Handwriting Variation In Urdu And English Language Using Cnn

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Abstract

Handwriting recognition is the automatic transcription of handwriting, where only the image of the handwriting is available. Manual matching shall be used by banks for the authentication of checks and signatures. In forensics, handwriting corresponding algorithms can help handwriting analysts to predict the author with greater precision. This handwriting needs to be scanned to the computer for the handwriting recognition system to access it and analyze it consequently. A variety of handwriting applications, including transcription papers, mail routing, and processor forms, checks, and faxes, may be envisaged. Several applications are also possible. The extensive research effort concentrated on the field of character recognition (CR), due both to its possible applications and to the difficulties involved in simulating human reading. The new Offline Handwritten Recognition (OHR) is designed for both Urdu and English. It mainly focuses on the removal of noises in word, character segmentation methods with higher recognition rate. The images which are scanned may contain noises and image denoising steps consist of binarization, noise elimination, and size normalization. Words and character segmentation are performed by using Particle Swarm Optimization (PSO) algorithm. Then those segmented samples are used for the next step which is feature extraction. Finally, word recognition is performed by using the deep neural network classifier.

Keywords: word recognition, neural network, feature extraction, segmentation, Urdu and English

1. INTRODUCTION

For the new generation, it will be important to popularize the language and benefit from the available documentation (old or current) (Shyni et al, 2015). The OCR interprets the scanned document image into a machine-understood script. The ability of a machine to obtain and read intelligible handwritten input from sources including paper papers, images, touch screens, and other devices is handwritten recognition (HR). The picture of the written text could be sensed "offline" by an optical scan or smart word recognition on a piece of paper. Alternatively, the motions on the tips of the pen can be detected "online" e.g. via a pen-based computer screen surface. Human functionality simulation in the field of vision and manuscript text in particular is still missing. The need to know the handwritten text is a challenge not only about behavioral biometry but also about trends. Writing is the most normal mode in which information is gathered, saved, and transmitted. It is not only a communication tool among people but also a communication tool between human beings and machines. The few applications listed for offline handwritten recognition require to

check recognition, file format recognition of manual applications, prescription of a doctor, checking signature, postal address interpretation, etc.

The intense research effort was focused on the field of recognition of character (CR) due to the problems associated with human reading simulation and its future applications. CR is a special pattern recognition branch, which includes the translation into the machine-readable text of the text written or printed (Mahmoud et al, 2014). While many promising research findings have been published in the field of the handwritten recognition of linguistics such as English, Chinese, Japanese, and Arabic, the Indian language scenario is not so strong. The two most popular writings in India are Devanagari and Bangla, most of the works in the Indian field of character recognition. India has 22 programming languages, multi-lingual, multi-script countries. Much of the Indian scripts come from the Brahmi script of old times. The Kadamba and the Grantha scripts of ancient Brahmi are derived from the South Indian languages. An analysis of the various aspects of the manuscript recognition method is carried out in this research for Urdu, and English.

The major aim of the work is to design a new offline handwritten recognition (OHR) system for multilingual, which maximizes the recognition rate with the least amount of elements. The major objectives of the design are designed as follows. To design new preprocessing methods such as noise elimination, binarization, size elimination, and thresholding for removing noises from the images because this increases the quality of the characters. To design a new optimization-based segmentation method that correctly segments the line, character, and word from the images. To design a new Character Recognition Method which correctly recognizes Urdu, and English increases the recognition rate of the characters.

2. RELATED WORK

Handwritten recognition can be broadly classified into two categories namely, online recognition and offline recognition. Offline handwriting can be of many formats and likely it could be obtained from paper or images. These types of contents could be extracted using Optical Character Recognition (OCR). This mechanism is very useful in many areas, one among those in the medical field. In ancient days, analyzing a doctor's handwriting is a bit difficult task. This methodology helps to analyze and retrieve the information from the doctor's handwriting. In this section, the researcher has discussed the review of the preprocessing methods, segmentation methods, feature extraction methods, and classification methods for the handwritten recognition of image processing.

