NOISE REMOVAL & SEGMENTATION OF MACHINE PRINTED & HANDWRITTEN GURMUKHI DOCUMENTS

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ABSTRACT

In this paper, noise removal and segmentation scheme is presented for Machine Printed & Handwritten Gurmukhi documents. The noise removal from the Gurmukhi documents whether machine printed or handwritten has been a very intensive area of research during last decade due to its wide range of applications as a solution to real world problems. Lot of work has been done on languages like English, Arabic, Chinese, Devnagari and Urdu. The whole process consists of two stages. The first step is addition of noises to a gurmukhi document. Then various filters are operated on these noisy documents. The quality parameters are calculated & analyzed for each filter operation. At last a comparative analysis is performed on the basis of quality parameters obtained for each set of noise & Filter.

Keywords: Segmentation, Handwritten Gurmukhi Script, Median Filter, Wiener Filter, Gaussian Filter, Speckle Noise, Gaussian Noise, Salt & Pepper Noise.

I. INTRODUCTION

Digital images are prone to a variety of noise. The varieties include Speckle noise, Gaussian noise, Salt and pepper noise. It is a difficult task to separate noise from an image while maintaining the desired information and quality of an image. Gurmukhi script is used primarily for Punjabi language, which is the world‟s 14th most widely spoken language. The Character set of Gurmukhi script is as in Fig. 1(a), 1(b) & 1(c). Some of the properties of Gurmukhi script are: Gurmukhi script is cursive and the character set consist of 41 consonants, 9 vowels, 3 sound modifiers (semi-vowels) and 3 half characters, lie at the feet of consonants.

In Gurmukhi Script, most of the characters, as shown in Fig. 1, contain a horizontal line at the upper of the middle zone. This line is called the headline. The characters in a word are connected through the headline along with some symbols as i, I, A etc.

The area of digital image processing belongs to processing of digital images by using digital computer [1]. Digital images are form of visual information captured or transmitted using camera or other imaging system. The received image might be corrupted due to the presence of noise. It becomes necessary to bring out the original image before applying to different applications [5].

Various kinds of noises exist in an image and a variety of noise reduction techniques are available to perform de-noising. Selection of the de-noising algorithm depends on the application. Gaussian noise, speckle noise, salt & pepper noise, shot noise are types of noises that are present in an image.

Fig. 1(a) Consonants (Vianjans) of Gurmukhi Script.

Fig. 1(b) Vowels and Vowel diacritics (Laga Matra)

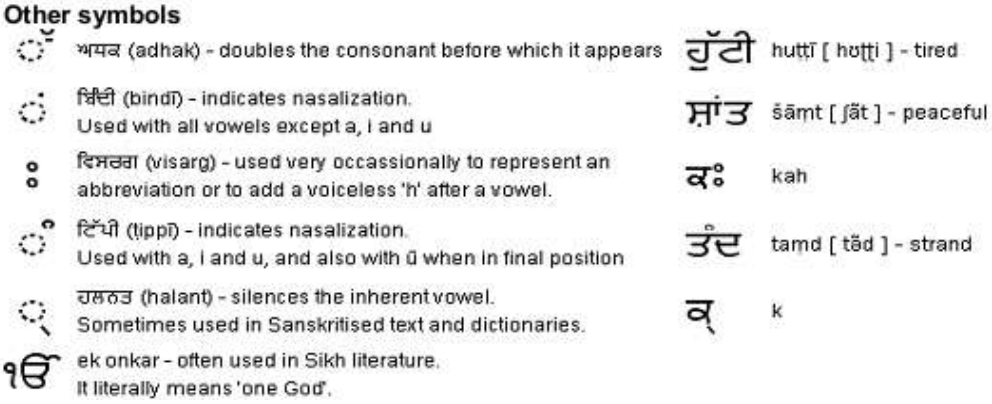

Fig. 1(c) Other symbols

The principle approach of image de-noising is filtering. Available filters to de-noise an image are median filter, Gaussian filter, average filter, wiener filter and many more.

