A 3-Level Mapped Segmentation based Handwriting Recognition System

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ABSTRACT
Handwriting recognition has become one of the most fascinating research areas in recent years. Handwriting recognition can be defined as the process of converting human written text into a standard text document form. Optical Characters Recognition (OCR) is one of the active subjects of research since the early days of computer science. There are two main stages in most of OCR systems:
features extraction and classification. Artificial Neural Networks and Hidden Markov Models are the most popular classification methods used for OCR systems. Handwriting recognition systems are of extreme significance in human computer based applications and in modelling human behaviour. In this paper a recognition system has been proposed to recognize characters involving both English alphabets and numerals. This method is capable of detecting characters without extracting any features from written text, by adopting a 3-level segmentation technique. We have achieved about 95% to 98% of recognition accuracies using this approach

1. INTRODUCTION
Handwriting recognition is used most often to describe the ability of a computer to translate human writing into text. This may take place in one of two ways, either by scanning of written text or by writing directly on to a peripheral input device The first of these handwriting recognition techniques, known as optical character recognition (OCR), is the most successful in the mainstream. Most scanning suites offer some form of OCR, allowing users to scan in handwritten documents and have them translated into basic text documents. OCR is also used by some archivists as a method of converting massive quantities of handwritten historical documents into searchable, easily-accessible digital forms. Handwriting recognition is a projective technique like body language which can profile human behavior in the areas of social skills, thinking styles, achievement/work habits, and possible ways of dealing with stress. It is a system of studying the frozen graphic structures which have been generated in the brain and placed on paper in a printed and/or cursive style. It is a way to compare different personalities and their potential for compatibility in the areas of problem-solving, interpersonal skills, how they would fit into a team situation, and how they will react under pressure. It is a method to view the emotional development of an individual relative to maturity and consistent actions. There are two types of handwriting recognition systems, offline and online. It is important to differentiate between offline and on-line handwriting recognition systems. The fundamental difference is in the nature of the handwriting sample used in each system. In off-line systems, the samples are static. The system analyzes a digital image using either the raw pixel data, or some sort of representation of the pixel data. Only data that can be obtained directly from the image is used, there is no additional information given to it. This differs from an online system, where the samples are analyzed in a dynamic environment. This allows on-line systems to collect detailed real time information. This information may include the pressure and speed that a sample is written with, and the specific order in which the different alphanumeric characters are placed. Some of the major applications of handwriting recognition systems are as follows:
1. For accurate recognition of handwriting in postal address recognition systems.
2. It is used for verification of authorized documents.
3. It is applicable for verification of historical documents.
4. Handwriting recognition systems serve as reading aids for blind people.
5. It can also be used as effective tool to profile human behavior depending on writing features of a person.

2. RELATED AND PROPOSED WORKS
A method has been proposed in order to recognize handwriting using ANN the proposed work is a diagonal feature extraction scheme for recognizing offline characters. In the feature extraction process, resized individual character of size 90x60 pixels is further divided into 54 equal zones, each of size 10x10 pixels. The features are extracted from the pixels of each zone by moving along their diagonals [1]. This procedure is repeated for all the zones leading to extraction of 54 features for each character. These extracted features are used to train a feed forward back propagation neural network employed for performing classification and recognition tasks. Recognition system using diagonal extraction of features provides good recognition accuracy. It requires less time for training of Neural Networks. Extraction of features is a complicated process and it is a time consuming task. Feature extraction process is modified by another method proposed that is based on the observation that there exists a relationship between the heights and widths of the alphabets written by an individual which is unique and specific to to a person[2]. The features extracted from the samples were the different heights and widths of the letters 'H' and 'E'. The desired features extracted from hand writing samples based on heights and widths of letters is given as input to MLFFNN. The desired output pattern consists of four Os and a 1. The height-width relationship is specific and unique to every individual. The height-width based extracted features may not be sufficient for accurate handwriting recognition. Features that rely on the position of the baselines can also be included for handwriting recognition. These baselines divide the image of handwriting into: a middle zone that doesn't contain ascenders and descenders, and 2 zones where ascenders and descenders can be found respectively [4]. The extracted features are therefore script independent. These baseline features can be added to other features of writing are then passed to a general purpose HMM classifier or a neural classifier. We can use Genetic Algorithms for the problem. In order to prove this, a pool of images of characters are converted into graphs. The basic idea

