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Recognition of Handwritten Devanagari Script : A Survey

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ABSTRACT

With the advancement in the technology the jobs for the human kind is becoming more and more tedious with millions and trillions of documents waiting to be processed. Certainly, such a daunting tasks are next to impossible to be completed manually. Over a period, the things are getting automatically done with the robots or intelligent computer systems. Optical character recognition is one of such recent fields that is used in automatic processing of the images captured by the high quality cameras. It finds one of the most popular uses in automated toll plazas. This paper represents survey about various optical character recognition techniques that have been researched upon by various authors in the past. OCR was generally used to recognize printed or typewritten documents. Character recognition has two categories i.e. Online Handwritten character recognition is defined as Writing with a special pen on a pressure-sensitive digital tablet and Offline Handwritten character recognition is defined as recognition of character by camera and scanner. To recognize offline handwritten Hindi text is very difficult and challenging task due to different writing styles are written by different person. This paper presents the recognition of offline handwritten Hindi characters using digitization , pre-processing, segmentation, diagonal feature extraction , zoning feature extraction and classification that is commonly used in Verifying Process , Recognizing process like bank cheques, Signature Verification, Postcode Recognition, Passport readers, offline document recognition.

Keywords: Feature Extraction, Zoning, Diagonal, K-Nearest Neighbor Classifier.

I. INTRODUCTION

Prior OCR was generally used to recognize printed or typewritten documents. There is an expanding pattern to recognize manually written documents. The acknowledgment of manually written documents is more convoluted in contrast with acknowledgment of printed documents. It is on account of manually written documents contains unconstrained varieties of composed styles by various scholars even unique written work styles of same essayist on various circumstances and states of mind. At times, even an essayist cannot recognize his/her own particular penmanship, so it is extremely hard to increase satisfactory acknowledgment precision including every single conceivable variety of manually written specimens. Generally, OCR is considered to recognize filtered documents in disconnected mode. As of late, because of increased utilization of handheld gadgets online transcribed acknowledgment pulled in consideration of overall analysts. This online written by hand acknowledgment plans to give common interface to clients to type on screen by penmanship on a cushion rather than by writing utilizing console. For the most part all printed or type-composed characters are arranged in disconnected mode. The on the web method of acknowledgment is for the most part used to recognize just written by hand characters. Disconnected penmanship acknowledgment alludes to the way toward perceiving characters in a document that have been examined from a surface, (for example, a sheet of paper) and are put away carefully in dark scale arrange. In the wake of being put away, it is ordinary to perform promote preparing to permit prevalent acknowledgment. In the event of online-transcribed character acknowledgment, the penmanship is caught and put away in computerized shape through various means. Typically, an uncommon pen is utilized as a part of conjunction with an electronic surface. As the pen moves over the surface, the two-dimensional directions of progressive focuses are spoken to as an element of time.

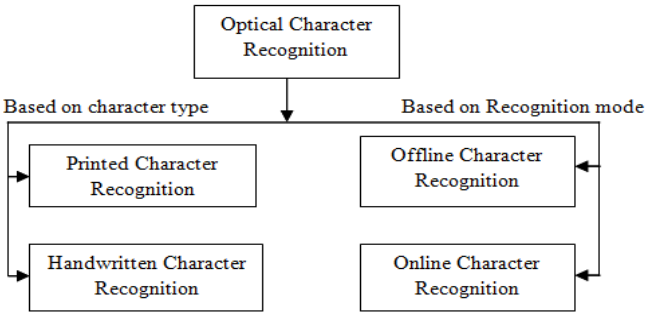

Figure 1. Classification of character recognition system

II. LITERATURE SURVEY

N. Venkata Rao (2016) proposed another neural network (NN) based strategy for optical character acknowledgment (OCR) and in addition manually Handwritten character recognition (HCR). Experiment comes about demonstrate that our proposed technique accomplishes expanded exactness in optical character acknowledgment and in addition manually written character acknowledgment. We exhibit through an outline of existing manually written character acknowledgment procedures. Every one of the calculations depicts pretty much all alone. Transcribed character acknowledgment is an extremely prominent and computationally costly assignment; we portray progressed approaches for written by hand character acknowledgment. In the present work, we might want to look at the most critical once out of the assortment of cutting edge existing methods, and we will systematize the procedures by their trademark contemplations. It prompts to the conduct of the calculations ranges to the normal network. (NN) based strategy for optical character recognition (OCR) and in addition handwritten character recognition (HCR). Trial comes about demonstrate that our proposed technique accomplishes expanded precision in optical character acknowledgment and additionally transcribed character acknowledgment. They introduce through a diagram of existing written by hand character acknowledgment procedures. Every one of the calculations portrays pretty much all alone. Written by hand character acknowledgment is an exceptionally well known and computationally costly errand; They depict progressed approaches for manually written character recognition. [9]

