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Handwritten Manuscript Recognition using Convolutional Neural Networks

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ABSTRACT: Handwriting recognition system is the ability of computers to detect and recognize human handwritten digits, characters and text. It is hard task because different humans follow different fonts which may not be perfect and sometimes unrecognizable. Today there is a need for handwriting recognition systems for reading old documents and letters. So, handwriting recognizer is solution to this problem. It uses images of handwriting and identifies what is written. To implement this python and deep learning concepts are used. It follows some steps like pre-processing, segmentation, classification, recognition and post-processing. Here we use Convolutional Neural Networks (CNN) algorithm and Convolutional Recurrent Neural Network (CRNN). It takes input from user, processes it and finally identifies corresponding digits and character. It also takes human handwriting as input and gives the corresponding output.

KEYWORDS: CNN, CRNN, Pre-Processing, Segmentation, Classification, Recognition, Post-Processing, Deep Learning.

1. INTRODUCTION

Handwriting recognition systems are emerging as one of the most undertaking researches in the area of image processing techniques and in the pattern recognition techniques in the domain of artificial intelligence. Handwritten recognition system is one of the areas of the example distinguishing the evidence that it is the subject of extensive in middle of the present decades. Human handwritten texts show the wide complex varieties. This system has more advantages like recognizing the digits and characters in bank checks and other text recognizing applications. It provides the advancement of the automation and improves the interaction between the machine and the human in various real time applications. In exact words handwriting recognition is the path towards the differentiating and the perceiving character and digits from the input image and it will convert it into the ASCII (American Standard Code for Information Interchange) or the other system editable format for comparison. The work of this handwriting recognition system divided into 2 types. They are, written manually by hand and the system typed. The typed digits and characters are excellent and uniform.

This handwriting recognition is implemented by using the deep learning algorithm. Deep learning technology is typically based on the multi-layered interconnected nodes or the neurons called as the deep neural networks. Deep neural networks contain of mainly three layers, which are the input layer, output layer (considered as visible layers) and the hidden layer. In the input layer the network takes the data as input for processing and the output layer is the result of its classification, detection or the prediction. The word deep in the deep neural networks means the number of the hidden layers through which the data is transformed. This handwriting recognition system used one of the efficient deep neural networks called convolutional neural network algorithm for more accuracy in less time.

II.LITERATURE SURVEY

[1] OFFLINE HANDWRITTEN DIGIT RECOGNITION USING NEURAL NETWORK

In this paper, they had proposed an idea of isolated handwritten digits recognition. They used the back propagated neural network and trained with a set of handwritten digits. The normalized and skeletonized images of isolated digits were used as inputs. Here handwritten recognition system can be divided into four stages. They are, data or image acquisition, pre-processing of digit, feature extraction and classification stage. During the stage of pre-processing, each character is (converted) normalized into a 32 x 32 pixel image, along with the removal of spurs and noise.

[2] SUPPORT VECTOR MACHINE (SVM) FOR ENGLISH HANDWRITTEN CHARACTER RECOGNITION

In this paper a recognition model for the English handwritten character recognition was designed and implemented for both the uppercase and the lowercase using a technique called Chain Code (or) Freeman Chain Code (FCC) as a technique for representing the image containing character with the NIST database which is a dataset for the characters. All the characters images in the NIST database cannot be used in this experiment. For example, the NIST database has 190,998 lowercase letters; but, only of 189,411 samples were used because of the very bad quality samples and those samples can sometimes have some broken parts, which made the recognition of characters more difficult. This handwritten character recognition mode began with pre-processing.

[3] HANDWRITTEN DIGIT RECOGNITION USING K-NEAREST NEIGHBOR CLASSIFIER

In this paper the handwritten digit recognition model was implemented using K-Nearest Neighbor classifier which is useful for classifying the digits. MNIST data set was used for training and the testing the data. In the k-Nearest neighbor classifier, the KNN computed the distance between the feature vector values of each image and the feature values of the test sample .The classes among the majority of k-nearest training samples was based on the Euclidian distance measures. The training vector is a multidimensional array and each row in the array contains the class label of the training images and the corresponding feature values where as the test vector contains only the feature values.

