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Handwritten Character Recognition Based On Hybrid Enhancement Technique

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ABSTRACT: In the age of digitalization,image processing techniques became a major part of the detection and recognition of image feed. In this paper, different enhancement techniques are proposed to improve the recognition rate further for handwritten Hindi characters. For classification purpose Support Vector Machine(SVM) is employed. The texture features are extracted from the original images directly and classified through Support Vector Machine(SVM).Then various enhancement techniques such as Laplacian filter, Adaptive Histogram Equalization, Butterworth Filter, Gaussian Filter, and Highpass Filter are applied to the original image. Similartexture features are extracted from different enhanced images and classified. Results show that the recognition rate of the original images improves by 15% using Butterworth, Gaussian and highpass filters and reduces by 5% using 2nd order Laplacian Filter.

KEYWORDS: Character classification,Feature extraction,Image Enhancement techniques, Support Vector Machine(SVM).

I. INTRODUCTION

Digital image processing has become crucial in many fields like signature recognition, iris recognition, and face recognition, in forensics and in automobile detection. The recent development of Machine learning algorithms for image processing results in cost-efficient systems used in healthcare, automotive and military. Computer vision on the edge is a good start but it is not enough, as it needs to deal with distorted images from a wide-angle lens, image stabilization, low-light conditions and so on which will be resolved by using image processing methods.

Shalini Puri& Satya Prakash Singh, (2019) Have discussed an efficient classification on handwritten mono-lingual datasets on Hindi, Sanskrit and Marathi languages using SVM. Their project includes projection profiles, Shirorekha-less characters, extract features and classifies into pre-defined categories "[1]".

Mahesh Jangid&Sumit Srivastava, (2014) have proposed Gradient Local Auto-Correlation (GLAC) for handwritten character recognition "[2]". In this paper, GLAC is proved to give better results than other methods such as Histogram Of Oriented Gradient (HOG) and Scale Invariant Feature Transform (SIFT) in object detection. The SVM is used for classification on datasets, ISIDCHAR and V2DMDCHAR with the accuracies of 93.21% and 95.21% respectively.

Bhalerao et al., (2018) has suggested concatenated multiple directional features that are the strength of gradient (SOG), angle of gradient (AOG) and histogram of gradient (HOG) and downsampled SOG and AOG to 392 dimensions with gaussian filter. The combination of quadratic and SVM results in an accuracy of 95.81% with 3-fold cross-validation "[3]".

Madhuri Yadav & Ravindra Purwar, (2017) have proposed to automate handwritten recognition using isolated Hindi characters using multiple classifiers "[4]". HOG and profile projection histograms are used as feature extraction methods and evaluate the performance of various classifiers. The quadratic SVM has been performed better results among other classifiers.

Ajay Indian &Karamjit Bhatia, (2017) have presented their research work on offline handwritten character recognition using various approaches like Artificial Neural Networks (ANNs), Genetic algorithms, Fuzzy Logic and machine learning algorithms like SVM, K-Nearest Neighbour (KNN), Hidden Markov model (HMM), Bacterial Foraging and Clonal selection algorithm "[5]".

Mohammed Z. et al., (2005) has proposed that Recognition of characters greatly depends upon the features used. Several features of the handwritten Arabic characters are selected and discussed. Evaluation of the importance and

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accuracy of the selected features is made. The recognition based on the selected features give average accuracies of 88% and 70% for the numbers and letters, respectively "[6]".

DewiNasien et al., (2010) has proposed the Freeman Chain Code technique for English Handwritten character recognition using a randomized algorithm from which 64 features are extracted and classified using an SVM classifier. This methodology applied to the NIST database which resulted in relatively high accuracy for English handwritten recognition "[7]".

S.V. Rajashekararadhya&P.Vanaja Ranjan, (2009) Have presented zone and distance metric based feature extraction where average distance from the character centroid is calculated for n features are extracted for classification and recognition. This model obtains a recognition rate of up to 97.75% for Kannada numerical "[8]".ChayapornKaensar, (2013) has proposed to considered error rate, misclassified image rate, computing time along recognition rate. Based on the above parameters SVM results better than K-Nearest Neighbor with a recognition rate up to 96.93% for Handwritten digit recognition.

L.S.Oliveira&R.Sabourin, (2004) have proposed that Heuristic over-segmentation for segmentation-based recognition system to prevent segmentation, overlapping and unknown number of digits. SVM classifier is preferred by R.Sabouin to deal with outliers which are over- and under- segmentation to multi-layer perception network "[C. Kaensar, C. (2013). A Comparative Study on Handwriting Digit Recognition Classifier Using Neural Network, Support Vector Machine and K-Nearest Neighbor.

