Volume 5, Issue 5, MAY 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Surveying Handwritten Alpha Numeral Recognition Approaches

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Abstract—Developing intelligent machines for recognizing a character is certainly not an easy task simply because a character could be printed in many possible methods. Also you will find so imperfections that are many variation of handwriting such as for example alignment, noise and angles, which will make handwritten character recognition tough to implement with a device. All these imperfections of handwritten characters may not be removed easily. This means that a single process or single machine just isn't capable of performing the method that is entire. You can accomplish it by a few processes that return some result that is desirable. This paper is about the related work for Handwritten Numeral Recognition and its Approaches.

Index Terms—OCR, Numeral Recognition, Supervised learning, Handwritten Recognition.

I. INTRODUCTION

Handwritten recognition has enticed countless researchers across the world. The setback of automatic recognition of handwritten text as challenged to contraption printed text is a convoluted one, exceptionally for cursive established languages. Countless researchers have given algorithms for character recognition for disparate tongues such as English, Chinese, Japanese, and Latin. Normal Optical Character Recognition (OCR) arrangement consists of the phases: preprocessing, segmentation, feature ex-traction, classifications and recognition. The output of every single period is utilized as the input of subsequent stage. Preprocessing period consists of countless adjustment procedures for slant correction, and normalization. Countless presently counseled methods have been given for the intention of feature extraction.

Soft computing methods are generally projected to address the real globe ill-defined, imprecisely formulated setbacks, joining disparate kind of novel models of computation, such as Bayesian Classifiers, neural networks, fuzzy sets and arrangements, and Genetic Algorithms (GAs), and needing huge computation. Handwritten digit recognition is a normal example of one such problem. To recognize handwritten digits of fluctuating forms and sizes, provoked by disparate handwriting styles of disparate people, perceptual use of

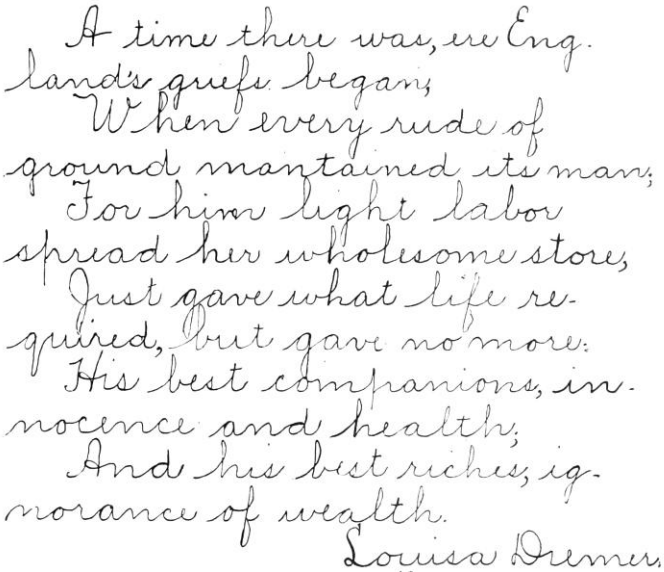

Fig 1: Handwritten Letter an Example showing Complexity of the recognition.

- Cognitive skills of a human are required. Due to colossal assortments of possible requests like removing data from loaded in forms, automatic postal program identification, mail sorting arrangements, automatic reading of bank cheques etc, handwritten digit recognition is believed as a vital problem.

Handwritten Alpha Numeral Recognition [4] is the mechanical or electronic translation of pictures of handwritten alphanumeric characters (usually seized by a scanner) into machine-editable form. Handwritten alpha numeral recognition

has collection of requests in assorted fields like reading postal zip program, passport number, operative program, bank cheque, and form processing. Handwritten alphanumeric recognition is a vital constituent of character recognition system. The setback of the handwritten alpha numeral recognition is a convoluted task due to the variations amid the authors like style of including, form, stroke etc. Contrasted to the setback of printed alpha numeral recognition, the setback of handwritten alphanumeric recognition is compounded due to variations in forms and sizes of handwritten characters.

