red, Green and Blue. It’s a three dimensional data. So, inorder to give an image as input to a model we perform flattening. Flattening is converting the data into a 1-dimensional array for inputting it to the next layer. We flatten the output of the convolutional layers to create a single long feature vector. And it is connected to the final classification model, which is called a fully-connected layer. In other words, we put all the pixel data in one line and make connections with the final layer.

1.3 Training

Training a model simply means learning (determining) good values for all the weights and the bias from labeled examples. We use “Conv2D” library to create intermediate layers of our model. Depending on the complexity of the image to be recognized we use different number of layers. In our case, we have 1 input layer + 2 hidden layers + 1 output layer.

Two hidden layers use “Relu” activation function and has 24 nodes each, whereas last layer uses “Softmax” function and has 47 nodes for all 47 classes. Once we have the model, we train it by passing flattened images and get the appropriate weights for each node in every layer.

1.4 Testing

Once we build an efficient model we validate the model against test dataset to know the accuracy of the model. The accuracy of our model comes out to be 85.3%. To validate the tested data we input our own image. First, we will load the same model and weights obtained during training process. Next, we need to perform some morphological operations on the image like - increasing the contrast, thickening the handwriting and fixing a threshold manually to convert the color image to binary.

Once we have the binary image, we find contours between the character in the image and the background of the image to detect the characters. We draw a boundary around all the characters. We pass all this characters to our neural network to predict the output. Once the modell predicts the character we display the same above the character.

2 Design Issues

- Image recognition in handwriting is more challenging because everyone has different forms of handwriting. We cannot ensure the model to detect all the forms accurately.

- Our model is designed only for the English language and implementing the same for different languages is going to be more complex and out of the scope of our project.

- Sometimes characters with similar shape like '1' and 'l' are interpreted incorrectly. We need to supply large datasets and use computers with higher processing powers to achieve high levels of accuracy.

- We have to adjust the threshold manually to convert color image to binary image. By automating this process, character recognition will be more accurate and simple.

- The sample image had higher resolution which had to be converted into 28x28 pixels, so some boundaries are not detected.

3 Results

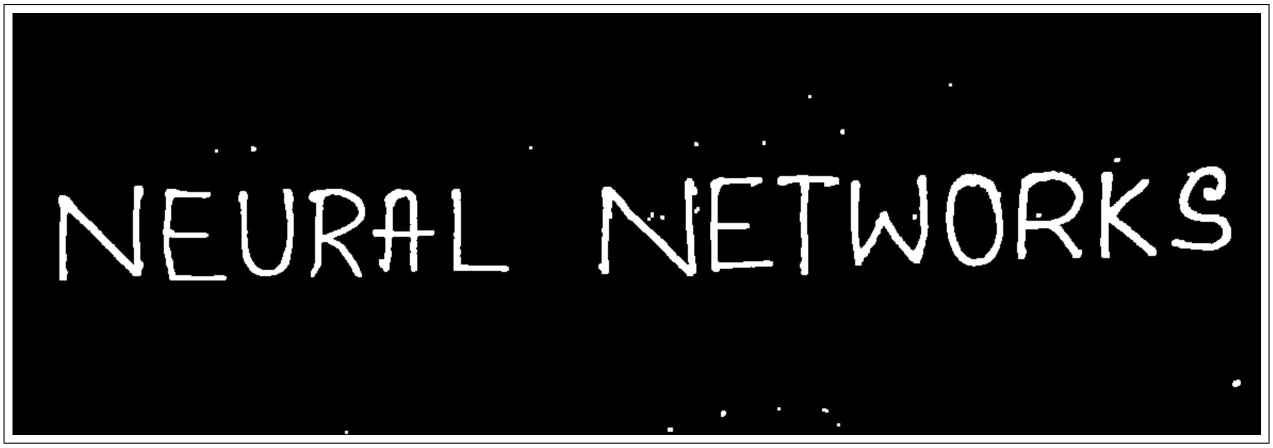

Figure 1: Binary Image obtained after all image processing operations.

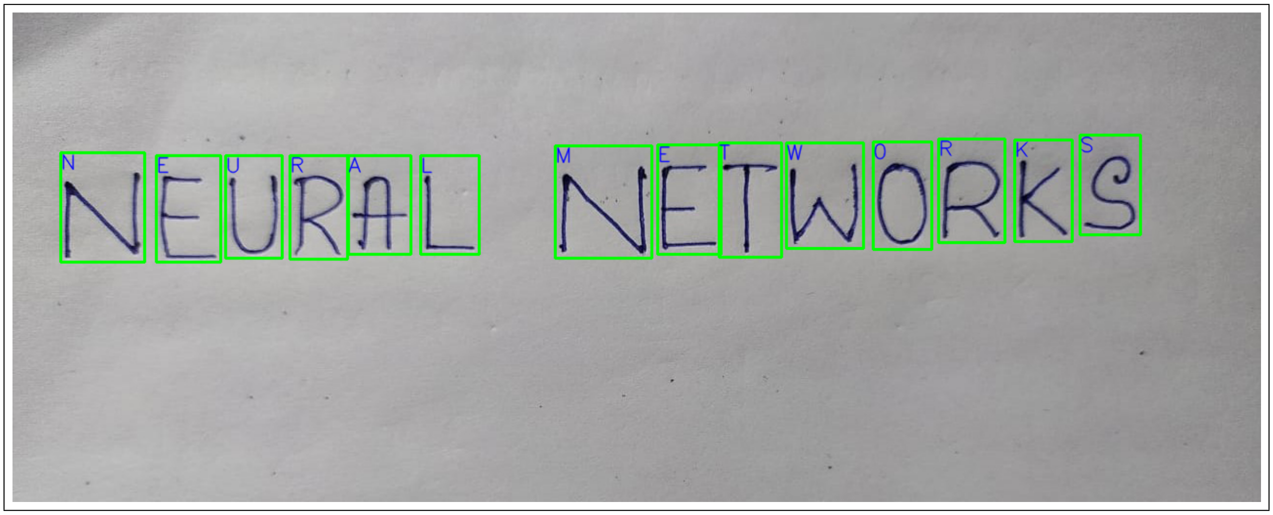

Figure 2: Final output.

4 Critical Part

- Choosing the right algorithm for handwriting recognition is really crucial. It has to be decided based on the accuracy needed and the purpose of use.

- Choosing the number of layers and number of nodes in each layer has to be decided according to the complexity of the application.

- The use of appropriate activation functions in each layer also effects the accuracy of the model.

- Quality and Quantity of the datasets matter, as the image with low quality causes feature loss and if the size of training set is not large enough then model will not be trained properly.

- Extra line of codes or redundant algorithm may cause wastage of memory. So by using inbuilt librarires we reduce the load on the systems.

5 Conclusion

Many regional languages throughout world have different writing styles which can be recognized using proper algorithm and strategies. We have a project suitable for recognition of English characters. It has been found that recognition of handwritten character becomes difficult due to presence of odd characters or similarity in shapes for many characters. Scanned image is pre-processed to get a cleaned image and the characters are isolated into individual characters.

Preprocessing work is done in which normalization, filtration is performed using processing steps which produce noise free and clean output. Managing our evolution algorithm with proper training, evaluation other step wise process will lead to successful output of system with better efficiency. Use of some statistical features and geometric features will provided better recognition result of English characters.

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