This paper organized as follows, Section 2 represents a brief review, Section 3 discusses the proposed methods in detail. The results are discussed in Section 4. Section 5 concludes the work.

II. RELATED WORK

A. *Second order derivative or Laplacian Transform*

The second-order derivative is used as an image sharpening technique. İt is commonly called as derivative operator Laplacian. The application of filter masks on top of the laplacian derivative equation generated grayish edge lines with a dark background.

$$\nabla^2 f(x,y) = \frac{\partial^2 f(x,y)}{\partial x^2} + \frac{\partial^2 f(x,y)}{\partial y^2}$$

B. *Adaptive Histogram Equalization*

The contrast of the image can be enhanced with adaptive histogram equalization. The basic difference between normal histogram to the adaptive histogram is that the adaptive histogram enhances the contrast of small portions of the image and eliminates the induced boundaries by adding adjacent portions using bilinear interpolation.

C. *Butterworth Filter*

In image processing, Butterworth acts as a filter that controls the sharpness of the image with the order. The parameters of Butterworth are order, radius, and, cutoff frequency. By increasing the cutoff frequency, we can observe a smooth transition in the blurring of an image. In Butterworth low pass filter, we can avoid rings/ripples in any of the processed images.

$$\left| H_b(jw) \right| = \frac{1}{\sqrt{1 + (\frac{w}{w_c})^{2N}}}$$

D. *Gaussian Filter*

The Gaussian filter is an image smoothing technique that blurs the image to reduce noise and detail. It is the convolution between image and gaussian function. Gaussian filter is a low pass filter which attenuates the high frequencies in the image.

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2}$$

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E. High Pass Filter

A high-pass filter is an image sharpening technique that enhances the details in the image. Unlike 23image at higher frequencies. By attenuating all the low frequencies, the brighter portion of an image gets brighter at the highest signal-noise ratio. But it decreases the quality of an image significantly.

$$f_c = \frac{1}{2\pi RC}$$

III.METHODOLOGY

The proposed method uses a Multi-SVM classifier considering the statistical features of the images iterated through every enhanced dataset. Our experiment follows preprocesses, enhancements, feature extraction, and classification. The classification works by identifying the minimum distance between close classes and classifies accordingly. Further, the validation images are separated before classification and used to evaluate the model performance on each applied enhancement technique.

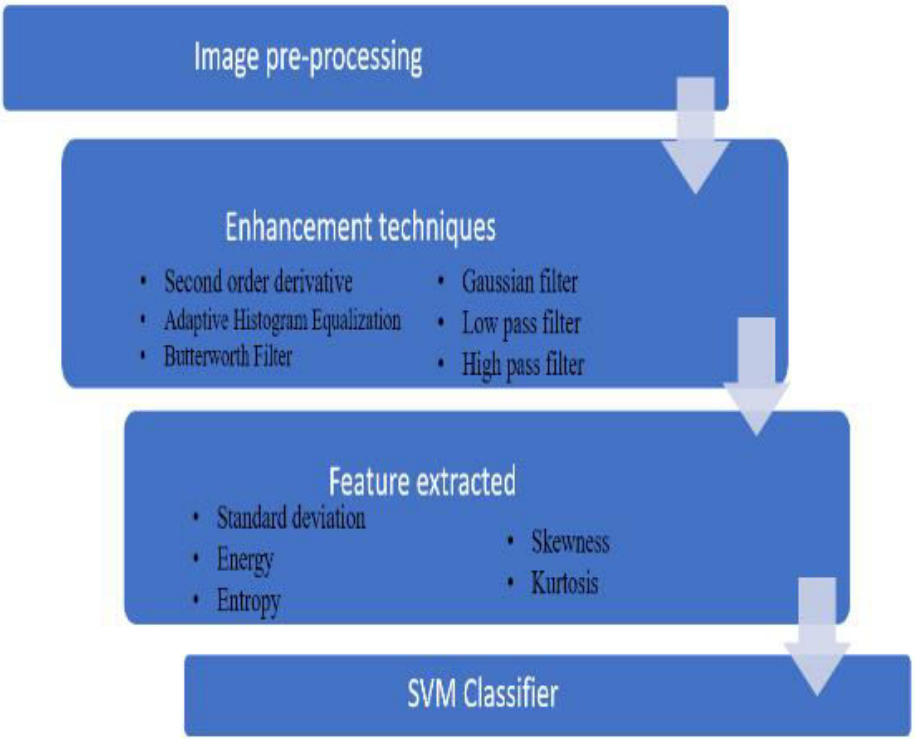

Fig 1.Block Diagram Of this experiment

A.Image Processing

In preprocessing, our methodology is to resize the images without losing the details at a resolution of 256x256. The considered dataset already consists of grey images with an original resolution of 800x600. And it follows with the application of image enhancement techniques.