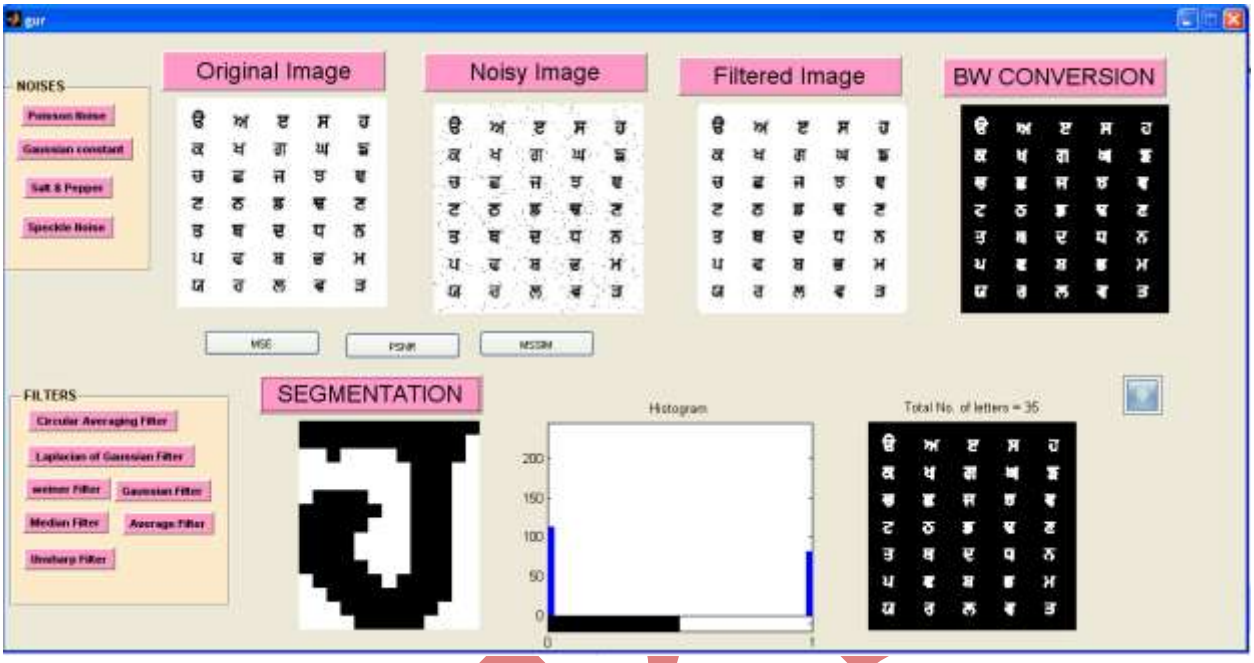

Figure 2 GUI tool for Noise removal.

II. IMAGE NOISE

Noise in an image is the result of errors in the image acquisition process that result in pixel values that do not reflect the true intensities of real picture. The presence of noise gives an image a grainy, rough, mottled or snowy appearance. The magnitude of image noise can vary from almost gradual specks on a digital photograph to optical and radio astronomical images that are completely noise. Various types of noises present in an image are as follows:

- Gaussian noise
- Salt and pepper noise
- Speckle noise

2.1 Gaussian Noise

Gaussian noise is a statistical noise. It is evenly distributed over the signal [5]. It is a major part of „read noise" of an image sensor i.e. of the constant noise level in dark areas of the image [4][10]. The probability density function (PDF) of Gaussian noise is equal to that of the normal distribution, also known as Gaussian distribution. It is usually used as additive white noise to give additive white Gaussian noise (AWGN). ***B. Salt and Pepper Noise*** Fat-tail distributed or impulsive noise is sometimes called salt and pepper noise or spike noise. An image containing salt and pepper noise will have dark pixels (black dots or pepper) in bright region and bright pixels (white dots or salt) in dark region [4][10]. An effective method to remove this type of noise involves the use of median filter, morphological filter or a contra harmonic median filter. ***C. Speckle Noise*** Speckle noise is a granular noise that

inherently exists in and degrades the quality of the active radar and synthetic aperture radar (SAR) images. Speckle is a random, deterministic, interference pattern in an image formed with coherent radiation of a medium containing many sub-resolution scatterers. Speckle noise is eliminated using adaptive and non-adaptive filters.

III. IMAGE FILTERS

A. *MEDIAN FILTER The* median filter is a non-linear digital filtering technique. It proves to be best in removing salt and pepper noise and impulse noise. Median filter erases black dots called the pepper and fills in white holes in the image, called salt. It better works than mean filter by preserving sharp edges. It simply replaces each pixel value by the median of the intensity level in the neighborhood of that pixel [1].

