# Critical Review on Handwritten Character Recognition by Using Several Classifier

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*Abstract— In this paper, we present a technique for off-line handwritten character recognition. Writer independent handwriting recognition systems are limited in their accuracy, primarily due the large variations in writing styles of most characters. Automatic handwritten character recognition is remains a challenging problem even with the proficient improvement in the classifier. Various research system or application develop of character recognition in English have been available but still recognition rate of handwritten characters is poor and is an open problem. Handwritten Character Recognition system consists of a number of phases which are preprocessing, feature extraction, classification and pursued by the genuine recognition. In this paper we can give the brief review on Data collection, Preprocessing, Feature extraction and Classification: Artificial Neural Network and our proposed algorithm of classification MLP and Gradient Descent Adaptive Momentum (GDAM) Algorithm which is effected for escalations of handwritten character reorganization rate.*

*Keywords— Segmentation, Binarization, classification, handwritten character recognition.*

## I. INTRODUCTION

In handwritten character recognition, the characters are implicit to be written readably permitting smaller variation in the shape of a character. In the present paper, an attempt is made to recognize unconstrained or free hand written characters. Because of various writing styles, recognition of this type of characters is a complex problem. Considering the difficulty of the difficult, an effort is made to develop off-line recognition strategies for isolated English characters. The recognition of handwritten characters has several applications such as office automation, bank cheque recognition [1]. Since handwritten numerals and characters are used in highly profound areas like finance and administration, the recognition system should be accurate, fast and easy to implement. The earlier systems grouped under optical character recognition (OCR) could recognize only the handwritten numerals of fixed size and fonts. But, 100 percent recognition rate is beyond the reach of these systems as reported in the literature. Therefore, the present study intentions at making a precise system pursuing 100 percent recognition in appearance of varied size, shapes and fonts.

In this paper, we present a recognition system for handwritten upper case characters (A–Z) and lower case characters (a–z), numerals (0–9).The preprocessing of characters comprises bounding of character for translation invariance and normalization of characters for size invariance. The variability in a character introduced by the various writing styles, rotation and deformation is the main concern of this learning [2].Challenges in handwritten character recognition wholly lie in the variation and distortion of handwritten digits, since different people may use different style of handwriting, and direction to draw the same shape of the digits of their known script. This paper demonstrates the nature of handwritten characters, conversion of handwritten data into electronic data, and the neural network approach to make machine capable of recognizing hand written characters[3].In this research paper we can describes the proposed technique for Pattern matching and analysis of handwritten character. The discusses and also explains all proposed technique methods i.e. image acquisition, gray conversion, binary conversion, edge detection, image dilate and image fill normalization method in detail. Like Proposed Algorithm Gradient Descent Adaptive Momentum (GDAM) Algorithm and Multi-layer perceptron [10].

## II. REVIEW LITERATURE

Pattern matching and analysis of handwritten character recognition is described as the ability of a computer to translate human writing into text. This can be achieved by two ways, the first of these handwritten character recognition techniques, known as optical character recognition (OCR), is the most successful. OCR is also used to convert large quantities of handwritten documents into searchable, easily-accessible digital forms. The second technique of handwriting recognition often referred to as on-line recognition. Methods and recognition rates depend on the number of constraints on handwriting. The constraints are mainly characterized by the types of handwriting, the character of writers, the size of the dataset and the spatial layout. From past many years, many academic laboratories and companies are involved in research on handwriting recognition [1].

M. Hanmandlu, O.V. Ramana Murthy have presented in their study the recognition of handwritten Hindi and English numerals by representing them in the form of exponential membership functions which serve as a fuzzy model. The recognition is carried out by modifying the exponential membership functions fitted to the fuzzy sets. These fuzzy sets are derived from features consisting of normalized distances obtained using the Box approach. The membership function is modified by two structural parameters that are estimated by optimizing the entropy subject to the attainment of membership function to unity. The overall recognition rate is found to be 95% for Hindi numerals and 98.4% for English numerals [2].

