ISSN:0975-9646

Reetika Verma et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (4) , 2014, 5565-5570

Enhanced Character Recognition Using Surf Feature and Neural Network Technique

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***Abstract*- Handwriting recognition has been one of the most fascinating and challenging research areas in field of image processing and pattern recognition in the recent years. The Biggest challenge in the field of image processing is to recognize documents both in printed and handwritten format. Recognition of handwritten character is a problem since there is a variation in same character due to different types of noises or font size. Character recognition is one of the most widely used for authentication of person as well as document. In this paper, the proposed solutions focus on applying Neural Network Algorithm model for character recognition. The primary function of which is to retrieve a character stored in memory, when there is a noisy or incomplete version of that character is presented. For the implementation of this proposed work we use Image Processing Toolbox under the Matlab software. Image pre-processing tool, created in MatLab, realizes many brightness transformations and local pre-processing methods. The proposed SURF Feature and neural network has the capability of strong robustness performance and good distinction between feature points it have greatly improved in computing speed. The result of the work performed in this paper the average success rates of recognition of all characters are 98.7753% by using neural network and SURF feature. These algorithms has been performed based on Noise in input image provide promising results in terms of PSNR and MSE.**

***Keywords*- Character Recognition, Neural Network, Surf Feature Extraction, PSNR, MSE.**

I. INTRODUCTION

In today's world of high technology, there is a greater want to convert the analog into digital. Since the advent of digital scanners after the computer came onto the scene, there has been the want to convert books/text into digital media viewable over the internet and/or on a computer. This is where optical character recognition comes in handy.

A. Optical Character Recognition

Handwritten character recognition is a field of image processing as well as pattern recognition. There are two approaches for the pattern recognition such as statistical and structural. In statistical approach, the ser of characteristic measurements of the input data is generated on the statistical basis and is assigned to one of the *n* classes. The structural description of the object is based on the interconnections and interrelationships of features of input data. In general, both approaches are widely used in the pattern recognition [2]. It is used as a form of data entry from some sort of original paper data source, whether passport documents, bank statement, receipts, business card, mail, or any number of printed records. It is a common method of digitizing printed texts so that they can be electronically edited, searched, stored more compactly, displayed on-line, and used in machine processes such as machine translation, text-to-speech, key data extraction and text-mining. OCR is a field of research in pattern-recognition, artificial-intelligence and computer vision [3].

B. Different Areas of Character Recognition

Optical Character Recognition deals with the problem of recognizing optically processed characters. Optical recognition is performed off-line after the writing or printing has been completed, as opposed to on-line recognition where the computer recognizes the characters as they are drawn. Both hand printed and printed characters may be recognized, but the performance is directly dependent upon the quality of the input documents [4]. The more constrained the input is, the better will the performance of the OCR system be. However, when it comes to totally unconstrained handwriting, OCR machines are still a long way from reading as well as humans [3]. However, the computer reads fast and technical advances are continually bringing the technology closer to its ideal.

C. Steps of Optical Character Recognition

Optical Character Recognition (OCR) using Neural Network is basically in the field of research. To gain better knowledge, techniques and solutions regarding the procedures that we want to follow, we studied the various re-search papers on existing OCR systems. All these study helped us with clarifying our target goals [5]. The basic steps involved in Optical Character Recognition are:-

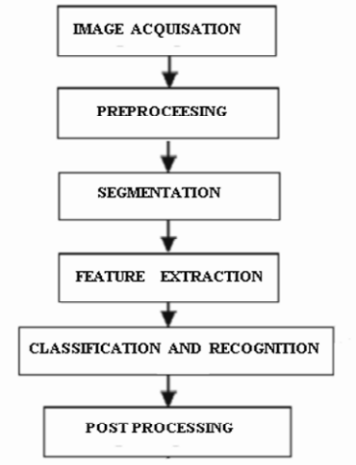


Figure1: Steps of Optical Character Recognition

1. Image Acquisition

In Image acquisition, the recognition system acquires a scanned image as an input image. The image should have a specific format such as JPEG, BMT, etc. This image is acquired through a scanner, digital camera or any other suitable digital input device [6,7].

