A REVIEW ON IMAGE DENOISING BASED ON GENETIC ALGORITHM IN SOFT COMPUTING

Achharish Jethi[1], Jyoti Arora[2]
Department of Computer Science & Engineering, Desh Bhagat University,
Mandi Gobindgarh, Punjab, India
Email: jethi.skj@gmail.com[1], karora61@gmail.com[2]

ABSTRACT

In This work presents image denoising algorithm based on hybrid genetic techniques. Image denoising's aim is to restore images to a better quality without losing any relevant information. The hybrid genetic algorithm is based on the concept of soft computing. The genetic algorithm have three phases i.e. fitness, crossover, mutation. There are various techniques for image denoising like wavelet, curve let transform. Intelligent approach based on cellular neural network has been discussed in this paper. How hybrid genetic algorithm is better than existing techniques also given. The experiments will be performed on a noisy image firstly image is taken then introduce noise into it then we apply image denoising methods and compare the obtained results with existing results.

Keywords: Image, Denoisig, Hybrid Genetic Algorithm, Wavelet, Curvelet .

1. INTRODUCTION

1.1 Background

Digital images plays a great role in our daily routine like they are used in handwriting recognition on checks, signature validation, television image and in area of technology and research like geographical information systems and astronomy, medical images, scanning techniques, printing skills etc. The noise can introduce due to transmission errors and compression. So when data set is collected by image sensor, through that time data is contaminated by noise. Noise can be introduced due to instrument problems or natural phenomena causes. Thus it is required to find out and remove noise in the image. The main aim of image denoising is to remove random noise as far as possible. Many Techniques are used to remove noise in digital image. But still it is challenging problem in image processing.

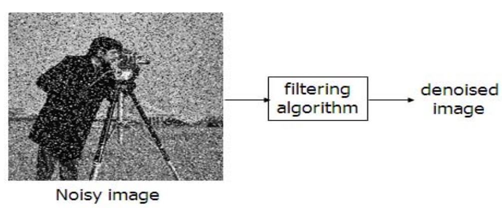

Fig 1: Pixels in an image

This work proposes and evaluates a genetic algorithm for image denoising. This method first collects the images that are noisy images. During this process crossover and mutation operators are used to find out the best image. The types of noise are:

1.2. Salt and Pepper Noise

This type of noise is commonly seen on images. It presents itself as white and black pixels. There are used many filters or reduction methods to remove this noise. In Salt and pepper noise, the pixels in the image are either black or white. In salt and pepper type of noise the noisy pixels take salt value (gray level value- 225) or pepper value (gray level value-

0) and it appears as black and white spots on the images with salt and pepper noise.

Fig 2: Blurred image Exact image

1.3. Gaussian Noise

Gaussian noise is the noise which is statistical in nature having a probability density function equal to the distribution which is normal in nature, is also known as the Gaussian distribution. Else the values that the noise can take on are Gaussian distributed random valued impulse noise. Noise in an image can take any gray level value from zero to 225. In this case, noise is also randomly distributed over the entire image and probability of recurrence of any gray level value as noise will be same.

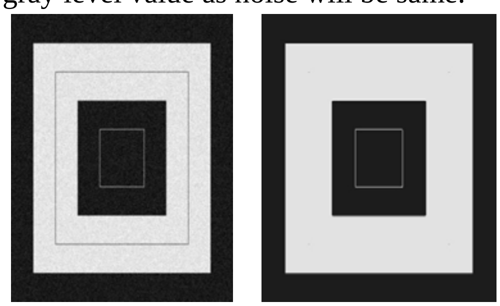

Fig 3: Blurred image Exact image

1.4. Image Denoising

Image Denoising is more important than any other tasks in image processing, analysis and applications. The main goal of image denoising is to reserve the details of an image and remove noise. The noisy image produces undesirable visual quality, it also lowers the visibility of objects. So, noise removal is necessary in applications of digital imaging .The image denoisng techniques amend and recover fine details which are hidden in the data. In many ways, noise in digital images is found to be accumulative in nature with Gaussian probability distribution and with uniform power. Such a noise is revert to as Additive White Gaussian Noise (AWGN). Linear and non linear filters are used to improve the effectiveness of image. Some other approaches have adaptive filter, wavelet transform etc. For best results there are using genetic algorithm based on soft computing method [1].

