OFFLINE HANDWRITTEN RECOGNITION USING FUZZY LOGIC AND GENETIC ALGORITHM

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Abstract: This paper discusses about the recognition of handwritten characters of Kannada. In particular we concentrate about the hybrid technique which is used in here. This approach uses two algorithms which are genetic and fuzzy logic for recognition. Feature extraction is the estimation of certain attributes of the target patterns. Selection of the right set of features is the most crucial and complex part of building a pattern recognition system. The novelty of this approach is to achieve better accuracy and reduced computational time for recognition of handwritten characters using Genetic Algorithm which optimizes the number of features along with a simple and Fuzzy Logic. We will analyze the performance and accuracy of the system.

Index Terms – Pattern recognition, Genetic algorithm, Fuzzy Logic.

I. INTRODUCTION

Off-Line handwritten recognition, often referred as optical character recognition, is performed where the converting of handwritten document to digital form is completed. The main advantage is it can be done at any time after the conversion process is completed even after many years. The disadvantage is it cannot be done in real time.

The application of handwritten recognition systems is Digital Character conversion, Meaning Translation, Content Based Image Retrieval, Keyword Spotting, Signboard Translation, Text-to-Speech Conversion, Scene Image analysis. Furthermore, OCR plays an important role for digital libraries, allowing the entry of image textual information into computers by digitization, image restoration, and recognition methods.

Offline handwriting systems generally consist of four processes: acquisition, segmentation, recognition, and post processing (Fig 1.1). First, the handwriting to be recognized is digitized through scanners or cameras. Second, the image of the document is segmented into lines, words, and individual characters. Third, each character is recognized using OCR techniques. Finally, errors are corrected using lexicons or spelling checkers.

Offline handwriting recognition systems are less accurate than online systems because only spatial information is available for offline systems, while both spatial and temporal information is available for online systems.

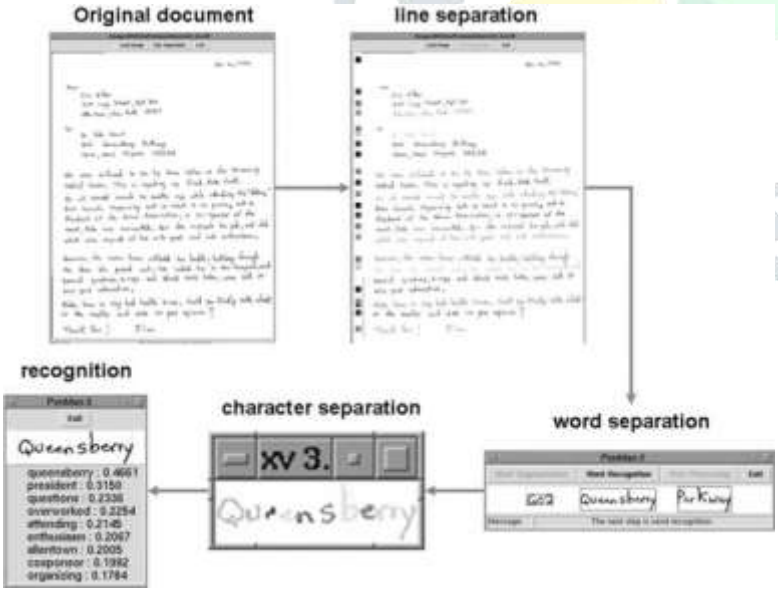


Figure 1.1. Offline handwriting recognition processes.

BACKGROUND

Handwritten recognition is converting handwritten text to a notable representation. It is a domain of pattern recognition and machine intelligence. Hand written recognition can be of two types: Online and Offline – Which will be dependent on the type of the data availability.

In Online character recognition the parts which are identified will be written by smart pen or tablets where as in offline recognition the characters are written in paper with pens and then it is scanned into digital pictures [1].

What Offline character recognition does is, the image of writing will be converted into bit pattern by a device like scanner or camera; the recognition will be done on this pattern of bits for both printed or hand written [2]. Off-line handwritten character recognition continues to be an active research area towards exploring the newer techniques because it has various applications such as postal sorting, bank cheque amount reading, and official document reading [3].

Feature Extraction plays an important role in any character recognition to classify the character's patterns efficiently. A feature is nothing but a property which can be used for representing different shapes and symbols. Every machine learning algorithms uses a set of features for the classification purpose [4]. The fundamental task of the feature extraction is to find out the most useful features for classification; that is, compressing from high to low dimensional feature space, so as to design the classifier very effectively [5].