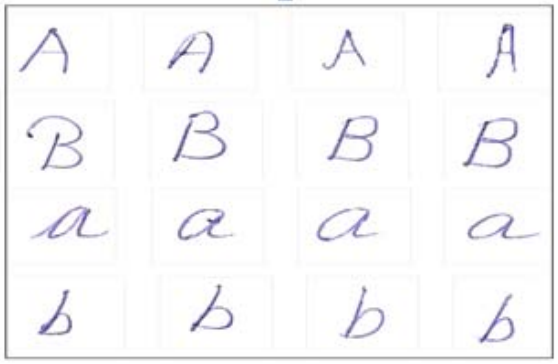


Figure2: Sample Dataset

2. Pre-Processing

The pre-processing is a series of operations performed on scanned input image. It essentially enhances the image rendering it suitable for segmentation. The role of pre-processing is to segment the interesting pattern from the background. Generally, noise filtering, smoothing and normalization should be done in this step [10].

Figure3: Gray-Scale Image

i) Steps In Pre-Processing

Whenever data is collected for recognition, it is collected as an optically scanned image of the paper document. Text digitization is done using a flat bed scanner having resolution between 100 and 600 dpi and stored in a file of picture elements, called pixels. These pixels may have values: OFF (0) or ON (1) for binary images, 0 – 255 for gray-scale images, and 3 channels of 0–255 colour i.e. RGB values for colour images [7].

ii) RGB to Gray Conversion

The scanned image is stored as a JPEG image but images of other formats like BMP, TIFF etc are also used for recognition. All these images are in RGB format. In order to start working with an image it must be converted into a gray scale image. A gray scale image represents an image as a matrix where every element has a value corresponding to how bright/dark the pixel at the corresponding position should be colored. The value of a pixel lies between 0 to 1 or between 0 to 255 depending upon its class [6].

iii) Thresholding/Binarization

Binarization process converts a gray scale image into a binary image using global Thresholding technique. This image format also stores an image as a matrix but can only colour a pixel black or white. It assigns a 0 for black and a 1 for white.

iv) Noise Reduction

The noise introduced by the optical scanning device or the writing instrument, causes disconnected line segments, bumps and gaps in lines, filled loops etc. The distortion including local variations, rounding of corners, dilation and erosion, is also a problem. Median filter is a process that replaces the value of a pixel by the median of gray levels in the neighbourhood of that pixel.

v) Thinning

Thinning is a morphological operation process that is used to remove selected foreground pixels from the binary images and thin the images to single-pixel width level so that their contours are brought out more widely [16]. In this way, the attributes to be studied later will not be affected by the uneven thickness of edges or lines in the symbol. Various standard functions are now available in MATLAB for above operations.

vi) Edge Detection, Dilation, and Filling

The boundary detection of image is done to enable easier subsequent detection of relevant features and objects of interest. After locating the edges the image is dilated and the holes present in the image are filled. These are the operations performed in the last two stages to produce the pre-processed image suitable for segmentation [7].

3. Segmentation

In the segmentation stage, an image of sequence of characters is decomposed into sub-images of individual character [9]. In the proposed system, the pre-processed input image is segmented into isolated characters by assigning a number to each character using a labeling process. This labeling provides information about number of characters in the image. Each individual character is uniformly resized into pixels.

4. Feature Extraction

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. Every character image is divided into equal zones, each of size 10x10 pixels [8,9]. The features are extracted from each zone pixels by moving along the diagonals of its respective 10x10 pixels.

5. Classification and Recognition

The classification stage is the decision making part of the recognition system [3]. A neural network is used in this work for classifying and recognizing the handwritten characters. The pixels derived from the resized character in the segmentation stage form the input to the classifier. The neural classifier consists of two hidden layers besides an input layer and an output layer [6].

6. Post-Processing

Post-processing stage is the final stage of the proposed recognition system. It prints the corresponding recognized characters in the structured text form by calculating equivalent ASCII value using recognition index of the test samples.