III.PROJECT OBJECTIVE

The objective of this project is to build a handwritten recognition system for characters, digits and text using different Deep learning techniques. Handwritten recognition for characters, digits and text plays an crucial role in real time and is presently grabbing the attentiveness of researchers due to the possible applications in aiding for the blind and people who have defect in sight (visually impaired people), automatic entry of data of documents for business, human-robot interactions and many more emerging applications. In this paper, a technique was proposed to recognize handwriting characters and digits with the help of deep learning algorithms like Convolutional Neural Network (CNN) with Dense Neural Networks and Adaptive Moment (ADAM). The main objectives of this handwriting recognition model are, to recognize handwritten documents.

To read and archiving old scripts. To convert human handwriting to machine readable formats. To make banking operations easier and error free. The objective of our recognizer is to create a GUI interface for the process of the handwriting recognition. To train and to enhance the input source consisting of images with human handwriting for the better accuracy. To recognize and display the recognized characters, digits and texts along with the actual ones.

IV.METHODOLOGY

4.1 Convolutional Neural Network(CNN)

Convolutional Neural Networks (CNNs) are a type of artificial neural network commonly used in computer vision tasks such as image classification, object detection, and image segmentation. CNNs are inspired by the biological structure of the human visual cortex, and they are designed to automatically extract relevant features from the input data. In a CNN, the input data is typically an image or a sequence of images. The first layer of the network is a convolutional layer, which applies a set of filters to the input data to extract features such as edges, lines, and curves. The output of the convolutional layer is passed through a non-linear activation function, such as a rectified linear unit (ReLU), to introduce non-linearity into the network.

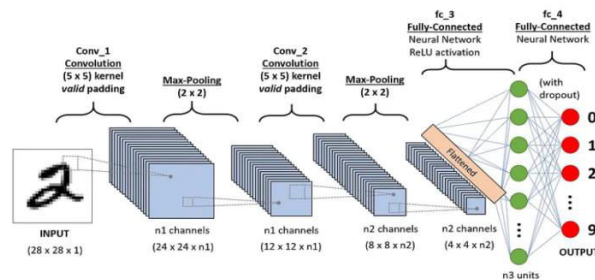


Fig 4.1 : CNN for digit recognition

4.2 Convolutional Recurrent Neural Network(CRNN)

Convolutional Recurrent Neural Networks (CRNNs) are a type of neural network that combines the convolutional and recurrent neural network architectures. CRNNs are typically used for tasks that require processing of sequential data, such as speech recognition, handwriting recognition, and video analysis. In a CRNN, the input data is typically a sequence of images or feature maps generated by a convolutional neural network.

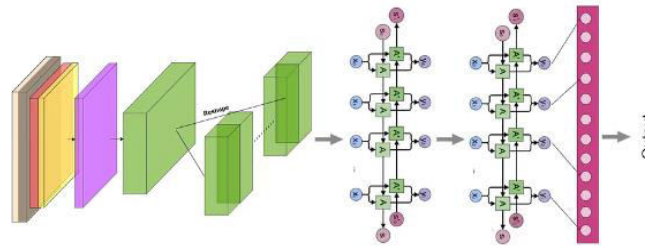


Fig 4.2 : CRNN representation

2. Implementation

The organization of this handwriting recognition model can be explained clearly and neatly by the given system architecture and the detailed steps involved in recognizing the characters, digits and the data sets which are used in this handwriting recognition is also clearly depicted. Here we will be having some training images which are to trained in order to remove the noise and have test images.

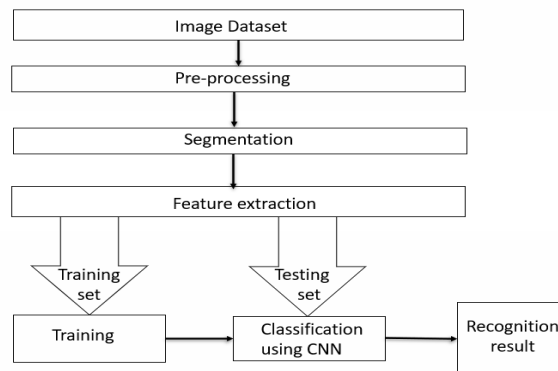


Fig 5 : architectural diagram

5.1 Image Acquisition

Image acquisition stage includes uploading an image to the computer to recognize the characters and digits. Along with the grey-scale level images, color images and binary document images containing text or characters are also used. In image acquisition phase, from an external source an image is taken for further processing steps.

