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Letter recognition using Deep learning

Prof. Yogesh
Artificial intelligence and machine learning
Mallareddy University

k.vishwa
Artificial intelligence and machine learning
Mallareddy University

Y. Mythri Reddy
Artificial intelligence and machine learning
Mallareddy University

Y. Rithesh Chandra
Artificial intelligence and machine learning
Mallareddy University

Y. Ajay Reddy
Artificial intelligence and machine learning Mallareddy University

Abstract

This paper introduces deep learning methods applied to character recognition. The abundance of data and sophisticated algorithms has facilitated the training of complex neural networks. Although there are alternative approaches to character recognition, the paper primarily concentrates on utilizing Convolutional Neural Networks (CNNs). The proposed method involves training a dataset and employing image segmentation to develop a character recognition system. The implementation of this system is accomplished through the utilization of the Python programming language.

INTRODUCTION

Currently, advanced technology heavily relies on vast amounts of data and the increasing demand for data storage in computers across various domains. Artificial Intelligence (AI) has gained widespread adoption worldwide, leveraging deep learning networks in various applications. However, deep neural networks (DNNs) come with a high cost and complexity. To enhance the efficiency of AI systems without compromising accuracy or incurring additional hardware costs, deep learning techniques are extensively employed.

The performance of DNNs depends on processing large volumes of raw data to extract relevant features. Although DNNs offer high accuracy, they require significant complexity. Computationally, DNN processing necessitates the usage of graphical processing units (GPUs) in addition to general-purpose computers. Optical Character Recognition (OCR) technology primarily focuses on character and word recognition, transforming them into digitized representations to extract information.

To address these challenges, this project combines neural network training with an algorithm that segments characters within given images. The

neural network is then augmented with additional layers to facilitate user accessibility, enabling the conversion of diverse characters into digitized outputs. Furthermore, the inclusion of layers allows for word segmentation. To tackle this task, we employ convolutional neural networks (CNNs), which demonstrate superior performance when working directly with raw input pixels rather than pre-extracted image features or parts of a complete word image. The proposed deep learning techniques are utilized for classification and identification of different images.

LITERATURE SURVEY

1. Offline Handwritten English Numerals Recognition using Correlation Method : In this paper author has proposed system is to efficiently recognize the offline handwritten digits with a higher accuracy than previous works done. Also previous handwritten number recognition systems are based on only recognizing single digits and they are not capable of recognizing multiple numbers at one time.
2. Recognition of Handwritten Hindi Characters using Backpropagation Neural Network : Automatic recognition of handwritten characters is a difficult task because characters are written in various curved and cursive ways, so they could be of different sizes, orientation, thickness, format and dimension. An offline handwritten Hindi character recognitionsystem using neural network is presented in this paper.
3. Character Recognition Using Neural Networks: Neural network approach is proposed to build an automatic offline character recognition system. Devnagari isan Indo-Aryan language spoken by about 71 million people mainly in the Indian state of Maharashtra and neighboring states. One may find so much work for Indian languages like Hindi, kanada, Tamil, Bangala, Malayalam etc butdevnagari is a language for which hardly any work is traceable especially for character recognition. In this paper, work has been performed to recognize Devnagari characters using multilayer perceptron with hidden layer.
4. Intelligent Systems for Off-Line Handwritten Character Recognition: A Review Handwritten character recognition is always a frontier area of research in the field of pattern recognition and image processing and there is a large demand for Optical Character 4 Recognition on hand written documents. This paper provides a comprehensive review of existing works in handwritten character recognition based on soft computing techniques during the past decade.
5. An Overview of Character Recognition Focused on Off-Line Handwriting Character recognition: has been extensively studied in the last half century and progressed to a level sufficient to produce technology-driven applications. Now, the rapidly growing computational power enables the implementation of the present CR methodologies and creates an increasing demand on many emerging application domains, which require more advanced methodologies.
6. A Recognition System For Handwritten Gurumukhi Characters: This paper represents a Handwritten Gurmukhi Character Recognition system using some statistical features like zone density, projection histograms, 8 directional zone density features in combination with some geometric features like area, perimeter, eccentricity, etc. The image document is first pre-processed by using many techniques like binarization, and morphological operations (erosion and dilation) applied to remove noise and then segmented into isolated characters.
7. Image preprocessing for optical character recognition using neural networks Primary task of this master's thesis is to create a theoretical and practical basis of preprocessing of printed

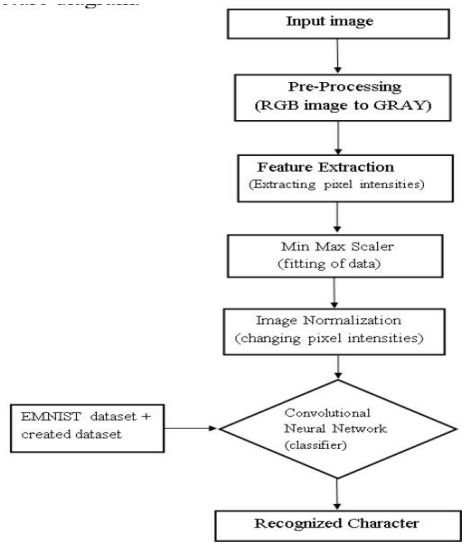
text for optical character recognition using forward-feed neural networks. A demonstration application was created and its parameters were set according to the results of realized experiments.

