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OFFLINE HANDWRITTEN CHARACTER RECOGNITION: A REVEIW

Sumedha B. Hallale[1] and Geeta D. Salunke[2]

[1]Dept. of Electronics and Telecommunication, G.S.Moze C.O.E., Pune University, India
[2]Dept. of Electronics and Telecommunication, AISSMS IOIT, Pune University, India
[*]Corresponding author: Email: hallalesumedha@gmail.com, Tel: 9167904587

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ABSTRACT:

Nowadays character recognition has gained lot of attention in the field of pattern recognition due to its application in various fields. In this paper, we have provided the detail study on existing methods for handwritten character recognition. Handwritten character recognition is still a popular research area of pattern recognition. Each and every step contributes straightforwardly to the accurateness of system, like preprocessing, segmentation, feature extraction and classification etc. A lot can be improved in future.

Keywords: character recognition, preprocessing, segmentation, feature extraction, classification.

I. INTRODUCTION

The first character recognizer appeared in around 1940s. The early works were concentrated either upon machine-printed text or upon a small set of well-separated hand-written text or symbols. Machine-printed CR generally used template matching and for handwritten text, low-level image processing techniques were used on the binary image to extract feature vectors, which were then fed to statistical classifiers [1],[2],[3]. A good survey of the CR techniques used until 1980s can be found in [4]. The period from 1980 - 1990 witnessed a growth in CR system development due to rapid growth in information technology [5-7]. Structural approaches were initiated in many systems in addition to the statistical methods [8,9]. The syntactic and structural approaches require efficient extraction of primitives [10].

Both recognition techniques and computers were not that powerful in the early days (1960s), OCR machines tended to make lots of errors when the print quality was poor, caused either by wide variations in type fonts and roughness of the surface of the paper or by the cotton ribbons of the typewriters [11]. To make OCR work efficiently and economically, there was a big push from OCR manufacturers and suppliers toward the standardization of print fonts, paper, and ink qualities for OCR applications. New fonts such as OCRA and OCRB were designed in the 1970s by the American National Standards Institute (ANSI) and the European Computer Manufacturers Association (ECMA), respectively. These special fonts were quickly adopted by the International Standards Organization (ISO) to facilitate the recognition

process [12-15]. As a result, very high recognition rates became achievable at high speed and at reasonable costs. Such accomplishments also brought better printing qualities of data and paper for practical applications. Actually, they completely revolutionalized the data input industry [14].

A generic character recognition system may be shown in Figure 1. Its different stages are as given below:

Input: Samples are read to the system through a scanner.

Preprocessing: Preprocessing converts the image into a form suitable for subsequent processing and feature extraction.

Segmentation: The most basic step in CR is to segment the input image into individual glyphs. This step separates out sentences from text and subsequently words and letters from sentences.

Feature extraction: Extraction of features of a character forms a vital part of the recognition process. Feature extraction captures the vital details of a character.

Classification: During classification, a character is placed in the appropriate class to which it belongs.

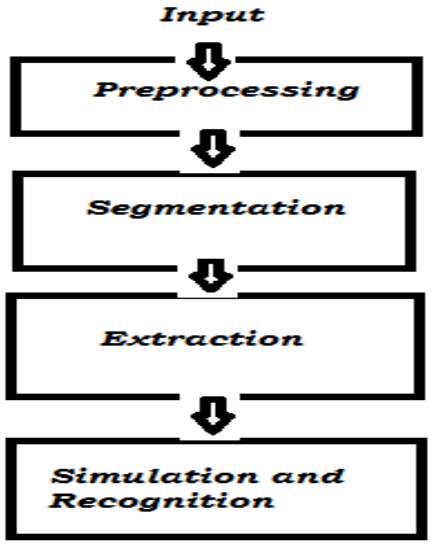

Fig.1 Block diagram of protocol to recognize the word character

II. DATA PRE-PROCESSING

The exchange of paper-based documents to electronic image format is an important process in computer systems for automated document delivery, document preservation, and other applications. The process of document conversion includes scanning, displaying, quality assurance, image processing, and text recognition. After document scanning, a sequence of data preprocessing operations are normally applied to the images of the documents in order to put them in a suitable format ready for feature extraction.

Fig.2 An image of original character and its normalized form

Conventional preprocessing steps include noise removal/smoothing [16], document skew detection/correction [17, 18], connected component analysis, normalization [19, 20–22], slant detection/correction [23], thinning [24-26], and contour analysis [27]. Post Processing includes combining the CR techniques either in parallel or series.[28] In binary (black and white) document images, smoothing operations are used to reduce the noise or to straighten the edges of the characters, for example, to fill the small gaps or to remove the small bumps in the edges (contours) of the characters. Smoothing and noise removal can be done by filtering.

III. SEGMENTATION

This research area, document image understanding, has been quite active [29]. The technology can be applied to analyzing documents with very complex structures, such as newspapers [30,31], mixed picture diagram documents [32], mail pieces [33], and technical documents with mathematical equations [34]. Common features are the use of document layout knowledge or an expert-system approach [35-37], a structure representation in a hierarchical or recursive framework [38, 39], and the use of spatial relationships between pattern elements [38], [40].

