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Handwritten Character Recognition using Machine Learning

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Abstract:- Handwritten character recognition(HCR) is a technique of making handwritten writing understandable by a computer. This research paper offers a thorough review of English-language handwritten character recognition. The banking and healthcare industries, among many other places that deal with handwritten employed in recent research in this field, features, and classifiers to make handwritten text recognition easier. The primary goal of doing this research paper is to build expert system for, "HCR using Machine Learning" that can effectivelly recognize a particular character of type format using the K Nearest Neighbours (KNN) algorithm and neural networks.When compared to, the planned recognition system performs fairly well and attains better levels of recognition accuracy. those using the traditional feature extraction techniques of horizontal and vertical.

materials, have used the handwritten character recognition technology in many different uses. Even if it's the same author the identical character, there are changes in the character's size, form, and placement since every writer has a different handwriting style. Numerous techniques have been

Keywords:- Elements extraction, Image processing, Handwritten database, classifiers and HCR systems.

I.INTRODUCTION

Among the most intriguing and difficult topics of pattern recognition and image processing research in upcoming years has been handwritten character recognition. [1] [2]. Character recognition has a long history that dates back to 1900, when Russian scientist Trying tried to create a tool for the blind. The advent of digital computers in the middle of the 1940s led to the development of the first character recognizers. Numerous studies have concentrated on innovative strategies and approaches that would speed up recognition while reducing processing time [3].

Online and offline handwriting recognition methods are the two main categories for handwriting recognition. A scanner will frequently optically capture the writing for offline recognition, and a photograph of the completed piece is subsequently made available. However, within the online platform, the order of the writer's strokes as well as the two- dimensional coordinates of succeeding locations are represented as functions of time. Due to the temporal information provided with the former, it has been demonstrated that online approaches are superior to their off- line counterparts at recognizing handwritten characters [4][5]. However, the use of neural networks to create comparably high levels of recognition has been successful. accuracy in the off-line systems. Several applications, such as document reading, bank processing, and mail sorting.[6]

Recognition system must start with pre-processing before moving on to segmentation and feature extraction. Pre-processing entails the procedures necessary to transform the enter a picture into a format appropriate for segmentation[7] [8]. The input image is split into distinct characters during Following the segmentation step, each character is scaled into the network's m x n pixels for training direction. Additionally, this study primarily makes use of several machine learning algorithms like KNN and neural networks to generate results that are more precise and superior to those produced by the present approach. Template matching, Deformable templates, Unitary Image transformations, Fourier descriptors, Spline Curve Approximation, Contour profiles, Gradient feature, Gabor feature, and Graph Description are some of the often employed feature extraction methods.

The primary goal of doing this research paper is:-

- Handwritten Character Recognition (HCR) Software has made it simple to extract data from handwritten papers and save it in electronic formats. HCR saves the human efforts and most important it also saves the precious time.
- It also helps to store the documents in digital formats for quicker retrieval or information collection.

There are various module of this project which is named as structure. The second structure of this project is literature survey, and the third structure of this project is Proposed system, and the fourth structure of this Project contain Results and Discussion and the last and fifth structure of this project is Conclusion.

II. Literature Survey

The acronym CNN stands for Convolution Neural Network. The word "convolution" means to twist or coil. The human brain is comparable to any neural network. The brain serves as an inspiration while designing neural networks. The major application of CNN is image categorization. Depending on the needs, CNN has numerous layers. Two distinct learning algorithms were presented by Ahmed Mahdi Obaid and his colleagues [11] for an efficient handwritten text recognition system. In comparison to Resilient Back-propagation algorithm, Scaled Conjugate Gradient algorithm shown exceptional results in term of training duration alongwith accuracy. The three primary CNN layers that Salma Shofia Rosyda and his colleagues[2] [10] described are as follows:-