of genetic algorithm comes from the fact that it can be used as an excellent means of combining various styles of writing a character and generating new styles. This algorithm takes as input an image, and returns the graph of the same. The whole procedure of the algorithm requires the principles of graph theory and coordinate geometry. The use of genetic algorithm is to mix 2 such graphs and to generate new graphs[3]. If difference between unknown input and training data is large, system may not behave well. Inter mixing of graphs may generate a lot of impossible graphs. Online handwriting recognition is possible by observing pen movements. The movement of pen is determined from a pair of accelerometers. These accelerometers are mounted on the side of a normal pen and produce a pair of time-varying waveforms. The output from an accelerometer is proportional to both the component of the Earth's gravitational field passing through it and the acceleration resulting from the actual motion of the pen[6]. The handwriting recognition is done by processing of acceleration signals .It involves stages such as sampling, Band pass filtering, Down sampling. The classifier of handwriting uses Hidden Markov Models (HMM).It is a simple methodology that involves a pair of accelerometers for a convectional pen. The HMM based classifier had to undergo a considerable structural modification in order to model the time varying nature of handwriting.

3. PROPOSED WORK AND EXPERIMENTAL SETUP

In this paper an Optical Character Recognition system is proposed that is based on extracting no features from handwritten text supported by 3-level segmentation process. Our proposed system is capable of recognizing both English alphabets and numbers 0 to 9.We have specified 35 possible outputs including 26 English assuming same outcome for letter o and zero. It is an offline recognition system where a scanned image of handwritten text is given as input data to the system, it is further subjected to various required preprocessing operations followed by 3-level segmentation. The isolated characters are resized to one-fourth of its initial size and are used for training the Artificial Neural Network classifier that performs text recognition. The schematic diagram of proposed system is shown below which involves scanning of input handwritten text, preprocessing, 3-level segmentation, Neural network character recognition and post processing. Fig 3.1 depicts the proposed system.

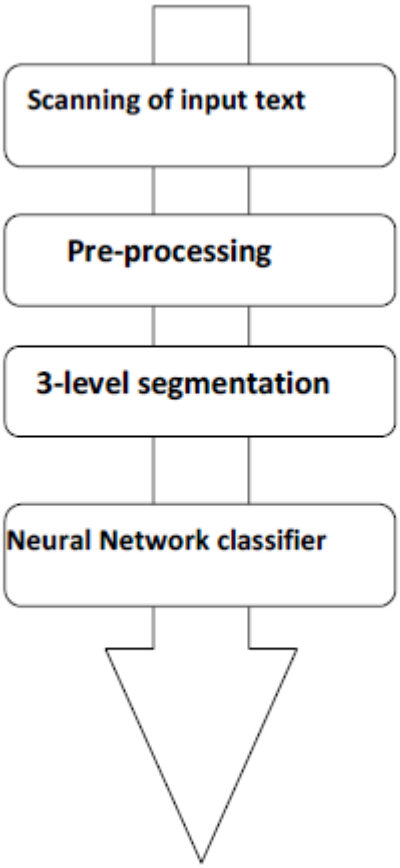

Fig.3.1 schematic view of proposed system

3.1 Creation of Database

We have setup a database consisting of 40 different styles for each character dataset, for each alphabet and number. We have stored the scanned images of character sets in JPEG format used for training ANN. Fig 3.2 shows database of letter A.

3.2 Scanning of handwritten text

An image of handwritten text is obtained from a a digital scanning device s shown in fig 3.3. The image obtained is subjected to further processing before segmentation process .since it is an offline recognition system which takes raw pixel data of and written text as input.

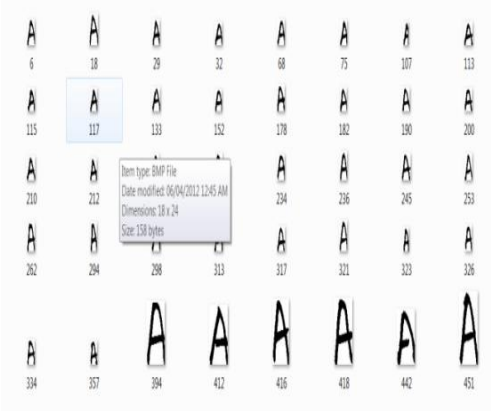

Fig.3.2 Dataset of letter A.