The influence of the coevolutionary depth of the network on its accuracy in the broad recognition environment was investigated by Simonyan and Zisserman (2014). The key contribution is to thoroughly analyze networks of growing depth using an architecture with a very small 3x3 convolution filter that shows that the depth of 16-19 weighing layers can be considerably improved in terms of prior art configurations. These results formed the basis for our submission to the ImageNet Challenge 2014 where our team won first and second place places in the position and grading routes respectively. Show also, that representations are common in other datasets.

Kumar et al (2016) employed the OCR for offline handwriting recognition. To implement the OCR the neural network has been utilized. This model has been developed for the medical domain in which the doctor's handwriting can be recognized. This model only predicts the prescribed medicines and does not provide an outcome for general purposes.

The off-line segmentation and reconnaissance method for uncontrolled handwritten linked digits has been proposed by Merabti et al (2018). By finding two forms of structural functionality, the framework proposed offers new segmentation routes. The input string image includes the background and foreground character points. From these feature points, the possible cutting paths are created. Based on their feature points and their height, each candidate variable is evaluated individually. The performance is evaluated with the Fuzzy artificial immune system the segmentation module (Fuzzy-AIS). The latter carries out a decision-making function in the resulting parts, followed by a global choice of the hypothesis with the best outcome.

Al-Maadeed et al (2016) aimed to develop a new system that selects the vital feature thereby eliminating the non-effective features. This model could be developed using Lukasiewicz's implication on fuzzy conceptual reduction. Both English and Arabic languages are taken into consideration for handwritten recognition of characters. The database of 121 writers is considered on which the k-Nearest Neighbors (k-NN) is used to evaluate the accuracy efficiency. The left or right-handedness parameter is considered for evaluation and it produces a high accuracy of 83.43%.

Govindarajan (2016) developed a hybrid which is of a new classification model for handwritten numerals detection by combining SVM and Radial Basis Function (RBF) classifiers. The original training sets are resampled to form modified training sets. Here classifiers are combined by voting after construction by using training sets. The proposed hybrid model system provides high accuracy of handwritten recognition of numerals and is illustrated by the empirical outcome obtained from the model.

Balci et al (2017) proposed a model for converting the handwritten text into digital documents. This model is designed such that it includes two approaches namely, direct classification of words and segmentation of characters. The Convolution Neural Network (CNN) is the methodology employed for the former approach. The latter approach involves Long Short Term Networks (LSTM) methodology with convolution for the construction of bounding boxes of every character. Then the segmented characters are passed to CNN for classification and thus the words are reconstructed based on results.

3. METHODOLOGY

The proposed work majorly focuses on the removal of noises and image segmentation methods with recognition methods. The proposed flow diagram is shown in Figure 3.1.

The handwritten recognition could be achieved effectively by implementing the following process:

(i) PRE-PROCESSING

This process involves the conversion of raw data into a user-readable form by undergoing various steps.

Binarization: The image digitization is one of the steps involved in preprocessing where the image is converted to a gray scale image and then transformed into a binary image.

Noise elimination: The scanned images generally contain noises. Filled loops, gaps, bumps, and disconnected line segments are the general noises occurring in images. So noise elimination is performed for effective recognition.
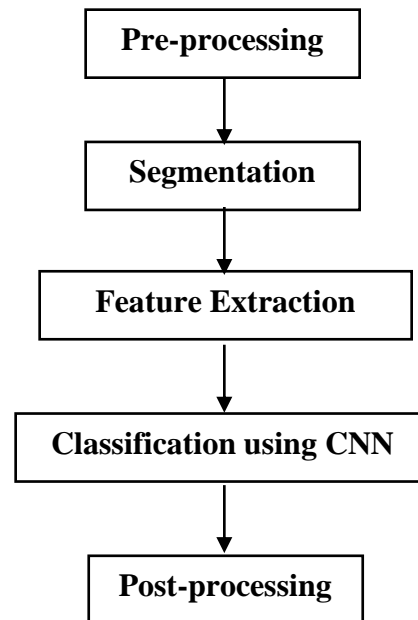
Figure 3.1. Proposed Flow Diagram for Handwritten Recognition

Normalization: Removal of variations from images without affecting word identity is the process of normalization. The initial process of normalization involves image cleaning and it involves the trailing process namely, skew correction. Next to that line detection and character size normalization occurs.

