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RECOGNITION OF HANDWRITTEN HINDI CHARACTERS USING SPEEDED UP ROBUST FEATURES (SURF) AND CNN

D. Anjali[1], Sk.Taj Mahabhoob[2], K.Siva chandra[3]

[1]M.Tech Student JNTU College of Engineering, Pulivendula, E-mail Id: devaraanjali4u@gmail.com.

[2]Assistant Professor JNTU College of Engineering, Pulivendula, E-mail Id: shaiktajmahaboob@gmail.com.

ABSTRACT:

Character recognition is a digital or computer conversion of typed, printed text, or computer-editable text images. Character recognition is more significant in the study of pattern recognition, machine intelligence and machine form. For recognition of character recognition, whether handwritten or type-written, two stages are needed to extract the features of the input image and classifier to perform the extracted features classification. The character image can be represented as a set of feature vector. To get, high recognition rate and low recognition duration, it is very necessary to reduce the dimension of the vectors. The size of the feature vector is very large in handwritten optical character recognition. By reducing the image size, the dimension of the feature vector can be reduced. But this reduction of the vector dimension feature also reduces the information about the pixels. In order to overcome this, we propose SURF (Speeded up robust feature technique) as feature extraction technique associated with CNN as classifier, and performance of the system is compared with three different feature extraction techniques of Chain code, canny edge detection and directional features associated with SVM classifier. Character recognition is used in a number of applications such as check reading, form processing, signature authentication, post code recognition, and ancient text recognition, etc.

Keywords: Handwritten character recognition, HINDI character set, Chain code, edge detection, directional features , SVM classifier, Speeded up robust features (SURF), CNN classifier,

I.INTRODUCTION:

Character recognition has a lot of interest in pattern recognition in today's environment. Optical Character recognition is a mechanism that enables the machine to recognize and convert words, numbers or images into a digital form that a computer can use, it is a mechanism in which the input image is identified, divided, classified and converted to the other equivalent computer editable form. To make important documents such as manuscripts, handwritten conversion is more important [1].

Character recognition (CR) is the digital conversion to machine-encoded text from handwritten text scanned images.

OCR has wide-ranging uses as telecommunications assistance for the deaf, interpreting postal addresses, direct document processing, and recognition of foreign languages, etc.,[2].

Optical character recognition solves the optically mediated character recognition issue.

Character recognition will be divided in to two types: 1) Online Character Recognition 2) Offline Character Recognition Online character identification in the writing process includes character recognition, Offline character identification recognizes characters previously depicted in a captured image. Compared to the computer printed document handwritten character recognition is more complicated because people have different handwriting styles [3].

Character Recognition (CR) has been used as a

paragliding term that incorporates all aspects of computer character recognition in different areas of application. The summary focuses on the methods required to increase use in emerging areas such as the development of digital databases, virtual databases and manual data entry systems [4].

One of its important steps in character recognition is segmentation, major problem facing character dividing when dealing with the identification of segmented handwritten characters is complexity and character illegibility[5].

There are many feasible data recognition techniques such as the Principle Component Analysis (PCA) and the Linear Discriminant Analysis (LDA) are two commonly adopted methods to classifying data and the dimensionality. LDA requires some data-simplifying assumptions. The data is Gaussian. When plotted, each function is formed as a curve. Every parameter have the same variation, by an average with the same amount, every quality of the variables is different around the mean.LDA handles the case of unequal class frequencies and their output has been studied on randomly generated test data. The LDA model calculates the mean and variance of data for each classification with all these hypotheses. By dividing the sum of values by the total number of values, the average (μ) value from each input sample(x) for each group (k) can be determined in the generally.

$$\mu_k = \frac{1}{n_k} * sum(x) \qquad 1$$

Where μ_k is a average value of x for the group k, nk is the number of cases with group k.

