A NOVEL AI ALGORITHM FOR HANDWRITTEN CHARACTER DETECTION

Mr. D Murahari Reddy, Associate Professor, Dept of CSE, Narayana Engineering College Gudur
Mr. T.Janardhan, **Mr. R.P.N Vandhansingh**, **Mr. S.Mohankrishna**, Student, Dept of CSE, Narayana Engineering College Gudur

Abstract: We describe a novel approach in this research for the identification of hand-written characters by use of deep neural networks. In the present era, the training of deep neural networks has gotten easier because to the availability of enormous data and different algorithmic advancements. Now, thanks to available services like the Google Cloud platform and Amazon Web Services which are some of the platforms that give resources to train a neural network on the cloud, the amount of processing power required to train a neural network has risen. We built a handwritten character identification method based on picture segmentation. For the process of image processing we have used the OpenCV and for the neural network training process we used TensorFlow. This system has been constructed using the python language.
Keywords: Handwritten, Characters, Segmentation

1. Introduction

Deep learning [3], [7] is a part of the learning process in which neural networks which are multi-layered act like the human brain and are modelled upon to learn from huge amounts of data. Deep learning algorithms perform computations in each neural network layer. You forecast and "learn" progressively over and over time. Just as the human mind gathers insights into the body and canals it across all the five senses, deep research in real time gathers and analyses data from several data streams.

Deep learning has the potential to boost automation and perform both analytical and physical operations without human interactions in multiple technology and artificial intelligence (AI) services. The context of everyday products and services (such as automated aids, voice-activated TV remote devices and credit card theft) with new technologies (such as self-driving cars).

Neural networks replicate human brain behavior, enabling the identification of patterns and resolve some common issues by computer programs, especially in AI, machine learning, and in-depth learning. Neural networks [6] are sometimes termed artificial neural networks (ANN) or simulated neural networks (SNN), which are part of machine learning. As the human intellect inspire you, its name and shape emit the impulses of biological neurons.

Artificial neural networks consist of a node layer with one or more input layers and a more hidden layer. Any node with a weight and related threshold links to another node. This nodes are activated and the data is sent in the next layer of the network if the node output passes the threshold defined. Data on the next network layer would otherwise not be sent.

CNN is one of the leading deep learning classes or algorithms used to visually analyze the pictures. The primary purpose of our model is to examine the characters in English that have been hand-written as the pre-processed input, and the neural network is used to form the considered input, which allows for characters to be recognized, which then compare with the considered input.

Recognition of character patterns [2] is regarded as the common use of neural networks. Some of the input data including the pattern information are supplied with the algorithm. The data might be a picture or other hand-written data. Once data is supplied, the model is trained and the output that matches or does not match the expected input is checked. The neural network that can be considered for the classification process is meant to split the input into categories. These divisions may be fluid or without well-defined limits. In this project we are mainly concerned about the handwritten character recognition.

In this framework, introduction was discussed in section 1. Related work will be discussing in section 2, proposed work will be describing in section 3 and section 4 consists of results for our proposed work and section 5 will be concluding the paper.

2. Related Work

In this investigation, [4], [5] the employment of the deep-seated neural network is studied according to the state of the alphabet categorization, based on the submitted photographs. With thirty (30) and an initial rate of learning of 0.0001 deep convolutionary neural networks the network achieved 84 percent accuracy. During the training, all photos of the classes were utilized. Photographs of the data set were generated or downloaded from the device for training and study.

One of the main issues for pattern recognition is the detection of Optical Character. The following [10] gives a framework for handwritten numbers recognition utilizing the modelling of neural networks. The integrated fuzzy logic module has been built on the basis of a structural approach. The design has modified the performance of the neural network to boost the accuracy of recognition. Scalable and achieving a high recognition rate of 99.23%, has been proven using the recommended approach.