(ii)   SEGMENTATION

The next step to pre-processing is segmentation where the characters in the image are segmented for providing separation between characters. This also helps to simplify the recognition process. Script segmentation and image segmentation are the kinds involved. The script segmentation is implemented using performing word, line, and character segmentation. Particle Swarm Optimisation (PSO) is one of the segmentation methods that enhances the solution by iterative optimization of the problem.

(iii)   FEATURE EXTRACTION

In the presence of the least amount of elements, the recognition rate could be increased by extracting the feature set in this process. There are various kinds of feature extractions. Some of them were Chain Code (CC), Principal Component Analysis (PCA), and so on. The output extracted from Feature extraction is being provided as input for classification.

(iv)   CLASSIFICATION

Classification is the vital phase and it acts as a part of the decision making of handwritten recognition. The feature quality decides the classifier's performance. The output of the classifier is provided as input to the deep neural network classifier. Artificial Neural Network where multiple hidden layers among the input layer and output layer occur is Deep Neural Network (DNN).

(v)   POST-PROCESSING

Structural text format is obtained as output from the post-processing as it is the final phase of recognition. Problems in segmentation and classification of character errors occur usually. So to eliminate these errors, this phase is executed. Statistical approach and dictionary lookup are the methods employed for error elimination. Thus the effective recognition of texts is obtained on performing that process.

Noise removal by Modified Median Filter Pre-processing deals with the reduction or removal of noise in images. There are different types of noise are available namely, noise, Salt, Shot, Quantization noise (uniform noise), Film grain, Anisotropic noise, and Periodic noise. To obtain efficient results, a modified mechanism is used in research areas namely K-Algorithm. This approach includes two different stages namely, binarization and filtering. A re-sampling algorithm has been used to perform filtering processing noise elimination steps. Filtering always refers to the various functions that are predefined in the image to assign value to the pixel which is considered as a function of values. Unwanted bit patterns are diminished using this methodology. It would remove the images that are textured slightly or background with color and sharper them. Due to this process, much possible noise is reduced by making retaining only relevant information. The filter is of two categories: non-linear and linear filters. Since linear type has some disadvantages, the non-linear type has been used to overcome those disadvantages such as blurring edges, blurring details, and destruction in lines.

```
Pseudocode: Modified_Median_Filter (Image, Matrix_Size)
1. SetA_Min=-(Matrix_Size)/2
2. Set A_Max=(Matrix_Size)/2
3. For X=Min_X toMax_X
4. For Y=Min_Y toMax_Y
5. For X1=A_Min toA_Max
5.1. SetTemp_X=X+X1
5.1.1. If (Temp_X>=Min_X andTemp_X<=Max_X)
5.1.2. For Y1=A_Min to A_Max SetTemp_Y=Y+Y1
5.1.3. If (Temp_Y>=Min_Y and Temp_Y<=Max_Y) Add Pixel_Intensity (Temp_X, Temp_Y) to
listPixel_Values
5.1.4. End If
5.1.5. EndFor
5.1.6. End If
6. EndFor
7. Sort the listPixel_Values
8. Set No_Occurences=Number of the occurrences of lowest pixel intensity value in listPixel_Values
9. If (No_Occurences==K)
9.1. Median_value=Value at Pixel_Values_Count/2
9.2. Set Pixel_Intensity(X, Y) =Median_Value
10. End If
11. EndFor
12. EndFor
13. Return Modified Image
```

Binarization is one of the approaches used for image denoising. The binarization step could be carried out after a filtering process. These filtering and binarization methodologies are adapted by modified mechanisms for noise reduction. The name of the modified technology is K-Algorithm which would

actively involve in performing the removal of noise present in the image. This binarization (Ntogas et al 2013) approach could be applicable for images to separate the text from the background. This process is purely based on thresholding and filtering which is combined with algorithms of image processing. The procedures of binarization involve 5 sets of discrete stages that depend on various classes of images. It acts as a refinement methodology to improve image quality. The result obtained in the filtering stage might still possess colored backgrounds slightly that lead to interference in the functioning of the next stages. To avoid and deal with these said issues, binarization has been introduced. The binarization step is involved in the conversion of filtering images into a digital image which means binary. From this, the value of the threshold could be calculated, and finally based on colors, the processes are carried out. That is if the intensity value of the pixel is above a threshold value, it is set as white (0) and if it is below the thresholding value, it is set to be black (1). Thus by using an average of overall pixel intensities in the document, the threshold value could be obtained.

