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Development of a Pixel Extractor System for Tiv Character Recognition

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Abstract
Artificial neural network has been found to be effective in developing optical character recognition (OCR) systems. These neural networks are made up of a large number of highly interconnected processing elements called neurons which serve as input, processing and output units of the system. This work seeks to develop a pixel extraction system that extracts the pixel values from characters images which is to serves as input to any neural network for character recognition or character analysis. We digitalize the images into an 18 by 20 (360) digital cells each having a single colour of either black or white. We then encoded this information in a form that is meaningful to the computer. To do this, we assigned a value of +1 to each black pixel and 0 to each white pixel to create a binary image. Digitalization into a binary matrix of specified dimension makes the input image invariant of its actual dimensions. Macromedia Fireworks 8 was used in the preprocessing of the character images so as to reduce noise and jitter in the original character images. Software called pixel extractor system was developed using Java programming language for the character extraction. The system was tested using Two hundred and fifty (250) samples of printed Tiv characters of different font types namely Aharoni, Arial, Courier, Franklin Gothic Heavy and Times New Roman and the result shows that the system was able to extract the pixel values of the characters and normalized them as a single vector. The pixel values extracted were served as comma separated values (CSV) file.

Keywords
Pixel extraction, character recognition, artificial neural network, Tiv Language

I. Introduction

Characters are the basic building blocks that are used to build different structures of a language. Characters are the alphabets and the structures are the words, strings and sentences etc. ([1, 2]). According to [3] character recognition techniques as a subset of pattern recognition gives a specific symbolic identity to an offline printed or written image of a character. Character recognition is better known as optical character recognition because it deals with the recognition of optically processed characters rather than magnetically processed ones. The main objective of character recognition is to interpret input as a sequence of characters from an already existing set of characters. The advantages of the character recognition process are that it can save both time and effort when developing a digital replica of the document. It provides a fast and reliable alternative to typing manually.

Pattern recognition is the assignment of a physical object or event to one of several pre-specified categories[4]. Optical Character Recognition (OCR) is one of the most successful applications that have been proposed for ANNs [5]. Recognition of any character is a process which loads that character image, preprocesses the image, extracts proper image features, classify the characters based on the extracted image features and the known features are stored in the vectors, and recognizes the image according to the degree of similarity between the loaded image and the image databases.

Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. Because of its parallel nature, it can perform computations at a higher rate compared to the classical techniques; and also adapt to changes in the data and learn the characteristics of input signals because of its adaptive nature [6].

Pixel stands for picture element. It is the smallest square element of an image that a computer is capable of printing or displaying. In this research work, we seek to develop a pixel extractor system for Tiv character recognition.

II. Literature Review

Reference [7] proposed an approach to recognize Telugu script using Neural Networks. The author developed a network architecture called Multiple Neural Network Associative Memory (MNNAM) for recognition of Printed Telugu characters. In this method, the exemplars to be trained are divided into groups, each of which is having a capacity less than the practical optimal storage capacity (POSC) of a network. Each group is trained into a separate network of same topology. The test pattern to be recognized is presented to each of these networks. The patterns to which each of the networks converge are then made as exemplars to train further levels of networks, called as combination networks. The main limitation of their work is that the character recognition is not invariant of size, translation and rotation.

An Arabic letter recognition system based on Artificial Neural Networks (ANNs) and statistical analysis for feature extraction was presented by [8]. The ANN was trained using the Least Mean Squares (LMS) algorithm. In the proposed system, each typed Arabic letter is represented by a matrix of binary numbers that are used as input to a simple feature extraction system whose output, in addition to the input matrix, are fed to an ANN. Simulation results were provided and shows that the proposed system always produces a lower Mean Squared Error (MSE) and higher success rates than the current ANN solutions.

Reference[9] in their work, presented a system to recognize handwritten Farsi characters by using a multilayer perceptron (MLP) with one hidden layer. The error back propagation algorithm was used to train the MLP network. In addition, an analysis was carried out to determine the number of hidden nodes to achieve high performance of back propagation network in the recognition of handwritten Farsi characters. The system has been trained using several different forms of handwriting provided by both male and female participants of different age groups. Finally, this rigorous training results an automatic handwritten character recognition (HCR) system using MLP network. In this work, the experiments were carried out on two hundred fifty samples of five writers. The results showed that the MLP networks trained by the error back

propagation algorithm are superior in recognition accuracy and memory usage. The result indicates that the back propagation network provides good recognition accuracy of more than 80% of handwritten Farsi characters.