5.2 Pre-processing

Pre-processing stage involves the image enhancement by removing the noise. Pre-processing step will be carried out in multiple steps like Gaussian blurring and colour conversion. The input image is converted from one colour space to another colour by using colour conversion function.

5.3 Segmentation

Segmentation acts as the most important phase in the computer vision operations. Segmentation of an image is the process of grouping small parts of an image together belonging to the same object class. Image segmentation is also called as pixel-level classification because images are defined in pixel matrix. It is done by image partitioning (or video frames) into multiple objects or segments.

5.4 Feature Extraction

Using this module, the contours will be identified, from which the contour approximation is applied and then the bounding rectangle is identified as the contour area. Here, the segmented image is stored as a temporary image, on



which OpenCV function such as resize and reshape are applied to get y Value images. The arrived y Value images is considered to be as the extracted feature.

5.5 Classification

In classification phase the extracted features are mapped to the different classes by using several models. It identifies the characters or words which represents the features. The features extraction from the image involves the image classification phase to notice some patterns in the dataset.

5.6 Post- processing

In post-processing method a candidate character table is generated by recognizing the necessary and simple features of characters. After, the words corresponding to character from the candidate character table are selected by going through a word and grammar dictionary before selecting the matched words.

5.7 Dataset

The datasets taken in this paper are MNIST and images consisting of digits and English alphabets of various font styles. MNIST is a data set of 60,000 gray scale images of dimensions containing small square 28x28 pixel. Those single handwritten digits are between 0 and 9 and 10,000 testing images. Extended MNIST consisting of handwritten characters converted to 28x28 pixel image format. The dataset is very important in this recognition process. This model also used IAM dataset which consists of English handwritten text .

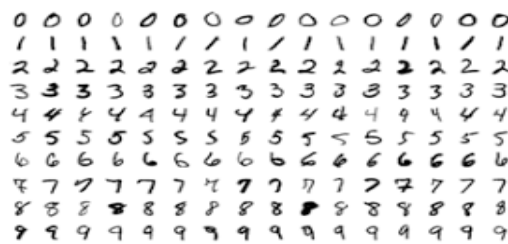


Fig 5.7 : MNIST dataset

6 Test Cases Reports

S. No	Test case passed	Expected output	Actual output	Result
1.	Image containing single character	Single character will be recognized	Single character recognized	Pass
2.	Image containing single digit	Single digit will be recognized	Single digit recognized	Pass
3.	Image containing a text	Text will be recognized	Text recognized	Pass
4.	Image containing a number written in paper	Number written in paper will be recognized	Number written in paper recognized	Pass
5.	Image containing a text written in paper	Text written in paper will be recognized	Text written in paper recognized	Pass
6.	Image containing both digits, characters	Both digits and characters will be recognized	Both digits and characters recognized	Pass
7.	No image selected	Shows input error	Input error	Pass