Dungre *et al.* (2010) they have looked into the procedures accessible for character recognition. They have presented picture pre-preparing systems for threshold, skew discovery and redress, estimate standardization and diminishing which are utilized as a part of character recognition. They have additionally looked into the component extraction utilizing Global change and arrangement extension like Fourier change, Gabor change, wavelets, minutes; measurable elements like zoning, projections, intersections and separations; and some geometrical and topological elements usually rehearsed. They additionally looked into the characterization utilizing layout coordinating, measurable strategies, neural network, SVM and blend of classifiers for better precision is polished for recognition work, we might want to analyze the most vital once out of the assortment of cutting edge existing procedures, and we will systematize the methods by their characteristic consideration. It prompts to the conduct of the calculations compasses to the normal similitudes [2].

Wang Jin *et al.* (2009) developed a progression of recognition frameworks by utilizing the virtual reconfigurable design based evolvable equipment. To enhance the recognition exactness of the proposed frameworks, a measurable example recognition-inspired philosophy was presented [6].

Prachi Mukherji and Priti Rege (2009) utilized shape highlights and fuzzy logic to recognize disconnected Devnagari character recognition. They sectioned the diminished character into strokes utilizing auxiliary elements like endpoint, cross-point, intersection focuses, and diminishing. They characterized the fragmented shapes or strokes as left bend, right bend, even stroke, vertical stroke, inclined lines and so forth. They utilized tree and fuzzy classifiers and acquired normal 86.4% exactness [3].

Nozomu Araki *et al.* (2008) proposed a measurable approach for character recognition utilizing Bayesian channel. They reported great recognition performance notwithstanding straightforwardness of Bayesian algorithm [5].

Sandhya Arora *et al.* (2008) utilized crossing point, shadow highlights, chain code histogram and straight line fitting components and weighted majority voting strategy for joining the characterization choice got from various Multi-Layer Perceptron (MLP) based classifier. They acquired 92.80% exactness comes about for handwritten Devnagari recognition. They additionally

utilized chain code histogram and minute based elements in to recognize handwritten Devnagari characters. Chain code was created by distinguishing the course of the next in-line pixel in the scaled shape picture. Minute elements were removed from scaled also, diminished character picture [7].

Anuj Sharma *et al.* (2008) have introduced the usage of three methodologies: versatile coordinating method, little line portions and HMM based strategy, to recognize on the web handwritten Gurmukhi characters and reported 90.08%, 94.59% and 91.95% recognition exactness separately. In versatile matching method, first they recognized the strokes and at that point assessed the character in light of the strokes [8].

Sarbajit Pal *et al*. (2007) have portrayed projection based factual approach for handwritten character recognition. They proposed four sided projections of characters and projections were smoothed by polygon estimated [4].

Mehmet Sezgin and Bulent Sankur (2004) have described the statistical and auxiliary components they have utilized as a part of their approach of Greek handwritten character recognition. The measurable highlights they have utilized are zoning, projections and profiling, and intersections and separations. Advance through zoning they inferred neighborhood highlights like thickness and course includes. In heading highlights, they utilized directional histograms of shape and skeleton pictures. In expansion to ordinary profile highlights they portrayed in-and out-profiles of form of pictures. The basic components they have delineated are end point, crossing point, circle, even and vertical projection histograms, outspread histogram, spiral out-in and in-out histogram [1].

III. METHODS

Optical character recognition involves many steps to completely recognize and produce machine encoded text. These phases are termed as: Pre-processing, Segmentation, Feature extraction, Classification and Post processing. The architecture of these phases is shown in figure 2 and these phases are listed below with brief description. These phases, except post processing are elaborated in next section of overview of OCR phases.