Velappa Ganapathy, and Kok Leong Liew they proposed a method in which first multi-scale neural training with modifications in the input training vectors is adopted to acquire its advantage in training higher resolution character images and then selective thresholding using minimum distance technique is proposed to increase the level of accuracy of character recognition. A simulator program (a GUI) is designed in such a way that the characters can be located on any spot on the blank paper in which the characters are written. The results show that such methods with moderate level of training epochs can produce accuracies of at least 85% and more for handwritten upper case English characters and numerals [3].

Mathias M.Adankon, Mohamed Cheriet the LS-SVM classifier, like other kernel machines, gives a poor generalization when the hyper parameters are not tuned efficiently. The authors proposed a model selection strategy for the LS-SVM which is a variant of the popular SVM classifier. They formed model selection using the empirical error criterion through the LOO procedure. They applied an algorithm on a handwriting recognition problem, which gave promising results. Compared with the SVM, the sparse LS-SVM classifier, empowered by model selection based on the empirical error criterion and the LOO procedure, achieved higher performance. They conclude from this that the sparse LS-SVM with model selection would be an interesting alternative classifier for the SVM in pattern recognition systems [4].

Ishani Patel, et.al in his paper literature review with result analysis is showing in table1, various feature extraction methods with recognition rate and classifier are showing in following table [5].

TABLE I  THE VARIOUS FEATURE EXTRACTION METHOD AND CLASSIER

| Sr.No. | Method | Classifier | Recognition Rate | Year |
|--------|--------|-----------|------------------|------|
| 1 | Diagonal | MLP | 98.54 | 2011 |
| 2 | Hotspot | SVM | 92.70 | 2013 |
| 3 | Water Reservoir | k-NN | 96.94 | 2014 |
| 4 | Fill hole density | k-NN | 96.94 | 2014 |
| 5 | Contour Angular | SVM | 96.00 | 2013 |
| 6 | Distance Profile | k-NN | 94.58 | 2012 |
| | | SVM | 98.13 | |
| 7 | Image Centroid & Zone Centroid | MLP | 94.60 | 2008 |
| | | k-NN | 94.70 | |
| 8 | Hough Transform | MLP | 72.50 | 2013 |
| | | SVM | 93.12 | |
| 9 | Four View Projection Profile | MLP | 98.73 | 2013 |
| | | SVM | 96.04 | |

## III.   METHODOLOGY AND TOOLS

### A.  Preprocessing

The image resulting from the scanning process may contain a certain amount of noise. Depending on the resolution on the scanner and the success of the applied technique for thresholding, the characters may be smeared or broken. Some of these defects, which may later cause poor recognition rates, can be eliminated by using a pre-processor to smooth the digitized characters [6]. Following in figure 1. Showing in sample of image.
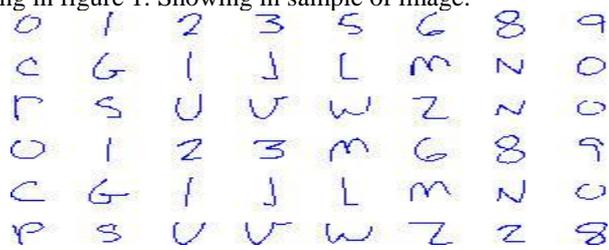

Fig. 1  Sample of scan image handwritten Character & Digits

### B.  Binarization

All handwritten digits were scanned into grayscale images. Each character image was traced vertically after converting the grayscale image into binary matrix [7][8]. The threshold parameter along with the grayscale image was made an input to the Binarization program designed in MATLAB.
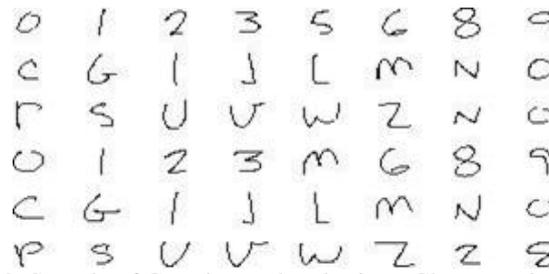
Fig. 2. Sample of Gray image handwritten Character & Digits

