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Research Article

Deep Learning Technique for Recognizing Hand Written Characters

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Abstract

Recognizing character is one of the main task for a human. In our proposed model we present a method that which recognizes the characters which are handwritten. This process was performed using deep neural networks. The process of training the considered dataset with neural networks has become easier. Where the GPU availability also made in training improvement using the neural networks. On other side some of the services like Google cloud and Amazon web services are also providing the cloud platforms to train the neural networks. Where, it become easier and available to train using the deep learning algorithms using the cloud services. Here, we designed a system that which recognizes the hand written characters based on the image segmentation. To recognize the characters we have used CNN method of the deep learning for the image processing and for the training of network we used TensorFlow. Emnist dataset is considered for the training and testing the architecture.

Keywords: *Character recognition, Deep Learning, Handwritten Characters, Pre-processing, Segmentation*

Introduction

Deep learning [3], [7] is a component of the learning process in which multi-layered neural networks are modelled to function like the human brain — to learn from vast quantities of data. Deep learning algorithms execute calculations within each layer of the neural network. They predict over and over the course of time and 'learn' gradually. Just like the human mind takes knowledge entered into the body and channels it through all five senses, so profound research collects and analyses information from various data streams in real time.

Deep learning powers numerous technologies and services for artificial intelligence (AI) that enhance automation, execute analytical tasks as well as physical tasks without human interaction. The context of daily goods and services (such as automated helpers, Television remotes which are voice enabled and fraud detection of credit card) and new technologies (such as self-driving cars).

Neural networks reflect human brain behaviour, enabling computer programmes, in particular in AI, machine learning and in deep learning, to identify patterns and solve some common problems. Neural networks [6] are also called as artificial neural networks (ANN) or simulated neural networks (SNN) which are the subpart of machine learning and considered as the heart of deep learning algorithms. As they are inspired by the human mind, their name and form, which emulate how biological neurons signals to each other.

Artificial neural networks (ANNs) consist of a node layer containing one or more input layers and one and hidden layers which will be in more number. Any node or artificial neuron connects to another node with a weight and threshold associated with it. If a node output reaches the threshold value specified, this node is enabled and the data is transmitted to the next layer of the network. No data would otherwise be transferred to the next network layer.

CNN is the one of the major class or algorithm of the deep learning which is used to analyse the images visually. The main purpose of our proposed model is to consider the characters which are in English which are handwritten as the input that which are to be pre-processed and neural network is used to train the considered input, from which we can recognize the characters which are then compared with the considered input and check whether the tested output matches with the considered input or not by using our proposed model.

Recognition of the patterns [2] of the characters is considered as the common use of the neural networks. The algorithm is provided with the some of the input data which contains the information about the pattern. The information may be an image or any data which was hand written. Once the input data is provided then the model is trained and checks the output that matches with the predicted input or not. The neural network which may be considered for the process of classification is designed in such a way that the considered inputs are divided into groups. This divided groups may be fuzzy or the required boundaries may not be clearly defined. In this project we concern in detecting the characters which hare handwritten.

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.

1.1 **Related Work**

In this analysis, [4], [5] the use of the deep-seated neural network in alphabet character classification according to specification status based on images uploaded is investigated. The network reached an accuracy of 84 % with thirty (30) and an initial learning rate of 0.0001 deep convolutional neural networks. Any pictures of the classrooms were used during the

course. The data set photographs for training and research have been compiled or downloaded from the device.

The identification of optical character is one of the major problems of pattern recognition. This [10] provides a framework for the recognition of handwritten numbers using neural network modelling. Based on a structural approach, the integrated fuzzy logic module was developed. The architecture has changed the neural network performance in order to increase symbol recognition accuracy. The suggested algorithm has been demonstrated to be scalable and to achieve a high recognition rate of 99.23%.

Recent advances [8] in CNNs have made it possible for researchers to vastly increase image recognition accuracy. In this deep learning based approach, characters and pests are found with images collected with heterogeneous backdrop in the real world and experimented on our massive dataset with many state-of-the-art neural networks. The findings reveal that characters of alphabets can be effectively detected and recognised by means of a deep neural network, with the highest accuracy of 84.53 % in test set. Where to detect characters accurately and promptly. It will assist with the prompt application of medical medications.

