Segmented Character Recognition using Neural networks

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ABSTRACT

In today's world computer has become an essential part of our life and it is our best companion. We expect a computerized solution to every problem even if that can be designated as a slight difficult one, and what to say about the difficult ones. The problem we intend to solve is a kind of pattern recognition. As the pattern recognition has got many flavors and, the one we have attempted here is recognition of handwritten characters. This has been done using Back propagation Neural Network Algorithm. The inputs taken were different handwritten samples of the English alphabets. The TIFF files of the samples have been preprocessed, so as to make them suitable to be fed to our set Neural network Model. Once inputs were ready to be fed to neural network, it took us almost one-month time to train our model. We have experimented with different control parameters of the model and were able to reach a success rate of about 80%.

Keywords – **Optical Character Recognition, Bi-linear interpolation, Bounding Box, Handwritten segmented characters, Neural networks, back propagation network, TIFF, Image Scaling.**

1. Introduction

A procedure has been proposed for recognizing handwritten segmented characters scanned in TIFF format, using Back-Propagation model of Neural Network. More specifically, character recognition has been performed without using Feature Extraction and has been implemented in C++. The problem we intend to solve is a kind of pattern recognition. As the pattern recognition has got many flavors and, the one we have attempted here is recognition of handwritten characters. This has been done using Back propagation Neural Network Algorithm. The inputs taken were different handwritten samples of the English alphabets. The TIFF files of the samples has been preprocessed, so as to make them suitable to be fed to our set Neural network Model. Once inputs were ready to be fed to neural network. The remainder of this paper is organized as follows.

1.1 Optical Character Recognition A process that converts words or characters, on a printed page into a digital image, and creates a digital file so that users can later search for that text and characters within that text. The document Image itself can be either machine printed or handwritten, or the combination of two. Computer system equipped with such an OCR system can improve the speed of Input operation and decrease some possible Human errors.
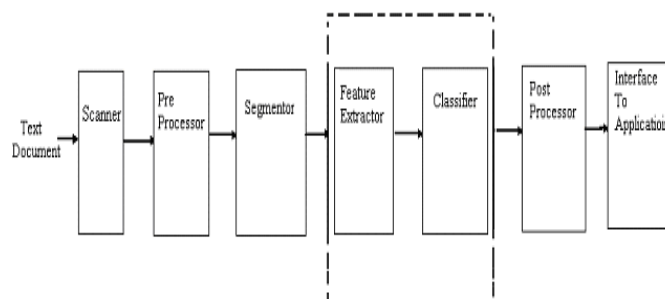

Fig1. Six stages of OCR

2. Approaches to OCR Process

Fuzzy Logic An expert system based on fuzzy logic for optical character Recognition of old printed documents. The fuzzy recognizer presents a very high character Recognition success rate, which confirms the advantage of using expert systems in image based decision systems

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Statistical Approach This approach is based on a similarity measure that is expressed in terms of a distance measure or a discriminate function. Jain, Duin and Mao have summarized and compared some of the well-known methods used in various stages of pattern Recognition system. Among the various approaches, statistical approach has been studied most intensively.

Template Matching Another approach used at is Template matching, or matrix matching. In template matching, individual image pixels are used as features. Classification is performed by comparing an input character image with a set of templates (or prototypes) from each character class. Each comparison results in a similarity measure between the input character and the template. It is a trainable process because template characters may be changed. In many commercial systems, PROMs store templates containing single fonts.

Neural Network Neural Networks are definitely the preferred approach for recognizers, in cases of small variability of patterns**.** . A neural network is a powerful data modeling tool that is able to capture and represent complex input/output relationships. Neural networks are ideal for specific types of problems, such as processing stock markets or finding trends in graphical patterns.

3. Methodology used Neural Networks
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3.1 Some Benefits of using Neural Network for OCR.
Massive parallelism, Adaptive Learning**,** Real Time Operation Inference from partial or noisy information Fault tolerance.

4. Core Issues
1. Image File Format to be used,
2. Preprocessing
    2.1. Noise Removal
    2.2. Problem of Creating Bounding Box.
    2.3. Image Scaling algorithm to be used.
    2.4. Mapping Grey values from [0-255] to [0-1]
3. Neural Network model selection.
4. How the inputs are available.
5. How many testing samples are required.
6. How the outputs are expected.
7. Input Output Resources Required.
8. Other Assumptions.