- Convolution layer
- Pooling layer
- Fully connected layer

To recognise handwriting, there are numerous algorithms available. OCR (Optical Character Recognition) is a process that can be used to read handwritten and printed documents. The use of unsupervised feature learning techniques to solve problems with digit recognition systems was described by Yuval Netzer and his colleagues [13]. Paper documents are ones that need to be scanned and some of them have digitally written text. Documents that are written by hand are referred to as handwritten documents. There are two different categories of natural language recognition techniques:-

- Onine Handwritten recognition
- Offline Handwritten recognition

Offline Handwritten recognition:- In this, the earlier-written and saved documents are used to identify the characters that are contained in the papers. Alphabets, integers, or any other type of sign can be used as characters. It is possible to recognize mathematical phrases using this technique. This is a common feature in mobile apps, and it allows students to scan documents to have the mathematical expression recognizer identify the equations and deliver answers. Online handwriting analysis Instead of having the data scanned from a document in this case, the characters are typed with an electronic pen and are instantly recognized[14]. Here, character identification is done by taking into account strokes.

Numerous techniques for handwriting recognition are given in [3][5].

- Convolutional Neural network
- Incremental Recognition
- Line and word segmentation
- Part based Approach
- Slope and Slant method
- Ensemble method

i. Line and Word segmentation:-

Salma Shofia Rosyda and his mates [12] examined Slope and Slant process, which had the modest accuracy, and CNN methods, which had the best accuracy. Segmentation is a crucial stage in character identification. Without segmentation, it is challenging to precisely identify the letters or figures. Following are the actions in the segmentation process.:

- Viewing scanned photos and crop imagery to identify an area of interest.
- An image should be cleaned up of noise using the subtraction technique. Pre-processing is carried out to get rid of.
- After that, backdrop is removed and by mining text, the noise on the image is turned into binary.
- Hough transform is used to identify and correct skew.
- Horizontal Projection is used for Line Segmentation.

ii. Part Based Method:-

This is a method which is used to recognize the object. The following list of this method's attributes: Multiple keypoints should be used to represent a single image are:-

- Comparability of picture will mainly rely on picture having crucial value or not.
- At times, a collection of key points is used to represent each class.
- The advantages of the part-based approach are: Character recognition is good but normalisation with pre processing is challenging.
- It has no bearing on the overall structure.
- It is applicable to cursive script.

iii. Zoning method:-

The zoning method was put into practise by P. Shankar Rao and his colleagues[11][15]. Zones are created from the processed image, and following that, the feature extraction of the sign or characters is done.

It has generally two methods:

- Dynamic Zone and
- Static Zone

a).Dynamic Zone:- In dynamic zone the altered image is segmented into erratic zones. There are numerous zones in this image that can be dynamically resized. It is also dynamic. The zone size is changed in accordance with the neighbouring zones. And by employing this technique, zones can be resized whenever some zones are identified.

b).Static Zone:- In the static zone firstly, the image is broken into standardized zones. The zones are fixed when recognition is complete. Without any prior knowledge of feature distribution or extraction, this is carried out. Static zoning is carried out based on experimental findings or the years of developer expertise.

Table 1:- Literature Survey

Table 1:- contains brief descriptions of all the papers thatwe have read..

Author& Year	Classifier	Features	Accuracy
J. Pradeep,E.Srinivasan S.Himavathi	NN	character shrunk to 30X20 Pixels taken As feature	94.15% 200databaseof each26characters Capital characters
D.K.Patel, T.Som, M.KSingh	ANN	Discrete Wavelet Transform (DWT)	98.46% 100samplesofeach Character for training,50samples For testing Capita l characters
M. Blumenstein, B.Verma,H. Basli	BP And R BF networкs	Directional and Transition features	85.48% for uppercase and 70.63% for lowercase,CASand BAC type database Small characters
S.B.Hallale, G. D.Salunke	directionalPattern matching	Twelvedirectional features	88.29% 500 trainingimages and200 testing images Capitalcharacters andnumerals
A. Choudhary, R.Rishi, S.Ahlawat	NN	Character imageresized to15X12size, featurevector ofsize 180is created	85.62%. Databasefrom10 peoples 5samples from eachthustotal 10X5X26=1300 characterimage smallcharacters
RafaelM.O. Cruz,George D. C. Cavalcantian d TsangIngRen.	MLP	Modified EdgeMaps andMulti zoning.	91.139% for uppercase 88.45% forlowerc ase C-CubeDatabase SeparateCursiveCharacters

Perform handwritten character recognition of distinct characters on the following paper.