D. Techniques of Optical Character Recognition

1. Neural Network (NN)

A neural network is a computing architecture that consists of massively parallel interconnection of adaptive 'neural' processors. Because of its parallel nature, it can perform computations at a higher rate compared to the classical techniques. Because of its adaptive nature, it can adapt to changes in the data and learn the characteristics of input signal. Output from one node is fed to another one in the network and the final decision depends on the complex interaction of all nodes.

Several approaches exist for training of neural networks viz. error correction, Boltzmann, Hebbian and competitive learning. They cover binary and continuous valued input, as well as supervised and unsupervised learning [11]. Neural network architectures can be classified as, feed forward and feedback (recurrent) networks.

A Neural Network is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of the NN paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. A NN is configured for a specific application, such as character recognition or data classification, through a learning process [1]. Artificial neural network have been developed as generalization of mathematical model of human cognition or neural biology based on the assumption

1. Information processing occurs at a simple element x called neuron.
2. Signals are passed between the neurons over connected link. Each connection link has associated weight which in typical neural net multiply the signals transmitted.
3. Each neuron applies to its activation function to its net input to determine the output signal [2].

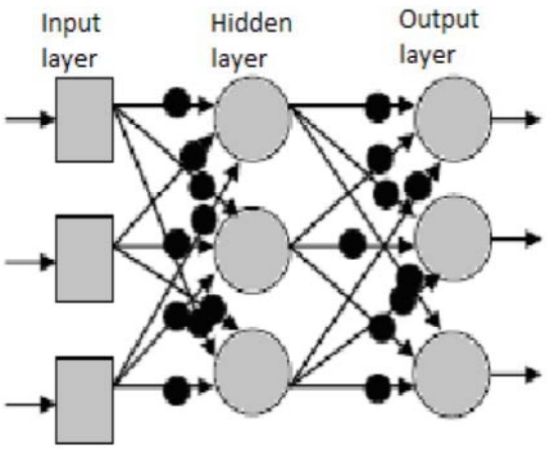


Figure 4: Neural Network

Many reports of character recognition in English have been published but till high recognition accuracy and minimum training time of handwritten English characters using neural network is an open problem. Therefore, it is a great important to develop an automatic handwritten character recognition system for English language[3] In this paper, efforts have been made to develop automatic handwritten character recognition system for English language with high recognition accuracy and minimum training and classification time. Experimental result shows that the approach used in this paper for English character recognition is giving high recognition accuracy and minimum training time [4].

i) A neural network is characterized by:

They exhibit some brain-like behaviour that is difficult to program directly like:

a. Training and learning (determining weights on the connection).
b. Fault Tolerant (graceful degradation of performance if damaged)
c. Evidential Response (confidence level improves classification)
d. Adaptively (Adapt weights to environment and retrained easily)
e. Activation function
f. generalization
g. noise immunity

NN ALGORITHM

Error correction for the individual

$$E^p = \frac{1}{2}\sum_0 \left(t_0^p - y_0^p\right)^2 \qquad \text{Equation (1)}$$

$$G = \frac{\partial E}{\partial w_{ij}} = \frac{\partial}{\partial w_{ij}} \sum_p E^p$$

$$= \sum_p \frac{\partial E^p}{\partial w_{ij}}$$

Chain rule

$$\frac{\partial E}{\partial w_{0i}} = \frac{\partial E}{\partial y_0} * \frac{\partial y_0}{\partial w_{0i}}$$

From 1 by taking derivation with respect to y_0 we get,

$$\frac{\partial E}{\partial y_0} = -(t_0 - y_0) \qquad \text{Equation (2)}$$

$$y_0 = \sum_j w_{oj} x_j$$

$$\frac{\partial y_0}{\partial w_{oi}} = \frac{\partial}{\partial w_{oi}} \sum_j w_{0j} x_j = x_i \qquad \text{Equation (3)}$$

We get the following by using the equations (2) and equation (3);

$$\frac{\partial E}{\partial w_{0i}} = -(t_0 - y_0)\, x_i$$

Therefore for applying the correction in a direction we get the following

$$\Delta w_{0i} = \eta\,(t_0 - y_0) x_i$$

is the rate of learning.

For learning rule, consider the simple case of a neuron *k* constituting the only computational node in the output layer of a feed forward neural network. Neuron *k* is driven by a *signal vector* x(n) produced by one or more layers of hidden neurons, which themselves driven by an input vector applied to the source nodes(i.e. input layer) of the neural network.