The process of normalization is linear. For instance, if the image has intensity ranges between 50 and 180 then the range desired is between 0 and 255. Every pixel-based intensity is multiplied by using 255/180 and obtains a range of 0 to 255. Automatic normalization typically normalizes the image in any file format. It leads to the production of the image in a constant dimension. It aims to reduce the variations which occur during the writing of data. For Instance, the size normalization (Kumar et al 2013) has been used to adjust the size of the character in a form of standard. This recognition of characters is applicable for both vertical and horizontal based size normalization

$$R_1 = \frac{min(W_1, H_1)}{max(W_1, H_1)}, R_2 = \frac{min(W_2, H_2)}{max(W_2, H_2)}$$

Thus ...

H1 ...

W2 ...

H2 ...

R1 ...

R2 ...

Seg...
eme...
stru...
In th...
with...
stan...

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Pseudocode:
 Binarization (Image)
1. For X=Min_X to Max_X//1
2. For Y=Min_Y to Max_Y //2
Pixel_Intensity_Sum=Pixel_Intensity_Sum+Pixel_Intensity(X,Y)
 Pixel_Count=Pixel_Count+1
3. EndFor
4. EndFor
5. Average_Intensity= Pixel_Intensity_Sum/Pixel_Count
6. For X=Min_X toMax_X
7. For Y=Min_Y toMax_Y
7.1. If (Pixel_Intensity(X, Y)>=Average_Intensity) Set Pixel_Intensity(X, Y) =WHITE
7.2. Else Set Pixel_Intensity(X, Y) =BLACK
7.3. End If
8. EndFor
 9. EndFor
 10. Return Modified Image
```

best value which is obtained from particle present in the neighborhood of particle. This type of value is said to be as gbest. By using the information, below each particle in PSO tries to change its state or position,

- ● The current velocities,
- ● The current positions,

- The distance between the current position and the gbest
- The distance between the current position and pbest,

This equation brings out a model based on mathematical for changes in the position of the particle,

$$V_i^{k+1} = wV_i^k + c_1 * rand_1(\ ) * (pbest_i - s_i^k) + c_2 * rand_2(\ ) * (gbest_i - s_i^k)$$

Where, V_i^k = In iteration k, i with agent velocity,

w = Function for weighting,

cj= Factor for weighting is j=1,2.

Rand = Distributed uniformly having number from 0 to 1 70 in a random manner,

k = denotes the agent i's current position of agent in kth iteration,

pbesti = i's pbest,

gbesti = gbest's group

$$W = W_{max} - [(W_{max} - W_{min})iter]/maxiter$$

where wMax = represents weight at initial, wMin = denotes weight during final, maxIter= represents iterations number by maximum, iter= denotes the number of iteration currently, Following specified equation could modify the currently available position which means searching point present in solution space.

$$s_i^{k+1} = s_i^k + V_i^{k+1}$$

DEEP NEURAL NETWORK CLASSIFIER

The deep neural network is called to be a learning approach, where it could be used for humans to obtain knowledge. In other words, it would be considered as an approach for automation of predictive base analysis. Deep Neural Network shortly DNN is an Artificial Neural Network with various hidden layers. These layers are placed between the output and input layers. It is used to develop complex non-linear relationships. This model involves the generation of a compositional approach where objects can be expressed in a layered based composition. Also, the layers that are available extra would enable the features from the lower layer. Since DNN is a feed-forward network, the data can flow from input to output layer in one direction which means not loop towards the back. This deep neural classifier has been used in Image recognition due to the presence of noise. The classifier has been designed for dealing with noise in images to remove it. Image denoising has always been a major issue in computer vision. At its core, denoising is an essentially ill-posed issue appropriate to the loss of data for the period of noise addition. The following formula is used for image denoising.

I=D(I) + h

Here, D(I) is the degrading function related to the original image I while h serves as additive noise. With the end aim of denoising, an image and returning a similar dimensional calculation, the mainly extensively used loss minimizer is pixel-wise Mean Squared Error (MSE). By removing noises, one can analyze the

performance and could obtain accuracy (Koziarski and Cyganek 2016). This process typically works on noise with known and unknown conditions. It consists of various types of neural networks. One of the most common types widely used is the Deep Convolutional Network. Each has network used by this has each network layers adjacently which is fully connected. This means that every neuron in the network has a connection with other neurons which is adjacently presented in layers. Various mathematical models are involved in image denoising using a deep neural network. One among them is discussed here,

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Proposed Algorithm Pseudo code :
Training set = PSO_Features, target, hidden neurons, Iterations_max, weights, bias.
Output: Network
1. Start
2. Network initialize net1 threshold ≤ T, [ro,co] = size (PSO_Features)
3. For i = 1:ro training_set =cat(1,1:50);
4. Endfor
5. For j = 1:co target (j) =j;
6. Endfor training_set = double(training_set);
7. For(i> 1, i ≤ Tmax,i++)
8. Do
8.1. net1 = newff(training_set,target,10);
 8.2. net1.trainParam.epochs=100;
8.3. net = train(net1,training_set,target);
9. While 9.1. backpropagateerror(net1,net,Network);
10. End while
11. End
```