Handwritten alpha numeral recognition can be differentiated into two groups i.e. Online Handwritten alpha numeral recognition and Offline Handwritten alpha numeral recognition. On-line handwritten alpha numeral recognition deals alongside automatic conversion of alpha numerals, which are composed on a distinct digitizer, tablet PC or PDA whereas a sensor picks up the pen-tip movements as well as pen-up/pen-down switching. Off-line handwritten alpha numeral recognition deals alongside a data set that is obtained from a scanned handwritten document. Nevertheless intellectual research in the earth endures, the focus on handwritten alpha numeral recognition has advanced to implementation of proven techniques. Handwritten alpha numeral recognition (using optical methods such as mirrors and lenses) and digital character recognition (using scanners and computer algorithms) were primarily believed distinct fields. Because extremely insufficient requests endure that use real optical methods, the handwritten character recognition word has nowadays been widened to contain digital picture processing as well. For extra convoluted recognition setbacks, intelligent character recognition arrangements are usually utilized that usually deals alongside the non cursive handwritings

II. RELATED WORKS

In present years a little researchers have industrialized computational intellect models for precise recognition of Latin text. Many utilized an average template matching approach for knowing Latin numerals. Some suggested the use of feature vectors representing a set of momentous frontier points distances from the center of gravity (COG) of the numeral object. Many also utilized these features to derive a ideal for every single numeric digit. Some of the recent work is summarized as follows.

Jayadevan, R. et al, 2011 - In India, extra than 300 million people use Devanagari script for documentation. There has been a momentous enhancement in the research connected to the recognition of printed as well as handwritten Devanagari text in the past insufficient years. State of the fine art from 1970s of contraption printed and handwritten Devanagari optical character recognition (OCR) is debated in this paper. All feature-extraction methods as well as training, association and matching methods functional for the recognition are debated in assorted servings of the paper. An endeavor is made to address the most vital aftermath described so distant and it is additionally endeavored to highlight the helpful orders of the research till date. Moreover, the paper additionally encompasses a comprehensive bibliography of countless selected papers materialized in reputed journals and session proceedings as an assistance for the researchers working in the earth of Devanagari OCR.

Sahani, S.K. et al, 2013 - This paper presents a online multi-font numeral recognition method, whose main target is to understand overlaid period numeral from video. The serving of the video construction encompassing the period text is binarized and segmented. Minimum rectangular bounding box is inserted above the remote numeral images. Euler number of numeral pictures is discovered out to primarily differentiate into three groups. Then, the numerals are knew by pondering the individual different features of every single numeral inside the group. This recognition procedure is grasped out for all numeral positions. From time to time it is perceived that whichever due to sound in video sequence or because of poor quality of recorded! Online video, a little of the numerals are not recognized. Therefore, picture correlation is gave as the last pace, merely for the unrecognized numeral images. Examinations were led on assorted infrared and CCD camera video sequences as well as on commercially obtainable CCTV CCD videos, by seizing disparate sizes and kinds of fonts. The method provides accuracy of 98.67% and the per-frame computation period is 15.413 ms that is fast as each interlaced video.