1.5 Classification of Image Denoising Methods

There are two elementary approaches to image denoising, spatial filtering methods and transform domain filtering methods.

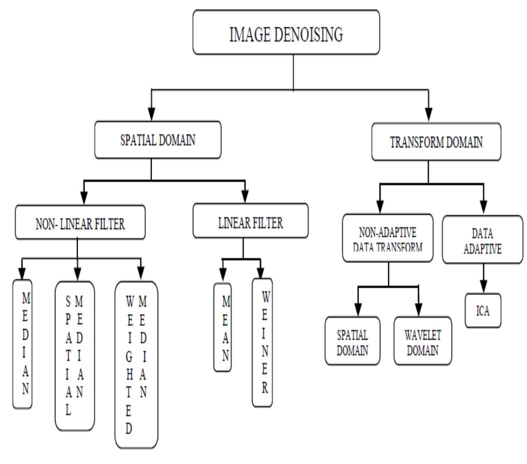

Fig. 4: Types of Image Denoising [1]

1.5.1 Spatial Filtering

Spatial filtering is a traditional method which is used to remove noise from image where spatial filters are used. It is mainly used for dirty or damaged optics. Spatial filters are further classified as non-linear and linear filters.

1.5.2 Non-Linear Filters

Spatial filters uses a low pass filtering on groups of pixels that noise occupies the higher frequency region of the spectrum. Generally spatial filters exclude noise to a considerable extent but at the cost of blurring images which in turn produce picture images invisible. In the past year's variety of non linear filters have been developed. The simplest nonlinear filter is known as the median filter [1].

1.5.3 *Median Filter*

Median filter is one of the most important filters to distance random valued impulse noise. It hits under the category of non linear filters. In this filter the value of perverted pixel in noisy image is replaced by median value of comparable window. Median value is the value which is in the middle position of any ordered sequence as in [2]. Set down that the values of pixel in a part are taken in a sequential order and it becomes after sorting in descending order or in ascending order.

$$x_{madian} = Med\{x_i\}$$

$$= \begin{cases} x_{i\frac{(n+1)}{2}} & ,n \text{ is odd} \\ \frac{1}{2}\left[x_{i\left(\frac{n}{2}\right)} + x_{i\left(\frac{n}{2}\right)+1}\right] & ,n \text{ is even} \end{cases} \quad (4)$$

1.5.4 Spatial Median Filter (SMF)

This filter is also known as noise removal filter where the spatial median is calculated by calculating the spatial depth in between a point and a set of points. This spatial depth is defined as

$$S_{depth} = 1 - \frac{1}{N-1}\left\|\sum_{i=1}^{N}\frac{X-x_i}{\|X-x_i\|}\right\| \quad (5)$$

In this type of filter after searching out the spatial depth of every point which is lying within the filtering mask, this information decides whether the central pixel of image window is corrupted or not. If central pixel is not corrupted then it will not be altered. Then we search out the spatial depth of every pixel within the mask and then select these spatial depths in descending order. The spatial median of the set is represented by the point with largest spatial depth. The central pixel it is replaced by calculated spatial median as in [1][3] if it is corrupted with noise.

1.5.5 Weighted Median Filter (WMF)

The extension of the weighted median filter is known as the centre weighted median filter. The previously designed weighted median filter gives more weight to a few values within the window as centre weighted median filter gives more weight to the central value of a window thus it is easy to design and implement than other weighted median filter.

1.5.6 Linear Filters

Linear filters also known as average filters are generally of two types: mean filter and wiener filter Linear filters are tend to blur sharp edges, destroy lines and other fine image information, and poorly executed in the presence of noise which is signal dependent.