*1) Skew Correction:-*

Skew Correction methods are used to align the paper document with the coordinate system of the scanner. Main approaches for skew detection include correlation, projection profiles, Hough transform.
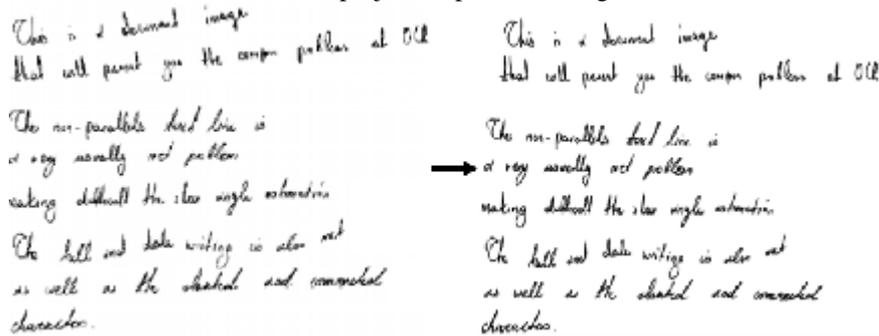
Fig. 3. Skew Correction image sample

*2) Slant Removal:*

The slant of handwritten texts varies from user to user. Slant removal methods are used to normalize the all characters to a standard form.
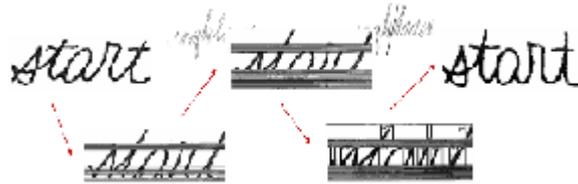
Fig. 4. Example of Skew Correction image

*3) Segmentation*

Segmentation is the process of separating the characters in a word, so that they may be used to assist in final word interpretation. Based on connected component analysis, those components that contain more than one character are over-segmented based on a face-up or face-down region. Then over-segmented components are merged into a single character based on the knowledge of the character structure [9][10]. In the proposed system, the pre-processed input image is segmented into isolated characters by assigning a number to each character using a labelling process. This labelling provides information about number of characters in the image. Each individual character is uniformly resized into pixels as shown in figure 5.

Fig. 5. Example of handwritten character segmentation from images

**C. Feature Extraction**

The objective of feature extraction is to capture the essential characteristics of the symbols, and it is generally accepted that this is one of the most difficult problems of pattern recognition. The most straight forward way of describing a character is by the actual raster image. Another approach is to extract certain features that still characterize the symbols, but leaves out the unimportant attributes. Representation of a character image by statistical distribution of points takes care of style variations to some extent. In this stage, the features of the characters that are crucial for classifying them at recognition stage are extracted. This is an important stage as its effective functioning improves the recognition rate and reduces the misclassification. Feature extraction methods are based on various types of features:

- ✓ Statistical
- ✓ Structural
- ✓ Global transformations and moments

- ✓  spectral analysis
- ✓  cosine transform
- ✓  direction encoding
- ✓  shape features sets
- ✓  force
- ✓  pressure
- ✓  angle function