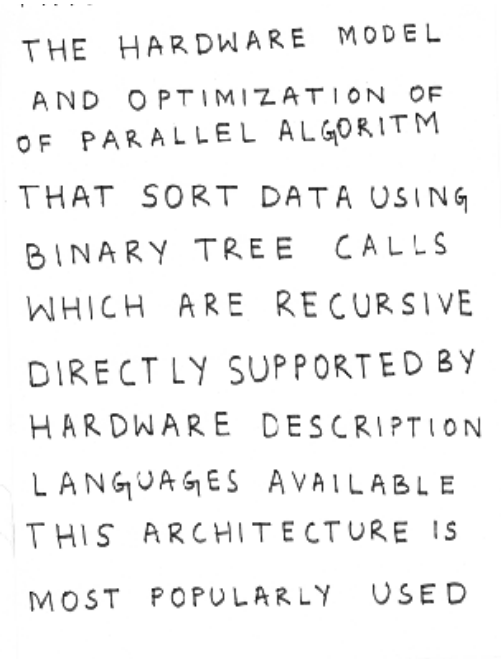

Fig 3.3 A sample of scanned handwritten text

3.3 Pre-processing

Preprocessing aims at eliminating the variability that is inherent in cursive and hand-printed words. following is a list of preprocessing techniques that have been employed by in an attempt to increase the performance of the segmentation/recognition process which is shown in fig.3.4.

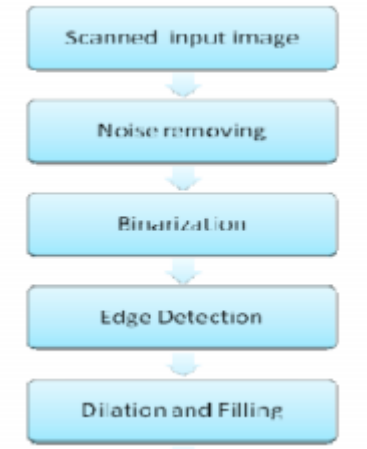

Fig.3.4 preprocessing operations

The scanned image of handwritten text consists of noisy pixels that occur due to defects present in scanning devices. noise filtering technique called median filter is adopted to remove existing noise. The filtered image free of noise is converted to a binary image for convenience such that characters are denoted by intensity value of 1(white pixel) and background is made black with intensity values of 0 for roper segmentation. Edge detection involves locating the boundaries of text image, unwanted rows and columns of mage on either sides of binary image can be removed. Next a morphological operation is done using dilation process to overcome contour errors which involves filling of gaps or holes found in written letters. Finally labeling is done by assigning integer values to a group of pixels that bear same intensity values starting from lower intensity to initial group o higher intensity as integer value increases.