1.5.7 Mean Filter

Mean filter is a simple sliding window spatial filter that supersedes the centre value of the window with the average values of its all nearest pixels values collected with itself. It is implemented with the convolution mask, which provides the result that is weighted sum of values of a pixel and its neighbors. It is also called linear filter. The shape of kernel is square. Often 3×3 mask is used.

1.5.8 Weiner Filter

Weiner filtering process requires the information on the spectra of noise and original signal and its mechanism performs good only if the underlying signal is smooth. To overcome the lowness of spatial domain filtering John Stone and Donoho proposed the wavelet based denoising schemes.

1.5.9 Transform Domain

Group of transform domain filtering approach depends upon choice of basic functions. The basic functions can be further grouped as data adaptive and non-data adaptive .At first we will discuss Non-data adaptive transforms because they are more popular as in [1][6].

1.5.9.1 Non-Data Adaptive Transform

1.5.9.1.1 Spatial-Frequency Filtering

Spatial frequency domain denoising method is a type of Transform Domain, filtering where low pass filters (LPF) are used by using Fast Fourier Transform (FFT).Here the process of denoising is done by designing a cut-off frequency. But these methods are time absorbing and may produced artificial frequencies in processed image.

1.5.9.1.2 Wavelet Domain

Wavelet Domain process is again subdivided into two dissimilar techniques i.e. linear and non-linear techniques:

1.6 Linear Filters

Generally used linear filter is Wiener filter. Wiener filter return most advantageous outcomes in the wavelet domain. Wiener filtering is used where data corruption in an image can be modeled as a Gaussian process and accuracy criterion is mean square error. But wiener filtering give results in a filtered image which is visually more displeasing than original noisy image .

1.6.1 Non-Linear Threshold Filtering

Non-Linear threshold filtering is the most investigated domain in denoising using wavelet transform. This filtering uses the properties of wavelet transform and the fact that wavelet transform maps noise in domain of signal to noise in transform domain. So, signal energy becomes more concentrated into fewer coefficients but in transform domain noise energy does not. The method in which small coefficients are removed remaining other untouched coefficients is called as Hard Thresholding. Yet this method produces spurious blips which are known as artifacts. To defeated these demerits soft thresholding was introduced where coefficients above the threshold value are shrunk by the absolute value of threshold itself.

1.7 Non-Adaptive Thresholds

Generally used Non-Adaptive thresholds are VISUShrink. It shows best performance in terms of MSE when the number of pixels reach infinity. VISU Shrink generally yields smoothed images.

1.7.1 Adaptive Thresholds

Adaptive Threshold technique involves SURE Shrink, Visu Shrink and Bayes Shrink methods. The work of SURE Shrink is improved in comparison to the VISU Shrink because SURE Shrink uses a mixture of the SURE [Stein's Unbiased Risk Estimator] threshold and the universal threshold. When the signal magnitudes are lower than the noise levels the assumption that one can distinguish noise from the signal solely based upon coefficient magnitudes is opposed. Bayes-Shrink outperforms SURE-Shrink most of the times. Bayes-Shrink lowers the Bayes' Risk Estimator whose purpose is assuming Generalized Gaussian prior and yielding data adaptive threshold [1]

1.7.2 Non-Orthogonal Wavelet Transform

This method involves Shift Invariant Wavelet Packet Decomposition (SIWPD) where a number of basic functions are retrieved. Then the perfect base function is raise out by using Minimum Description length principle which yields smallest code length for given data .Then to denoise the data thresholding was applied. In extension to this Multiwavelets is explored that further increases the work but also enhances the computational complexity as in [1][7].

1.7.3 Wavelet Coefficient Model

The multi resolution properties of Wavelet Transform is utilized by this method. The modeling of the wavelet coefficients can either be statistical or deterministic. This model outcomes excellent output yet computationally much more complex and costly as in [1][10].

1.7.4 Deterministic

The Deterministic approach of modeling proves forming tree structure of wavelet coefficients. Each scale of transformation and every nodes representing wavelet coefficients is representing by every level of the tree.