2. Surf Feature Extraction

The purpose of feature point matching is to find up the feature point from the same location in two images and match a couple of feature points. SURF adopts nearest neighbor. A SURF descriptor is a 64-dimensional vector which need new data structure to place. So, we use KD-tree to make matching [26].

i) SURF Feature Matching

Many approaches have been proposed to match corresponding features between two images. Low proposed the using of the ratio between the Euclidean distance to the nearest and the second nearest neighbors [27].However, the method only match feature points from a single direction. The error rate of matching is still high. One-to-many matchings are often appeared in results. This paper presents a fast matching method. They detected feature points, the method only select part of them to match.

II. EXPERIMENTAL RESULTS AND OUTPUTS

Evaluation Indexes for Character Recognition

In this paper, presented the experimental results has been performed to calculate the CCRs (Correct Classification Rate) are shown in the table. We compute the CCRs by three strategies: directly using NN, using Surf and NN + Surf.

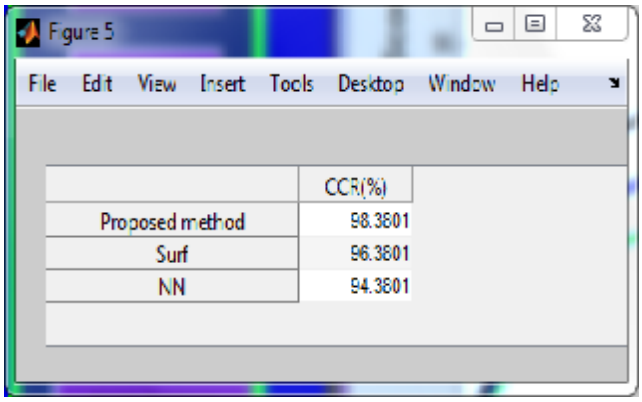


Figure 5: CCRs of the three strategies

The above figure shows the cumulative scores or correct classification rate for recognized character. There are three strategies used to calculate the CCR values in (%). It is to be noted that the cumulative scores of recognized character is equivalent to the CCRs as shown in Figure 5. The three strategies are Neural Networks (NN), SURF, and NN + SURF, which are used to recognize the characters of English language.

A. Table

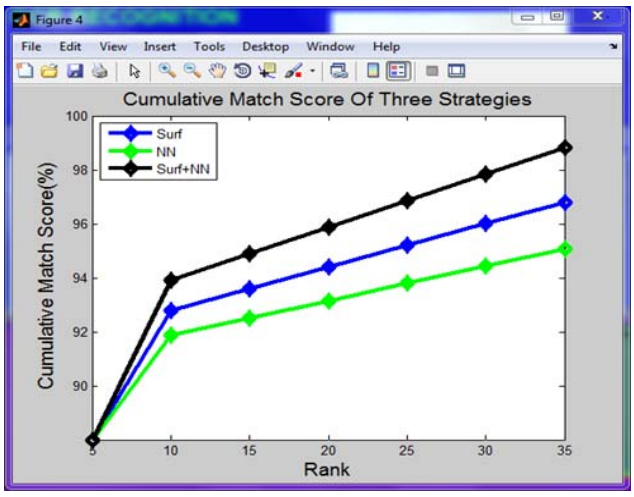
Given table show all three techniques provide different accuracy for all characters. Better accuracy was achieved by Neural Network and Surf feature when we combine these both techniques. In this table shows the better recognition rate removing noise and feature extraction by using these techniques. These algorithms has been performed based on Noise in input image provide promising results in terms of PSNR and MSE. The accuracy of these techniques and performance of these parameters can see in this table.

Table 1: CCR Shows Accuracy of Different Characters.