Patel, D.K. et al, 2013 -The present paper deals alongside the setback of handwritten character recognition of English character. This paper presents a novel method of handwriting character recognition that exploits a compression skill of discrete wavelet change to enhance the accuracy of recognition at the pixel level, the discovering skill of manmade neural web and computational skill of Euclidean distance metric. The setback of handwritten character recognition has been tackled alongside multiresolution method employing discrete wavelet change and discovering law across the manmade neural network. Recognition accuracy is enhanced by Euclidean distance metric alongside alongside recognition score in case of misclassification. Features of the handwritten character pictures are removed by discrete wavelet change utilized alongside appropriate level of multiresolution. Handwritten acts are categorized into 26 outline classes established on appropriate properties i.e. shape. Across preprocessing every single character is seized inside a rectangular box and next resized to a threshold size. Heaviness matrix of every single class is computed employing the discovering law of manmade neural web, and next the unfamiliar input outline vector is fused alongside the heaviness matrices of all the classes to produce the recognition scores. Maximum score corresponds to the understood input character. Discovering law provides a good recognition accuracy of 88.46%. In case of misclassification, the Euclidean distance metric enhances the recognition accuracy to 92.31% and next its product alongside recognition score more enhances the recognition accuracy to 99.23%. The counseled method provides such good recognition accuracy for handwritten acts even alongside less data samples.

Dadong Zhao et al, - Because of its colossal contrasts in including style, context-independency and elevated recognition accuracy necessity, free handwritten digital identification is yet a extremely tough problem. Analyzing the characteristic of handwritten digits, this paper proposes a new handwritten digital identification method established on joining structural features. Given a handwritten digit, a collection of structural features of the digit encompassing conclude points, bifurcation points, horizontal lines and so on are recognized automatically and robustly by a counseled spread

structural features identification algorithm and a decision tree established on those structural features are crafted to prop automatic recognition of the handwritten digit. Experimental consequence demonstrates that the counseled method is superior to supplementary finished methods in recognition rate and robustness.

Rajashekararadhya, S.V. et al 2010 - Handwriting recognition has almethods been a challenging task in picture processing and outline recognition. India is a multi-lingual, multi-script state, whereas eighteen authorized scripts are consented and there are above a hundred local languages. The feature extraction method is plausibly the most competent method in accomplished elevated recognition performance. In this discover they counseled a zone-based feature extraction algorithm scheme for the recognition of off-line handwritten numerals of south-Indian scripts. The character centroid is computed and the character/numeral picture (5010). The average distance from the picture centroid to the pixels present in the zone was computed. This procedure was sequentially recapped for the whole zone present in the numeral picture (50 features). There might be a little zone/zone column that is empty of foreground pixels, next the feature worth of that zone column/zone in the feature vector is zero. Finally, 300 such features were removed for association and recognition. The nearest acquaintance, feed onward back propagation neural web and prop vector contraption classifiers were utilized for consecutive association and recognition purposes. They obtained a recognition rate of 98.05, for Kannada numerals, 95.1 for Tamil numerals, 97.2 for Telugu numerals and 95.7 for Malayalam numerals employing prop vector machine.

Kale, K.V. et al, in 2013 - Compound character recognition of Devanagari script is one of the challenging tasks as the acts are convoluted in construction and can be adjusted by including combination of two or extra characters. These compound acts occurs 12 to 15% in the Devanagari Script. The moment established methods are being prosperously requested to countless picture processing setbacks and embodies a frank instrument to produce feature descriptors whereas the Zernike moment method has a rotation invariance property that discovered to be desirable for handwritten character recognition. This paper debates extraction of features from handwritten compound acts employing Zernike moment feature descriptor and proposes SVM and k-NN established association system. The counseled association arrangement preprocess and regularize the 27000 handwritten character pictures into 3030 pixels pictures and divides them into zones. The pre-classification produces three classes reliant on attendance or nonexistence of vertical bar. More Zernike moment feature extraction is gave on every single zone. The finished recognition rate of counseled arrangement employing SVM and k-NN classifier is upto 98.37%, and 95.82% respectively.