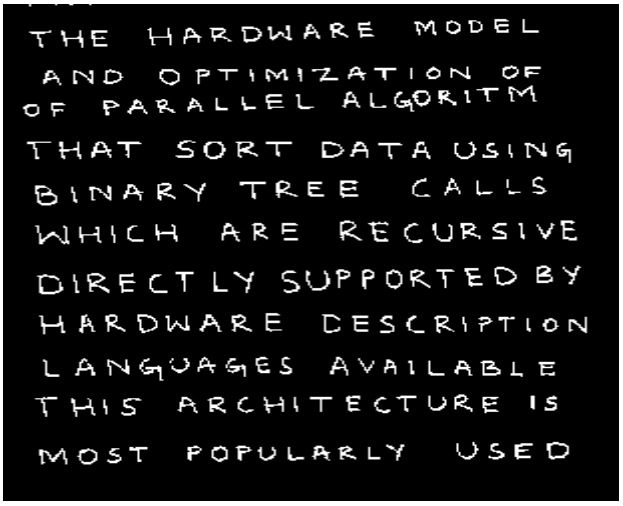

Fig3.5 Edge removed binary image

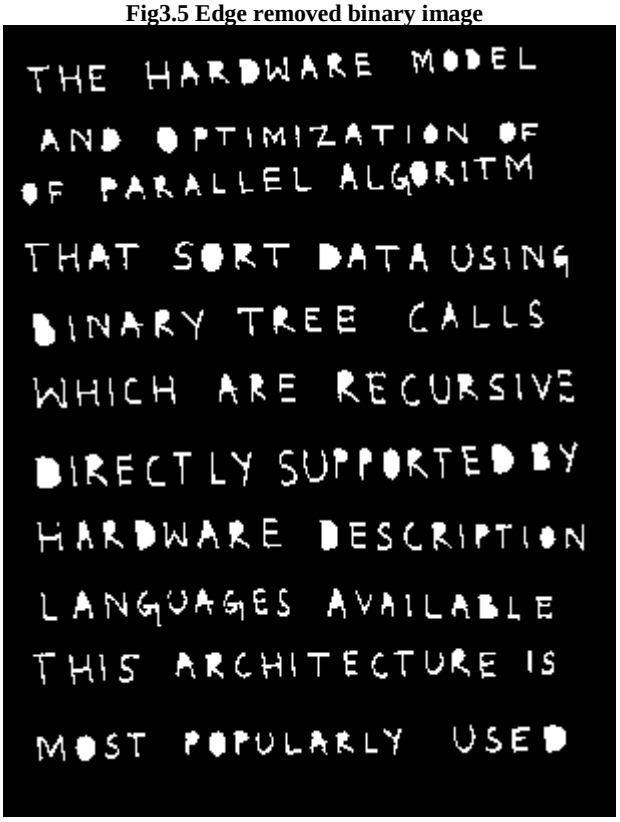

Fig 3.6 Noise free dilated image

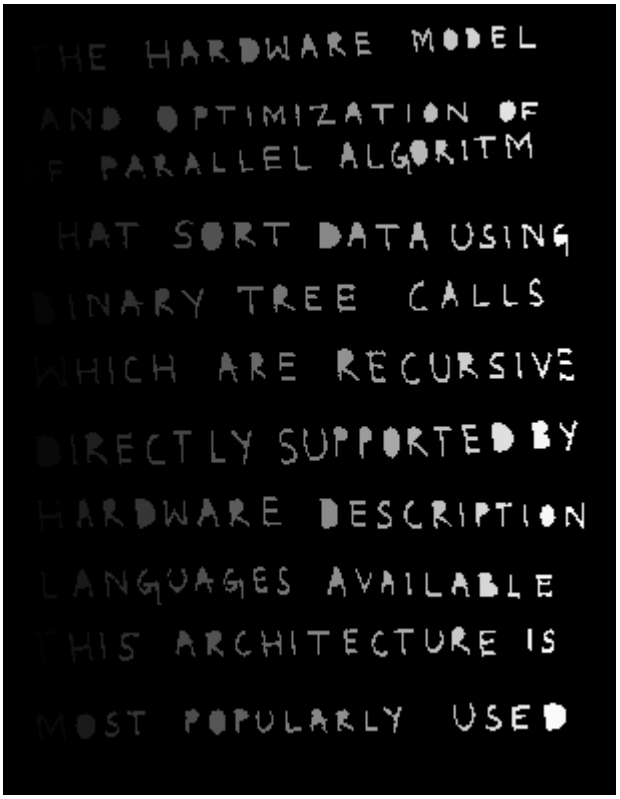

Fig 3.7 Labeled image

3.4 3-level mapped segmentation:

Segmentation of handwriting is defined as an operation that seeks to decompose a word image into a sequence of characters or into sub images of individual characters .we have adopted a 3- level segmentation process that maintains perfect alignment with all words that are written onto same horizontal line as shown in fig 3.8. This permits establishment of 3 levels of word orientation , mapping sequence of characters at 3 levels mainly core, ascending and descending portions before exact isolation. Hence this technique allows detection of handwritten text even if it is written very slant or overlapped with adjacent horizontal lines of text to some extent. Hence such a 3-level mapping based segmentation increases overall recognition accuracy.