The difference is defined as the mean squared variance between each value as well as the mean across all classes.

$$\sigma^2 = \frac{1}{(n-k)} * sum((x-\mu)^2) \qquad 2$$

Where σ^2 is the variability for all inputs (x), n was the number of cases, k is the number of classes and μ is the average of x[6]. First, to reduce data dimensions and distinguish information attributes from raw information, PCA and LDA are implemented differently. The classical method for SVM is then used to distinguish types of mistakes. A reduction in the number of input result in fewer iterations and less techniques of learning while integrating PCA and LDA techniques. Fault identification technologies has become one of the important issues as rise of modern industry. As shown in fig-1, the preferred solution consisting of several sections: Technical part removal and wrong diagnosis. The data collected obtained from the rolling bearing network is separated into train data and test data in the information field reduction section. PCA and LDA methods are being used to prepare the information in order to obtain processed data and processing matrixes.

On testing data, such matrixes are then implemented and the same functional test data is obtained. SVMs are prepared with the train data extracted from the first portion as one of the fault analysis.

A structure is based for more defect analysis after the conclusion of SVM's preparation. Extract test information from both the input and collect results of the test use a trained SVM system [7].

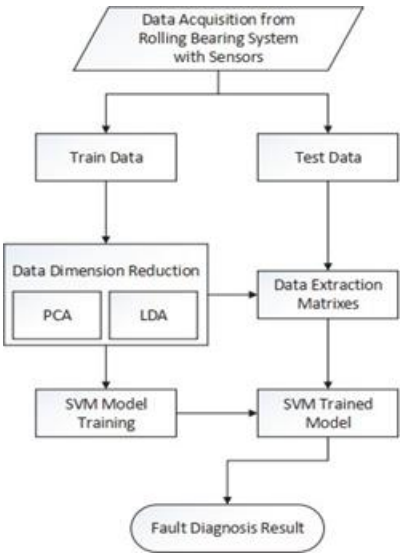


Fig-1: Flow chart for fault diagnosis operation

II.RELATED WORK:

In [8], Suruchi suggested many methods of character recognition focused on the identification of characters online and offline. Online methods for recognizing characters are classifier K-NN and method dependent on direction. Methods of offline character recognition are K-means, centralized, SOM (self-organizing graph) and EM (maximization of expectations).The BTT (border transition method) graph matching technique and zoning technique are based on the projection method of extraction of features. Based on the directional technique of pattern matching. RBFNN and parallel BPNN approaches are implemented on the basis of artificial neural network BPNN. It is explicit that, in complicated cases, segmentation as well as identification must be done in an automated way in order to obtain reliability.

In [9], Dipak D. Bage, K. P. Adhiya, Sanjay S. Gharde, Displayed character geometry including chain code, directional characteristics, local characteristics, global characteristics, ink based characteristics, refined period invariants and pattern geometry as attribute extraction methods and SVM as a classifier.

We concluded that similar methods of extracting characteristics are used independently for mark, character and phrase recognition. Word Geometry is also identified to be mostly used for the objectives of character recognition but have not yet used for mathematical formulas.

In [10],W. Li, S.M. Xiang, H.B. Wang, Combination of architectural characteristics, statistical characteristics, gradient characteristics and distance transformation. In that, we have implemented the universe of discussion & skeletonization of input picture to reduce the extraction time function specifically needed for geometric features. In future research, they suggest working to reduce the processing time needed and that with full precision, the actual process would become faster.

In [11], Munish Kumar, Identified a novel attribute extraction method for the Gurmukhi object detection program offline handwritten. We also extracted different topological characteristics, including peak extent characteristics, shadow characteristics and centroid characteristics. Use horizontal maximum extent functions and the vertical level extent options, a major feature collection is also suggested. They utilized k-NN and Linear-SVM classifiers for identification. Using SVM with vector kernel classifier, the proposed solution achieves a cumulative identification accuracy of 95.62%.A cumulative accuracy of 95.48 percent and 94.74 percent respectively while using k-NN and MLPs.