Halder, C. et al, - Handwritten Bangla numeral recognition has outstanding prospects in Author Identification, Postal Automation, Bangla OCR (Optical Character Recognizer) etc. In this paper they have gave the methodical analogy of classifiers for Bangla handwritten numeral recognition. For this work they have utilized their own database (WBSUCS character database) that consists of finished 517 documents and ISI Bangla Numeral database that consists of extra than 12000 numerals. For their database every single author was asked to comprise predefined loaded in forms five times. Later accumulating and removing acts from loaded in forms, 400 dimensional feature vectors is computed established on gradient of the images. The feature and classifier selection is one of the most challenging tasks in the earth of Outline Recognition. As the presentation of 400 dimensional feature is by now instituted in numeral recognition earth, for the present work they have concentrated on presentation evaluation of classifiers in grasping convoluted real period Outline Recognition setbacks like Numeral Recognition. Here they have selected Prop Vector Contraption (SVM), Library for Colossal Linear (LIBLINEAR), Multilayer Perceptron (MLP), Fuzzy Un-ordered Law Induction Algorithm (FURIA), Adjusted Quadratic Discriminant Purpose (MQDF) as the classifiers for recognition of the numerals and analogy of the results. Nevertheless all these classifier are suitable for this work but LIBLINEAR is discovered to be the fastest in words of convergence criteria as MQDF outperform others in words of recognition consequence for their WBSUCS character database.

Rajashekararadhya, S.V. et al,- Character recognition is the vital span in picture processing and outline recognition fields. Handwritten character recognition has consented comprehensive attention in intellectual and creation fields. The recognition arrangement can be whichever online or off-line. Off-line handwriting recognition is the subfield of optical character recognition. India is a multi-lingual and multi-script state, whereas eighteen authorized scripts are consented and have above hundred local languages. In this paper they present zone and distance metric established feature extraction system. The character centroid is computed and the picture is more tear in to n equal zones. Average distance from the character centroid to the every single pixel present in the zone is computed. This procedure is recapped for all the zones present in the numeral image. In the end n such features are removed for association and recognition. Prop vector contraption is utilized for consecutive association and recognition purpose. They obtained 97.75% recognition rate for Kannada numerals.

Reddy, G.S. et al, 2012 - This work describes the progress of an Assamese handwritten numeral recognizer. Online handwritten numeral recognition arrangement is industrialized employing x, y coordinates as the feature and Hidden Markov Ideal (HMM) as the modelling technique. Offline handwritten numeral recognition arrangement is industrialized employing vertical protrusion profile and horizontal protrusion profile (VPP-HPP), zonal discrete cosine change (DCT), shackle program histogram (CCH) and pixel level data as features and vector quantization (VQ) as the modelling technique. The confusion outlines of online and offline arrangements are analysed. Instituted on this, the two arrangements are more joined to attain a final numeral recognition system. The joined arrangement exhibits enhanced presentation above the individual methods, clarifying the meaning of disparate natures of data present in every single mode.

Mamatha, H.R. et al, - Optical Character Recognition (OCR) is one of the vital earth in picture processing and outline recognition domain. Countless useful requests use OCR alongside elevated accuracy. The accuracy of the Optical Character Recognition arrangement depends on the quality of the features removed and the effectiveness of the classifier. This paper discovers the effectiveness of feature extraction method like run length count (RLC) and directional shackle

program for the recognition of handwritten Kannada numerals. In this paper, K-Nearest Neighbour (KNN) and Linear classifiers are utilized for the classification. The novelty of this way is to accomplish larger accuracy and period intricacy alongside insufficient features employing easy classifiers. Aftermath display that the directional shackle program way outperforms the RLC way in words of recognition accuracy.

Pirlo, G. et al, 2012 - In the earth of handwritten character recognition, picture zoning is a extensive method for feature extraction as it is rightly believed to be able to cope alongside handwritten outline variability. As a matter of fact, the setback of zoning design has enticed countless researchers who have counseled countless image-zoning topologies, according to static and vibrant strategies. Unfortunately, slight attention has been paid so distant to the act of feature-zone membership purposes that delineate the method in that a feature influences disparate zones of the zoning method. The consequence is that the membership purposes described to date pursue nonadaptive, globe methods that are incapable to ideal innate data on feature distributions. In this paper, a new class of zone-based membership purposes alongside adaptive skills is gave and its effectiveness is shown. The frank believed is to select, for every single zone of the zoning method, the membership purpose best suited to exploit the characteristics of the feature allocation of that zone. In supplement, a genetic algorithm is counseled to determinethe most favorable membership purposes alongside alongside the optimal zoning topology, delineated by Voronoi tessellation. The experimental examinations display the predominance of the new method alongside respect to established zoning methods.