Here [1], [11] the paper shows how neural networks can be used to create a framework that can understand English and Tamil handwritten alphabets. This system represents each English alphabet and also Tamil alphabet with binary values that are used as the input for a basic functional extraction system, the output of which is supplied to neural network system.

The document [9] describes an off-line manuscript alphabetical character recognition device that uses a multilayer transmission neural network. In order to remove the characteristics of the handwritten alphabets, a new approach called diagonal function extraction is implemented. The neural network is being used to train fifty data sets, each with 26 alphabets written by various authors, and for evaluating 20 different manual alphabets. In comparison with technologies using traditional horizontal and vertical extraction processes the proposed reconnaissance device performs very easily to achieve higher levels of identification precision.

Handwritten text recognition remains an open research topic in the field of recognition of optical character (OCR). This paper [12] suggests an effective solution to the implementation of handwritten structures for text recognition. In this document, a supervised learning technique is used for 3-layer Artificial Neural Network (ANN). Therefore, bitmap representation of the entries samples are used as a functional vector to choose the best feature vector for any text recognition device. The feature vectors are pre-processed first and then added with the generated objective vectors to the ANN.

Man is assured that the handwriting sequences are unconsciously traced throughout his brain through handwriting practise as written texts are recognised. In this article, here [13] a suggestion is given on a handwriting sequence prediction model for recognition of the text which is a hand written. The model is conditioned first by image sequences obtained during text writing. Series image attributes are arranged automatically via the images with Self-Map. The functional sequences are used in the formation of a model for neuro-dynamics. The text image is entered in the model to predict and recognising the text which was written.

In this article OCR was introduced [14] by integrating the CNN and ECOC classifications for the correction of errors. The OCR takes the optical character image as input and outputs the matching character as output. It has a wide variety of uses from traffic monitoring, robotics, paper digitalisation, etc. The OCR can be implemented through the common deep neural network architecture of Convolutional Neural Network (CNN). The traditional CNN classifiers can learn the relevant 2D features in the images and label them. The soft-max layer classification can be used.

In this article [15] the machine learning algorithms are been explained in detail. The advances in computer and technology have made the digitization of typed or hand-written texts very common. Human beings attempted by combining themselves with robots to automate their jobs. The transition from manual to automation led to many fields of study, one of which is text recognition. Deep learning and machine learning approaches have proven very appropriate for the identification of optical character. A current description of four machine learning and profound learning architectures has been explored in depth in this work: support for the vector machine, artificial neural network, Naive Bay and the confusionary neural network.

With fuzzy logic and a Strokes Bayesian programme a hybrid method is suggested [16] to recognise the character. During the segmentation of characters, characters which are touching are segregated with supporting vector machines and a three-feature, blurry, particle swarm optimization segmentation technique. This technique involves a modern way of displaying and extracting strokes using a prefabricated primitive strike library of previous experience. A mathematical character model by using stroke Bayesian programme learning is constructed throughout character recognition. Monte Carlo Markov chain sample for each character is used to create a fitting pattern.

The scope and implementation of recognition of handwriting in indexed texts is explained in this article [17]. Handwriting identification is the method of keyboard or other computer interpretation of text which is written by hand. The method of this recognition includes many

stages such as data acquisition, data pre-processing, long stroke segmentation, extraction, classification and post-processing, etc. Identification of writing by hand has a wide range of uses such as electronic type completion, sign-up checking, automatic notation readers for music symbols, handwriting reading, writing and sending SMS and alternative to practical keyboards.

Here [18] the work is related to identify the hand written digits. Hand-written and digital character identification is one of the most demanding and comprehensive areas for identification of pattern and image processing. The manual digital identification is a very demanding process. Sometimes, numbers are not exactly scripted in the task of recognition because they vary in form and size, this makes it difficult to isolate function and fragment the hand-written numerical script. For the purposes of segmentation the techniques of vertical and horizontal projections are used. Recognition and classification is requested by SVM.

This article [20] offers a short guide about the pre-processing of data and illustrates its advantages by using the competition problems of MNIST handwritten digits. This article presents and discusses how the efficiency of three CNNs, LeNet, Network 3 and Drop Connect, along with its assemblies, is affected by various pre-processing technologies. The transformations studied include centering, elastic deformation, translation, rotation and various combinations. Research shows techniques of pre-processing such as elastic distortion and rotation combined with ensembles can further boost the classification of the MNIST.

