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ACO Based Adaptive Filter for High Density Impulse Noise

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ABSTRACT

In this paper, we proposed an ACO based adaptive non-casual linear prediction technique for vector median filter to remove high density impulse noise from color images. It is a new method for impulsive noise reduction and edge preservation in images. Generally, when an image is affected by high density of impulse noise, homogeneity among the pixels is distorted. Images of different characteristics corrupted with a wide range of impulsive noise densities using impulsive noise model is examined using the proposed method. This paper, based on the basic ant colony algorithm and integrating with the genetic algorithm, proposes an image restoration processing method based on hybrid ant colony algorithm. This method transforms the optimal population information of genetic algorithm into the original pheromone concentration matrix of ant colony algorithm and uses it to compute the parameters of degradation function to get a precise estimate of the original image. By analyzing and comparing the restoration results, the method of this paper cannot only overcome the influence of noises, but it can also make the image smoother with no fringe effects in the edges and excellent visual effects, verifying its practicability. The proposed filter improves the Peak Signal to Noise Ratio (PSNR).

Keywords: Image Restoration, Impulse Noise, ACO (Ant Colony Optimization), Adaptive filtering

I. INTRODUCTION

Image restoration is to research how to restore the degraded image into real image, or to research how to invert the information obtained into the information related to the real objective [1]. Certain degree of degradation and distortion are inevitable in the formation, transmission, storage, recording and display of the image. Since image quality degradation may be caused in every link of the formation of digital image, in many cases, the image needs to be restored in order to get high-quality digital image [2].

Images are corrupted by noise during transmission of information through the channel or due to the faulty switching acquisition device. Noise can also be appears on the image due to the low quality sensing element, such as malfunctioning of imaging sensor and by environmental ambience. Noise is present in the form of Gaussian, Rayleigh, Gamma, Exponential, Uniform, Impulse or combination of more than one. Image restoration is an important pre-processing technique, which can be used before performing any subsequent task such as, image segmentation, image compression and object recognition. In this paper, we are concentrating on restoring the image from an impulse noise. Salt & pepper noise is another name of impulse noise, as it is characterized by relatively high (salt) or low (pepper) intensity value, compared to the neighbouring elements. Spatial filtering is a technique, used to restore the degraded image, i.e. operation is directly perform on an element and its neighbourhood elements within a rectangular mask. The filtering process applies on each mask. It starts from top left element as the corner of starting mask, and then moved on to next element and so on, as to cover the entire image and get the restored image. Mainly, two types of spatial filtering are used, i.e. linear filtering and nonlinear filtering.

Median filter is an effective technique, used to get the quality of restored image, but only at low noise density. However, median filter is most popular among nonlinear filter for removing impulse noise with its high computational efficiency. It does not provide good job at high noise density, as it is smoothing away from discontinuities.

Here, we will use this restoration technique for removing impulse noise. This paper proposed new hybridization technique, to recover the original image by removing salt and pepper noise from the noisy image.

II. IMPULSE NOISE MODEL

There are two types of impulse noise: two sided fixed valued impulse noise and random valued impulse noise. The two sided fixed impulses model is also called the "salt and pepper noise model" [6].When impulse noise have very large value (255), it is called the 'salt' noise and if then noise is having very small value (0) it is called the 'pepper' noise. If 'p_1' denotes the probability of occurrence of very valued impulse noise in a signal component and that ' p_2' gives the probability of occurrence of a very high valued impulse noise in the same signal, then the total probability of occurrence of 'salt and pepper noise' in the signal under consideration is given by $(p_1 + p_2)$. If 256 (one pixel in a gray channel is represented using 8 bit) is the number of gray levels used per pixel, then we assume that 255 or '*h*' represents the 'salt noise, while 0 or '*l*' represents the 'pepper' noise. Let X_c, (where c = 1 for red, 2 for green or 3 for blue) be a pixel component of a vector pixel in any one of the channels of a multichannel image.

The salt and pepper noise is expressed through following model:

$$X_c = \begin{cases} l\,, with\ probability\ p1 \\ h,\ with\ probabilty\ p2 \\ S_c, with\ probability\ p3 \end{cases} \tag{1}$$

III. PROPOSED MODEL

For the removal of impulse noise of all density of impulse noises, ACO based non-causal linear prediction adaptive median filter has been proposed in this paper. This filter considers all the pixels from its non-causal neighbouring area for calculating prediction error. The coefficients are calculated using autoregressive moving average model (ARMA) [25]. In the ACO based non-causal linear prediction adaptive vector median filter, the size of the window is varied according to the prediction error during the filtering operation. The proposed algorithm performs uniformly well on all the images corrupted either by the "salt & pepper" noise or "random valued" noise.