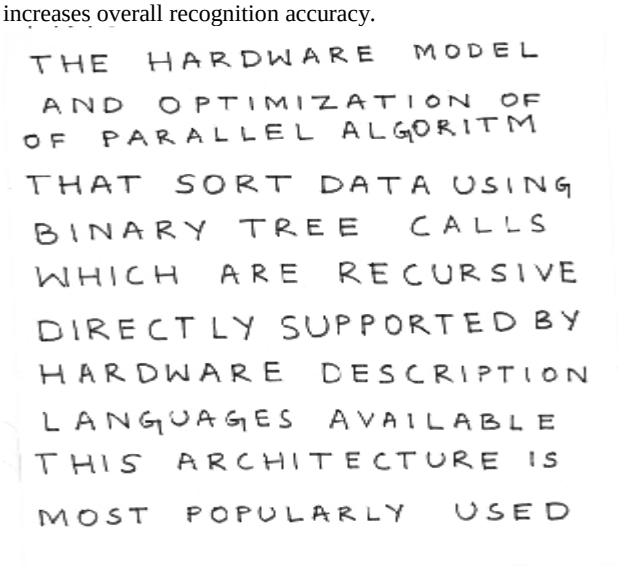

Fig.3.8 level mapping before segmentation

3.5 Neural Network Classifier

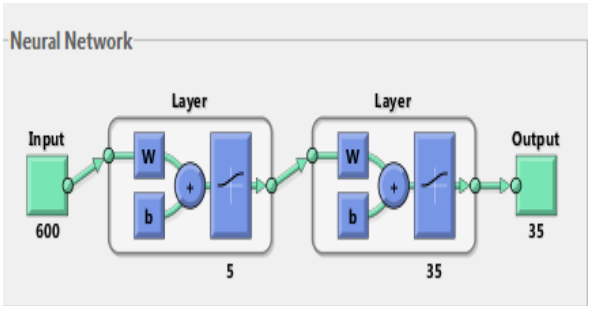

Fig .3.9 ANN architecture used.

Artificial Neural Networks are essential in identification o handwritten text. The feed forward neural networks are built from interconnected artificial neurons (processing units), grouped in three or more layers .The network we choose consisted of input layer, two hidden layers and an output layer which is shown in fig 3.9 .Every connection has associated a real numerical value, named weight or the strength of connection .Each segmented character is resized to preferably fourth of its original size. All the pixels of resized sub mage are given as input neurons .The inputs from the current pattern determine certain values for the outputs these output values are computed. These calculated output values are compared with the desired output values that are located in datasets used for training ANN's. The difference of the two values (the calculated one and the desired one) is back propagated to minimize error. The accuracy of character recognition depends upon number of layers used in Neural networks and distribution of neurons in each of hidden layers.

4. RESULTS & DISCUSSION

The recognition system has been implemented using Matlab7.1 using Image processing and Artificial Neural Network Toolboxes. The scanned image is taken as dataset/ input and feed forward architecture is used. The structure of neural network includes an input layer with 600 inputs, two hidden layers used each one with 5 neurons and an output layer with 35 neurons. The gradient descent back propagation method with momentum and adaptive learning rate and logsigmoid transfer functions is used for neural network training Neural network has been trained using known dataset. Fig.4.1 shows the Error (MSE) vs. Training Epochs performance of the network. It can be noted that it requires 18 epochs to reduce the mean square error to the desired level. With the application of mapping at 3 different levels before segmentation we have obtained recognition accuracy rates up

to 95 to 98%

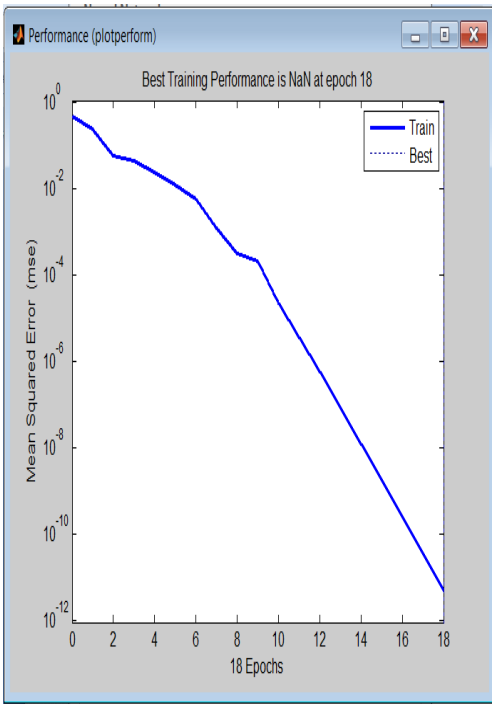

Fig 4.1 Error (MSE) vs. Training Epochs

5. CONCLUSION

In this paper we have discussed the importance of handwriting recognition in various applications related to human computer interactions . This paper proposes a handwriting recognition system that is capable of identifying 35 characters including both numbers and alphabets. we have adopted a 3-level segmentation process that maintains perfect alignment with all words that are written onto same horizontal line. This permits establishment of 3 levels of word orientation , involves mapping sequence of characters at 3 levels mainly core, ascending and descending portions before exact isolation. Hence this technique allows detection of handwritten text even if it is written very slant or overlapped with adjacent horizontal lines of text to some extent. Hence such a 3-level mapping based segmentation increases overall recognition accuracy. ANN based classifiers are immensely popular and have proved to be excellent means for optical character recognition. It provides acceptable recognition rate of about 98%. It is very hard to build a network that recognizes all writing styles. The proposed system has laid emphasis only on character recognition and numerals so it can be further extended to support recognition of special characters. The resolution for detecting small case letters with 3-level mapped segmentation is comparatively low which can still be improved.

6. REFERENCES

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