4. RESULTS AND DISCUSSION

40 samples of Urdu language from different handwritten documents are obtained to test the effects of these methods. Python is used to develop models for training and testing. Character Recognition steps like Preprocessing, feature extraction, segmentation, and recognition is used for implementation. For these steps, the character image is considered as input for recognition.
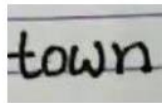
A. Input image
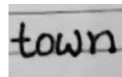
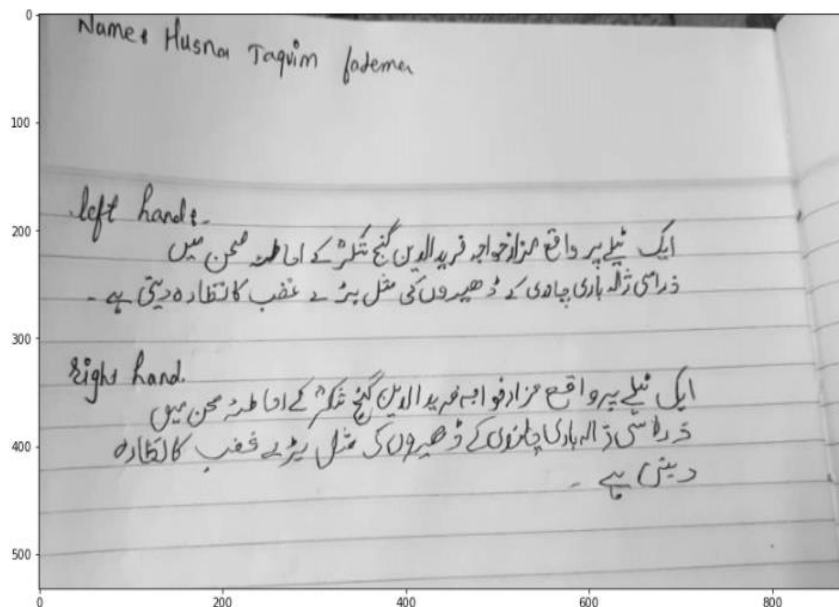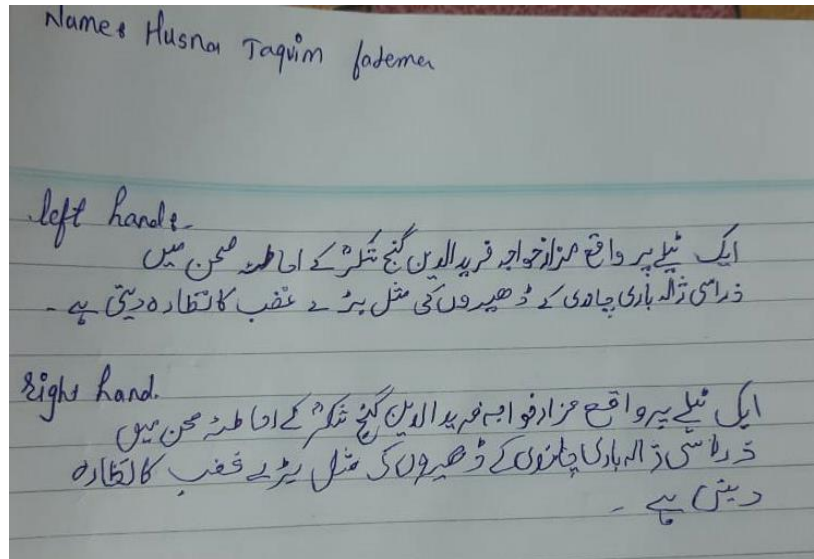