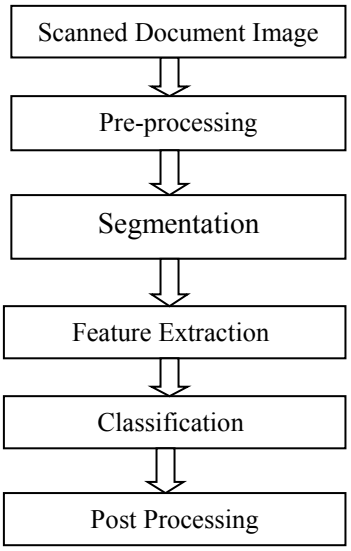

Figure 2. Architecture of character recognition system

1. Pre-processing:

Many techniques applied for binarization, noise removal, skew detection, slant correction, normalization, contour making and skeletonization included in pre processing phase and processes to make character image easy to extract relevant features and efficient recognition.

1.1.Gray Scale Image: If the input document is scanned in colored image format, It may be required to first convert it into gray scale, before converting to binary image. Gray scale image is in which each pixel shows intensity information that is used to decide how much dark or white the pixel is to be shown. Gray scale image is also called black and white image. These images are composed of shades of gray level varying from black at weakest intensity and white at strongest intensity. This intensity is measured in range of 0 to 1. Gray scale image is monochromatic but multilevel. Multilevel in the sense having multiple shades of gray level for each pixel between range of 0 to 1. While bi-level images have only two levels black or white and are called binary images.

1.2 Binarization: Binarization converts coloured (RGB) or gray scale image into binary image. In case ofconverting coloured image it first needs to convert it into gray image. To convert a gray image into binary image we require to specify threshold value for gray level, dividing or mapping range of gray level into two levels either black or white i.e. either 0 or 1 not between it. In binary image each pixel has one of possible two values 0 and 1, representing black or

white respectively. There are many techniques to find threshold value. The popularly used method for threshold value is Otsu‟s method [1].

1.3 Smoothing and Noise Removal :Smoothing operations are used to blur the image and reduce the noise. Blurring is used in pre-processing steps such as removal of small details from an image[2]. In binary 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. Filtering is a neighbourhood operation, in which the value of any given pixel in the output image is determined by applying some algorithm to the values of the pixels in the neighbourhood of the corresponding input pixel. There are two types of filtering approaches: linear and nonlinear, based on the value of an output pixel as a linear and non-linear combination of the values of the pixels in the input pixel‟s neighbourhood [3].

1.4 Skew Detection and Correction : Deviation of the baseline of the text from horizontal direction is called skew. Document skew often occurs during document scanning or copying. This effectvisually appears as a slope of the text lines with respect to the x-axis, and it mainlyconcerns the orientation of the text lines.In anattempt to partially automate the document processing systems as well as to improvethe text recognition process, document skewangle detection and correction algorithmscan be used. In skew detection skew angle of character string is detected. Some methods rely on detecting connected components and finding the average anglesconnecting their centroids, others use projection profile analysis.[3]

1.5 Slant Correction :The character inclination that is normally found in cursive writing is called slant.Slant correctionis an important step in the pre-processing stage of both handwritten wordsand numeral strings recognition. The general purpose of slant correction is to reducethe variation of the script and specifically to improve the quality of the segmentationcandidates of thewords or numerals in a string, which in turn can yield higher recognitionaccuracy. To correct the slant presented first we need to estimate the slant angle (θ), then horizontal shear transform is applied to all the pixels of images of the character/digit in order toshift them to the left or to the right (depending on the sign of the θ).[3]

2. Segmentation

Sometimes segmentation phase considered within pre-processing phase itself, doing the splitting the image document into classifiable module object generally isolated characters or modifiers. The various used segmentations are line segmentation, word segmentation, character segmentation and horizontal segmentation to separate upper and lower modifiers particularly in context to most Indian scripts.

3.Feature Extraction

Feature extraction is used to extract relevant features for recognition of characters based on these features. First features are computed and extracted and then most relevant features are selected to construct feature vector which is used eventually for recognition. The computation of features is based on structural, statistical, directional, moment, transformation like approaches.

3.1. Zoning The image which consists of the alphabet is fragmented in many overlaying or non-overlaying regions and the density of object pixels in every region is computed. We compute the density with the help of the no of object pixels in every region and then divide it by total no of pixels. Density = Number of Object Pixels in Every region / Total Number of Pixels. Zoning attribute is one of the most popular, easy and fast working method to recognise a character. It is accurate technique. It is computed by the density of pixels in all regions so we divide the character sample. Zoning terms is used for divide the trained characters in 100*100 segments by different perspective and store its values in forms of bits such as true or false means Zero or one such as it denotes to black and white. If there is a black part in the segmented 100*100 zone then it will save the value as 1 in matrix and if there a white part then it will store the value 0 in the 100*100 matrix.