E. Srinivasan, J. Pradeep, alongwith S. Himavathi used neural networks to (2019) [19] created a recognition system. (Phrased as follows: They assessed the performance of each network, optimised the hidden layer's number of neurons (which is independent of the initial value), and came to the conclusion that the best results were obtained by combining a typical feature extraction method that uses back propagation and feed-forward.

The handwritten English character identification method used by T. Som, M. K. Singh, and D. K. Patel (2019) [17] uses a multi-resolution methodology along using Euclidean Distance Metric (EDM) and Discrete Wavelet Transform (DWT) (EDM). EDM calculates the distances between each of the vector of the mean and the unknown input pattern. Input pattern vector's class membership is determined by the minimum distance. A recognition accuracy of 98.46% is provided by EDM. By comparing results, followed by combining the Euclidean distances to acquire recognition scores, the learning rule using ANN increases the recognition accuracy. in cases of misclassification to 85.48%, subsequently increasing it to 88.29%[27].

Amit Choudhary, Rahul Rishi alongwith Savita Ahlawat (2018) [16].This study shows lowercase English alphabets are recognised by handwriting by employing binarized picture pixels as characteristics, operating as a multilayer back network with neural propagation as the classifier. The character picture is filtered, binarized, and shrunk to 15X12 in size; as a result, each character has a 180-by-180 feature vector, which is provided to the neural network for training. As a cost function, MSE (mean square error) is employed. Back-propagation is used neural network classifier and binarization features, categorization precision is 85.62 percent. As direct pixel values are taken, the characteristics are straightforward.

George D. C. Cavalcanti, Tsang Ing Ren, and Rafael M. O. Cruz (2020) [18]. This article recognises distinct handwritten cursive scripts. A modified edge map and multiple zoning are the two features suggested by the scribbler, among the many features that were withdraw in this instance. They evaluated the effectiveness in each network, optimised the neuronal density in the covert layer that are independent of the initial value, and came to the conclusion that the best feature extraction method is used in conjunction with feed- forward back propagation. They assessed the performance of each network, optimised the hidden layer's number of neurons (which is independent of the initial value), and came to the conclusion that the best results were obtained by combining a common approach for employing backwards-propagating feed-forward algorithms for feature extraction[28].

Geeta D. Salunke and Sumedha B. Hallale (2013) [20]. The traditional and directional feature extraction approaches are contrasted in this study. Twelve directional qualities are used to distinguish between letters and numbers. To extract the directional feature of each pixel, the values of the gradient are transformed onto 12 values for directions and a gap about to 30 degrees among the two consecutive values for directions. The mean of the feature matrices for each class is calculated to form the feature vector for that class. The examining pictures is a member of the class with the greatest resemblance when comparing the testing feature vector to feature vectors from all other classes[26].

III. Proposed System

In this segment, the suggested recognition process is covered. The typical stages in a handwriting recognition system are pre-processing, segmentation, feature extraction, classification, recognition, and post-processing. The schematic of the suggested recognition system is given in Fig. 1.

i. Image Acquisition:-

A filtered picture is used as an input image during the process of image acquisition. The picture must be in a certain pattern like JPEG, BMT, etc. This picture was captured with a digital camera, scanner, or another suitable digital input device.

ii. Pre-processing:-

Several operations are carried out on the scanned input image during pre-processing. It effectively improves the image, making it segmentation-ready[21]. Fig. 2 displays the numerous operations carried out on the picture while the pre-processing step. A binary picture is created from a grayscale picture during the binarization process using the global thresholding approach. The operations carried out in the final two phases to create the segmentation-ready image after preprocessing include detecting while using the borders in the binarized picture the Sobel technique, dilating the picture, and stuffing the gaps available in it [21][29].

