COMPACT NN BASED SMART PEN

Project Reference No.:*45S_BE_3464*

College ***:*** *The Oxford College of Engineering*
Branch ***:*** *Department of Information Science and Engineering*
Guide(s) ***:*** *Asst. Prof. Ms. Vidhya S*
Student(S) ***:*** *Ms. Aishwarya*
Ms. Jyothi G
Mr. N S Dhanush
Ms. Sowmya

Keywords*:*

NLP, Convolutional Neural Networks, handwritten prediction, wrong prediction correction.

Introduction

The Convolutional Neural Network approaches are employed to predict the handwritten letters using the standard dataset for training and testing. CNN, one of the deep learning techniques, is used to recognize the alphabet, and a comparison of the architectures of CNN is performed to get the best possible results with the greatest possible accuracy and the least amount of data loss. The essential of handwritten recognition in various fields such as banks, college notifications, and government and non-governmental institutions to convert the handwritten documents into the digital format with a high prediction rate. The research gap in this field is to predict the handwritten words or numeric values as everyone’s handwriting style is different. The capacity of a computer to identify the human handwritten text present in a variety of manual sources, such as images, papers, documents, and so on is referred to as "handwritten recognition." It is not difficult for a person to recognize the character based on the visual; nonetheless, the issue is whether or not it is feasible for a computer to reliably identify it. As a result, the notion of CNN is put into practice. The proposed framework addresses the above issues, the camera is attached to the pen and the signal is extracted by using the Convolutional Neural Network model using Natural Language Processing (NLP) to predict the words once the word is predicated it is passed through the dictionary application to predict the exact word if NLP fails to recognize the handwritten words.

Objective

The proposed project's main objective is to create a device that can help us improve the quality of our writing. This project will describe a device known as a smart pen, which is a new and evolving technology that does not cause distractions due to its portability, user-friendliness, and, most importantly, affordability. The main objectives of the Compact NN based smart pen are to achieve Handwriting recognition, Spelling checking, Sentence Scanner, and Digital conversion. There is no smart device that can check the spelling of

words as you write them, nor does it offer suggestions for alternate words or meanings. Even if you're writing in a notebook, having a device that can convert your sentences into digital notes will be quite useful.

Methodology

1. Dataset Description:

IAM Dataset: contains 13,353 images of handwritten lines of the text created by 657 writers.

RIMES database: (Reconnaissance et Indexation de données Manuscrites et de fac similÉS / Recognition and Indexing of handwritten documents and faxes) was created to evaluate automatic systems of recognition and indexing of handwritten letters.

2. Data Pre-processing:

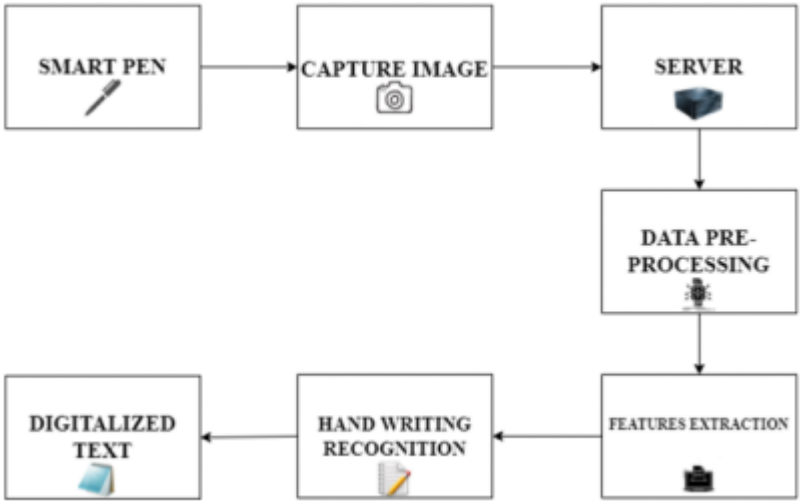
The data used is pre-processed to correct some usual characteristics of the handwriting text. This pre-processing was applied at the line-of-text level. In particular, we have identified the baseline and the corpus line, corrected the slant, and normalized the height of the characters based on the baseline and corpus line.

3. CNN Model:

(a) Step 1: Convolutional Neural Networks: Every layer is made up of a set of neurons, where each layer is fully connected to all neurons in the layer before. The final output will be reduced to a single vector of probability scores, organized along the depth dimension.
(b) Step 2: Feature Extraction: In this part, the network will perform a series of convolutions and pooling operations during which the features are detected.
(c) Convolution: Convolution in CNN is performed on an input image by establishing a kernel.
(d) Padding: There are two types of results to the operation — one in which the convoluted feature is reduced in dimensionality as compared to the input, and the other in which the dimensionality is either increased or remains the same.
(e) Non-Linearity: The activation function usually used in most cases in CNN feature extraction is ReLU which stands for Rectified Linear Unit. Which simply converts all of the negative values to 0 and keeps the positive values the same.
(f) Pooling: The pooling layer is responsible for reducing the spatial size of the Feature and decreasing the computational power required to process the data
(g) Step 3: Classification — Fully Connected Layer (FC Layer): The classification layer is the final layer of the architecture. This layer classifies the classes based on probabilities obtained from the SoftMax layer and also calculates the cost function.

4. Smart Pen:

The smart pen is fitted with an ESP32 camera and OLED display. While witting the camera captures the image and uploads it to the server. The server processes the image and detects the characters. The detected characters are appended in the notepad. Then the word will be processed to find the meaning from the dictionary module. If the word is not found, it checks the spelling. The correct word is transferred to the ESP32 Wi-Fi module and get displayed on the OLED.



Results and Conclusions

The model is trained using the IAM and RIMES dataset, both the dataset contains the hand-written sentences written in pages by the volunteer. To capture the testing images the smart pen is employed where the camera is attached to the pen to fetch the character and send it to the server for predicting the letters. The dataset is trained by using the CNN model. The model predicts the sentences. If by chance there is a wrong predication then the dictionary library called as textblob is employed to correct misspelled letters in the predicated sentences. Some of the screenshots are shown below, the various cases of implemented results are:

The word written in the image is coming soon the input and output word predicated is

Figure: Input to the model

```
Tensorflow: 2.9.1
2022-06-17 18:20:36.553631: I tensorflow/core/platform/cpu_feature_guard.cc:193] This TensorFlow binary
ormance-critical operations:  AVX AVX2
To enable them in other operations, rebuild Tensorflow with the appropriate compiler flags.
Init with stored values from ../model/snapshot-13
2022-06-17 18:20:36.641986: I tensorflow/compiler/mlir/mlir_graph_optimization_pass.cc:354] MLIR V1 opti
Recognized: "coming Soon"
Probability: 0.4381757080554962
coming Soon
corrected one  None
[]

(base) D:\Smartpen\handwritten\src>
```

Figure: Output generated from the model.

The word written in the image is oxford college of engineering and the results are shown below,

Figure: Input image for the model

Figure: Output generated for the word.

Future Scope

The future scope includes the development of a smart pen that meets industrial requirements, along with improved recognition and feature extraction methods that involve new algorithms and hardware equipment.