Rajashekararadhya, S.V. et al, 2009 - Handwritten numeral character recognition has been an intensive research in the earth of manmade intellect as countless decades. This paper proposes a radial basis purpose neural web ideal for knowing handwritten numerals. The geometric form of handwritten numerals is delineated by computing a feature vector established on the skeleton of the images. The normalized central moment features are removed from the skeleton of the images. Association is gave alongside these normalized moment features by a radial basis purpose neural network. The novelty of this way is that the normalized moment features from the skeletons gives good recognition rate than the contour pictures and thinned pictures alongside radial basis purpose neural network. The presentation of the counseled work is computed from the error rate. Aftermath of this counseled method on MNIST handwritten numeral database is reported.

Susan, S. et al, 2011 - This paper proposes to find an optimal feature set for handwritten numeral recognition employing the box partitioning method. The feature below discover is the mean normalized distance compute that is the most accepted descriptor in this regard. Though it is almethods utilized in combination alongside supplementary descriptors and does not give good association aftermath after utilized on its own. The descriptor vector is obtained by partitioning the numeral picture into sub-boxes and computing the distance compute from every single sub-box seized in order. A sequence of evaluations is grasped out in this work to confirm the optimal size and number of sub-boxes by subjecting the emerging feature vectors to a rigorous handwritten numeral association examination, employing a easy MLP neural web classifier. It is proved in their work that larger aftermath are obtained after the number of partitions alongside the horizontal and vertical axis of the picture is fixed, rather than the standard method of arbitrarily dividing the picture into sub-boxes of pre-defined dimensions.

Kumar, R. et al, 2012 - Unconstrained offline handwritten numeral recognition is a challenging problem. It is extremely tough to find elevated recognition aftermath employing a solitary classifier. This paper presents a easy profile, joined innate & globe features and bulk electing scheme classifier for unconstrained handwritten numeral recognition. The easy profile feature is computed by employing the left, right, top and bottom profile of an image. A feature vector of length 112 is industrialized by joining all the profiles. The innate feature vector is removed by requesting Daubechies wavelet change on the four pictures that were obtained by requesting the Kirsch operator, and the globe features that are obtained by requesting the alike Daubechies wavelet change on the early image. A feature vector of length 80 is industrialized by joining the 64 innate and 16 globe features. The feature vectors are the intensity of a pixel in the third level approximation constituent of an image. In this examination four neural web classifiers: Multilayer feed onward, Outline recognition, Cascade onward, Purpose fitting neural web classifiers & two statistical classifiers: Linear discriminant research and KNN classifiers are utilized for categorizing these features. A bulk electing scheme has been gave alongside three neural web classifier and KNN classifier. The presentation is tested on MNIST dataset. The web was trained on 60,000 and tested on 10,000 numeral examples of that 98.05% examination examples are accurately recognized.

Alaei, A. et al, 2012 - In present years, countless methods for the recognition of Persian/Latin handwritten documents have been counseled by researchers. To examination the promises of disparate features extraction and association methods and to furnish a new benchmark for upcoming research, in this paper a comparative discover of Persian/Latin handwritten character recognition employing disparate feature sets and classifiers is presented. Feature sets utilized in this discover are computed established on gradient, directional shackle program, shadow, under-sampled bitmap, intersection/junction/endpoint, and line-fitting information. Prop Vector Mechanisms (SVMs), Nearest Neighbour (NN), k-Nearest Neighbour (k-NN) are utilized as disparate classifiers. They assessed the counseled arrangements on a average dataset of Persian handwritten characters. Employing 36682 examples for training, they tested the counseled recognition arrangements on supplementary 15338 examples and their methodical aftermath are reported. The best correct recognition of 96.91% is obtained in this comparative study.

