EFFECT OF TWO INTERMEDIATE HIDDEN LAYERS IN NEURAL NETWORK ON OPTICAL CHARACTER RECOGNITION: A REVIEW FOR NEW RESEARCH DIMENSION

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Abstract—

Optical Character Recognition, usually abbreviated to OCR, is the mechanical or electronic translation of images of handwritten document into machine-editable text. An emerging technique in this particular application area is the use of Artificial Neural Network implementations with networks employing specific guides (learning rules) to update the links (weights) between their nodes. Such networks can be fed the data from the graphic analysis of the input picture and trained to output Characters in one or another form. There are much work is done on this system uptill now but mostly on single hidden layer of neural network. This paper gives overview of that work.

Keywords--- OCR, Handwritten Character Recognition (HCR).

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I. INTRODUCTION

Handwritten Character Recognition is the mechanical or electronic translation of images of handwritten Characters (usually captured by a scanner) into machine-editable form. Handwritten Character recognition has variety of applications in various fields like reading postal zip code, passport number, employee code, bank cheque, and form processing. Handwritten Character recognition is an important component of character recognition system. The problem of the handwritten Character recognition is a complex task due to the variations among the writers like style of writing, shape, stroke etc. Compared to the problem of printed Character recognition, the problem of handwritten Character recognition is compounded due to variations in shapes and sizes of handwritten characters.

Handwritten Character recognition can be differentiated into two categories i.e. Online Handwritten Character recognition and Offline Handwritten Character recognition. On-line handwritten Character recognition deals with automatic conversion of Characters, which are written on a special digitizer, tablet PC or PDA where a sensor picks up the pen-tip movements as well as pen-up/pen-down switching [1]. Off-line handwritten Character recognition deals with a data set, which is obtained from a scanned handwritten document. Though academic research in the field continues, the focus on handwritten Character recognition has shifted to implementation of proven techniques. Handwritten Character recognition (using optical techniques such as mirrors and lenses) and digital character recognition (using scanners and computer algorithms) were originally considered separate fields. Because very few applications survive that use true optical techniques, the handwritten character recognition term has now been broadened to include digital image processing as well. For more complex recognition problems, intelligent character recognition systems are generally used which generally deals with the non-cursive handwritings.

A System for Optical Character Recognition (OCR) has been a frontline research area in the field of human-machine interface for the last few decades. Recognition of Indian language characters has been a topic of interest for quite some time. The need for efficient and robust algorithms and systems for recognition is being felt in India, especially in the post and telegraph department where OCR can assist the staff in sorting mail [2].

II. BACKGROUND

History of Automatic Recognition Engines

Handwritten Character recognition is in general a benchmark problem of Pattern Recognition and Artificial Intelligence. Compared to the problem of printed Character recognition, the problem of handwritten Character recognition is compounded due to variations in shapes and sizes of handwritten characters. Considering all these, the problem of handwritten Character recognition is addressed under the present work in respect to handwritten multi script Characters.

Gustav Tauschek obtained a patent on OCR in Germany in 1929, followed by in 1933 and in 1935 Handel who obtained a US patent on OCR in USA (U.S. Patent 1,915,993) and Tauschek was also granted a US patent on his method (U.S. Patent 2,026,329) respectively.

Tauschek's machine was a mechanical device that used templates [10]. When the template and the character to be recognized a photodetector was lined up for an exact match and a light was directed towards them, no light would reach the photodetector.

In 1950, Frank Rowlett who had broken the Japanese PURPLE diplomatic code, to work with Dr. Louis Tordella to recommend data automation procedures for the Agenc, asked for David H. Shepard, a cryptanalyst at the Armed Forces Security Agency in the United States, , This included the problem of converting printed messages into machine language for computer processing. Shepard decided it must be possible to build a machine to do this, and, with the help of Harvey Cook, a friend, built "Gismo" in his attic during evenings and weekends [1,13].

