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RESEARCH ARTICLE

Adaptive Median Filtering with Modified BDND Algorithm for the Removal of High-Density Impulse and Random Noise

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Abstract: The impact of noise on image will degrade its feature. Suppression or removal of noise in 2D images would be very worth in medical image processing, satellite image processing and various other domains. Switching median filters outperform standard median filters in the removal of impulse noise due to their capability of filtering candidate noisy pixels and leaving other pixels intact. The BDND - boundary discriminative noise detection is a great example in this class of filters. Certain issues in BDND algorithms are evaluated and enhanced by increasing the window size of the filter. In this project, we propose modifications to the filtering step of the BDND algorithm by increasing the window size one step higher to existing size to address those problems. The evaluation shows that the proposed modifications produce sharper image than the image produced by using BDND algorithm. The noise elimination with around 70% of noise has been proposed and implemented using MATLAB 7.12 using image processing tool box.

Keywords: BDND, Median filtering, Impulse noise, Boundary-detection, Adaptive filtering

I. INTRODUCTION

While capturing image there is a chance of inclusion of noise, which will affect the pixel intensity values. There are a plenty sources of noise that affects the image. Some sources included imperfect instruments, imperfect data acquisition process, natural phenomena, transmission errors and compression techniques. The image noise may not be visible but will be there in the image.

The image quality is affected by many factors such as environmental temperature, sensitivity of camera, time taken to capture images and so on. The brightness, colour, smoothness in the image gets affected thus producing a picture which is undesirable. The following image is a noisy image with the presence of excessive random noise.

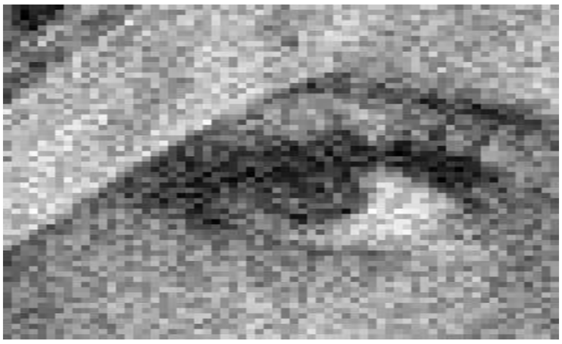

Figure.1 (a) Image with noise

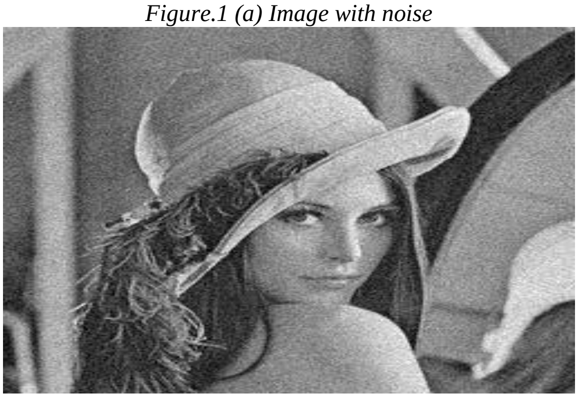

Figure.1 (b) Captured image

There are many types of noise will degrade the image. We have focused on the removal of impulse noise using median filtering method. The adaptive median filtering is totally different from the conventional median filtering method. Also the noise degrades the edges of images very easily rather than other parts of the image. Hence the removal of noise at boundary is essential.

II. EXISTING SYSTEM

The BDND algorithm is effective to remove the impulse noise from the image. This makes use of median filter which is switching based. This involves two steps, first is noise detection and second is filtering. In the noise detection step the pixels are grouped based on their influence of impulse noise into three, lower intensity, higher intensity and uncorrupted. This technique helps to map the noise efficiently.

The second step that is filtering is done to the affected pixels by carefully setting the window size, to avoid inclusion of pixels. The window size is set initially and is checked for uncorrupted pixels, if not found the window size is increased and checked. This process is repeated until the detection of uncorrupted pixel.

There is a chance for image blurring while performing the filtering step for high density noisy image. The wrong influence of median value will create unsharp image boundaries.

III.PROPOSED SYSTEM

The proposed system makes use of higher window size and incorporates adaptive median filter to remove the noise in the image. The addition of adaptive nature in the will increase the time taken for de-noising process for choosing appropriate algorithm for removing noise from the image. The probability of achieving noise free image will be more and high, when compared to conventional method. The block diagram for the proposed system is shown below, where the noise is added with the original test image and that noise is removed later using the proposed system (BDND).

In our proposed method the noise estimation is done with linear regression and the filter window is increased to 15x15. This method is likely to give a better PSNR value in our sequence of works as mentioned in the above block diagram.

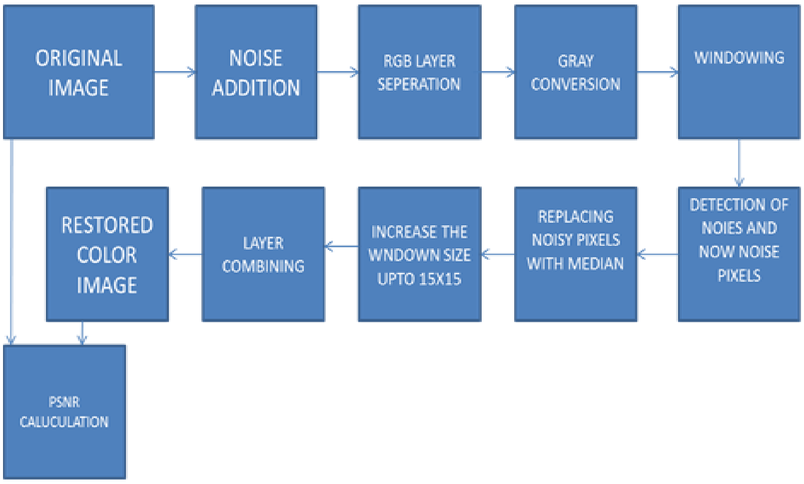

Figure.2 Block Diagram of proposed Technique

The block diagram shown above explains the entire process involved in the proposed method. This method will result in greater PSNR (**Peak Signal-to-Noise Ratio**) value, which is the ratio of power of the signal to the power of the corrupting noise. To improve the PSNR value we make use of linear regression technique to remove the noise from the image.

