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Intelligent Character Recognition of Handwritten Characters using Artificial Neural Network

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Abstract - *Optical Character Recognition (OCR) is the conversion of images of typed, handwritten or printed text into machine-encoded text, from a scanned document, a photo of a document or from subtitle text superimposed on an image.[1] This paper presents a way to convert the images of characters into machine-encoded text using artificial neural network to improve the process of collecting and storing data. This paper approaches the problem of optical character recognition in two stages, the training stage in which the system is provided with handwritten characters of all alphabets and the prediction stage in which an input image is classified as a character by the trained neural network. In this approach, characters are recognized even when noise are present in the input image. The neural network is trained using stochastic gradient descent (SGD) algorithm which in turn uses backpropagation algorithm to compute the error and learn from it.[2]*

Key Words: Artificial Neural Network, Backpropagation, Feedforward Network, Gradient Descent, OCR, Supervised Learning.

1. INTRODUCTION

Optical Character Recognition was developed to convert printed text into text-code so that it can be machine-read. It was used for building reading devices for the blind and for recognizing received telegraphic messages as well as to read characters and convert them into telegraphic messages. Later in the 1950's OCR was commonly used in data entry applications. OCR is also used during the conversion of foreign text into another language.

Handwritten and printed documents which are either scanned or photographed cannot be used as they are in an image format. The conversion of data from image format into computer-readable format is costly for organizations that handle large amounts of data and the conversion process can also generate human errors in the resulting documents. Computer aided conversion of such documents can be used when efficiency needs to increased. Existing techniques such as OMR sheets and form data have been outdated due to the changes in type of data.

A neural network based approach is required to convert data of varied types into computer-readable format. The task of converting information present on paper into computer data can be easily done using neural network based approach. This computer aided conversion can be very productive if done on similar types of documents.[3]

2. OBJECTIVE

The objective of this paper is to develop a system to convert handwritten characters into machine-encoded text using artificial neural network to improve the process of collecting and storing data. The developed system can recognize handwritten characters by converting the images of handwritten characters from a scanned document or a photo of a document to a 28x28 pixel grayscale image. These images are taken as input to train the neural network using stochastic gradient descent (SGD) algorithm. SGD uses backpropagation algorithm to compute the error and learn from it. After the neural network has been trained, test images are used for checking the accuracy and efficiency of the trained neural network.[2]

3. EXISTING SYSTEM

The existing system requires you to manually input data of handwritten characters into the machine. A lot of organizations spend a lot of money, time and labor for converting information present on a paper into computer data.

Existing techniques to overcome these problems were OMR sheets and form data. Handwritten characters, printed text, documents were converted to machine-usable text by entering it word by word. This was very tedious and labor-intensive work. As the data was being converted to machine-usable format manually, it was inefficient and prone to human errors.

After this traditional existing system, many OCR algorithms were coded but they all lacked accuracy and efficiency. These algorithms failed to address several issues due to the dynamic nature of the input data. Common optical character recognition tasks involve simple edge detection and matching them with pre-defined patterns.

When a machine encounters a normal printed text, it might detect the text very easily. However, the challenge arises when the input data starts becoming dynamic, i.e., when the

text is handwritten or sometimes when there is a variation in styles, fonts, etc.[3]

4. PROPOSED SYSTEM

Traditional OCR systems trained to recognize a given font or handwriting can only be used to recognize the same font or handwriting. These systems are unable to recognize any other font or handwriting. When a machine encounters a normal printed text, it might detect the text very easily. However, the challenge arises when input data starts becoming dynamic i.e. when the text is handwritten or sometimes when there is a variation in styles, fonts, etc. The proposed system solves the issues faced by the traditional OCR systems.

The proposed system uses neural network which is used to classify handwritten characters. The problem of classifying handwritten characters is done in two stages, the training stage in which the system is provided with handwritten characters of all alphabets and the prediction stage in which the trained neural network classifies the handwritten character. The neural network is trained using stochastic gradient descent (SGD) algorithm. SGD uses backpropagation algorithm to compute error and learn from it.[2]

5. SYSTEM DESIGN

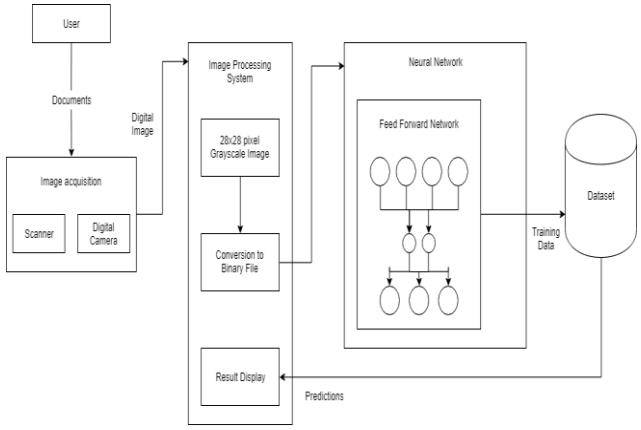

Fig -1: System Architecture

The above figure shows the steps required to train the neural network and also shows how a raw input image is processed and is converted to a form such that the trained neural network can recognize the input image. First, a user writes a character on a piece of paper and then scans it to convert it into an image format. This digital image is then processed to remove noise. The brightness and the contrast of the image is adjusted such that the image can be easily recognized. Then the image is converted into 28x28 pixel grayscale image. The processed image is then stored into a binary file. Now, the binary file is given as input to the input layer of the neural network. The input layer of the neural network contains neurons encoding the values of the input pixels. The input pixels are greyscale, with a value of 0.0 representing white, a value of 1.0 representing black, and in between values representing gradually darkening shades of grey. The neural network is trained using stochastic gradient descent (SGD) algorithm which in turn uses backpropagation algorithm to compute the error and learn from it. Once the neural network has been trained, user inputs another image and the network classify the input image as a character.[2]

6. SYSTEM IMPLEMENTATION

To classify handwritten characters, we will use a three-layer neural network. The input layer of the network contains neurons encoding the values of the input pixels. Our training data for the network will consist of many 28x28 pixel images of scanned handwritten characters, and so the input layer contains 28 x 28 = 784 neurons. The second layer of the network is a hidden layer, contains 30 neurons. The output layer of the network contains 62 neurons, 10 neurons are for digits, 26 neurons are for lowercase letters, 26 neurons are for uppercase letters.

We use stochastic gradient descent (SGD) algorithm to train the neural network. SGD algorithm takes weights and biases as variables in the quadratic cost function to train the neural network. SGD uses backpropagation algorithm, feed forward network and the quadratic cost function to train the neural network. Feed forward network is used to compute the vector of activation of the next layer using the output values of the previous layer. The values of the vector of activation shows which character is more likely to be the predicted as the output. After computing the output value of each neuron, backpropagation algorithm checks whether the output is correct. It backpropagates to correct the error by changing weights and biases of the neural network using the cost function. The cost function gives the difference between the predicted output and the desired output.[2]

7. CONCLUSIONS

In this paper we have designed a simple OCR. It uses stochastic gradient descent algorithm which uses backpropagation algorithm. After the training phase, the weights and biases of the trained neural network are stored in a binary file. In the prediction phase, the values for weights and biases are taken from the binary file. OCR systems like this that makes use of artificial neural network can be used to classify the characters more accurately and efficiently. It also reduces significant human efforts.

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