In [12], Pratibha Singh, Attributes are measured using three various methods of zoning. Directional function is considered to be obtained by quantizing the orientations with chain coding and gradient orientation. Quadratic bayes clustering algorithm and linear base algorithm are selected as the base algorithm for identification1-nearest neighborhood based

algorithm. The base optimization algorithms are integrated using four laws, including maximum decision mix, median, average, and majority vote. The method is used for checking the performance of the against ambiguity detection system. Recognition of optical characters using chain code, canny edge detection and directional technologies to monitor the external line of the input picture and resize the picture. The system of canny edge detection is being used to identify edges and characteristics such as points of intersection, staters and minor staters ... etc. The spatial characteristics identify the vertical horizontal lines. The classifier for SVM identifies the characteristics of the input file. Ultimately, it gives the quality that is remembered. Utilizing SURF, optical character identification is used to remove the attribute and the attribute to minimize the image compression of the SURF feature vector. CNN clustering algorithm is used to define input characteristics.

Chain code and SVM approaches are substituted by SURF and CNN due to improved results from SURF and CNN and improved system performance, increased detection rate and decreased identification time.

III.METHODOLOGY

The Fig-2 as shown on the is steps with multiple processes for object detection, such as pre-processing, segmentation, representation, extraction of features, reduction of features and classification. Pre-processing decreases the noise and increases the picture quality, the individual will have to be partitioned in segmentation and may be described. The characteristics are extracted, the identification is finally conducted.

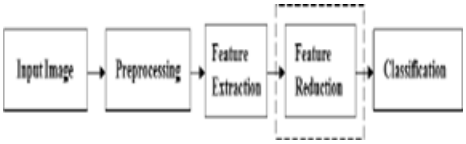


Fig-2 : Steps for the character recognition

The Fig-3 as shown on the illustrates the diagram of the proposed model i.e. by considering one input picture as well as using Average filtering the current noise will be removed and the picture will be transformed from gray to binary image, Dilation will improve the quality of the input picture. The picture is finally recognized for the attribute extraction SURF and for the methods of CNN classification.

It describes the current method, using S.U.R.F features for collection of features for the proposed method, and using CNN for identification.

Using surf attributes, the characteristics were determined. S.U.R.F or Speed up Robust Attributes is a proprietary algorithm that is mainly used during computer vision activities and is linked to object detection. By extracting important points from various regions of a given picture, SURF falls under the category of attribute descriptors and is therefore very helpful in finding similarities between pictures: find features / main points which are likely to appear in various images with the same thing.If necessary, these characteristics should be symmetric in size and rotation. Corners, blobs, and so on are fine and checked in different scales commonly.

Find the correct "orientation" of that position so that both images are associated with that single key point when the image is oriented according to that alignment.

Computation of a descriptive term with details about how (after alignment) the area of the main point appears in the right scale. A convolutionary neural network includes of a layer of input and output, as well as several hidden layers. Typically, a CNN's hidden layers include of convolution levels, RELU layer i.e. activation method, pooling layers, fully connected layers, and layers of normalization.

Every convolutionary layer within the same

neural network need to have the following characteristics when training a convolutionary layer.

Input is a shape (picture amount) x (picture width) x (picture height) x (picture depth) tensor. Amount of kernels of convolution. Hyper-parameters are the width and height of the kernels.

Kernel depth must be identical to the depth of the image. Convolutionary layers attach an action of convolution to the input and transfer the output to the next layer. The convolution resembles a specific neuron's reaction to external stimuli.