When the input image with multiple characters will be given as input to recognize the handwritten characters, then the zoning technique will recognize the characters and then divide in segments. Then the feature will be extract of input image’s character using Zoning and

then Support vector machine will classify the characters according to the feature extracted.

3.2. Diagonal feature extraction To attain high recognition efficiency the diagonal features are very important. Diagonal feature extraction scheme for recognizing off-line handwritten characters is proposed in this work. Steps for extracting the diagonal features are as following:-

- Firstly every character image of size 90x 60 pixels is divided into 54 equal zones, each of size 10x10 pixels.

-The features are extracted from each zone pixels by moving along the diagonals of its respective 10X10 pixels.

- Each zone has19 diagonal lines and the foreground pixels present long each diagonal line is summed to get a single sub-feature, thus 19 sub-features are obtained from the each zone as shown figure.

-These 19 sub-features values are averaged to form a single feature value and placed in the corresponding zone**.** This procedure is sequentially repeated for the all the zones.

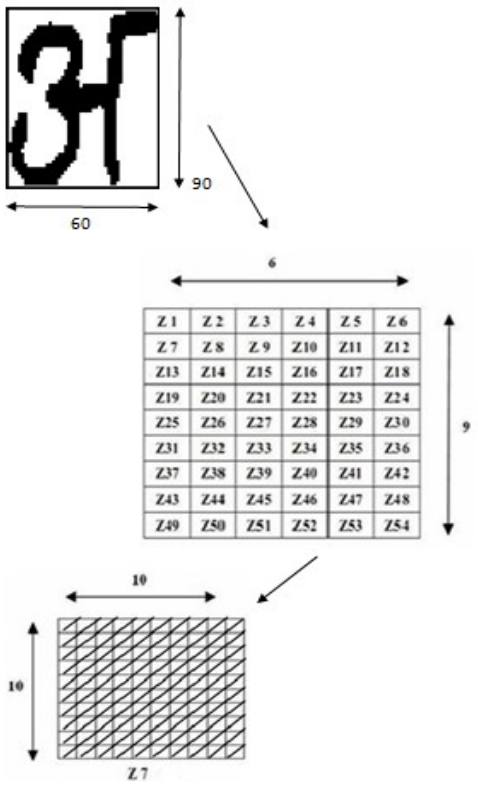

Figure 3. Procedure for extracting feature from the character

-There could be some zones whose diagonals are empty of foreground pixels. The feature values corresponding to these zones are zero. Finally, 54 features are extracted for each character.

4. Classification

Each pattern having feature vector is classified in predefined classes using classifiers. Classifiers are first trained by a training set of pattern samples to prepare a model which is later used to recognize the test samples. The training data should consist of wide varieties of samples to recognize all possible samples during testing. Some examples of generally practiced classifiers are- Support Vector Machine (SVM), K-Nearest Neighbour (K-NN), Artificial Neural Network (ANN) and Probabilistic Neural Network (PNN).

4.1. K-Nearest Neighbour Initially all the training is given to the OCR and after that when the testing of samples starts then OCR finds the nearest neighbour which matches closely to the testing sample from the training given with the help of nearest neighbour algorithm.

IV. CONCLUSION

The problems in handwritten Hindi text written by different persons is identified after carefully analyzing the text. These problems is solved new techniques have been developed for segmentation, feature extraction and recognition or classification. The OCR can easily recognizes all forms of character are written by different person in different handwritings styles with different objects such as pen, pencil, marker or sketch even of different colour as well as oriented handwritten Hindi characters and it is an efficient technique, but the difficulty or problem of this OCR are needs more polishing. It does not recognize pure form of consonants or half characters and missing part of Hindi text. This Optical character recognition does not recognize words as it is made only for single characters and also occur some difficulty or problem to recognition of characters which are not in black marker. Some hindi characters are similar in shape for example ङ and ङ . From the survey, it is observed that the errors in recognizing printed. Devanagari characters are mainly due to improper segmentation of touching or broken characters. Because of upper and lower modifiers of Devanagari text, maximum areas of

two consecutive lines may also overlap. If proper segmentation of such overlapped portions are done then accuracy will be improve. If standard database is not available then according to writing style of different person, accuracy may affect. Zoning and diagonal feature extaction is used in this work to improve the efficiency of off-line handwritten Hindi character recognition.

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