Recent developments [8] in CNNs have made the accuracy of picture recognition much higher for researchers. Characters and pests are uncovered in this in-depth learning methodology with photographs gathered from a heterogeneous background in the actual world and tried with several state-of-the-art networks in our enormous amount of data. The data shows that the alphabet letters can be identified and recognized with the best accuracy of 84.53% by a deep neural network. Where to reliably and quickly recognize characters. It helps to implement medicinal products promptly.

The study here [1] [11] explains how neural networks may construct an enabling framework for understanding hand-written alphabets in English and Tamil. Each English alphabet and Tamil alphabet with binary values, employed as an input for a basic functional removal system with a neural system output, are represented by that system.

The document [9] proposes a multi-capacity neural transmission network that employs an off-line manuscript alphabetical character recognizing mechanism. A novel methodology termed diagonal function extraction is performed in order to eliminate the features of the handwritten alphabets. Fifty data sets each having 26 alphabets created by different authors, and 20 distinct manual alphabets will be evaluated by this neural network. The suggested recognition device is extremely easy to reach better degree of identification precision when compared to technologies employing typical horizontal and vertical extraction techniques.

The recognition of handwritten text is an open problem in the realm of optical character recognition (OCR). This work [12] proposes an effective way to develop handwritten text recognition systems. A supervised learning methodology for an Artificial Neural Network is utilised in this article (ANN). Bitmap representation of samples of entries is therefore utilised to select the optimal feature for any text recognition device. As a functional vector, The function vectors are initially pre-processed and added to the ANN with the resulting objective vectors.

Man can be certain that the handwriting sequences are unknown to his brain as written texts are acknowledged. Here [13] a proposal is made for a model for handwriting a sequence prediction, to recognize a handwritten text. The model is initially conditioned by sequences of images that were collected while writing text. The picture properties of series are ordered automated by the Self-Map pictures. In the construction of a model, the functional sequences are utilized. The picture of text is put in the model to forecast and acknowledge the written word.

OCR has been included into this article [14] by merging CNN and ECOC error correcting classifiers. The OCR uses the image of the optical character as the input and output as the output. It offers a wide range of applications from traffic monitoring, robotics, document scanning, etc. OCR may be done through the Convolutional Neural Network's common deep neural network architecture (CNN). The classic CNN classifiers can learn and label the corresponding 2D characteristics of the pictures. The categorization of the soft-max layer is possible.

This article [15] explains in full the machine learning algorithms. Computer and technological improvements have made it quite usual to digitize typed or manual writings. People tried to automate their work by merging with robots. The change from manual to automated led to several fields of research, including text recognition. Deep learning and machine learning technologies have been very suitable for optical character identification. In this study, a current description of 4 machine

learning and deep learning architectures has been studied in depth: Vector support, artificial neural network, Naive Bay support and convolution neural network.
A hybrid way of recognizing characters is suggested [16] with fuzzy logic and a Strokes Bayesian algorithm. During character segmentation, characteristics that touch are separated by supporting vector machines with a three-functional segmentation technology for blurring particle swarm optimization. This approach incorporates the use of the primitive strike library from past experience to show and extract strokes. This approach is current. During character recognition, a mathematical character model is created using stroke Bayesian program learning. For each character, a fitting pattern is applied for the sample of Monte Carlo Markov chains.
This article [17] explains the scope and application of handwriting recognition in indexed texts. Identification of handwriting is the keyboard method or other manually typed computer interpretation of the text. This approach covers various phases such as data collection, pre-processing of data, long-term stroke segmentation, extraction, classification, and post-processing, etc. Hand writing identification is a wide variety of applications such as completion of electronic type, sign up checks, automatic music-symbol notation readers, manual reading, writing, and sending SMS and practical keyboards.
The work here [18] is linked to the identification of hand written numbers. Handwritten and digital identification of characters is one of the most challenging and extensive fields for pattern and image processing identification. The digital manual identification is a difficult process. Sometimes the numbers are not perfectly written in the recognition job because they vary in form and size, making it impossible to differentiate the hand-written numerical script from its purpose and fragmentation. Vertical and horizontal projections methods are utilised for segmentation. SVM is required to recognize and classify.
This article [20] provides a short guidance on data pre-processing and demonstrates their advantages by employing MNIST's handwritten numbers for competition situations. This article describes and explores how different pre-processing technologies impact the efficiency of three CNNs: LeNet, Network 3 and Drop Connect together with their assembly. Centre, elastic deformation, translation, rotation and different combinations were the transformations explored. Research demonstrates the ability to significantly enhance MNIST classification approaches such as elastic distortion and rotation paired with assemblies.
Functional hierarchy is considered in brain systems [19] to be a hard subject of neuroscience study and is characterized by the hypothesis that things can be split into simpler and single parts embedded in complex entities. Such hierarchy may be seen logically in two ways: one is space-life hierarchy and one is time-like hierarchy. The visual information processing is an example of hierarchy of spaces, in which primary data is incorporated into complex picture elements in an extended space in tiny reception regions.
In view of the above-mentioned research, we have created a system that recognizes this image using the CNN model. The next parts will describe our work.