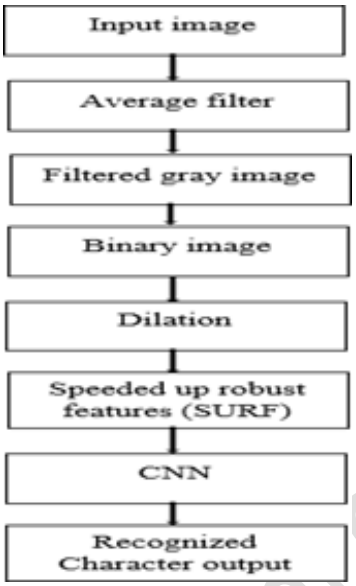


Fig-3: Flow chart for SURF and CNN method

3.1 Fully connected:

The Fig-4, shown below, illustrates the proposed system procedure. Fully connected structures link each neuron in one surface in a another layer to each neuron. It's exactly the same as for the conventional neural perceptron multi-layer (MLP) network. The Fig-4, as shown on the, illustrates the proposed system procedure. Fully connected structures link each neuron in one surface in a another layer to each neuron. It's exactly the same with the conventional neural perceptron multi-layer (MLP) network.The added restriction helps to combine preparation faster than it would otherwise be. Softmax is imposed just before output component via a neural network method. The layer of Softmax should have the same collection of nodes as the level of output.

Fig-4: Block diagram for SURF and CNN

3.2 CNN:

It is a Deep Learning technique that can accept an input picture, assign significance (fairly basic weights and perceptions) to different aspects / items in the picture and distinguish one from another. In a ConvNet, pre-processing is much smaller than other classification techniques. Although filters are hand-crafted in primitive ways, Convent's have had the capacity to learn these moderators / characteristics with sufficient training. A ConvNet's architecture is similar to that of the human brain's Neurons communication pattern and was influenced by the Visual Cortex's structure.

Only in a small area of the visual field defined as the Receptive Field, individual neurons respond to stimuli. To cover the whole visual region, a set of such fields coincides.

IV. RESULTS AND DISCUSSION:

The proposed method has been given best results when compared with the existing method. Here, input images are taken for feature extraction and classification.

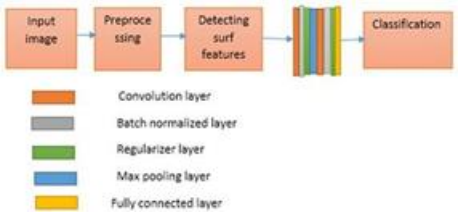


Fig-5: Input image

Here, Fig-5 is the input image is taken, in that the input character has to be recognized. The features of the input image are extracted by using the SURF features and the features are classified by using CNN classifier.

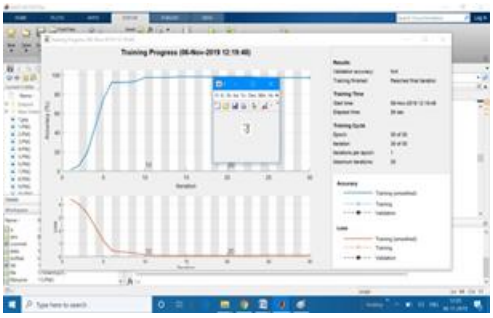
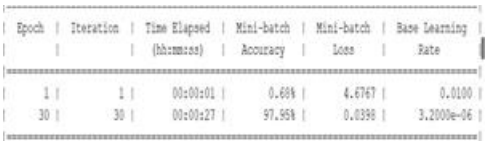


Fig-6: Classified output

Finally, in Fig-6 the input character is recognized, the above graph indicates maximum recognition rate and below graph indicates minimum error.

Fig-7: Showing command window

The Fig-7 showing command window, the recognized output maximum accuracy is 97.95% and the loss is 3.25%.



Epoch	Iteration	Time Elapsed (hh:mm:ss)	Mini-batch Accuracy	Mini-batch Loss	Base Learning Rate
1	1	00:00:01	0.68%	4.6767	0.0100
30	30	00:00:27	97.95%	0.0398	3.2000e-06

Fig-8: Input image

Here Fig-8 is the input image, in that the input character has to be recognized. The features of the input image are extracted by using the SURF features and the features are classified by using CNN classifier.

Fig-9: Classified output

Finally, Fig-9 explains about the recognized letter the above graph indicates maximum recognition rate and below graph indicates minimum error.