1.7.5 Statistical Modeling of Wavelet Coefficients

This method focuses on a few more interesting and appealing Wavelet Transform's properties like as multi scale correlation within the wavelet coefficients, local correlation within neighborhood coefficients etc. Based upon a probabilistic model the successive two methods prove the properties which are statistical of the wavelet coefficients.

1.8 Marginal Probabilistic Model

Under this category the generally used Marginal probabilistic models are Generalized Gaussian distribution (GGD) and Gaussian mixture model (GMM).The GMM is simple to use but GGD is more accurate.

1.8.1 Joint Probabilistic Model

Here, Random Markov Field Model and Hidden Markov Model (HMM) and are generally used. The disadvantage of HMM is the computational load of the training stage, so a simplified HMM was proposed.

1.8.1.1 Data-Adaptive Transforms

An Independent component analysis (ICA) transformation methods latterly gain more importance add key component analysis, projection detection and factor analysis. ICA method is mostly used for blind source partition problem. One dominance of using ICA is it's guess of signal to be Non-Gaussian which helps denoising of images with Gaussian distribution as well as Non-Gaussian. Some functions of ICA method are finding hidden factors in financial data text, document analysis, seismic monitoring, machine fault detection , reflection cancelling, radio communications, image processing, audio signal processing, time series forecasting ,data mining, bio medical signal processing ,defect detection in patterned display surfaces. The disadvantage of ICA based techniques is the computational cost because it accounts a sliding window and it catches sample of minimum two image frames of the same scene as in [5].

1.9 Data Mining

Data mining refers to collect the knowledge from huge amount of the data. The term data mining is also named as Knowledge mining. Data collection and storage technology accumulate huge amounts of data at lower cost. From this raw data is used to extract useful and actionable information. The main goal of the generic activity named as data mining. The presently definition is given: Data mining is the method of analysis and exploration, by automatic or semiautomatic means of enormous amount of data in order to invent meaningful patterns and rules[14].Types of data mining are:

1.9.1 Neural Network

Neural Network is a biological system that detects patterns and makes predictions. This is powerful predictive model techniques. Neural network applications solve the real world problems like fraud detection ,customer response prediction etc. The data mining techniques such as neural networks model make relationships that exist in data collections and can increase business intelligence across a variety of business applications[4]. Artificial neural network is widely used in tasks like decision problem, pattern recognition and prediction applications. ANN is a non linear system which is adaptive in nature that learns to perform a function from data and that modifying phase is normally training phase where system parameter is changed during operations. After the completion of training the parameters are unchanged. If there are plenty of data, the problem is poorly understandable then using ANN model which is accurate, the non linear characteristics of ANN give it lots of flexibility to achieve input output map [17].

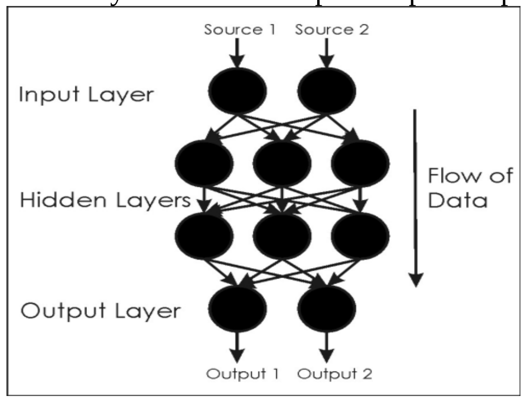

Fig. 5: Neural Network with hidden layers

1.9.2 Decision Tree

A decision tree is a type of flow chart like structure where each node refers a test on an attribute, every branch represents an output of the test and tree leaves represent class distribution or classes. A decision tree is a predictive model. Decision trees partition the input space into cells where each cell belongs to one class. Interior node in the decision tree checks the value of some input variable, and the branches from the node are label with the possible results of the test.[15].