5. Proposed Algorithm

Algorithm:
Segmented_Character_Recognition
Steps involved in Segmented Character Recognition using back-propagation neural network are given. The algorithm works in two phases.
Phase 1(Training)
(Steps 1.1 to 1.5 are preprocessing steps)
1.1 Scan the sample character in TIFF format.
1.2 Perform Noise removal.
1.3 Create the Bounding Box.
1.4 Scale Image using Bi-linear interpolation fitting in 20 x 20 matrixes.
1.5 Map the image vector (taken as Row Major-Order of above matrix) values in range [0, 1].
1.6 Make the corresponding correct output vector (Supervised Learning).
1.7 Prepare files containing the relevant parameters required to set up and train Network.
1.8 Train the Network and save the status of the Network in a file.

Phase 2 (Testing)
1.9 Reconstruct the Network using the information produced from the above algorithm.
1.10 .Repeat the steps 1-5 of the above algorithm.
1.11 Apply the example to the Network and determine the output.
1.12 Repeat the steps 2.1 –2.3 for all the test cases.
1.13 Map the image vector (taken as Row Major-Order of above matrix) values in range [0, 1].

6. Experimental setup
6.1 Reading TIFF File -Tagged Image File Format is a file format that is strictly used for

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bitmap data. TIFF files don't contain text or vector data, even though the file format theoretically would permit additional tags to handle such data. It is a highly flexible and platform-independent format which is supported by numerous image processing applications and virtually all prepress software on the market. Once an image of handwritten character is scanned into tiff format, it has to be read and manipulated (preprocessing) before it can be fed to neural network.
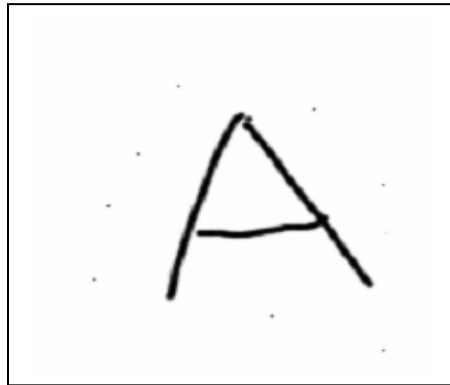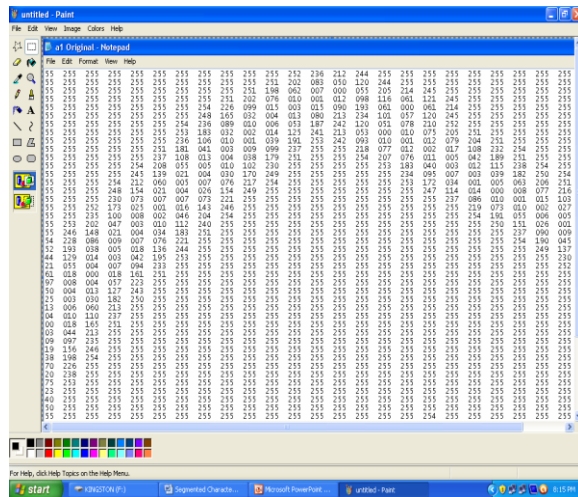

Fig2.Image in Tiff File to be read

Fig3. Pixel values of image read

6.2 Noise removal
The median filter is normally used to reduce noise in an image, somewhat like the mean filter. However, it often does a better job than the mean filter of preserving useful detail in the image. The median filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighboring pixel values, it replaces it with the median of those values. The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value. (If the neighborhood under consideration contains an even number of pixels, the average of the two middle pixel values is used.).
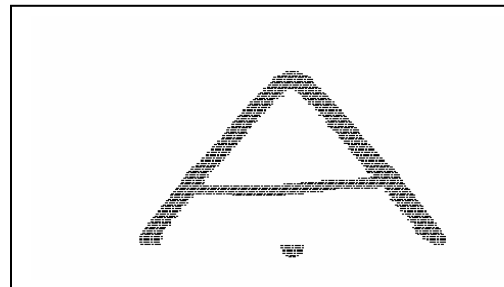

Fig4. Image after removing noise

6.3 Creating Bounding Box
The bounding box of a is the tightest rectangle which encloses the image. This is required to crop off the unusable area around the character. This will help in reducing the image size and also the number of pixels to be fed to neural network.
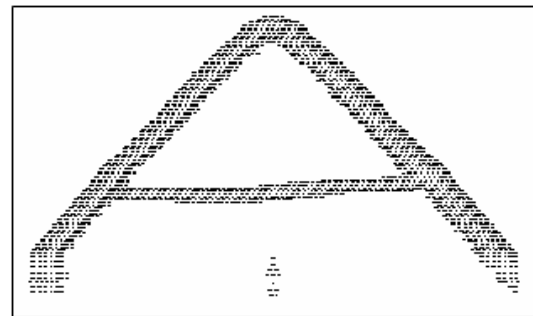