B. *WIENER FILTER* Wiener filters are a class of optimum linear filters. It provides linear estimation of a desired signal sequence from another related sequence [10]. The wiener filter provides a solution of signal estimation problem for stationary signals. It also provides successful results in removing noise from photographic image. The design of the filter is distinct. It is based on statistical approach. The filter is optimal in the sense of MMSE.

C. GAUSSIAN FILTER Gaussian filters are a class of linear smoothing filters. The weights are chosen according to the shape of Gaussian function. The Gaussian smoothing filter is a very good filter to remove noise drawn from a normal distribution. The Gaussian filter is non-causal i.e. the filter window is symmetric about the origin in time domain. Because of this property Gaussian filters are physically unrealizable.

D. AVERAGE FILTER

Average filter or mean filter is simple, instinctive and easy to understand. It performs smoothing of images i.e. reducing the amount of intensity variation between one pixel and the next. Each pixel value in an image is replaced with the average value of its neighbors, including that pixel. This has the effect of eliminating pixel values which are not representative of their surroundings.

IV RESULTS AND DISCUSSION

4.1 Quality Metrics

Digital image compression techniques are normally analyzed with objective fidelity measuring metrics like Mean Square Error (MSE) and Normalized Absolute Error (NAE), Peak Signal to Noise Ratio (PSNR) is defined as

$$MSE = \frac{1}{MN} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} |x(m,n) - \tilde{x}(m,n)|^2$$

Where M * N is the size of the original image.

Normalized Absolute Error (NAE) The larger value of Normalized Absolute Error (NAE) means that image is poor quality. NAE is defined as follow

$$NAE = \sum_{m=1}^{M}\sum_{n=1}^{N}\left|x(m,n) - \hat{x}(m,n)\right| \Big/ \sum_{m=1}^{M}\sum_{n=1}^{N} x\left|m - n\right|$$

4.2 Peak Signal to Noise Ratio (PSNR)

PSNR is the evaluation standard of the reconstructed image quality, and is an important measure of image compression. The objective performance is measured by **peak signal-to-noise-ratio (PSNR)** of the reconstructed image $\bar{x}$. PSNR measured in decibels (dB) is given by:

$$PSNR = 10\log_{10}\left(\frac{255^2}{\text{MSE}}\right),$$

Where the value of 255 is the maximum possible value that can be attained by the image signal Higher the PSNR value is, the better the reconstructed image is.

Table 1 Poisson Noise

Filter	MSE	PSNR	MSSIM
Median	51.3824	31.0227	0.8601
Wiener	63.4363	30.1074	0.9646
Average	125.1214	27.1575	0.8951
Circular Averaging	870.8468	18.7314	0.8751

Table 2 Speckle Noise

Filter	MSE	PSNR	MSSIM
Median	396.5730	22.1476	0.3961
Wiener	564.1168	20.6171	0.7939
Average	603.3851	20.3249	0.5512
Gaussian	613.1292	20.2553	0.5516

Table 3: Gaussian Noise

Filter	MSE	PSNR	MSSIM
Median	103.7611	27.9705	0.7348
Wiener	166.4323	25.9184	0.9218
Average	210.144	24.9083	0.7909
Gaussian	492.1408	21.2092	0.9020

Table 4: Salt and Peppers Noise

Filter	MSE	PSNR	MSSIM
Median	31.6185	33.1314	0.9936
Wiener	221.6074	24.6750	0.7147
Average	210.144	26.2419	0.7909
Gaussian	395.3784	22.1607	0.8599

V CONCLUSION & FUTURE SCOPE

A small set of all characters using back propagation neural network is trained then testing was performed on other character set. The accuracy of network was very low. Then some other character images in the old character set are added and trained the network using new sets. Then again testing was performed on some new image sets written by different fonts and it was found that accuracy of the network increases slightly in some cases. Again some new character images into old character set are added (on which network was trained) and trained the network using this new set. The network is presented new character images and it has been seen that recognition increases, although at a slow rate. The result of the last training by 25 character set and testing with the 6 character set are presented. It can be concluded that as the network is trained with more number of sets, the accuracy of extraction of Punjabi word will increase definitely. In future work, this can be implemented for recognition & extraction of complete Gurmukhi words including lower & upper Zone Characters.

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