3. Methodology

The procedure to develop our system is clearly described in this section.

- We require a character dataset at beginning to carry out the procedure. We collect pictures of alphabet letters and produce a data set of our own for the procedure. After the data set has been prepared, the increase is made to the prepared dataset.
- We execute preprocessing on the chosen data set after the dataset is developed and increased. We eliminate noise from the data during pre-processing and partition the data into train data and test data.
- With Keras and TensorFlow in the train process, we are building our suggested network. Here we use the Convolutional Neural Network profound learning model (CNN).
- The CNN design offered is based on the model of the neural network. The model suggested is constructed using convolution layer, pooling layer and dense layer, with Softmax and ReLU layers being followed.

- The model testing is initialized once the data training has been finished. The test is seen as the front end of the model being suggested.
- Our train portion executes the operation on the basis of the model proposed and classifies the picture in the test part images.
- Here the proposed model mainly detects the alphabets which we have produced to our system.
- The result of the uploaded image is shown on the basis of this proposed model categorization.

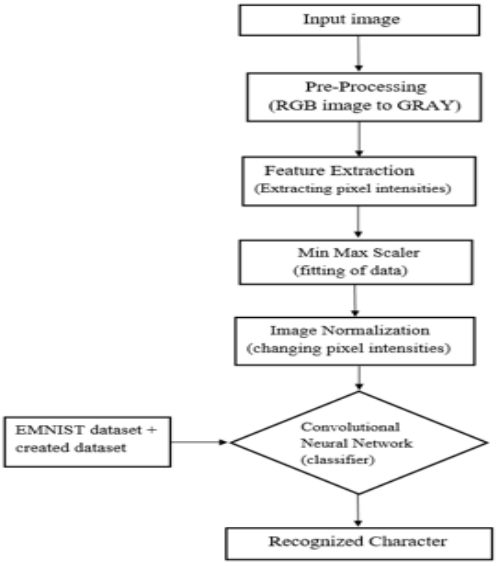

Fig 1. Proposed method block diagram

Convolutional neural network

Convolution network is one of the algorithms used mostly to visualise and analyse pictures. This operates mostly through neural networks. The weights in the architecture of the considered convolution kernels that are utilised to scan the cached layers are also termed differently. This network also uses the image and video recognition in the other applications. This is used to segment, classify, and analyse pictures in many disciplines. The name of this convolution is determined mostly by mathematical processes. Where this operation is used for the matrix multiplications in the layers of the network.