Kumar, S. 2009 - In this paper, a three tier strategy is counseled to understand the hand-printed acts of Devanagari script. In main and secondary period association, the structural properties of the script are exploited to circumvent association error. The aftermath of all the three periods are described on two classifiers i.e. MLP and SVM and the aftermath attained alongside the afterward are extremely good. The presentation of the counseled scheme is described in respect of recognition accuracy and time. The recognition rate attained alongside the counseled scheme is 94.2% on their database encompassing of extra than 25000 acts fitting in to 43 alphabets.

Kumar, M. et al, in 2011 - Offline handwritten character recognition has been a frontier span of research for the last insufficient decades below outline recognition. Recognition of handwritten acts is a tough task owing to assorted including styles of individuals. A scheme for offline handwritten Gurmukhi character recognition established on k-NN classifier is gave in this paper. The arrangement early prepares a skeleton of the character, so that feature data concerning the character is extracted. There is plentiful works on the handwriting recognition on non-Indian scripts, but there are extremely insufficient article obtainable connected to recognition of Indian scripts such as Gurmukhi. This paper presents an effectual offline handwritten Gurmukhi character recognition arrangement established on diagonal features and transitions features employing k-NN classifier. Diagonal and transitions features of a character have been computed established on allocation of points on the bitmap picture of character. In k-NN method, the Euclidean distance amid assessing point and reference points is computed in order to find the k-nearest neighbors. In this work, they have seized the examples of offline handwritten Gurmukhi acts from one hundred disparate writers. The partition strategy for selecting the training and assessing outlines has additionally been experimented in this work. They have utilized in all 3500 pictures of Gurmukhi acts for the intention of training and testing. The counseled arrangement achieves a maximum recognition accuracy of 94.12% employing diagonal features and k-NN classifier.

Pradeep, J. et al, 2012 - In this paper, an off-line handwritten English character recognition arrangement employing hybrid feature extraction method and neural web classifiers are proposed. A hybrid feature extraction method merges the diagonal and directional established features. The counseled arrangement suitably merges the salient features of the handwritten acts to enhance the recognition accuracy. Neural Web (NN) topologies, namely, back propagation neural web and radial basis purpose web are crafted to categorize the characters. The k-nearest acquaintance web is additionally crafted for comparison. The Feed onward NN topology exhibits the highest recognition accuracy and is recognized to be the most suitable classifier. The counseled arrangement will assistance requests for postal/parcel address recognition and conversion of each hand composed document into structural text form. The presentation of the recognition arrangements is contrasted extensively employing examination data to sketch the main conclusions of this paper.

III. CONCLUSION AND FUTURE SCOPE

Digitization of documents is a very vital task, to save manpower and cash related to digitization process, automatic character recognition from optically scanned image becomes very important. The segmentation of each character is made at first from the complete image of a web site and after that recognizes the each individual character from the segmented image and provides the corresponding digitized or computerized character in this conversion process. In future The focus of our work are going to be the recognition and verification of unconstrained handwritten alpha numerals, with high accuracy, that will be challenging research task as these alpha numerals are written without any constraints, (e.g., they are not all written in separate boxes, nor all written neatly, nor all utilizing a specific kind of pen). In addition, unconstrained alphanumeralic character that are handwritten varieties of composing styles due to differing backgrounds associated with writers. Technically speaking, this system pursues a high recognition rate while seeking the highest reliability, rendering it practical for recognizing unconstrained handwritten alpha numerals. Handwritten alphanumeric Recognition System that is constructed using artificial network that is neural expects become efficient in alpha numeral recognition of mass standardized document.

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