B. Preprocessed image
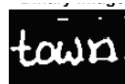
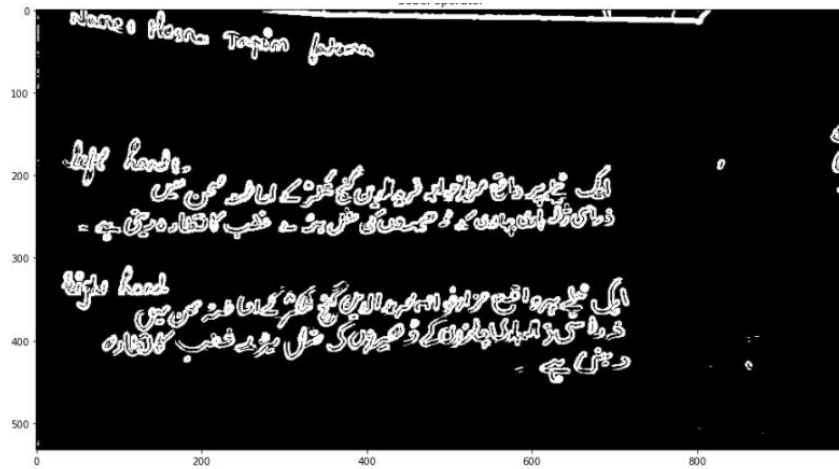C. Binary image

town

D. Output Image

Figure 3.2. English Handwriting recognition results of small letters

Figure 3.2 shows the results of the English handwriting recognition for the small letter of proposed steps. Figure 3.2 (A) shows the results of the input image of small English letters, Figure 3.2(B) shows the results of the preprocessed image of small English letters, Figure 3.2(C) shows the results of the binary image of small English, and finally Figure 3.2(D) shows the output of recognition results of small English.
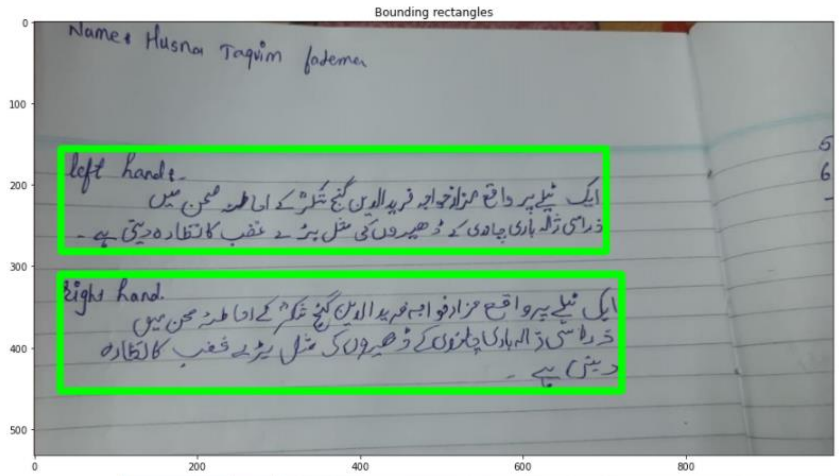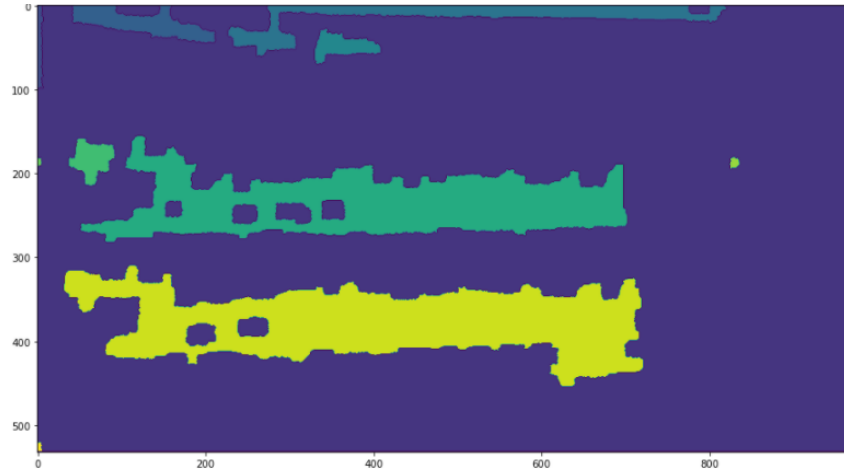
A. Input image