In the neural systems the functional hierarchy is considered [19] as a demanding field of research in neuroscience and is characterised as the theory that entities can be segmented into elements which are simpler and single elements embedded into entities which are complex. Such hierarchy can be rationally considered in two ways: one of them is hierarchy as space, and the other one is hierarchy as time. Information processing which is a visual one is an example of hierarchy of spaces, where elementary information is integrated into complex elements of an image in a wider space in small receiving areas.

By considering above related works, we have implemented a system which will recognize the image using Convolutional Neural Network (CNN) model. Next sections will describe about our proposed work.

Methodology

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

- At first, to perform the operation we need a dataset of the characters. We collect some images of the characters of alphabets and prepare our own dataset for the process. After preparing the dataset, we will perform the augmentation on the prepared dataset.
- Once the dataset is prepared and augmented, we perform preprocessing on the considered dataset. In the preprocessing, we remove noise from the data and split the dataset into train data and test data.
- In the train process, we build our proposed network with the help of Keras and TensorFlow. Here, we are using deep learning model Convolutional Neural Network (CNN).
- The proposed CNN architecture is based on neural network model. The proposed model is built using convolution layer, pooling layer and dense layer followed by Softmax and ReLu layers.
- Once the data training is completed, testing of the model is initialized. The testing is considered as the front end of the proposed model.
- In the testing part image is uploaded and our train part performs the operation based on the proposed model and classifies the image.
- Here the proposed model mainly detects the alphabets which we have produced to our system.
- Based on this proposed model classification, the output is displayed for the uploaded image.

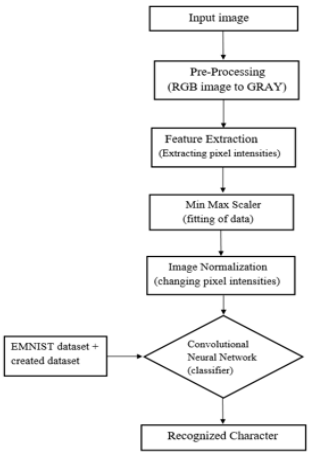

Figure 1 Proposed method block diagram

Convolutional neural network

Convolution network is one of the deep learning algorithm which is mainly used for visualizing the images and analysing them. This mainly works on the basis of neural networks. There are also named differently based on the weights shared by them in the architecture of the considered kernels of convolution which are used for scanning the layers which are hidden. This network is used in the other applications also that which are based on the recognizing of image, video. This are used for the segmentation, classification, in analysing the images in different fields. The name of this convolution is mainly given by the operations that are done by using mathematics. Where this operation is used for the matrix multiplications in the layers of the network.

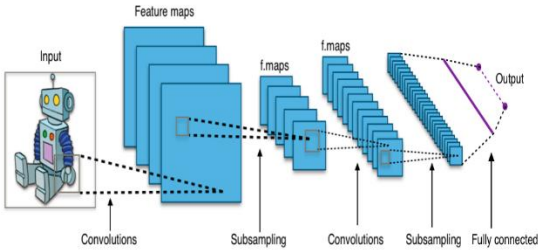

Figure 2. Architecture of CNN

The above figure shows the architecture of CNN. This neural network consists of some of the layers named as input, hidden and output. In neural network the middle layers of feed forward are named as hidden because activation is used which is a function for input and output masking. Where some of the layers are also included in this layers of hidden for the operation of convolution. And this layers are included for the operation of multiplication and some product operations. ReLu is commonly used as a function for the activation. Along with this some of the other layers are also present along with them namely pooling, fully connected and normalization.

2.1 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.

2.2 Pooling layer

Local layers or global layers are the pooling layers which are included in the convolution networks which are used for the computation. This layers are used for reducing the dimensions in the considered data where the outputs are combined of the clusters of neural into a single neuron. Here there are two types in this pooling namely max layer and average layer. Max is used for calculating the maximum values and average is used for calculating the average values. The below figure shows the working of types of pooling.

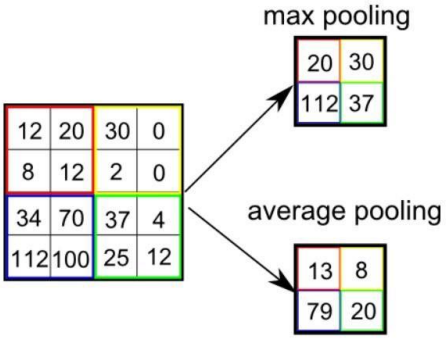

Figure 3. Types of pooling

2.3 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.