Epoch	Iteration	Time Elapsed (hh:mm:ss)	Mini-batch Accuracy	Mini-batch Loss	Base Learning Rate
1	1	00:00:02	2.05%	4.9778	0.0100
30	30	00:00:26	93.84%	0.1962	3.2000e-06

Fig-10: Showing command window

Fig-10 showing command window, for the recognized output maximum accuracy is 93.84% and the loss is 7.25%.

4.1 Experimental Results of Chain code, canny edge detection and directional features, SVM; SURF,CNN:

SL.NO	INPUT IMAGE	% OF RECOGNITION RATE			
		Chain code + SVM	Edge Detection + SVM	Directional Features + SVM	SURF + CNN
1	Img1	96.71	95.36	73.70	97.95
2	Img2	86.59	87.38	77.61	97.95
3	Img3	93.12	94.64	92.03	97.26
4	Img4	91.66	93.10	72.92	95.21
5	Img5	94.65	95.01	64.14	97.26
6	Img6	96.32	95.29	89.32	96.52
7	Img7	98.26	98.80	90.89	97.95
8	Img8	88.53	82.58	75.69	95.47
9	Img9	83.07	92.65	82.96	96.24
10	Img10	95.12	86.91	87.63	97.78

The above table indicates the comparison between Chain code ,canny edge detection and directional features, SVM; SURF, CNN method results that shows, SURF, CNN having best accuracy and less recognition time.

Chain code + SVM gave the highest recognition rate for image1, Directional features + SVM gave the least recognition rate. Edge detection + SVM gave the best recognition rate for image2,Directional features+ SVM gave the least recognition rate. Edge detection +SVM gave the highest recognition rate for image3, Directional features +SVM gave the least recognition rate and so on..,

We conclude that on an average SURF + CNN gives an higher recognition rate for all the images.

4.2. Graphical representation: The belowFig-11 explains about graphical representation, blue color indicates Chain code, Edge detection, Directional features and SVM results and red color indicates SURF, CNN results.

Fig-11: Graphical representation of the Chain code, edge detection, Directional features and SVM , SURF and CNN methods

4.3 Limitation:

When the Optical Character Recognition (OCR), is applied for the word like 'kall'. The image is first converted into the gray level to binary level image. The horizontal line is a part of the character, also there are some characters in the Hindi language that use small horizontal line. To separate the individual letters from the given name or word, the character segmentation is needed. Apply the bounding box for each character using MATLAB functions region props and rectangles. Then characters will be separated from the input image. But in this particular case the word 'kall' is getting separated from the input without shirorekha but not with shirorekha.

The below Fig-12 is the input image. The input image is ,Hindi word without shirorekha.

Fig-12: Input image

Fig-13: Bounding box

The above fig-13 explains about the bounding box, the character segmentation i.e., the bounding box is applied for both characters.

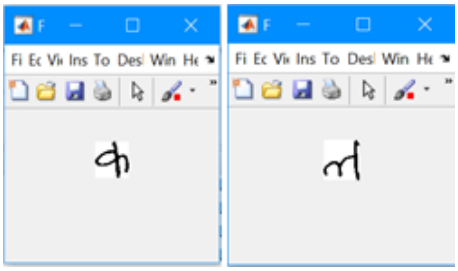


Fig-14: Separated characters

The above Fig-14 explains about the separated characters by using bounding box.

V.CONCLUSION:

We conclude that the highest recognition rate is obtained for SVM96.71%using Chain code and 73.70% less recognition rate is obtained using Directional features for image. Highest recognition rate is obtained for SVM 87.38% using Edge detection and 77.61% less recognition rate is obtained using Directional features and so on.., On an average Chain code gave the highest recognition rate , Edge detection gave the moderate recognition rate and Directional features gave the less recognition rate.

In this paper SURF is used for feature extraction and CNN for classification gives the best recognition rate for all the images compared to Chain code, Edge detection and Directional features with SVM.

The limitation that has to be mentioned in the related work, the given word, is getting separated by using the character segmentation with the help of bounding box is achieved without shirorekha. But actually, it is possible to achieve with shirorekha. By using these methods the recognition rate will be improved, recognition time will be reduced and the system performance is improved.

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