B. Preprocessed image

C. Binary Image

D. Output Results

E. Left and right hand-writing recognition

Figure 3.3. Urdu Handwriting recognition results of small letters

Figure 3.3 shows the results of the Urdu handwriting recognition of proposed steps. Figure 3.3 (A) shows the results of the input image, Figure 3.3(B) shows the results of the preprocessed image, Figure 3.3(C) shows the results of the binary image, Figure 3.3(D) shows the output of recognition results and finally Figure 3.3(E) shows the categorization of the left hand and right handwritten text in Urdu language.

The results are shown in Table 3.1 and Figure 3.2. The quality of the image is increased for clear recognition as it improves the performance of the system. The deep neural network classifier provides efficiency of 90.52% whereas SVM gives only 85.13%, Naive Bayes yields 87% efficiency in handwritten recognition of data. There are 100 iterations used in this work with 10000 samples and 48 samples for the Urdu language.

Table 3.1. Performance comparison results of English character

Algorithm	Sensitivity (%)	Specificity (%)	Precision (%)	F-measure (%)	Accuracy (%)
DNN	88	76	88	88.04	91.5
NN	84	72	87	85	89
Naïve Bayes	83	70	86	85	84.5
SVM	81.12	69.5	85.62	83.56	85.32

Table 3.2. Performance comparison results of Urdu text

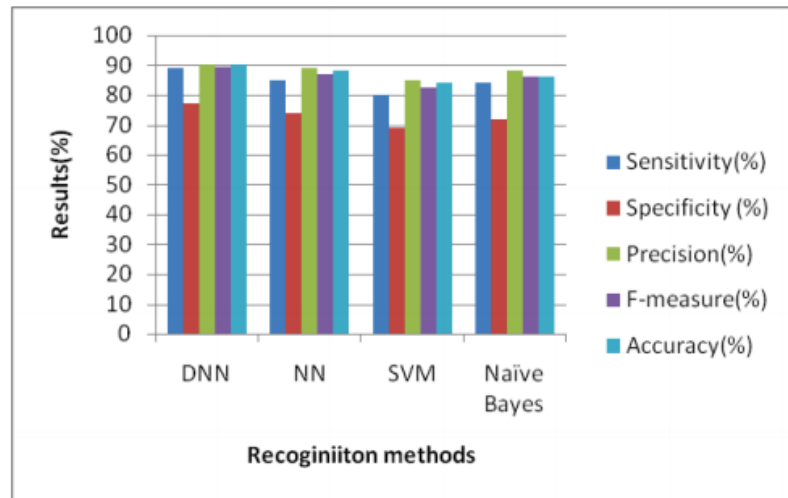| Algorithm	Sensitivity (%)	Specificity (%)	Precision (%)	F-measure (%)	Accuracy (%)
DNN	89	78	90	89	91
NN	87	76	88	87	89
Naïve Bayes	85	74	85	86	87
SVM	82	70	86	84	85