2.4 Drop Out

Dropout is not used for predicting the fit network during exercise.

Dropdown can result in a network weight that is higher than average. Therefore, weights are first reduced by the selected drop-out rate before the network is finalised. The network will then be used to forecast as normal.

The weight rescaling should be carried out instead after the workout, after each weight update at the end of the mini-batch. Often this is referred to as "reverse abandonment" and does not entail a weight change during exercise. The deep learning libraries Keras and PyTorch all enforce this dropout.

2.5 Dense Layer

The layer named dense is one of the layer from a neural network which are deeply connected. That which define that it receives the input from each neuron that which are used in the

previous layers. The most common layer used in the model is dense layer. The below figure shows the architecture of dense layers.

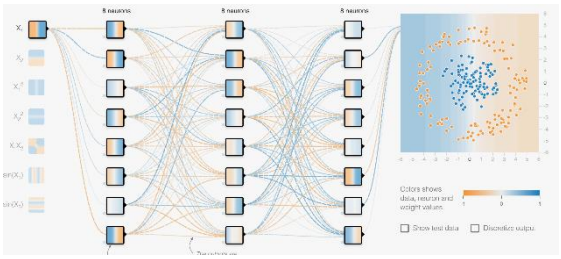

Figure 4. Representation of Dense neural network

This layers are used for performing the multiplications of matrix vectors. Back propagation is used for training and updating the values that are been used in the matrix. The output is generated from this layer is with a specific dimension as a vector. From this the dense is used mainly for dimension changing. By this some of the operations can also be performed namely, rotation, translation and scaling of the vectors.

2.6 ReLU Layer

ReLU is called as rectified linear unit, which is used for the function of activation. This is mainly used for removing the negative values from the activation and making them as zero values. This is used for increasing the properties of non-linear that which are using for making the affectless the fields of the convolution.

Along with this ReLU some other functions are also used that which helps in the non-linearity improvement.

2.7 Softmax

The Softmax is a function which is used for converting the real values of a vector to the sum to 1. Here the inputs that is considered may be a positive value, a negative value and may be a zero value or it may be also greater than one also.

Where this Softmax function is used to convert the values in between the range of 0 and 1. So, that the probabilities are considered easily. If among the considered inputs are may be a small value or a negative one then this function turns this into a smaller probability. Even is the input is larger then turns the probability as a larger probability. Where, this always considered in the range between 0 and 1.

2.8 Fully Connected Layer

Fully connected layers are the layers in which all inputs from one layer communicate with each triggering device of the next layer are entirely linked to one network. The last few layers in the most common learning machines are complete layers, which compile the data collected

from the previous layers in order to form the final output. It is Convolution Layer's second most time consuming layer. The accompanying diagram clarifies the declaration.

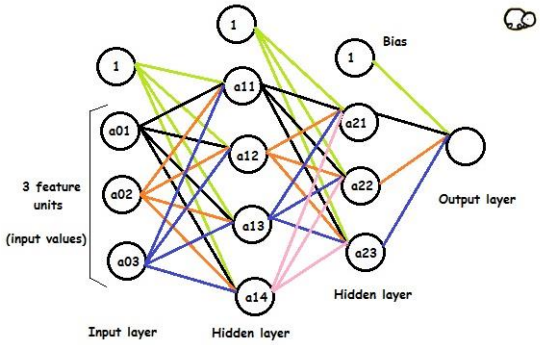

Figure 5. Neural Network with fully connected layers

2.9 TensorFlow

TensorFlow is one of the open-source framework for the development of software for machine learning. It is a library of the mathematical operations which uses data flow and differentiable programming for different training and inference tasks in the field of deep neural networks. It enables developers to build computer apps for learning using different software, libraries and community resources.

At present, Google's TensorFlow is the world's most popular deep learning library. Google's product utilises machine learning to enhance the search engine, localization, subtitling or suggestion in all its products. Google users can encounter the AI search faster and more sophisticated to have a specific example. Google gives a suggestion about what the next word that could be if the user enters a keyword into the search bar.