### D.  *Classification and Recognition*

Off-Line Handwritten Character Recognition system consists of a number of stages which are pre-processing, binarization feature extraction, and classification and followed by the actual recognition as shown in below figure 6.
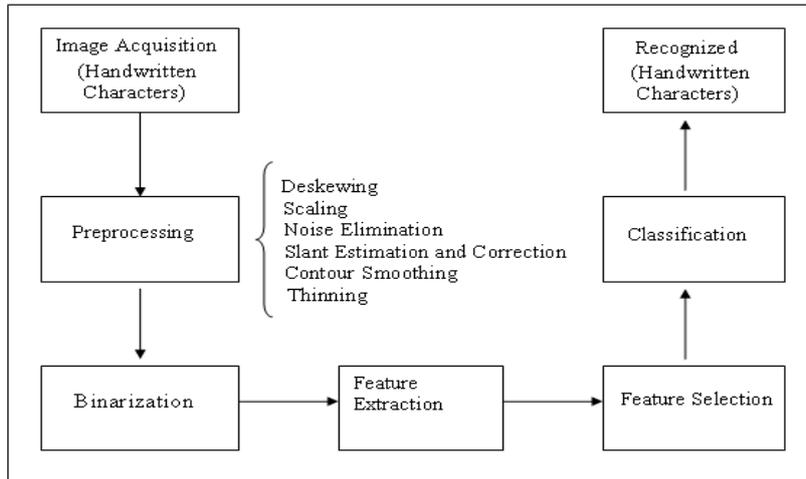


Fig. 6. Illustrative Off-Line Handwritten Character Recognition System

### E.  *Artificial Neural Network (ANN)*

A neural network is a powerful data modelling tool that is able to capture and represent complex input/output relationships. The motivation for the development of neural network technology stemmed from the desire to develop an artificial system that could perform "intelligent" tasks similar to those performed by the human brain. Neural networks resemble the human brain in the following two ways:

1.  A neural network acquires knowledge through learning.
2.  A neural network's knowledge is stored within inter-neuron connection strengths known as synaptic weights.
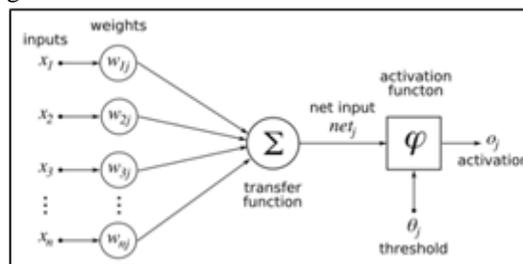


Fig. 7. Structure of ANN

### F.  *Multilayer Perceptron (MLP)*

The most common neural network model is the multilayer perceptron (MLP), this type of neural network is known as a supervised network because it requires a desired output in order to learn. The goal of this type of network is to create a model that correctly maps the input to the output using historical data so that the model can then be used to produce the output when the desired output is unknown. A graphical representation of an MLP is shown below figure 8.
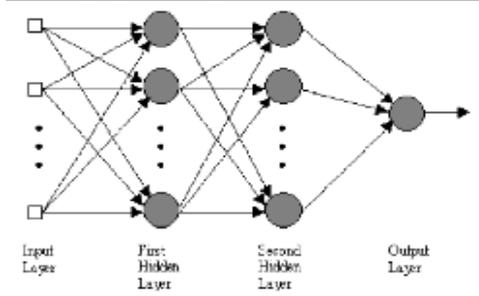


Fig. 8. Block diagram of MLP

*G. Gradient Descent Adaptive Momentum (GDAM) Algorithm*

The Gradient Descent Back propagation uses two types of training modes which are incremental mode and batch mode. In this paper, batch mode training is used for the training process in which momentum, weights and biases are updated for the complete training set which is presented to the network. (GDAM) is proposed which adaptively changes the momentum while it keeps the gain and learning rate fixed for each training node [10]. Mean Square Error (MSE) is calculated after each epoch and compared with the target error. The gradient descent method is utilized to calculate the weights and adjustments are made to the network to minimize the output error.

## IV.  CONCLUSIONS

This paper has presented a review about pattern recognition and Handwritten Character Recognition (HCI) is one of the main branches of pattern recognition. Three stages of HCI are presented namely, preprocessing, binarization feature extraction and classification. This paper focuses on the review of the relevant literature on existing handwritten character and digits techniques. Various methods for recognition character & digits have been proposed in literature. The main approaches used in the field of handwritten recognition during the last decade have been surveyed. Different Pre-processing, Binarization, segmentation techniques and various classifiers with different features are also discussed. MLP, ANN and GDAM, all these classifier are the optimization or robust result to the dynamic changes in the problem of the environment and often require a complete improve in order to provide a solution.

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