Fig6. Bounding box created

6.4 Image Scaling
Image scaling is the process of resizing a digital image. Scaling is a non-trivial process that involves a trade-off between efficiency, smoothness and sharpness. As the size of an image is increased, so the pixels which comprise the image become increasingly visible, making the image appears soft. Conversely, reducing an image will tend to enhance its smoothness and apparent sharpness. Image need to be rescaled since input to neural network must

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me of fixed size, irrespective of size of handwritten character.

6.5   Bi-linear   interpolation   Bilinear interpolation is one of the basic resampling techniques. In texture mapping, it is also known as bilinear filtering or bilinear texture mapping, and it can be used to produce a reasonably realistic image. An algorithm is used to map a screen pixel location to a corresponding point on the texture map. In texture mapping, it is also known as bilinear filtering or bilinear texture mapping, and it can be used to produce a reasonably realistic image. An algorithm is used to map a screen pixel location to a corresponding point on the texture map. A weighted average of the attributes (color, alpha, etc.) of the four surrounding texels is computed and applied to the screen pixel. This process is repeated for each pixel forming the object being textured. Bilinear interpolation can be used where perfect image transformation with pixel matching is impossible, so that one can calculate and assign appropriate intensity values to pixels. Bilinear interpolation   considers   the   closest   2x2 neighborhood of known pixel values surrounding the unknown pixel's computed location. It then takes a weighted average of these 4 pixels to arrive at its final, interpolated value. The weight on each of the 4 pixel values is based on the computed pixel's distance (in 2D space) from each of the known points. This algorithm reduces some of the visual distortion caused by resizing an image to a non-integral zoom factor, as opposed to nearest neighbor interpolation, which will make some pixels appear larger than others in the resized image. Bilinear interpolation tends, however, to produce a greater number of interpolation artifacts (such as aliasing, blurring, and edge halos) than more computationally demanding   techniques   such   as   bicubic interpolation.
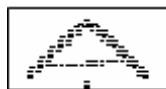

Fig5. Image Rescaled to Fixed Size 20x20 using bi-linear interpolation

6.6 Mapping Grey Values Mapping grey values from [0-255] to [0-1].
The need was felt to convert pixel values in the range [0-255] to real numbers in the range [0-1]. This will help in reduce calculation related run time errors.
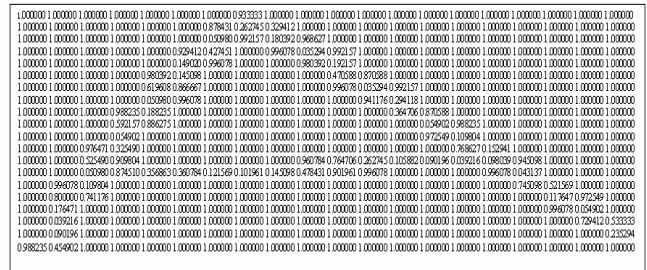

Fig 7. Final values Scaled to size 20 x 20 and in the range [0-1] ready to be fed to Neural Network.

7 Intermediate files used
Training.dat Contains training patters i.e. scaled image data, along with expected output bits for each pattern. For twenty six alphabets, five output bits were required.
Weights.dat Produced by network after running it in Training mode. This file contained the weights adjusted by the network.

8. Results & Discussions
Various hand written characters were trued. Initially when image was scaled to 20x20 size and was input to neural network, training success was only up to 10 % with very small recognition rate. Later it was realized to further reduce the image size to 15x15. It resulted in successful training of the network, very close to 99% and network
was able to recognize the characters successfully more than 95% times.

Data Set	Input Vector Size	Training Success	Recognition Rate (%)
A-E	20x20	10%	3-5%
A-Z	15x15	99%	95%

9. Conclusion and Future Work
Segmented character classifier developed here is working well, though it is working only on small character set, but it was a good learning experience. Limited time period was a main factor due to which it was restricted to segmented, few, upper case characters only. The scope of the problem can further be extended to recognize lower   case characters, digits, punctuation marks and then the
 Combinations and still further can be extended to altogether different language

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