This was reported in the Washington Daily News on 27 April 1951 and in the New York Times on 26 December 1953 after his U.S. Patent 2,663,758 was issued. Shepard then founded Intelligent Machines Research Corporation (IMR)[11,13], which went on to deliver the world's first several OCR systems used in commercial operation. While both Gismo and the later IMR systems used image analysis, as opposed to character matching, and could accept some font variation, Gismo was limited to reasonably close vertical registration, whereas the following commercial IMR scanners analyzed characters anywhere in the scanned field, a practical necessity on real world documents [1].

The first commercial system was installed at the Readers Digest in 1955, which, many years later, was donated by Readers Digest to the Smithsonian, where it was put on display. The second system was sold to the Standard Oil Company of California for reading credit card imprints for billing purposes, with many more systems sold to other oil companies.

Other systems sold by IMR during the late 1950s included a bill stub reader to the Ohio Bell Telephone Company and a page scanner to the United States Air Force for reading and transmitting by teletype typewritten messages. IBM and others were later licensed on Shepard's OCR patents.

In about 1965 Readers Digest and RCA collaborated to build an OCR Document reader designed to digitize the serial numbers on Reader Digest coupons returned from advertisements. The font used on the documents were printed by an RCA Drum printer using the OCR-A font. The reader was connected directly to an RCA 301 computer (one of the first solid state computers). This reader was followed by a specialized document reader installed at TWA where the reader processed Airline Ticket stock (a task made more difficult by the carbonized backing on the ticket stock). The readers processed document at a rate of 1500 documents per minute and checked each document rejecting those it was not able to process correctly. The product became part of the RCA product line as a reader designed to process "Turn around Documents"[13] such as those Utility and insurance bills returned with payments.

The United States Postal Service has been using OCR machines to sort mail since 1965[10] based on technology devised primarily by the prolific inventor Jacob Rainbow. The first use of OCR in Europe was by the British General Post Office or GPO [2]. In 1965 it began planning an entire banking system, the National Giro, using OCR technology, a process that revolutionized bill payment systems in UK. Canada Post has been using OCR since 1971.

OCR systems read the name and address of the addressee at the first mechanized sorting center, and print a routing bar code on the envelope based on the postal code. After that the letters need only be sorted at later centres by less expensive sorters which need only read the bar code. To avoid interference with the human-readable address field which can be located anywhere on the letter, special ink is used that is clearly visible under ultraviolet light. This ink looks orange in normal lighting conditions. Envelopes marked with the machine readable bar code may then be processed.

In 1974, Ray Kurzweil started the company Kurzweil Computer Products, Inc. and led development of the first omni-font optical character recognition system--a computer program capable of recognizing text printed in any normal font.

He decided that the best application of this technology would be to create a reading machine for the blind, which allow blind people to understand written by having a computer read it to

them out loud. However, this device required the invention of two enabling technologies--the CCD flatbed scanner and the text-to-speech synthesizer. On January 13, 1976, the finished product was unveiled during a widely reported news conference headed by Kurzweil and the leaders of the National Federation of the Blind. Called the Kurzweil Reading Machine, the device covered an entire tabletop, but functioned exactly as intended. On the day of the machine's unveiling, Walter Cronkite used the machine to give his signature sound off, "And that's the way it was, January 13, 1976." While listening to The Today Show, musician Stevie Wonder heard a demonstration of the device and personally purchased the first production version of the Kurzweil Reading Machine[1].

In 1978 Kurzweil [1] Computer Products began selling a commercial version of the optical character recognition computer program. LexisNexis was one of the first customers, and bought the program to upload paper legal and news documents onto its nascent online databases. Two years later, Kurzweil sold his company to Xerox, which had an interest in further commercializing paper-to-computer text conversion. Kurzweil Computer Products thus became a subsidiary of Xerox known as Scan soft (now Nuance).