A system to recognize Handwritten English Character using a multilayer perceptron with one hidden layer was developed by [10]. The feature extracted from the handwritten character was Boundary tracing along with Fourier Descriptor. Character is identified by analyzing its shape and comparing its features that distinguishes each character. Also an analysis was carried out to determine the number of hidden layer nodes to achieve high performance of back propagation network in the recognition of handwritten English characters. The system was trained using 500 samples of handwritings given by both male and female participants of different age groups. Test result was performed on 500 samples other than samples for training that indicates that Fourier Description combined with back propagation network provide good recognition accuracy of 94% for handwritten English characters with less training time.

Reference[11] proposed Neural Network based English character recognition system. In this work, MLP with one hidden layer was used. About 500 testing were carried out to test the performance of the design. The best case accuracy obtained in this work was 94%.

An Offline Character Recognition System Using Artificial Neural Network was designed by [12]. Each image character comprised of 30×20 pixels. They applied feature extraction technique for calculating the feature. Features extracted from characters are directions of pixels with respect to their neighboring pixels. These inputs are given to a back propagation neural network with hidden layer and output layer. They also used the Back propagation Neural Network for efficient recognition where the errors were corrected through back propagation and rectified neuron values were transmitted by feed-forward method in the neural network of multiple layers.

Reference[2] propose a neural-network based size and color invariant character recognition system using feed-forward neural network. Their feed-forward network has two layers. One is input layer and another is output layer. The whole recognition process was divided into four basic steps such as pre-processing, normalization, network establishment and recognition. Pre-processing involves digitization, noise removal and boundary detection. After boundary detection, the input character matrix is normalized into 12×8 matrix for size invariant recognition and fed into the proposed network which consists of 96 input and 36 output neurons. Then the network was trained in a supervised manner and established the network by adjusting weights. Finally, the network was tested by more than 20 samples per character on average and give 99.99% accuracy only for numeric digits (0-9), 98% accuracy only for letters (A-Z) and more than 94% accuracy for alphanumeric characters by considering inter-class similarity measurement.

III. Methodology

In this section, we proposed an Artificial Neural Network Model for Tiv Character Recognition (ANNTCR) and describe in details how the character images are prepared in order to remove noise and jitter. We also show how pixel values are then extracted from the character images to be feed into the proposed neural network.

A. Network Architecture

The architecture of neural network systems is specified by the number of inputs to the network, the total number of nodes that represents the processing elements for the entire network, the number of outputs, and how they are organized and interconnected. The proposed feed-forward neural network architecture to recognize Tiv characters is as shown in figure 3.1. The network consists of three layers namely input, hidden and output layers. The feed forward neural network works by having one or more hidden layers sandwiched between an input and output layer. We proposed a feed forward neural network with resilient propagation training to develop ANNTCR.

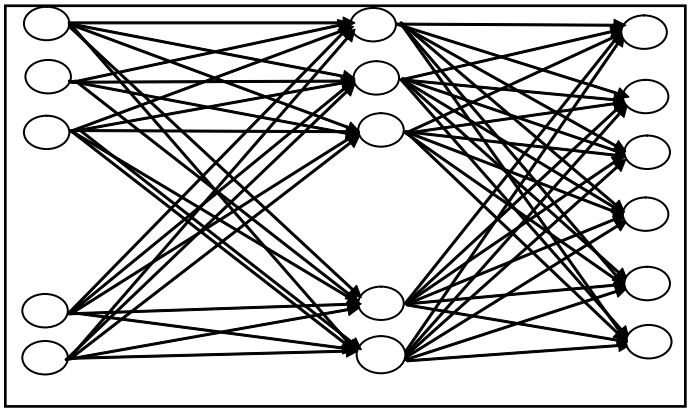

Fig. 1: Proposed Feed Forward Network Architecture for Tiv Character Recognition

B. Preparing Character Images for Training and Testing.

The characters to be used for the training and testing of the proposed network were created using Macromedia Fireworks 8. Macromedia Fireworks is a bitmap and vector graphics editor that can be used to create images.