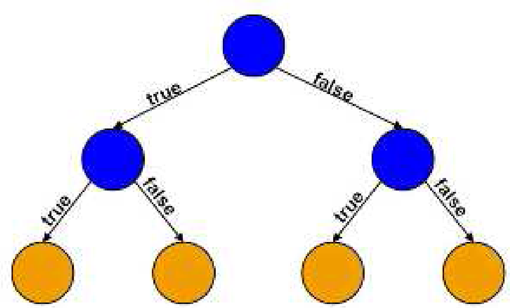

Fig. 6: Decision Tree

A Decision Tree is a conventional tree-shaped diagram which is used to show a statistical probability or regulate a series of actions[6]. Decision trees can be looked from the business perspective. So, marketing managers make the use of products, segmentation of customers and sales region for predictive study. These predictive segments which are formed from the decision tree also come with a detail of the characteristics that represent the predictive segment. Due to their tree structure and skill to easily generate rules the method is technique for building understandable models [14].

1.9.3 Genetic Algorithm

The genetic algorithm is a method for solving both unconstrained and constrained optimization problems that is based on natural selection. This process is biological evolution. It gives optimal solution. The basic principle of evolution and selection to produce some solution to a given problem. The solution has three distinct stages[15].

- Selection rules elect the individuals, called parents, that devote to the population at the next generation.
- Crossover rules associate two parents to form children for the next generation.
- To form children from individual parents mutation rules apply random changes.

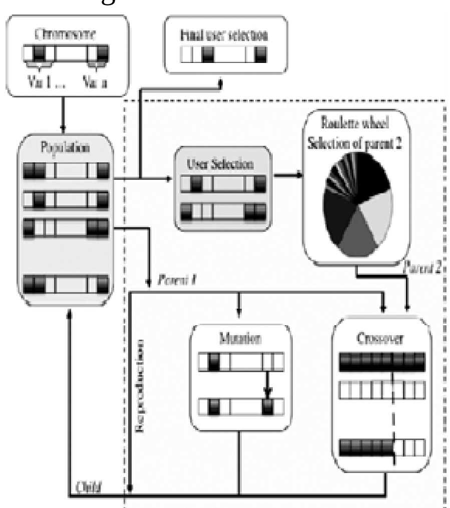

Fig. 7 Structural View Of Genetic Algorithm

The main basic parameters are used in these Genetic Algorithms are:

1. PSNR (peak signal-to-noise ratio): one of the most common metrics, measured in decibels(dB) and proved in equation for images of 8-bit gray-scale:

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

2. The MSE is the mean squared error within the original and the recovered images. It is defined in Equation, where M and N are the dimensions of the image.

$$\mathrm{MSE} = \frac{1}{M\,N}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}[O(i,j)-K(i,j)]^2$$

3. SSIM (structural similarity index): maps two images to an interval [−1, 1], where similar images have higher values [14], [26]. This metric is defined in Equation , where μA, μB, σB and σB are the values of mean and standard deviation for A and B, σAB is the covariance between A and B, $c1 = (k1L)2$ and $c2 = (k2L)2$, whereas L is the dynamic range of the pixel values ($2bitsperpixel - 1$) and $k1 = 0.01$ and $k2 = 0.03$ are constants [6].

$$\mathrm{SSIM}(A,B) = \frac{(2\mu_A\mu_B + c_1)(2\sigma_{AB} + c_2)}{(\mu_A^2 + \mu_B^2 + c_1)(\sigma_A^2 + \sigma_B^2 + c_2)},$$

4. IEF(Image Enhancement Factor)

$$\mathrm{IEF} = \frac{\sum_i\sum_j(\eta(i,j) - \hat{Y}(i,j))^2}{\sum_i\sum_j(\hat{Y}(i,j) - Y(i,j))^2}$$

3. CONCLUSION

In this paper, various techniques of image denoising have been discussed. These techniques show the average results between 50 to 60% and some have maximum restore the image 90% to overcome the noise image. But there is Incompletion to gives best accuracy to make de noise images .there are different algorithm like Genetic algorithm ,Firefly algorithm ,Analysis of algorithm etc to represent best results. There is mainly worked further on genetic algorithm to make Hybrid genetic algorithm .But it is also have high complexity. So for the best result it need to further work using soft computing on noisy images.

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