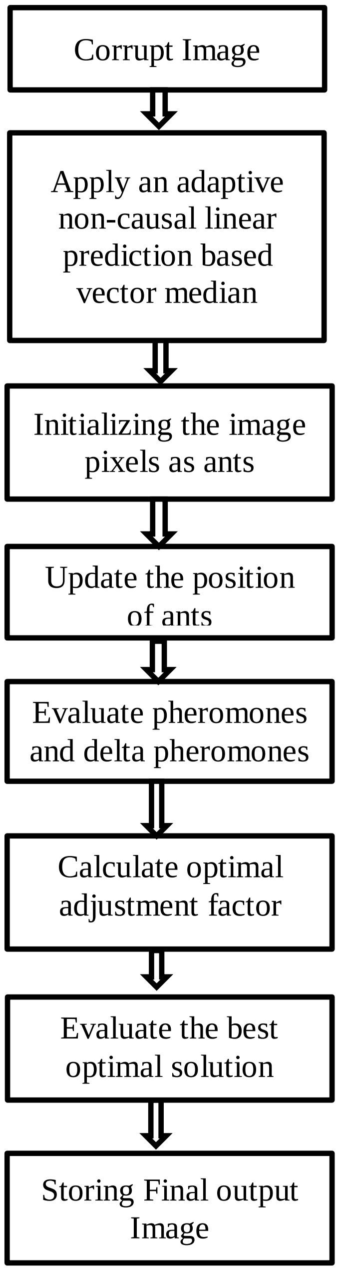

Figure 1. Shows the methodology of proposed method

IV. RESULTS AND DISCUSSIONS

The experiments have been carried out on large image dataset with varying density of noises. The performance of the system is evaluated using performance measure such as PSNR. The analysis has been done in terms of two sided fixed valued impulse noise. Standard color images like Lena, Mandrill, Tulip, Pepper, and Cameraman are some of the images used in this study. During the process of experiments, the impulse noises are artificially injected in these images. The performances are evaluated in terms of the visual quality, Peak Signal to Noise Ratio (PSNR).

The PSNR is measured in terms of dB. The PSNR for color images is given by:

$$PSNR=10log_{10}(\frac{I_{MAX}^{2}}{MSE}) \qquad (2)$$

Where, I_{MAX} is the maximum pixel value of the component of the vector pixel of the original image.

During the study of performance analysis, the proposed filter has been compared with state of art filter an adaptive non-causal linear prediction based vector median filter (ANCLPVMF) [20].

Figure 2. (a) Original image 1 (Lena), (b) Image with 30% impulse noise, generated using two-sided fixed impulse noise model, (c) Filtered output of ANCLPVMF, (d) Filtered output of PROPOSED METHOD.

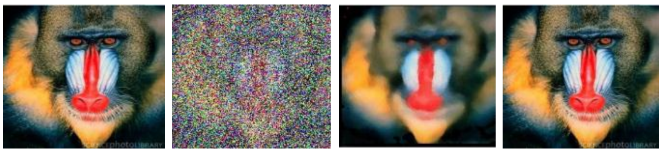

Figure 3. (a) Original image 2 (Mandrill), (b) Image with 30% impulse noise, generated using two-sided fixed impulse noise model, (c) Filtered output of ANCLPVMF, (d) Filtered output of PROPOSED METHOD.

Figure 4. (a) Original image 3 (Tulip), (b) Image with 30% impulse noise, generated using two-sided fixed impulse noise model, (c) Filtered output of ANCLPVMF, (d) Filtered output of PROPOSED METHOD.

Figure 5. (a) Original image 4 (Pepper), (b) Image with 30% impulse noise, generated using two-sided fixed impulse noise model, (c) Filtered output of ANCLPVMF, (d) Filtered output of PROPOSED METHOD.

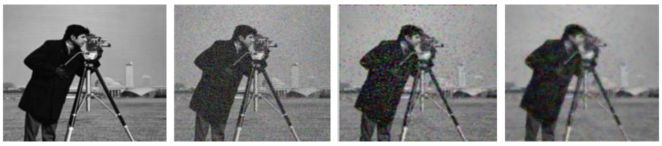

Figure 6. (a) Original image 5 (Cameraman), (b) Image with 30% impulse noise, generated using two-sided fixed impulse noise model, (c) Filtered output of ANCLPVMF, (d) Filtered output of PROPOSED METHOD.

From above Figures, visual observation of different images has been shown for proposed method while impulse noise has been injected artificially to the images. It has been observed that the impulse noise is removed even if there exists high density of impulse noise.

A. Performance analysis for Fixed Valued Impulse Noise

Table 1 Performance Comparison of different filters on various images corrupted with 30% two-sided fixed impulse noise. The PSNR values in dB have been listed.

Images/Filters	**ANCLPVMF**	**PROPOSED METHOD**
Image 1	25.27	35.41
Image 2	23.05	35.17
Image 3	28.28	35.51
Image 4	24.43	35.06
Image 5	23.08	35.78

In Table 1, experiment has been done with different types images. It is observed that the proposed filter provides satisfactory performance for all images as shown.

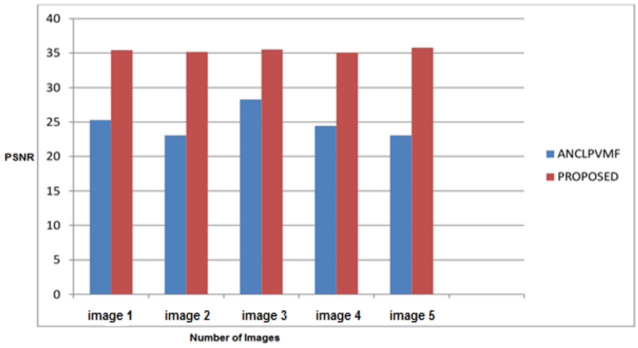

Figure 7. PSNR graph for no. of images

V. CONCLUSION

In this paper, we proposed an ACO based adaptive non-casual linear prediction technique for vector median filter to remove high density impulse noise from color images. The performance of the system is evaluated using objective measure such as PSNR (Peak Signal to noise ratio). The Experimental results and comparisons show that our algorithm performs significantly better than several compared filters in both visually and quantitatively. The experimental results show that the proposed method can efficiently remove the impulse noise from a corrupted image for different noise corruption densities (from 10% to 70%); meanwhile the denoised image is freed from the blurred effect. Therefore, the restored image of the proposed method is visually pleasant.

VI. REFERENCES

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