1. Creating Image Characters

The procedure for creating the Tiv characters in macromedia fireworks is as described below:

- Create new image from file menu
- Set the image and canvas size to 18 by 20
- Set canvas colour to white
- Set text colour to black
- Type the letter using text tool from the toolbox
- Set magnification to1600%
- Set the anti-aliasing level to 'No Anti-Alias' to remove noise around the character edges
- Save image into designated folder on the system.

This procedure was repeatedly used to create all character images to be used for both training and testing of the network. Figures 3.2 to 3.4 shows the pictorial description of the steps described above.

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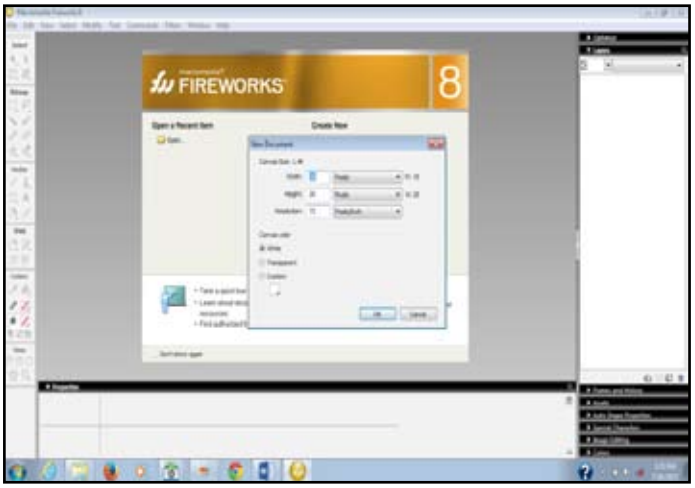

Fig. 2: Creating a Blank Image Document.

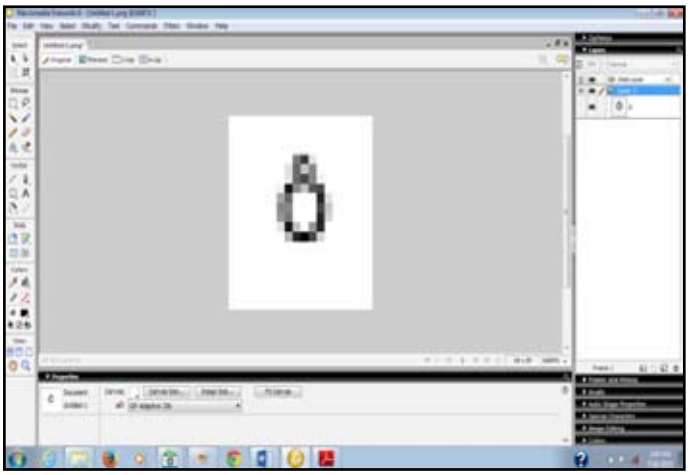
Fig. 3: Typing the Letter

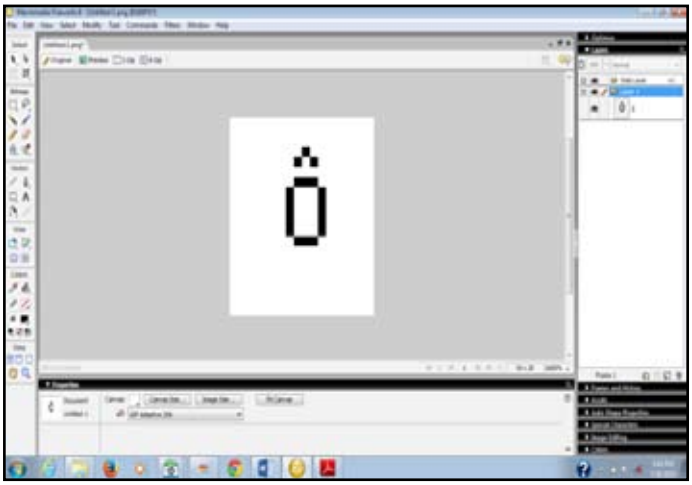
Fig. 4: Setting the anti-aliasing level to "No Anti-Alias"

The characters prepared are then saved in either the training or testing folders to be used for training and testing of the neural network respectively.

C. Conversion of Character Images to Pixel Matrices

In order to get inputs into our proposed ANN, the character images are converted into pixel matrices which is made up of zeros (0s) and ones (1s) that represent that character image. Java programming language was used to achieve this purpose.