II. LITERATURE SURVEY

The $paper^{11}$ written by Yang, J., Ren, P., & Kong, X really gives us a new method with a new dimension which is transforming the many problems by their new design. And this model showed a better result than the traditional OCR. The dataset used in this paper are 3 different datasets which are Letter, word, EMNIST datasets.

The $paper^{12}$ written by Ahmed Talat Sahlol; Mohamed Abd Elaziz; Mohammed A. A. Al-Qaness; Sunghwan Kim was written in MATLAB with the stages preprocessing, feature extraction and selection by the algorithm Hybrid whale optimization algorithm using neighboring rough set, while the last stage classification was done in python. The dataset used in this was CENPARAMI which was published in Canada. The dataset contains Arabic characters. The number of features in the dataset is 261 which give an accuracy of 96% with Precision, Recall, and time as 97, 86 and 1.91.

The $paper^{13}$ written by T. T. Zin, S. Z. Maw and P. Tin uses EMNIST (Extended MNIST) handwritten datasets. They used deep convolutional neural networks for character classification and segmentation. This method is most effective for school children and this approach makes the children to self learn and self correcting the numerical and character so that they can improve the hand writing.

Another approach which was proposed by Z. Huang and Q. Zhang is Skew correction algorithm based on residual neural network. This was for Chinese handwritten characters and two models were proposed by the one was 4-D classification and other was 181-angle classification and these two frameworks were formed on RESNET. While precisely anticipating the heading and the edge of the character pictures, it likewise demonstrates that rearranging the picture by anticipating the heading of the character picture will bring about higher acknowledgment $precision^{14}$.

The method proposed by B. Dessai and A. Patil was nothing but implementing CNN for OCR which are very efficient in image classification than SVM's. CNN are prepared with trained dataset. They gathered information tests of 15 characters from various people. 1500 examples of each character were utilized for preparing and 250 examples of each character were utilized for testing. After the system was prepared obscure characters from word were given as contribution to the acknowledgment framework. Working with Devanagari characters were more unpredictable on the grounds that of their compound structures when contrasted with the roman characters. Likewise, the nearness of a header line for each word furthermore, uniqueness recorded as hard copy styles of each individual increment the intricacy. The accuracy from this method was 89.34% including क ख ग ब र स द य र म त ज ल न श ण and excluding श ग ण the accuracy was 91.11% .To make the OCR framework more proficient compound manually written characters which are framed by mixes of two unique characters can be incorporated for $acknowledgment^{15}$.

The main objective of this $paper^{2}$ is to build a character recognition system, which is able to recognize the both handwritten and printed character from A to Z and for this it undergoes three stages which are preprocessing, feature extraction and discrimination. In this we will use wavelet compression for the image compression in which the most important coefficient from the images are extracted. The $paper^{1}$ describes a hybrid approach to achieve a better accuracy and reduced computational time for handwritten characters using genetic algorithm which optimizes the number of features along with MLP classifier. Here they have used CEDAR database for English alphabet. For this, the hybrid feature extraction and GA based feature selection for off-line handwritten characters by using adaptive MLPNN classifier for achieving an improved overall performance on real world recognition problems. In this two different recognition networks are built which is Adaptive MLP classifier without feature reduction and adaptive MLP classifier with feature reduction. This is trained and tested on the CEDAR dataset. From the results the network which uses GA based feature selection method improves overall performance of the recognition system in terms of speed and storage requirement. It also provides better accuracy. The accuracy of capital alphabets is 94.65% and as for small alphabet is 91.11%. For the adaptive MLP classifier without feature reduction, the accuracy for capital alphabet is 91.56% and the accuracy for small alphabet is 87.49%.

This $paper^{6}$ gives us the best approach which gives us an accuracy of more than 90% in the handwritten character recognition field. Here the approach which is been used is convolutional neural networks and tensor flow. The method which is used for assigning probabilities to handwritten characters being one of the several characters as it gives values between 0 to 1 summing up to 1 is soft max regression. In neural network it uses feed forward network mainly trained as back-propagation algorithm so as to clarify and recognize the characters as well as get it trained more and more. It is also observed that the bigger training set the better neural network and it provides the best result.

In this $paper^{7}$, the purpose of the pattern recognition is to categorizing or classifying data or object of one of the classes or categories. The goal is to recognize the input characters or image correctly then analyze to many automated systems. This model gives us an accuracy of 94%. This type of model is built to analyze text written and convert it in computer text and voice format. This can be helpful in many sectors such as healthcare and consumer sector. In healthcare sector this application can be used to understand the perspectives of people and store each and every record digitally.