III. LITERATURE SURVEY

Basics of Neural Network, its underlying principles and Algorithms is explained in the book by S.Rajsekaran, G.A.Vijayalakshmi Pai[1]. This book elaborates the basic concept of neuron, activation function and the network formation concept that is used in this dissertation.

Sang Sung Park constructed OCR system based on three layers that saves abstracted characters to database automatically after extracting only equivalent and necessary characters from a large amount of documents by using BP algorithm that is one of Artificial neural network.[3]

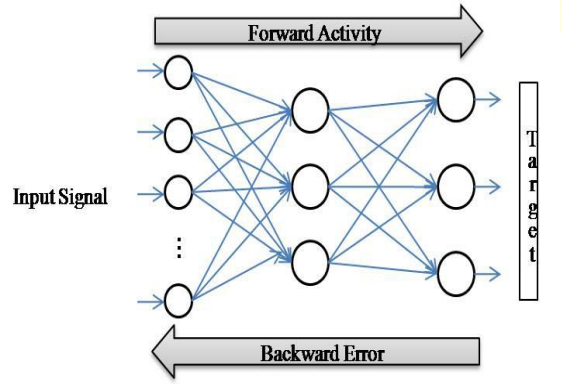

Fig 1: Structure of BP Algorithm[3]

S.V. Rajashekararadhya and P. Vanaja Ranjan [4] propose a Zone and Distance metric based feature extraction handwritten Character recognition system for Kannada and Telugu scripts. The character centroid is computed and the image is further divided in to n equal zones. Average distance from the character centroid to the each pixel present in the zone is computed. This procedure is repeated for all the zones present in the Character image. Finally n such features are extracted for classification and recognition. Feed forward back propagation neural network is designed for subsequent classification and recognition purpose. The result indicates that the back propagation network provides good recognition accuracy of 98 % and 96 % recognition rate for Kannada and Telugu Characters respectively.

K. Roy, S. Vajda, U. Pal, B. B. Chaudhuri[5] proposed method which uses Run Length Smoothing Algorithm (RLSA), in which decompose the image into blocks. Based on the black pixel density and number of components inside a block, non-text block (postal stamp, postal seal etc.) are detected. Using positional information, the destination address block (DAB) is identified from text block. Next, pin-code box from the DAB is detected and Characters from the pin-code box are extracted. For the sorting of postal documents written in Arabic and a local language Bangla, a two-stage MLP based classifier is employed to recognise Bangla and Arabic Characters. The system has been implemented and it has 92.10% recognition accuracy.

Dong Xiao Ni [6] describes the basic biological neuron and the artificial computation model; outlines network architectures and learning processes; and presents multilayer feed-forward networks. It presents two OCR demo applications, one with VB.Net, one with C#.Net. It concludes with a real-world application like Advanced Facer Canceller System-Optical Character Reader from United State Postal Service.Figure 3 shows a window. The goal of this window is to demonstrate basic character recognition. The left side in an input you can draw on and the six check boxes labeled "A" through "F" are the outputs.

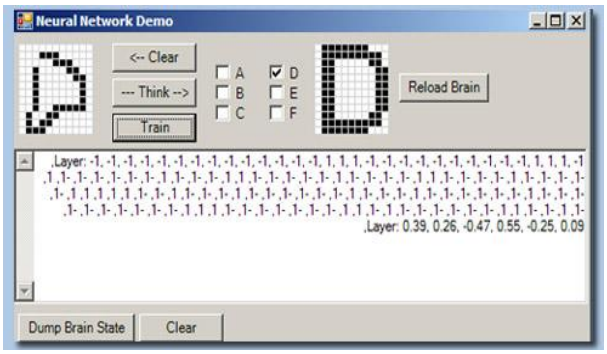

Figure 2: Character recognition demo.[6]