This is just image augmentation

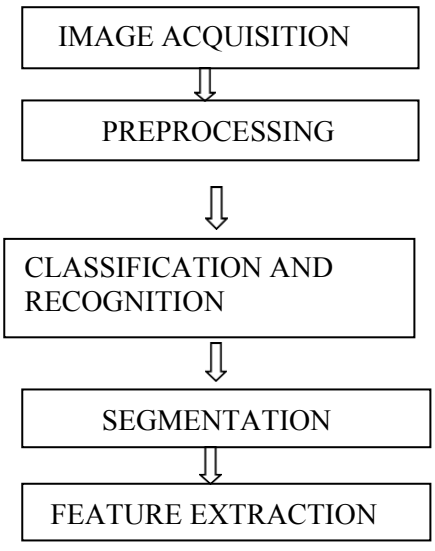


Figure 1. Flowchart of proposed recognition system

Tokenization

Segmentation:-

During the segmentation stage, an image of a group of characters is split within smaller pictures of each distinct character. The suggested method separates isolating the input picture after preprocessing and uses a labeling approach to assign a number to each character, how many characters are in the image is shown by the labeling. Each character is equally scales to 90X60 pixels for categorization and identification. This is most important method because it helps the system to understand the the input text by breaking into the further smaller pieces

.

Characteristic of global transition features based on global transformation provide accurate depiction of image shape. It is a translation of the picture using the spatial to the occurrence range. This feature provides energy compactness by storing the information present in the entire image in a small number of coefficients[20]. Examples of different types of global transformation-based traits include the discrete Fourier transform, discrete Cosine transform, discrete Wavelet transform, and others[30].

D-Classification:-

Use of dataset

The categorization stage, that employs the attribute gathered in the prior phase, is where a identification system makes decisions. The feature vector is represented by the notation X, where X = (f1, f2,…. ,fd), and where f abbreviate for features and the d stands for the number of attribute retrieved due to character. Characters are effectively recognised and classified into the proper class based on the comparison of feature vectors.

There are two different types of learning methods

based on classifiers:-

Supervised learning:-

It is the type of learning in which the model is firstly trained using training data that accurately reflects the class. Supervised[22] learning method is generally used to test the data to ensure appropriate categorization. The input and the targeted outcomes are both included in the training data.. After going through a learning process, the model uses what it has learnt to classify test data. Examples include SVM, HMM, etc.

Unsupervised learning:-

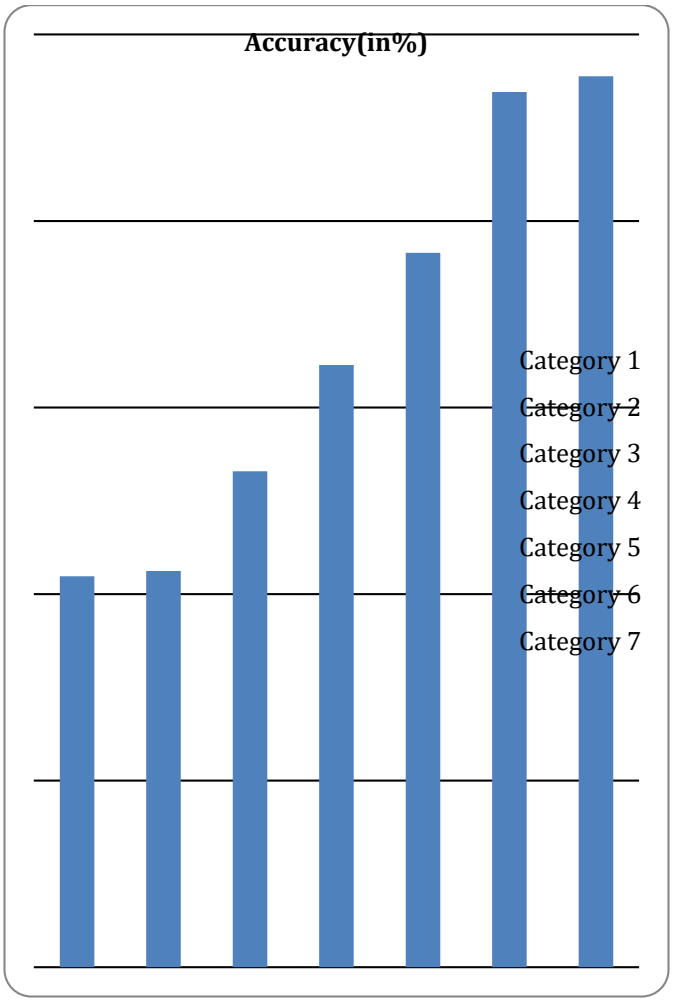
There are no training data given to the unsupervised learning model. It doesn't call for education. Unsupervised learning model uses statistical properties to classify test data, spatial grouping, and closest neighbour consideration. For instance: k means, clustering, etc. E-Post-Processing[23] By connecting a dictionary to the system and using higher level concepts like syntactic and semantic analysis to check the recognised character, the accuracy of recognition is further improved at this stage. HCR system does not require completing this stage.