III. SYSTEM DESIGN

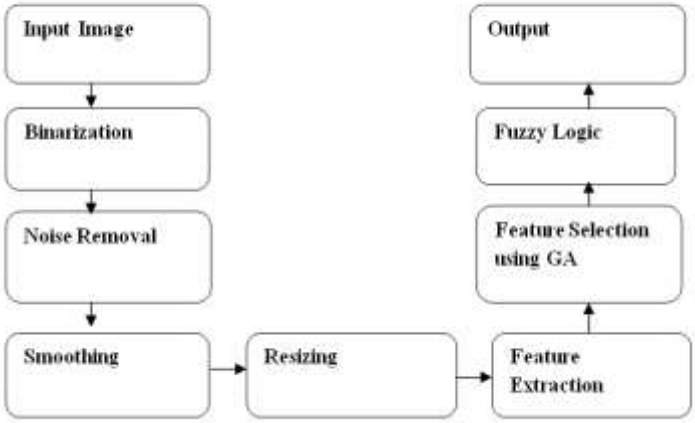


Figure2. System model

3.1. Phases of recognition:

A. Acquisition of Image:

Acquisition of image is the first step. Here, we should get an image or picture from the camera or other sources. The image which we get will be in the form of JPEG or PNG format. The input may be in colored, gray or black and white.

B. Binarization:

Binarization of image means we convert the image into 0 or 1 form which can alphabet or numerical. The process becomes much easier when we do Binarization on an image which we get as an input and it also provides us a good result if we do this process.

C. Slant Correction:

Slant is characterized as incline of the overall composing pattern as for the vertical line. The picture framework is isolated into upper and lower parts. The focuses of gravity of the lower furthermore, upper parts are figured and associated. The slant of the interfacing line characterizes the incline of the $window$[16,17].

D. Smoothing and noise removal:

Smoothing is a procedure is proposed to allocate non-zero likelihood to alter tasks not present in the preparation corpus. It also suggests both filling and thinning. Filling takes out little breaks, holes and openings in digitized characters while diminishing decreases width of $line$[18].

We should also remove the noise present in the image it is one of the methods in preprocessing. If the noise is present in the image it will affect the accuracy and by removing, it enhances the image quality. On the off chance that commotion signals between segments of the lines are definitely not taken out, incredible holes will emerge; these clamors ought to be eliminated to acquire all the critical information. In a lot of pictures, one of them may have numerous $noises$[19].

E. Size normalization:

It is required as the size of the character differs starting with one individual then onto the next and furthermore now and again in any event, when the individual is same. Standardization helps in likening the size of the character picture (double network) so highlights can be separated on a similar $balance$[12].

F. Feature Extraction and Feature Selection:

Feature Extraction is the strategy of gathering huge materialistic data from the substance of crude data. Significant materialistic data is the exact and viable delineation of characters. The arrangement of qualities got from crude data is alluded to as highlight extraction to augment the character acknowledgment rate including minimal amount of parts. There are several techniques used to do this part as it is most crucial part, and its selection of the right amount of set of features is the important step in the classification $process$[20]. The algorithms like SIFT, PCA, Genetic Algorithms, LDA, Histograms etc.

Feature Selection is a procedure to choose the highlights that is pertinent for arrangement stage. The objective of highlight choice (FS) is that of diminishing the quantity of highlights to be considered in the order stage. This assignment is performed by eliminating unessential or uproarious highlights from the entire arrangement of the accessible ones. Highlight choice is achieved by decreasing however much as could reasonably be expected the data misfortune because of the list of capabilities decrease: in this manner, at list on a fundamental level, the determination cycle ought not to lessen grouping $execution$[21].

G. Classification and recognition:

Classification is characterized as the way toward grouping a character into its fitting classification. The basic way to deal with grouping depends on connections present in picture segments. The factual methodologies depend on utilization of a segregate capacity to characterize the picture. Some of the characterization approaches are Bayesian classifier, Decision tree, neural system classifier, SVM's and so forth. At long last, there are classifiers dependent on syntactic methodology that expects a syntactic way to deal with make a picture from its sub-constituents.

3.2 Genetic Algorithm

Genetic algorithms are a very good means of optimizations in such problems. They optimize the desired property by generating hybrid solutions from the presently existing solutions. These hybrid solutions are added to the solution pool and may be used to generate more hybrids. These solutions may be better than the solutions already generated. All this is done by the genetic operators, which are defined and applied over the problem. We already have a set of graphs generated from training data for any character. The use of genetic algorithm is to mix 2 such graphs and to generate new graphs. These newly generated graphs may happen to match the character better than the existing graphs. Hence genetic algorithms are a good means of optimizations. We discuss each of the points in detail in the coming sections.