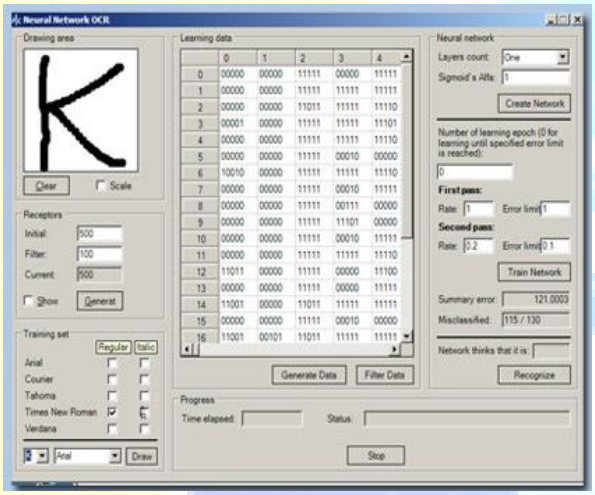

Figure 3: Another Neural Network OCR with C#[6]

Hirokazu Muramatsu, Takashi Kobayashi [7] proposed new matching method for Handwritten Character Recognitionwhich is supplementing contour orientations with convex/concave information and a new evaluation method considering the structure of strokes. With these improvements the recognition rate rose to 96.0%.

Marco Alfonse, Mohamed Almorsy, Mohamed Samir Barakat[8] make an attempt to recognize Eastern Arabic Characters by using the hybrid classifier consists of Multilayer neural network and decision tree. The testing of the proposed recognition system indicates that the classification accuracy is in average 83%.

B.V.Dhandra, R.G.Benne, Mallikarjun Hangarge [9] proposed a novel approach for Kannada, Telugu and Devanagari handwritten Characters recognition based on global and local structural features. Probabilistic Neural Network (PNN) Classifier is used to classify the Kannada, Telugu and Devanagari Characters separately. Algorithm is validated with Kannada, Telugu and Devanagari Characters dataset by setting various radial values of PNN classifier under different experimental setup.

Altun and Curtis [11] state that accurate prediction of demand is the key to reduce the cost of inventory for an enterprise in Character Recognition. Based on recurrent neural networks, a new prediction model of demand in supply chain is proposed. The learning algorithm of the prediction is also imposed to obtain better prediction of time series in future. In order to validate the prediction performance of recurrent neural networks, a simulated time series data and a practical sales data have been used.

By comparing the prediction result of Multi-Layer feedback neural networks and recurrent neural networks, it can be shown that the recurrent neural networks prediction model can help in improving the prediction accuracy.

Anita Pal and Daya Shankar Singh[12] elaborate the work has been performed to recognize English Character using a multilayer perceptron with one hidden layer. The feature extracted from the handwritten character is Boundary tracing along with Fourier Descriptor. Character is identified by analyzing its shape and comparing its features that distinguishes each character.

Leonardo Noriega[13] gives full detail about the types of the activation function like step activation function, sigmoid activation function, logarithmic activation function and the learning rule. The Multilayer Perceptron algorithm is explained.

IV. CONCLUSIONS

After having detailed analysis on all the research papers that are being used in Characteral character recognition purpose, conclusion can be made that no one got the output result touching to 100% under non ideal condition .Also existing work do not support multiscript style. Multiscript style means that in a scanned Character document, some of the digits are written in one scripting language (say Tamil numbers or Hindi numbers) and rest of the digits are in

another different scripting language (like telegu or arabic),then the existed methodologies fails because it work on ideal conditions which specifies same scripting language and size of the characters all over the document .

Also, the feed forward neural network used in the existing approach uses only single hidden layer. Because of the single hidden layer, less weight balancing modules works which results less preciseness to the accuracy in character recognition.

This thesis work is done keeping these drawbacks in mind. Two hidden layers were used instead of one hidden layer. Because of two hidden layer, weight balancing can be done in more precise manner and hence more accurate results can be obtained. Also, The proposed can work for mixed scripting language as shown in the result analysis. In sample 1(using two hidden layers), three different scripting language styles namely, Tamil, Telegu and English are used in the same scanned document and result is evaluated to be nearly 100% which is great achievement.

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