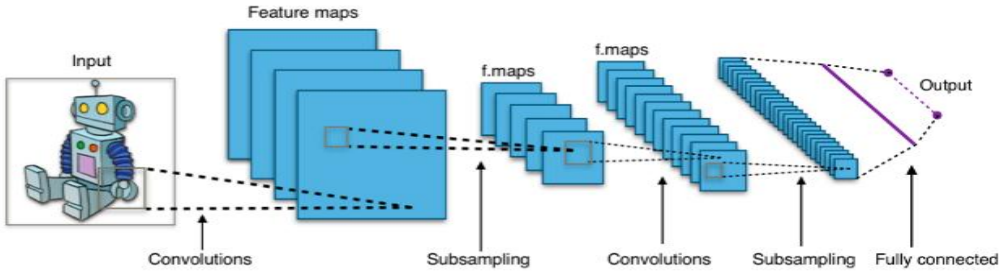

Fig 2. Architecture of CNN

The figure above depicts CNN's architecture. This neural network includes several layers called input, hidden and output. The middle layers of the forward feed in the neural network are called hidden since the activation is utilised to disguise the input and output. Where parts of the layers for the operation of convolution are also included in these layers. And these layers for the multiplication and some product operations are included. ReLU is mostly used for activation purposes. In addition, certain further layers, notably pooling, complete connection and standardisation, are also available.

Convolutional layer

A convolution layer should follow the some of the attributes in a neural network. Those are shown as following:

- Convolution filters or also called as kernels that which means height and width, which are hyper parameters
- The consideration of input and output channels that are to be used.
- The depth of the filter or kernel in an input channel of the convolution should be same as channels of the depth of the input.
- Padding size and strides are used in the operation of the convolution.

The input from the layers of the convolution are considered and those are passed to the next layers. This is considered as equal to the neuron response in the visual cortex to the stimulus.

Pooling layer

The grouping layers that are included in the convergence networks utilised to calculate are the local layers or global layers. The dimensions of the investigated data are reduced by these layers, when the outputs of the neural clusters are integrated into one neuron. Here, the max layer and average layer are two forms of this pooling. Max is used for maximum values calculation and average values are utilised for average values calculation. The below figure shows the working of types of pooling.

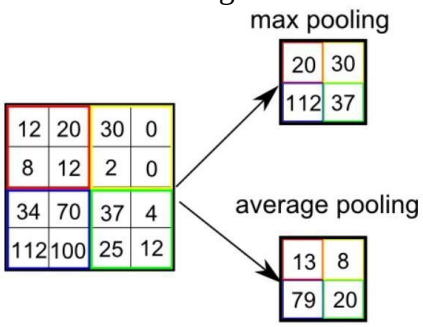

Fig 3. Types of pooling

Flattening

The next move will be to flatten the pooled featured diagram. Applause entails converting the whole pooled feature map matrix into a single column that is then transformed into the neural network.

Drop Out

Dropout is not employed during the experiment to estimate the fit network.

Dropdown might lead to a network weight over normal. Weights will be lowered before the network is completed by the set drop-off rate. Then the network is utilised to predict as usual.

After each weight update at the conclusion of the mini batch, weight rescaling should be done instead after workout. This is sometimes called "reverse abandonment" and does not include a change in weight during activity. This dropout is enforced by the deeply learned libraries Keras and PyTorch.

Dense Layer

The dense layer is one of the densely linked layers of a neural network. The definition is that it gets the input utilised in the preceding levels from each neuron. Dense layer is the most popular layer for the model. The construction of dense levels is seen in the figure below.