$$\begin{aligned} PSNR &= 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) \\ &= 20 \cdot \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right) \\ &= 20 \cdot \log_{10}(MAX_I) - 10 \cdot \log_{10}(MSE) \end{aligned}$$

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

IV. LEAST-SQUARES ESTIMATION

Ordinary least squares (OLS) is an algorithm used to analyze data. It is simple to understand but its computation is difficult. It helps to generate closed form equation for an unknown variable by reducing the existence of squared residuals. The unknown parameter can be found by the following equation

$$\hat{\beta} = (\mathrm{X}^{\mathrm{T}}\mathrm{X})^{-1}\mathrm{X}^{\mathrm{T}}\mathrm{y} = \left(\tfrac{1}{n}\sum \mathrm{x}_i\mathrm{x}_i^{\mathrm{T}}\right)^{-1}\left(\tfrac{1}{n}\sum \mathrm{x}_i y_i\right).$$

For the errors with the finite variance the estimator is found to be unbiased and consistent. The error should also be uncorrelated with the regressors.

$$\mathrm{E}[\,\mathbf{x}_i\varepsilon_i\,] = 0.$$

This method is found to be efficient when the errors have finite variance and E[εi2|xi] should not depend on i.. Making the errors uncorrelated with the regressors is difficult task. Especially with the observational data, removing the error is more difficult.

The possibility of omitting the covariates z in the observed and the response variable is tedious. If such a variant exist, then this will cause the correlation between the regressors and the response variable which will cause the system inconsistency of the estimator.

The homoscedasticity condition will not be satisfied either with the experimental or with the observational data. For smaller size samples the OLS method may not produce good performance in the presence of multi – collinearity. For samples of big size this method is good to employ.

Normally, from the estimator with only one regressor, The coefficient from the OLS will be equivalent to the correlation coefficient of the response variable and the covariates. The extension of this method is the generalized least squares (GLS). This helps to estimate the unknown β, in the presence of heteroscedasticity or correlation or both in the error terms that has to be removed.

The condition is that the heteroscedasticity and correlation should not depend on the given data. The nth case is inversely proportional to the variance, when the error terms are uncorrelated with the regressors. This is done to handle the heteroscedasticity image. The square residuals presence is reduced as much as possible and the special case is known as weighted least squares. The solution from this method is given as below,

$$\hat{\boldsymbol{\beta}} = (\mathbf{X}^{\mathrm{T}}\boldsymbol{\Omega}^{-1}\mathbf{X})^{-1}\mathbf{X}^{\mathrm{T}}\boldsymbol{\Omega}^{-1}\mathbf{y},$$

where, Ω - covariance matrix of the errors. To meet the requirements to transform a data into error free, this GLS method with the adaptive median filter is more suitable.

V. RESULTS

As in the proposed block diagram, a test image is taken and noise is added. Then it is recovered by this modified BDND algorithm.

Figure.3 Results obtained from proposed method

The graphs are plotted for various iterations by proposed system (Proposed Vs BDND).

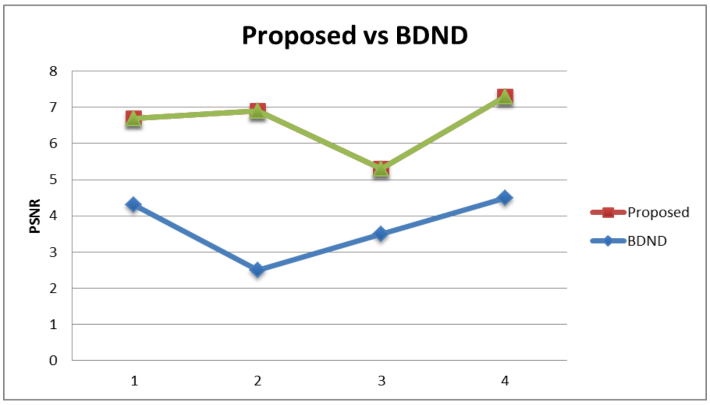

Figure.4 Adaptive Vs Conventional

TABLE I
COMPARISON OF IMPULSE NOISE

Noise Density (%)		**PSNR (dB)**
Low – Intensity Impulse Noise	**High – Intensity Impulse Noise**	
30	50	7.564
40	45	12.5333
50	35	11.636

This algorithm tolerates upto 70% of the noise. PSNR obtained in our algorithm is about 30db.

VI. CONCLUSION

In this work, a modification in the BDND algorithm is carried out. The value of PSNR we got is above 50 db, and we try to decrease the noise level up to 90% of impulse noise, which is actually 70% in the existing work. Various reference papers had been analyzed to compare our novel proposed method. This noise elimination work could be very promising method in all applications like defence communications and bio medical image processing.

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