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Survey On Optical Character Recognition Using Neural Network

P. B. KUMBHAR, A. N. HOLAMBE

T.P.C.T.'s College Of Engineering, Osmanabad, Maharashtra, India.

Abstract: In this paper, an Optical Character recognition system based on Artificial Neural Networks (ANNs). The ANN is trained using the Back Propagation algorithm. In the proposed system, each typed English letter is represented by binary numbers that are used as input to a simple feature extraction system whose output, in addition to the input, are fed to an ANN. Afterwards, the Feed Forward Algorithm gives insight into the enter workings of a neural network followed by the Back Propagation Algorithm which compromises Training, Calculating Error, and Modifying Weights.

Keywords: Optical character recognition, Artificial Neural Network, supervised learning, the Multi-Layer Perception, the back propagation algorithm.

I. INTRODUCTION

Pattern Recognition is one of the very important and actively searched trait or branch of artificial intelligence. [1] Introduces the basic concepts of pattern recognition, the underlying system architecture and provides the understanding of various research models and related algorithms for classification and clustering. In [2] paper Pattern recognition was introduced including concept, method, application and integration. At the same time, ten definitions and more than ten methods of pattern recognition were summarized. Neural networks are composed of simple elements operating in parallel. These elements are inspired by biological nervous systems. As in nature, the network Function is determined largely by the connections between elements. We can train a neural network to perform a particular function by adjusting the values of the connections (weights) between elements. Commonly neural networks are adjusted, or trained, so that a particular input leads to a specific target output. Network is adjusted, based on a comparison of the output and the target, until the network output matches the target. Typically many such input/target pairs are used, in this supervised learning, to train a network. Automatic Postal sorting, automatic bank cheque processing is application of Character recognition. The main idea is that we should first prepare a training set and then train a neural network to recognize patterns from the training set. In the training step we teach the network to respond with desired output for a specified input. For this purpose each training sample is represented by two components: possible input and the desired network's output for the input. After the training step is done, we can give an arbitrary input to the network and the network will form an output, from which we can resolve a pattern type presented to the network.

II. OPTICAL CHARACTER RECOGNITION

Optical Character Recognition (OCR) is the mechanical or electronic translation of images of handwritten, typewritten or printed text (usually captured by a scanner) into a machine-editable text. It is often used to convert paper books and documents into electronic files. Optical Character Recognition (OCR) is used to recognize printed and handwritten characters. There are numerous approaches that address the problem and they vary in the features extracted from the graphical representation of the Characters. There are many different approaches to optical character recognition problem. One of the most common and popular approaches is based on neural networks, which can be applied to different tasks, such as pattern recognition, time series prediction, function approximation, clustering, etc. [4]The most popular and simple approach to OCR problem is based on feed forward neural network with back propagation learning. All OCR systems include an optical scanner for reading text, and sophisticated software for analyzing images. Most OCR systems use a combination of hardware and software to recognize characters, although some inexpensive systems do it entirely through software.

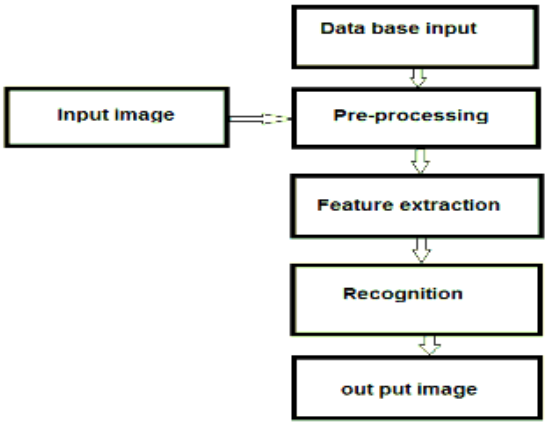

Fig. 1Block Diagram of OCR

2.1 COMPONENTS OF OCR SYSTEM

- ***Optical scanning***

Through the scanning process a digital image of the original document is captured. In OCR optical scanners are used, which generally consist of a transport mechanism plus a sensing device that converts light intensity into gray-levels. Printed documents usually consist of black print on a white background. Hence, when performing OCR, it is common practice to convert the multilevel image into a bi-level image of black and white. Often this process, known as thresholding, is performed on the scanner to save memory space and computational effort.