1. Linearized Matrix to Feed into the Network

The matrix for each of the character image (18 by 20 pixels) is linearized into a vector and saved into a comma separated values (CSV) file. The length of the vector is 360 bits which are input data for the neural network system that will be develop to recognize Tiv alphabets (characters).

IV. Results

The results for the system are presented in fig. 4.1 to fig. 4.6. The results contains how pixels are extracted from the character images to be use for training and testing of the proposed system and a view of the numerical data extracted from the characters.

Fig. 4.1: The Pixel Extractor Dialogue Box.

Fig. 4.2: An Error Message when a User Forgets to Choose the Destination Folder.

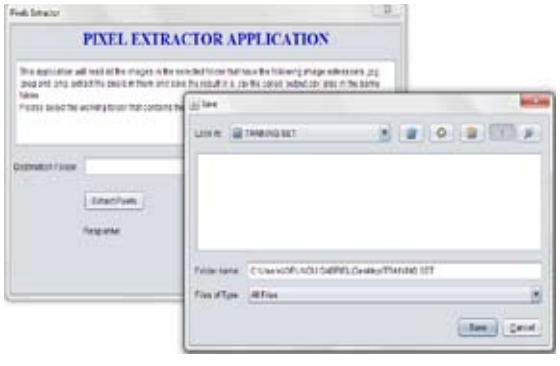

Fig. 4.3: Setting the Destination Folder.

Fig. 4.4: A Response Message showing that the Pixels are extracted.

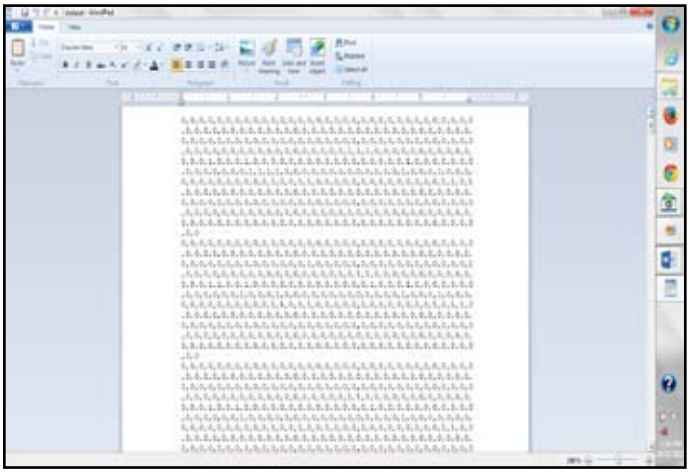

Fig 4.5: A View of the Output in WordPad

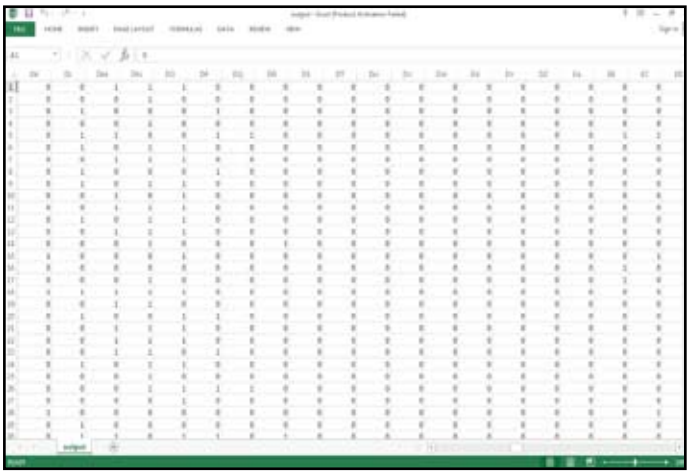

Fig. 4.6: A View of the Output in Excel

V. Discussion

Figure 4.1 represents the pixel extractor dialogue box when the program is executed. The user has to first and foremost, select the destination folder where the output of the system should be written to. If the user forgets to choose the destination folder and clicks on the button "Extract Pixels", then the program alerts the user to select the destination folder as shown in figure 4.2. However, when the destination is set and the user clicks on the button, a success message is given indicating that the pixel values have been extracted successfully as shown in figure 4.4.

VI. Conclusion

A pixel extractor system for Tiv character recognition has been developed. The system was developed to extract numerical data from characters that will serve as input into a neural network system which shall be develop to recognize Tiv characters. The system was developed using Java programming language. The system output are serve as a CSV file to be use for neural network training and testing.

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