CHARACTER	SURF	Neural Network	Proposed SURF+NN	PSNR	MSE
A	97.63	95.63	99.63	25.02	204.67
B	95.53	93.53	97.53	23.76	273.27
C	97.82	95.82	99.82	24.06	255.21
D	97.89	95.89	99.89	22.69	349.95
E	94.10	92.10	96.10	24.75	217.56
F	96.30	94.30	98.30	24.40	235.93
G	94.79	92.79	96.79	24.66	221.88
H	97.78	95.78	99.78	24.59	225.52
I	96.38	94.38	98.38	25.24	194.30
J	94.54	92.54	96.54	23.76	258.42
K	97.89	95.89	99.89	23.65	280.24
L	94.10	92.10	96.10	25.34	193.67
M	92.30	95.30	99.30	22.95	329.35
N	97.35	95.35	99.35	24.10	252.77
O	95.08	93.08	97.08	24.44	233.78
P	94.93	92.93	96.93	23.74	274.65
Q	96.84	94.84	98.84	24.06	255.31
R	97.28	95.28	99.28	23.46	292.85
S	97.60	95.60	99.60	24.25	244.17
T	97.08	95.08	99.08	25.67	176.18
U	96.79	94.79	98.79	24.68	221.19
V	96.80	94.80	98.80	25.25	193.72
W	97.32	95.32	99.32	23.86	267.15
X	94.33	92.33	96.33	24.19	247.70
Y	97.36	95.36	99.36	25.09	201.14
Z	95.23	93.23	97.23	25.45	185.34

B. Graphical Representation

The experiment has been performed of a character 'A' which shows the cumulative match score of three strategies that are NN, Surf and NN + Surf. It shows all three tehniques with different cumulative match score. Graphical representation of these three techniques have different rank neural network has lowest rank and surf has in between and by combining of these both techniques surf and neural network gives better performance.



Graph 1: Cumulative Match Score of Three Strategies

C. Recognized Character Using SURF and NN

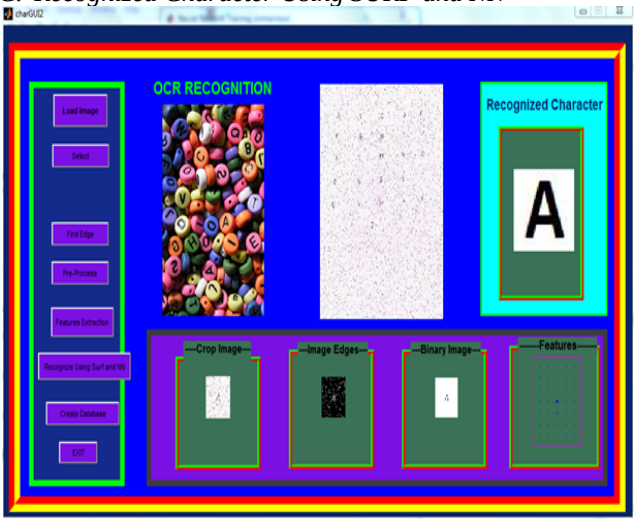


Figure 6: Shows the Recognized Character

1. Load an input character noisy image.
2. Select a particular character from the input image.
3. Find edges for an particular image.
4. Pre-processing can be done in this stage first we remove the noise then convert it into binary image.
5. At last feature extraction will be done for pattern matching. Pattern match from the database.
6. Finally we recognize a character by using neural network and surf feature.

III. CONCLUSION

It is hoped that this detailed discussion will be beneficial insight into various concepts involved, and boost further advances in the area. The accurate recognition is directly depending on the nature of the material to be read and by its quality. Current research is directly concern to the characters. From various studies we have seen that selection of relevant feature extraction, Neural Network (NN) and Surf technique plays an important role in performance of character recognition rate. This review establishes a complete system that converts scanned images of optical characters to text documents. This material serves as a guide and update for readers working in the Character Recognition area.

ACKNOWLEDGEMENT

I would like to thank my guide Mrs. Rupinder Kaur, Assistant Professor in Department of Computer Science and Engineering at RIMT-IET (MandiGobindgarh), Punjab, India for motivating me to do research work on the topic Enhanced CHARACTER RECOGNITION Using Surf Feature and Neural Network technique. I would also like to thank my mother, my father and my siblings for their continuous support, cooperation, and guidance throughout my M.Tech work. Moreover I would also like to thank my Professors who were always there at the need of the hour and provided with all the help and facilities, which I required, for my thesis work.

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