V.RESULTS

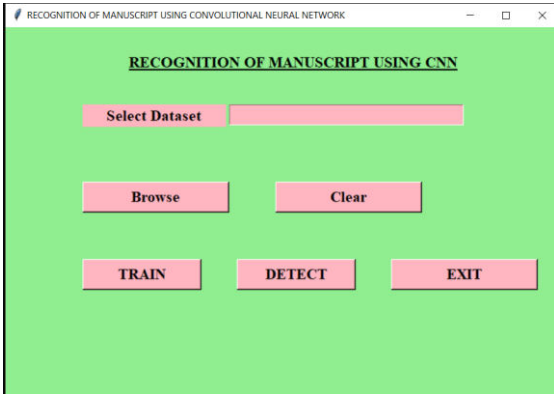


Fig 7.1 : GUI Interface

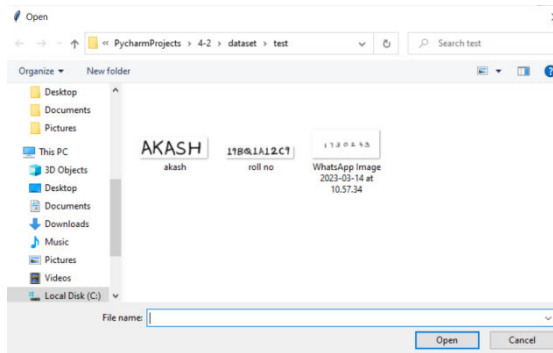


Fig 7.2 : Select Test image

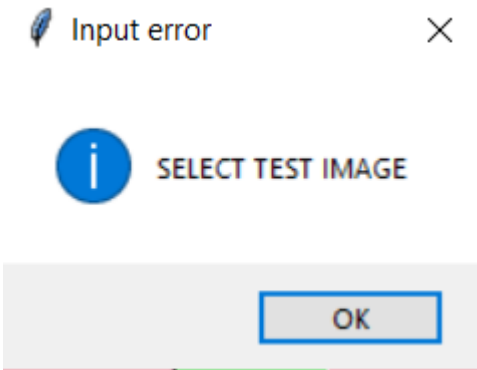


Fig 7.3 : No image selected

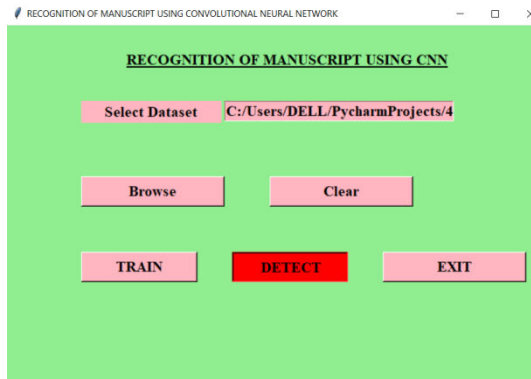


Fig 7.4 : Click the Button to Detect

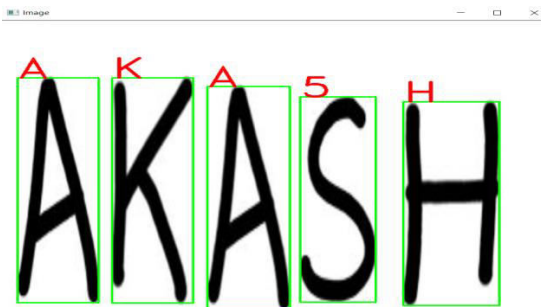


Fig 7.5 Text recognised

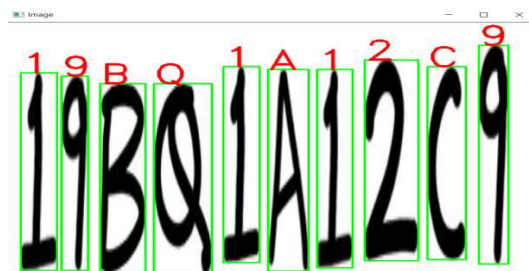


Fig 7.6 alphanumeric text recognised

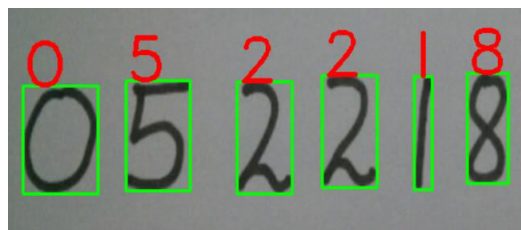


Fig 7.6 Number recognised



S.No	Title	Algorithm	Efficiency	Data set used	Recognizes
1	Recognition Of Manuscript Using Convolutional Neural Network	Convolutional Neural Network	96%	MNIST and image data sets	Digits (0-9), English Characters (A-Z) both lower and upper case, Text

VI.CONCLUSION & FUTURE SCOPE

In this paper the handwriting recognition model for both digits and characters was proposed by using an efficient deep neural networks called Convolutional Neural Network (CNN). In this model the CNN algorithm used the processes before recognizing the digits and characters in the input image. Those steps are image acquisition, pre-processing, segmentation, feature extraction, classification and post-processing. The CNN algorithm will be involved in the classification phase. We used 44500 training images. The handwriting recognition model for digits and characters was tested by using different possibilities of the test cases like taking images of single character, single digit, text, some digits written in paper, some text written in paper, combination of both digits and characters and we also tested by passing no image. By implementing the handwriting recognition system for digits and characters, training the images in the entire data sets obtained the results with high accuracy and recognized in very less time. The future scope of the handwriting recognition system is we can design more real time applications like music note reader, sending messages in their own mother language, reading addresses from forms, reading bank check amounts, reading doctor prescription form and many more can be created.

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