TensorFlow allows you to create data flow map and framework for describing how data is passed through a chart by using inputs as a multi-dimensional Tensor array. It helps you to create a flow diagram for these inputs, which goes to the one end and comes to the other which will be considered as output. The architecture of this follows mainly divided into three parts. Which are explained below.

- Data preprocessing
- Model building
- Model building and estimating

It is called TensorFlow since it takes inputs, also known as tensors, as a multi-dimensional sequence. You can create a kind of operation diagram (called as graph) you want to execute at that input. The input is reached at one end, and then this multi-operational device runs through and the other end that which arrives at the output. That's why TensorFlow is named

since the tensor flows into a list of the operations, so the other side is taken out, which is to be considered as the output.

Abstract is the largest advantage of TensorFlow for the development of machine learning. The developer should concentrate on the general logic of the programme instead of discussing the nitty-gritty particulars of the implementation of the algorithms or finding appropriate ways to attach the performance of one component to another. TensorFlow takes control of the background details.

For developers who need debugging and introspection in TensorFlow applications, TensorFlow provides additional conveniences. The eager mode allows you, instead of assembling the whole map as a single opaque entity, to analyse each graph operation individually and transparently, and to evaluate it all at once. The Visualization Suite from Tensor Board allows you to inspect and profile how the charts are performed through an immersive Online Dashboard.

TensorFlow also benefits from funding Google's A-list market equipment. Google has not only powered the project's exponential growth, but has also built several big solutions to promote implementation and use of TensorFlow: the TPU silicone for accelerated output in Google's cloud; an online hub for model-sharing created with the application; in-browser, mobile-friendly framework embodiments; and more.

2.10 Keras

Keras is one of the Python library that can run over Theano or TensorFlow for deep learning.

It has been planned to make application of profound learning models for research and development as simple and convenient as possible. This is running on Python 2.7 or 3.5 and it will run smoothly in the underlying architectures on GPUs and CPUs. It is issued under the MIT licence. François Chollet, a Google engineer with four guiding principles, created and preserved Keras:

- **Modularity:** A sequence or a graph alone can be understood as a model. A deep learning algorithm has all questions about discrete elements, which can be randomly merged.
- **Minimalism:** the library just has sufficient results, no frills and maximises readability.
- **Extensibility:** Modern components are deliberately simple to incorporate and use for researchers to test and to explore new concepts. Extensibility:
- **Python:** No custom file format model files. It's just Python native.

Results and Discussions

In this session we will discuss about the results that are obtained by performing the above proposed method and how they are extracted by using the CNN architecture.

After completing the pre-process and the training part we will go for the testing process. Where, we will upload some of the images of the characters which were hand written. Based on the training by our model the system will predict the character and displays the detected character of the uploaded image.

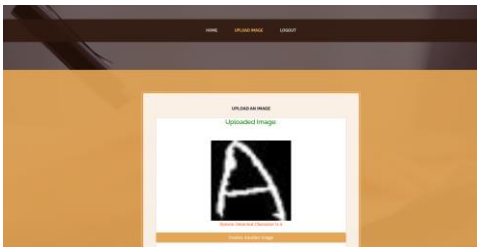

Figure 6. System Detected Character is A:

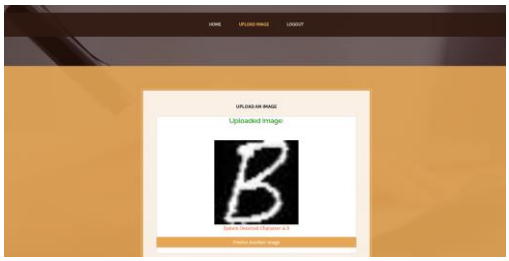

Figure 7. System Detected Character is B:

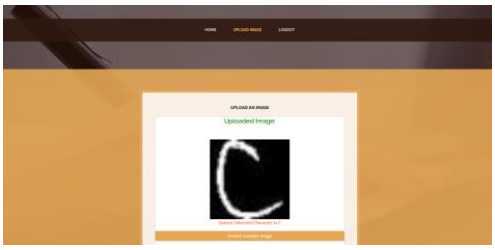

Figure 8. System Detected Character is C:

Figure 9. System Detected Character is D:

From the above shown figures 2, 3, 4, 5 we can see the results of the uploaded images. Here we are mainly detecting images of alphabets.

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 characters are accurate and provides a great performance as 82.5% of accuracy. From our model we can detect the images of characters more accurately.

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