- ***Location and segmentation***

Segmentation is a process that determines the constituents of an image. It is necessary to locate the regions of the document where data have been printed and distinguish them from figures and graphics. For instance, when performing automatic mail-sorting, the address must be located and separated from other print on the envelope like stamps and company logos, prior to recognition.

- ***Pre-processing***

The image resulting from the scanning process may contain a certain amount of noise. Depending on the resolution on the scanner and the success of the applied technique for thresholding, the characters may be smeared or broken. Some of these defects, which may later cause poor recognition rates, can be eliminated by using a pre-processor to smooth the digitized characters.

- ***Feature extraction***

The objective of feature extraction is to capture the essential characteristics of the symbols, and it is generally accepted that this is one of the most difficult problems of pattern recognition. The most straight forward way of describing a character is by the actual raster image. Another approach is to extract certain features that still characterize the symbols, but leaves out the unimportant attributes.

- ***Post processing: -***

Post processing are two types-

1. Grouping
2. Error-detection and correction

III. ARTIFICIAL NEURAL NETWORK

An Artificial Neuron is basically an engineering approach of biological neuron [6] [7] i.e. Neural Networks basically aim at mimicking the structure and functioning of the human brain, to create intelligent behavior. A Neural Network is a massively parallel distributed processor made up of simple processing units which have natural propensity for storing experiential knowledge and making it available for use. It resembles to brain in two aspects. First, Knowledge is acquired by the Network from its environment through a learning process. Second, Interneuron connection strength is used to store acquired knowledge. In Neural Network, each node performs some simple computation and each connection conveys a signal from one node to another labeled by a number called connection strength‖ [8].

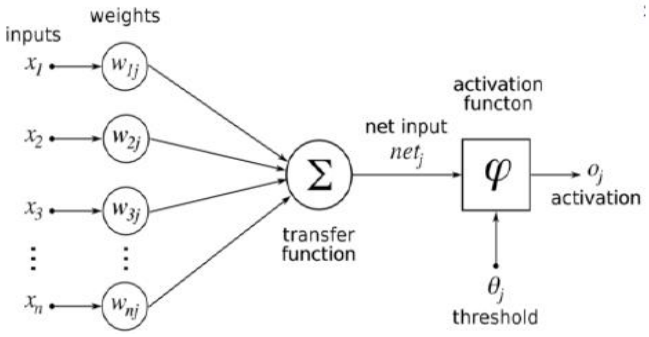

Fig 2: Structure of ANN

Linear Combination Uk

$$Uk = \sum wkj * xj$$

Induced Local Field Vk

$$Vk = Uk + bk,$$

Activation function defines the value of output Yk

$$Yk = \phi (Vk)$$

The Activation function used here are of different type, Threshold Activation Function, Piecewise Linear Activation Function, Sigmoid Activation Function, Signum Activation Function etc. Learning is formally defined as a process by which free parameters of a Neural Networks are adapted through a process of simulation by the environment in which the network is embedded. Once the system begins to learn containing some initial weight values, as the learning process increase weight values keeps on changing and provide the final output at end. Learning can be classified as: First, Supervised Learning i.e. learning with Teacher, Second, Unsupervised Learning i.e. learning without Teacher. Typical pattern recognition systems are designed using two pass. The first pass is a feature extractor that finds features within the data which are specific to the task being solved. The second pass is the classifier, which is more general purpose and can be trained using a neural network and sample data sets.

IV. BACKPROPAGATION ALGORITHM

As Optical Character Recognition is defined as a Multiclass Problem, amongst various classification methods [8] [9], we have used, Multilayer Feed Forward Architecture, which contains an Input Layer, an Output Layer and one or more Hidden Layer [10]. As the number of Hidden Layer increases the complexity of network also increases.