B.Enhancing images for feature extraction

As stated in Section 2, the enhancement techniques we used in our methodology are 2nd order derivative or Laplacian, Adaptive histogram equalization, Butterworth filter, Gaussian Filter, and, High-pass filter. Five datasets are been generated from the enhancing section. Each dataset structured with the classes and divided into training and testing classification.

C. Feature Extraction And Classification

During this method, the statistical features in image processing are used in our experiment such as Energy, Standard deviation and kurtosis are calculated and extracted for every enhanced dataset and represented in the matrix form. These extracted features are used to train the SVM classifier with the labels as their folder names. And tested with the prediction function of the trained classifier on unknown images to analyze the performance of each enhancement technique.

IV. EXPERIMENTAL RESULTS

A.Data Set

The proposed approach is verified on Devanagiri handwritten character dataset "[6]" from the UCI Machine Learning repository. This dataset is created by annotation and extraction of characters from handwritten documents. It consists of 26 alphabets in which 5 classifiers are considerd and each classifier consists of 10 images. Here 6 images used for training and 4 images used for testing. This dataset consists of a variety of handwritten fonts that almost sufficient for machine learning classification.

B.Results And Discussion

After training the classifier, the results of each enhanced dataset are presented below. The recognition rate of the original dataset without enhancements on the SVM classifier is 75%. After the 2nd order derivative, the recognition rate drops to 70%. Applying Adaptive Histogram equalization improves accuracy to 80% using similar feature extraction methods. Butterworth filter results in a recognition rate of 90% . Similarly, Gaussian or Low-pass filter and High-pass filter also improve the recognition rate up to 90%. The results are tabulated in Table 1 presented below. Some of the features that were extracted in the svm classifier are standerd deviation, Energy, Entropy, Kurtosis, Skewness.

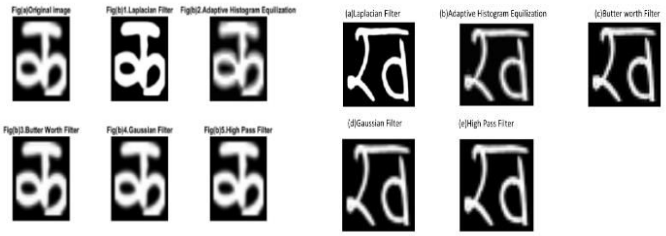

Fig 2. Images for different Enhancement Techniques

Methods	Accuracy(in %)
1. Original dataset	75
2. Laplacian derivative	70
3. Adaptive Histogram equalization	80
4. Butterworth Filter	90
5. Gaussian Filter	90
6. High-pass Filter	90

Table 1. Classification accuracies for applied enhancement techniques.

From Table 1 it is observed that when the 2nd order derivative or Laplacian derivative enhancement technique is applied, the recognition rate decreased by 5% while Adaptive histogram equalization improves by 5% and Butterworth, Gaussian, and, high-pass filter improves recognition rate by 15% each.

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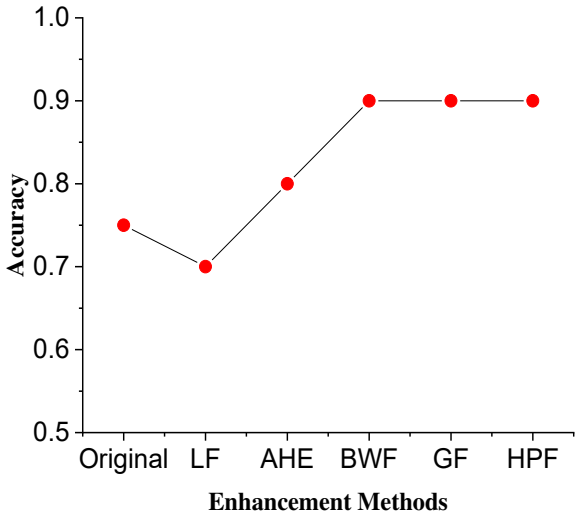

Fig 3.Charcterstics Of Enhancement Methods

V. CONCLUSION AND FUTURE WORK

In this paper, different enhancement techniques are implemented such as second-order derivatives, adaptive histogram equalization, Butterworth, Gaussian, High Pass, and Lowpass filters. Here the challenge is to improve the handwritten character recognition rate. The performance results show that Butterworth, Gaussian, and High Pass filters are efficient for handwritten character recognition. We aim to improve the recognition rate of classifiers without tuning hyperparameters of the machine learning model which is useful to reduce the high computational power for testing in real-time applications. The output from enhancement techniques can be implemented in the field of medical, self-driving automotive, microscopic imaging and pattern recognition.

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BIOGRAPHY

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