IV. Results And Discussions

"The goal of "HCR Using Machine Learning" is to identify handwritten characters. Utilizing this method, the original image is first transformed to grayscale, then segmented and converted to black and white. The "handwritten Character Recognition System" is created using machine learning and neural networks. After preprocessing and segmentation procedures, the system presents the final result. The suggested handwritten character recognition system[24] has been implemented utilising a menu-based GUI (Graphical User Interface), as shown in Figure 1. The user is presented with two selections by the interface system: in the first menu there is five stages and also there is other menu where they can select the feature extraction type .

The end user can perform the task like pre processing, and they can also select the kind of feature extraction, carry out feature selection by using the selected method, and likewise user can train the network by using the menu-based GUI[25]. Lastly as compared to all existing handwritten character ,the predicting accuracy of this current handwriting character recognition is 98.88%,which is the highest among all the existing methods.

Figure 2:- Main menu



Graph 1:-Accuracy of handwritten character recognition

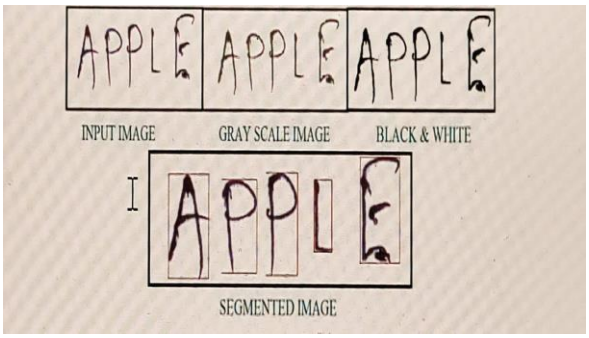


Figure 3:-Module Result

Figure 4:-Recognized text

VI. Conclusion

Plenty of studies and analysis has been already done in the field of discrete character recognition for handwritten text. However, the fact that 100% accuracy has not yet been attained leaves room for additional effort in this regard. Separate characters provide good accuracy, although differing writing styles have an impact on word recognition. There are numerous methods for recognising handwriting. Some of these are semi-incremental segmentation, incremental segmentation, zoning, convolutional neural network , slope and slant correction. While comparing to all the existing methods ,the top perfection is accomplished by using convolutional neural network, whereas the lowest perfection is accomplished by using Slope and Slant method. It is one of the most fruitful methods for hand writing identification, and when the photos are trained by using CNN, we will obtain better accuracy. The biggest flaw of CNN method is that it takes too long to train the model because so many image samples are needed..

Due to its complexity, segmentation-based methods have lower accuracy. The classifier exhibits good accuracy when the vocabulary is restricted to fixed numbers. Lastly as compared to all existing handwritten character ,the predicting accuracy of this current handwriting character recognition is 98.66%,which is the highest among all the existing methods.

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