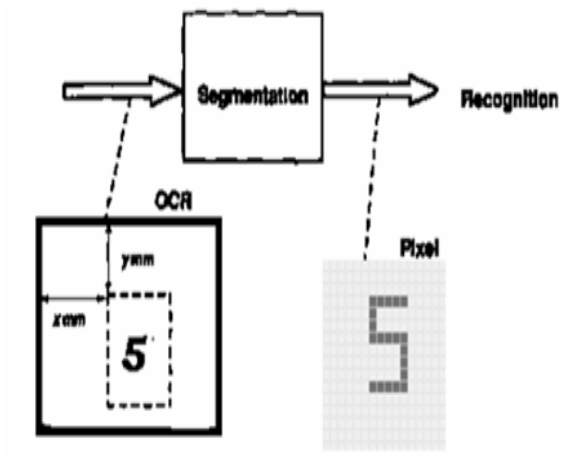

Fig. 3 Pixel-oriented character segmentation

IV. FEATURE EXTRACTION AND CLASSIFICATION

In feature extraction stage each character is represented as a feature vector, which becomes its identity. The major goal of feature extraction is to extract a set of features, which maximizes the recognition rate with the least amount of elements. The features extracted are given as input to the classification stage and the output of this stage is a recognised character. The selection of the combination of feature-classifier contributes to the performance of the system. Several research works has been focussing toward evolving such methods to reduce the processing time and providing higher recognition accuracy.

Dayashankar Singh, Maitreyee Dutta [41] proposed a feature extraction technique to calculate only twelve directional feature inputs depending upon the gradients. In this paper direction is divided into twelve regions with each region covering angle of 30 degree. Thus direction value of any pixel may have only 12 values assigned from 1 to 12. The features are extracted from the direction of pixel with respect to their neighboring pixels and given as input to the neural network. After training the network with back propagation learning algorithm, high recognition accuracy with minimum training and classification time. Experimental result of conventional gradient and 12 directional features are compared in terms of recognition accuracy, training time and classification time. This system is able to recognize all type of handwritten characters including special character in any language.

Bindu S. Moni and G Raju [42] proposed the work in which twelve directional codes depending on the gradient direction is coupled with the statistical classifier for handwritten isolated Malayalam characters. In this method, images are decomposed into sub image using fixed meshing strategy. The feature values for classification are formed by twelve directional features. Classification has been carried out with quadratic discriminant function (QDF) and modified quadratic discriminant function (MQDF) improves the classification performance and reduces the computation cost as compared to QDF.

In this paper [43] the advances of directional features and related methods are briefly discussed to analyze similarity measure of directional pattern matching. It attempts to express the

directional features with the properties that the similarity measures should hold to improve the performance of character recognition, more information and discriminative features synthesized from the directional maps.

Anita Pal, Dayashankar Singh [44] performed the experiment to recognize the handwritten English character using multilayer perceptron with one hidden layer. The features are extracted with the boundary tracing technique using Fourier descriptors. The analysis was carried out to determine the number of hidden layer nodes to achieve high performance of back propagation network. The result of analysis showed that if the no. of hidden nodes increases, the number of epochs taken to recognize the handwritten character increases.

In this paper [45] a simple and efficient off-line handwritten character recognition system using a radon feature extraction is proposed. Handwritten alpha-numeric character is recognized using three different recognition networks such as feed forward networks and Hopfield networks from the test results it is identified that the Hopfield network has more accuracy percentage of recognition than other two networks.

Mitrakshi Patil, Vaibhav Narwade [46] proposed a method for recognition of off-line handwritten devnagari characters using segmentation and artificial neural networks. The whole procedure of recognition includes two phases segmentation and feed forward neural networks. To improve performance in terms of time, they proposed a method which does segmentation of handwritten characters into line segmentation, word segmentation and character segmentation.

P. B. Khanale, S.D Chitnis [47] proposed a devnagari handwritten character recognition system using artificial neural networks. A two layered feed forward networks with 10 neurons each and log-sigmoid transfer function is used. The training of network is done with back propagation algorithm with adaptive learning rate. The network is trained with ideal vectors having 0.1 sum squared error and noisy vectors having 0.2 sum squared error. For certain characters 96% recognition rate is achieved.

In this paper [48] proposed a generic scheme for off-line handwritten English alphabets character images using gradient change features. These gradient values are normalized for training and testing of neural networks. The recognition scheme uses multilayer perceptron (MLP) neural networks. To avoid overtraining whole available dataset is divided into two subsets such as training set and test set. They achieved 99.10% and 94.15% recognition rates on training and test sets respectively. Experimental results showed that recognition accuracy on test set of samples can be improved by taking optional segment size and by using proper normalization factor.

In this paper [49] an attempt is made to extract minimum number of features to represent the pattern which is given as input to the feed forward back propagation neural networks (FFBPNN). A feature from each recognition is calculated by the co-ordinate distance of 1s pixels and density. The neural network is trained with the extracted features and root mean square error is obtained and is used as performance indicator to stop FFBPNN learning. A very good classification and recognition rate is found with minimum training time.

In this paper [50] a diagonal feature extraction, scheme along with neural network for recognizing off-line handwritten characters is proposed. In diagonal feature extraction, each individual character recognized 90 X 60 pixels and again divided into 54 equal zones of size 10 X 10 pixels. The relevant features are extracted from pixels of each zone by moving along their diagonals of each zone. These features are used to train feed forward back propagation neural networks for performing classification. This

proposed method provides good recognition accuracy and less time for training.

V. CONCLUSION

In present review, concluded that, although each of the methods mentioned have their own advantages and limitations, the success level is achieved by each method. This paper serves as a part of the whole research work that aims at recognizing handwritten characters. However, taking in to account various databases, constraints and sample spaces it is difficult to comment about the success of recognition methods, especially in terms of recognition rates. Handwritten character recognition is still a burning research area of pattern recognition. Each and step contributes directly to the accuracy of system, like pre-processing, segmentation, feature extraction, training methods etc all. So all these area are open for independent research. A lot can be improved in each of step.

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