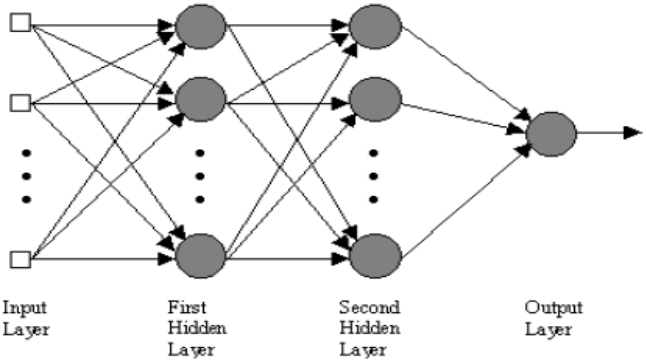

Fig 3: Back-Propagation Neural Network

Back-Propagation Neural Network (BPNN) algorithm is the most popular and the oldest supervised learning multilayer feed-forward neural network algorithm proposed by Rumelhart, Hinton and Williams . Input vectors and the corresponding target vectors are used to train a network until it can approximate a function, associate input vectors with specific output vectors, or classify input vectors in an appropriate way as defined by you. Networks with biases, a sigmoid layer, and a linear output layer are capable of approximating any function with a finite number of discontinuities.

Steps of Back Propagation Algorithm are as follows

The back-propagation algorithm consists of four steps:

1. Compute how fast the error changes as the activity of an output unit is changed. This error derivative (EA) is the difference between the actual and the desired activity.

$$EA_j = \frac{\partial E}{\partial y_j} = y_j - d_j$$

2. Compute how fast the error changes as the total input received by an output unit is changed. This quantity (EI) is the answer from step 1 multiplied by the rate at which the output of a unit changes as its total input is changed.

$$EI_j = \frac{\partial E}{\partial x_j} = \frac{\partial E}{\partial y_j} \times \frac{dy_j}{dx_j} = EA_j y_j (1 - y_j)$$

3. Compute how fast the error changes as a weight on the connection into an output unit is changed. This quantity (EW) is the answer from step 2 multiplied by the activity level of the unit from which the connection emanates.

$$EW_{ij} = \frac{\partial E}{\partial w_{ij}} = \frac{\partial E}{\partial y_j} \times \frac{\partial y_j}{\partial w_{ij}} = EI_j y_i$$

4. Compute how fast the error changes as the activity of a unit in the previous layer is changed. This crucial step allows back propagation to be applied to multilayer networks. When the activity of a unit in the previous layer changes, it affects the activities of all the output units to which it is connected. So to compute the overall effect on the error, we add together all these separate effects on output units. But each effect is simple to calculate. It is the answer in step 2 multiplied by the weight on the connection to that output unit.

$$EA_i = \frac{\partial E}{\partial y_i} = \sum_j \frac{\partial E}{\partial x_i} \times \frac{\partial x_j}{\partial y_i} = \sum_j = EI_i W_{ij}$$

By using steps 2 and 4, we can convert the EAs of one layer of units into EAs for the previous layer. This procedure can be repeated to get the EAs for as many previous layers as desired. Once we know the EA of a unit, we can use steps 2 and 3 to compute the EWs on its incoming connections.

V. CONCLUSION

Artificial neural networks are commonly used to perform character recognition due to their high noise tolerance. The systems have the ability to yield excellent results. The feature extraction step of optical character recognition is the most important. A poorly chosen set of features will yield poor classification rates by any neural network. At the current stage of development, the software does perform well either in terms of speed or accuracy but not better. It is unlikely to replace existing OCR methods, especially for English text. A simplistic approach for recognition of Optical characters using artificial neural networks has been described. Despite the computational complexity involved, artificial neural networks offer several advantages in back-propagation network and classification in the sense of emulating adaptive human intelligence to a small extent.

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