METHODOLOGY

Convolutional Neural Networks (CNNs) consist of interconnected neurons with learnable weights and biases. The architecture of CNNs comprises layers, including an input layer, multiple hidden layers, and an output layer. When CNNs have a significant number of hidden layers, they are often referred to as deep neural networks. In CNNs, the neurons in the hidden layers are connected to small regions (receptive fields) of the input space generated from the previous layer, unlike fully connected networks such as Multi-Layered Perceptron (MLP) networks, where neurons are connected to all inputs. This approach reduces the number of connection weights (parameters) in CNNs compared to MLP networks, resulting in faster training for networks of similar size. The input to CNNs typically consists of two-dimensional arrays of data, such as images.The architecture of CNNs includes several modules:

Pre-processing: Pre-processing is the initial stage in the recognition process, where the data is prepared for further algorithms. It involves tasks like removing unnecessary distortions, fine-tuning the image, slant correction, noise removal, baseline alignment, etc. Pre-processed data is then passed to the next module for feature extraction.

Feature extraction: After pre-processing, the feature extraction step involves extracting sets of features that will be used for classification. Feature extraction is essential for deriving meaningful properties from the dataset, which will be used to classify letters or images.



Classification: Classification involves assigning labels or categories to images, enabling them to be categorized and trained accordingly. There are various methods of classification, and in this project, a CNN algorithm is utilized for classification.

Recognition: The final step is recognition, where pre-processed and feature-extracted images are passed through the trained model to identify and recognize the words. The model is trained on a training dataset, and the recognized words can be predicted based on its output.

FIG : 3.1 : FLOW DIAGRAM

ARCHITECTURE

The following are the types of layers commonly found in Convolutional Neural Networks (CNNs):

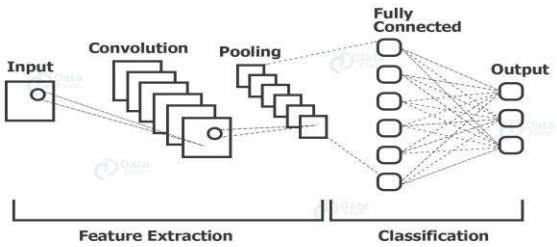


Fig : 4.1 : Layers of CNN

1. Input Layer: This layer acts as a buffer to hold the input data and passes it to the next layer.

2. Convolution Layer: The convolution layer performs the crucial task of feature extraction. It applies the convolution operation on the input data using a kernel. By sliding the kernel over the input and performing the sum of products at each location, multiple convolution operations are performed, resulting in different feature maps. The stride determines the step size of the kernel sliding.

3. Rectified Linear Unit (ReLU): ReLU is an activation function that introduces non-linearity to the network. It replaces negative values with zero, which helps speed up the learning process. The output of each convolution layer is passed through the ReLU activation function.
4. Pooling Layer: The pooling layer reduces the spatial size of each feature map, thereby reducing computation in the network. It uses a sliding window with a specific stride to transform the feature map into representative

values. Commonly used pooling techniques include min pooling, average pooling, and max pooling.

5. Fully Connected Layer: The fully connected layer connects every neuron in the layer to all the neurons in the previous layer. It learns the non-linear combinations of features and is used for classification or prediction tasks. For classification problems, a fully connected layer is often followed by a softmax layer, which produces the probabilities of each class for a given input. In regression problems, a regression layer is used to predict the output following the fully connected layer.

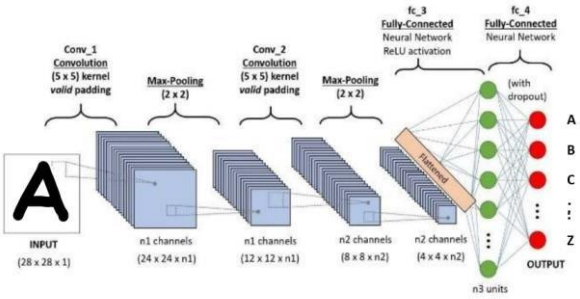


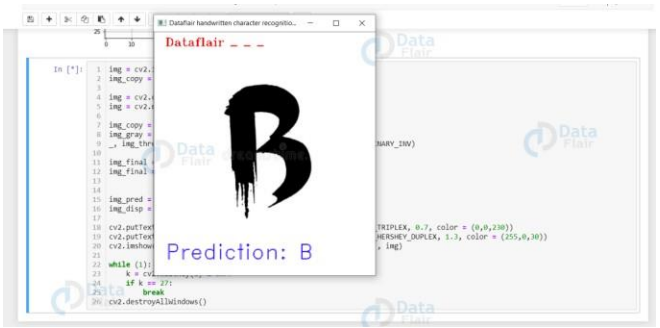
Figure 1. Process of Convolutional Neural Network

RESULTS

We give the input as image of any letter then our model will be able to predict the letter using CNN

Here we inserted the image of letter ‘B’

The Output will be displayed as:



CONCLUSION

Handwritten Character Recognition (HCR) systems can effectively identify various regional languages worldwide by employing suitable algorithms and strategies. While recognition of English characters has been extensively studied, handwritten character recognition becomes challenging due to the presence of unusual characters or similar shapes for multiple characters. To address this, scanned images are pre-processed to obtain clean images, and characters are isolated individually. The pre-processing involves normalization and filtration techniques, ensuring a noise-free and clear output. By employing proper training, evaluation, and step-by-step processes within our evolutionary algorithm, we can achieve a successful and efficient HCR system. Incorporating statistical and geometric features through neural networks enhances the recognition results for English characters. This research work will not only benefit researchers working on other scripts but also contribute to advancements in HCR technology

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