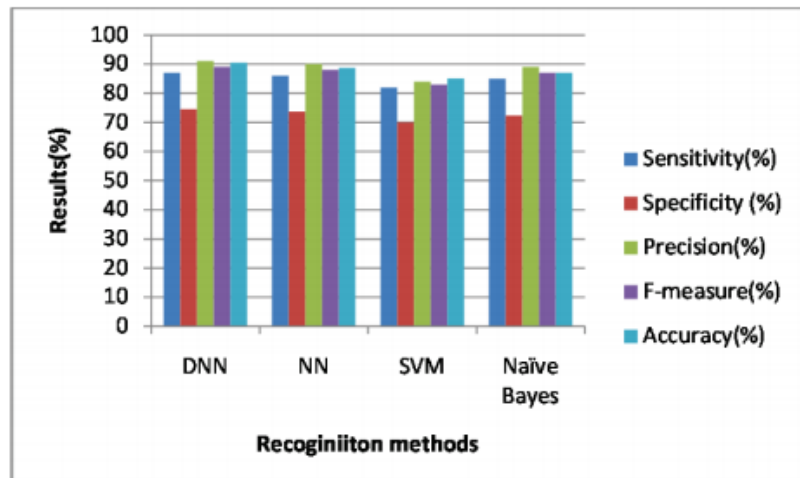Figure 3.4. Proposed Algorithm Performance (English)

Figure 3.5. Proposed Algorithm Performance (Urdu)

5. CONCLUSION

Online recognition and off-line recognition are the two most common ways of recognizing a word or character. This model is designed in such a way that it is based on an off-line recognition system that involves various phases of recognition in it. The initial contribution of the work deals with the off-line recognition in which the pre-processing of the image is performed in which binarization; noise elimination and normalization are also performed. The segmentation is performed by using Particle Swarm Optimization (PSO) algorithm. The feature extraction phase helps to obtain the set of features and then the classification phase is where the Deep Neural Network (DNN) classifier is used for handwritten extraction. It is an iterative model. The final phase is where post-processing is done for efficient identification in which the errors that occurred in classification and recognition of words are eliminated.

REFERENCES

[1] Shyni, SM, Raj, MAR & Abirami, S 2015, Offline Tamil handwritten character recognition using sub line direction and bounding box techniques', Indian Journal of Science and Technology, vol. 8,no.S7,pp.110-116.

[2] Mahmoud, SA, Ahmad, I, Al-Khatib, WG, Alshayeb, M, Parvez, MT, Märgner, V & Fink, GA 2014, KHATT: An open Arabic offline handwritten text database', Pattern Recognition, vol.47, no.3,pp.1096-1112.

[3] Simonyan, K & Zisserman, A 2014, Very deep convolutional networks for large-scale image recognition, pp.1-14

[4] Kumar, R & Ravulakollu, KK 2014, Handwritten Devnagari Digit Recognition: Benchmarking On New Dataset', Journal of theoretical & applied information technology, vol.60, no.3,pp.543-555.

[5] Kumar, S, Deep, NSA &Ghosh, KGMR 2016, Offline Handwriting Character Recognition (for use of medical purpose) Using Neural Network', International Journal of Engineering And Computer Science, vol.5, no.10,pp.18612-18615.

[6] Merabti, H, Farou, B and Seridi, H 2018, A Segmentation-Recognition Approach with a Fuzzy-Artificial Immune System for Unconstrained Handwritten Connected Digits', Informatica, vol.42, no.1,pp.95-106.

[7] Ntogas, N & Veintzas, D 2013, A binarization algorithm for historical manuscripts', In WSEAS International Conference. Proceedings. Mathematics and Computers in Science and Engineering,vol.12, pp.41-51.

[8] Al-Maadeed, S, Ferjani, F, Elloumi, S & Jaoua, A 2016, A novel approach for handedness detection from off-line handwriting using fuzzy conceptual reduction', EURASIP Journal on Image and Video Processing, vol. 2016, no.1, pp.1-14.

[9] Balci, B, Saadati, D & Shiferaw, D 2017, Handwritten Text Recognition Using Deep Learning. CS231n: Convolutional Neural Networks for Visual Recognition', Stanford University, Course Project Report, pp1-8.

[10] Govindarajan, M 2016 Recognition of handwritten numerals using RBF-SVM hybrid model', Int. Arab J. Inf. Technol., vol.13,no.(6B),pp.1092-1098