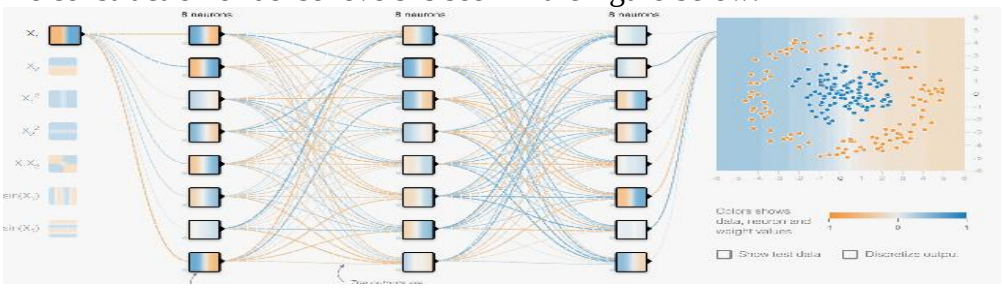

Fig 4. Representation of Dense neural network

These layers are utilised to carry out matrix vector multiplication. Back propagation is used to train and update the values utilised in the matrix. The output from this layer is created with a particular vector dimension. The dense is usually used to change dimensions from this. This also allows the rotation, translation and scaling of vectors. Some activities are carried out.

ReLU Layer

ReLU is referred to as a rectified linear correction unit utilised for the activation function. This is generally used to remove and make the negative values null and void. This is used to enhance non-linear characteristics which are utilised to make the fields of convolution without effect.

In addition to this ReLU, certain additional functions are utilised, which aid to enhance non-linearity.

Softmax

The Softmax is a feature used to transform the true vector values to the sum of 1. The inputs which are analysed here can be a positive, a negative, and a zero, or even larger than one.

When using this Softmax function, the values are to be converted from 0 to 1. So that the chances are simply taken into account. If there may be a little or negative value among the analysed inputs, this function makes it a smaller chance. Even though the input is bigger, the likelihood is higher. Where it always took account in the range of 0 to 1.

Fully Connected Layer

Fully connected layers are the layers in which all inputs of one layer interact fully with each of the following layer's triggers. The most common layers in algorithm are full layers that collect the data from the preceding levels to create the final result. It is the second most time demanding layer of Convolution Layer. The figure below clarifies the statement.

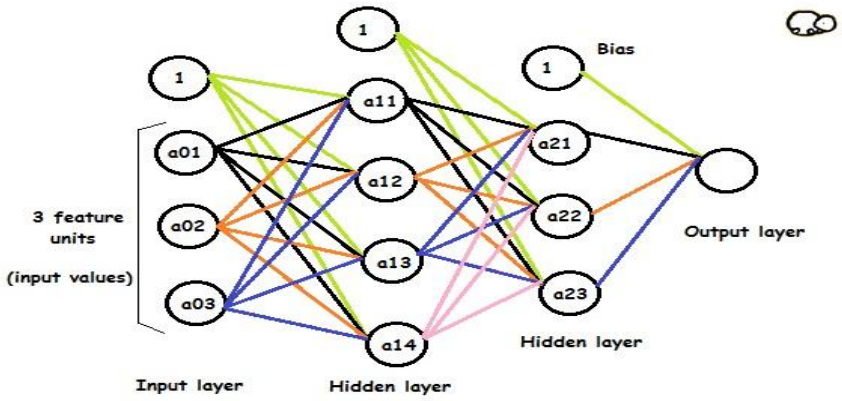

Fig 5. Neural Network with fully connected layers

4. Results and Discussions

In this session we will explain the results achieved via the implementation of the above-mentioned technique and how they are extracted by our proposed architecture.

We will take the test after finishing the pre-process and the training section. Where we are going to submit some of the hand-written character photos. The system predicts the character and displays the detected character of the image submitted, based on the training of our model.

Fig 6. System Detected Character is A:

Fig 7. System Detected Character is B:

Fig 8. System Detected Character is C

Fig 9. System Detected Character is D:

From the above shown figures 6, 7, 8, 9 we can see the results of the uploaded images. Here we are mainly detecting images of alphabets.

5. Conclusion

The study provides the detection of characters using a deep learning technique. Here we used Convolution Neural Network (CNN) algorithm. Our proposed architecture CNN, which is a one of the main algorithms of neural networks is considered for the training and testing the Emnist dataset which is collected from internet.

By using our proposed architecture, detection of the results are accurate and provides a great performance. From our model we can detect the images of characters more accurately.

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