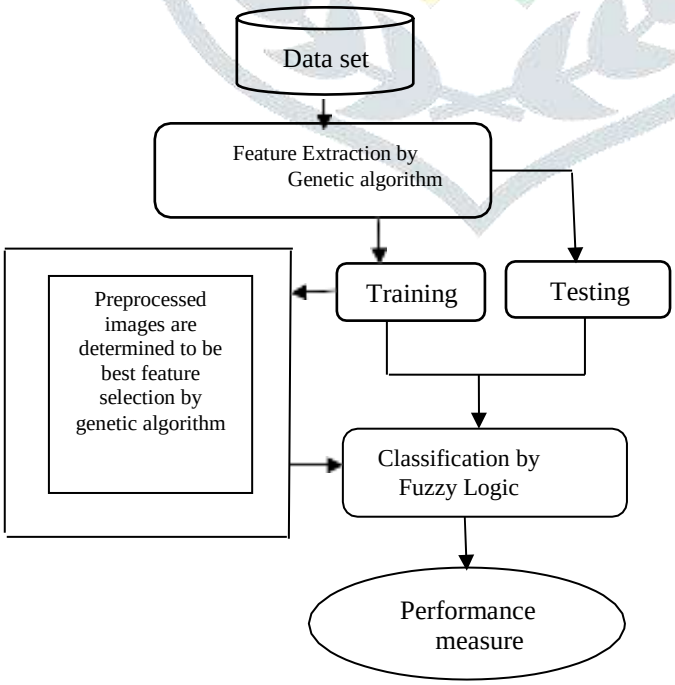
a. Fitness function:

In Genetic Algorithms, the fitness function is used to test the goodness of the solution. This function, when applied on any of the solution from the solution pool, tells the level of goodness. In our problem, we have used fitness function to measure the deviation of the graph of the solution, to that of the unknown input. If the two graphs are very similar, the deviation would be low and hence the value of the fitness function would be low. The lower the value of the fitness function, the better would be the matching. Hence the graph with the lowest value of fitness function would be the most probable answer. We first devise a formula to find the deviation between any two edges. This would be then used as a means of finding the deviation between two graphs.

b. Crossover function:

Crossover is the operation in genetic algorithms where we mix two solutions and form a new solution. This may be better than the two existing solutions. The crossover operation helps us to generate newer solutions and thus helps in optimization. In this problem we have a graphical representation of the solution sets. Each solution is a graph which contains both edges and vertices. The crossover operation uses two graphs to mix them and forms a new graph. This graph takes some characteristics from the first graph and some characteristics from the second graph. The graph generated from this operation may be better than the parent graph and hence useful. The basic motive of using this operation is to mix styles. If the two graphs have characters in different styles, we would be able to mix them and form a style that is intermediate between the parent styles. The crossover operation makes sure that the style of writing a particular section of the character is taken from one of the graph. This section is removed from the other graph and the new section is added. Hence using the crossover operation we may be able to mix styles to form unique new solutions. Many solutions are possible for every combination of parents. In this algorithm, we generate all the forms and add it as a solution. Hence one crossover operation results in many solutions being generated.

3.3 Block Diagram



IV. ENVIRONMENT SPECIFICATIONS

The device which based on it, the analysis and evaluation of various algorithms has the following specification (as in the table below)

Processor	Intel(R) Core(TM) i7-7500U CPU @2.70GHz
Installed Memory	8.00GB
System Model	64-bit operating system, x64-based processor
Os Name	Microsoft Windows 10

V.IMPLEMENTATIONS

In analysis this approach is called hybrid approach which is a combination of genetic algorithm and fuzzy logic with both training and testing results got a good results. Genetic algorithm is implemented for the feature selection as it is the best algorithm for feature selection.

VI.RESULTS AND DISCUSSION

4.1 Results of Descriptive Statics of Study Variables

As we come to the results of this implementation, we got a good accuracy for this hybrid technique that is 99.67% which is a good one.

VII. CONCLUSION

Here we took the chars74 dataset which has all the numerical and letters of Kannada and later we evaluated using the training dataset and testing dataset with the help of genetic algorithm for the feature selection and then followed by the fuzzy logic which performs the best fitness function and took the best values which then performed the classification using the fuzzy logic and we got an accuracy of 99.67%.

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