

Enhanced Adaptive Weighted Mean Filter With Non-Local Means To Denoise Image Corrupted By Salt And Pepper Noise

Sukina K

Department of computer science and engineering
Malabar Institute of Technology
Kannur University
Kerala

Reshna T

Department of computer science and engineering
Malabar Institute of Technology
Kannur University
Kerala

Abstract— There exist different kind of techniques to remove unwanted signals from images. The major denoising methods include filtering technique which is under the category of neighbourhood methods. The drawback of neighbourhood method is that tend to lose fine details of the image so that blurring may occur. Noise reduction and preservation of actual image can be done efficiently if we extend the consideration area such a way that not only comparing the grey level in a single point but also the geometrical configuration in a whole neighbourhood. This paper combines a new adaptive weighted mean filtering technique and the nonlocal means filtering algorithm to denoise image corrupted by salt and pepper noise.

Keywords— De-noising, Non-local means, Salt and pepper noise

INTRODUCTION

Image processing is applicable for improving the image quality. Image noise is the random variation of brightness or colour information in images. It can be classified as Salt and pepper noise and random valued noise. The salt impulse noise have the brightest gray level and appear as white spot as well as pepper impulse noise having darkest gray level with black spot. The SPN is also called fat-tail distributed, impulsive noise or spike noise.

This paper proposes a technique of two level filtering .The corrupted input image is first subjected to a new adaptive weighted mean filter. For each pixel, we firstly determine the changing window size by continuously enlarging the size up to the point in time the extreme values of two nearby windows are equal respectively. Then the current pixel is regarded as noisy pixel if it is equal to the maximum or minimum values, otherwise, it is regarded as noise-free pixel. The filtered image is then de-noised using nonlocal means filtering technique[2]. The NLM filter was introduced by Buades in 2005[1]. This method of image denoising consist of weighted average of all pixel intensities where the family of weights depends on the similarity between the pixels and the neighbourhood of the pixel being processed[3].

PROPOSED SYSTEM

The main objective of my work is enhance the performance of denoising. For that a two phase filtering technique is proposed here. The image can be corrupted by different levels of salt and pepper noise.

A. Noise Detection-Enhanced Weighted Mean Filter

For each pixel ,we firstly determine the adaptive window size by continuously enlarging the window sizes up to the point in time the extreme values of two successive

windows are equal respectively. Then the center pixel is regarded as noise candidate if it is equal to the maximum or minimum values, otherwise it is regarded as noise free pixel. By this way the detection error can be largely decreased especially for very high level noise[4].

B. Noise Removal-Nonlocalmeans Filtering

The approach of Non Local Means filtering is based on estimating each pixel intensity from the information provided from the entire image and hence it exploits the redundancy caused due to the presence of same kind of patterns and features in the image. In this method, the restored gray value of each pixel is obtained by the weighted average of the gray values of all pixels in the image. The weight assigned is proportional to the similarity between the local neighborhood of the pixel under consideration and the neighbourhood corresponding to other pixels in the image.

Given a discrete noisy image $v = v(i)$ for a pixel i the estimated value of $NL[v](i)$ is computed as weighted average of all the pixels $NL[v](i) = \sum_j w(i,j) v(j)$ where the family of weights $w(i, j)$ depend on the similarity between the pixels i and j . The similarity between two pixels i and j depends on the similarity of the intensity gray level vectors $v(N_i)$ and $v(N_j)$, where N_k denotes a square neighborhood of fixed size and centered at a pixel k . The similarity is measured as a decreasing function of the weighted Euclidean distance. The pixels with a similar grey level neighborhood to $v(N_i)$ have larger weights in the average. These weights are defined as,

$$w(i,j) = \frac{1}{Z(i)} e^{-\|v(N_i) - v(N_j)\|_{2,\alpha}^2 + h^2}$$

where $Z(i)$ is the normalizing constant and the parameter h acts as a degree of filtering. It controls the decay of the exponential function and therefore the decay of the weights as a function of the Euclidean distances[1].

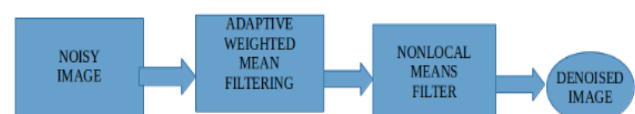


Fig. 1. proposed system

PERFORMANCE ANALYSIS

Extracting usable information from the image is the fundamental objective of image processing. So if the image is contaminated with any noise, it will deteriorate the quality of the image.

The fat-tail distributed noise is special type of noise in which salt impulse noise is distributed with brightest gray level as white spot and pepper impulse noise with darkest gray level as black spot.

For any noise removal, First we need to determine whether image pixel is affected by noise or not. Then if the pixel is corrupted , it will be replaced by any other value. Otherwise the uncorrupted pixels are left unchanged. In the first phase, For noise detection and restoration, a new adaptive weighted mean filter is used. For a given pixel, firstly, we increase its size of the window repeatedly up to the time the extreme values of two successive windows are equal respectively. Then , if we detect that the intensity value is affected by noise, it will be modified by the nonlocal means algorithm, Otherwise it will be unchanged. The AWMF has lower detection errors and better restoration image quality than many other existing filters. It can work effectively even if there is a high level of SPN in the image. In image processing, restoration and noise reduction is expected to improve the qualitative inspection of the image and the performance of quantitative image analysis techniques.

This paper proposes the combination of a new adaptive weighted mean filtering technique and the nonlocal means filtering algorithm for image denoising SPN to yield a considerably high PSNR[3].

For that, we have the idea that any natural image may contain redundant pixels. That is, it is based on estimating each pixel intensity from the information provided from the entire picture and hence it exploits the redundancy caused due to the existence of same patterns and features in the image.

In this method, The re-established gray value of each pixel is taken by the weighted average of the gray values of all pixels in the picture. The weight assigned is proportional to the similarity between the local neighbourhood of the pixel under consideration and the neighbourhood corresponding to other pixels in the image.

So when we use NLM filter after AWMF ,We will get much greater post-filtering clarity and less loss of detail in the image compared with local mean algorithms[1].

The performance of proposed method can be quantified using various performance metrics such as MAE,MSE,S/MSE and PSNR.

A) Mean Average Error (MAE)

$$MAE = \frac{1}{MN} \sum_i \sum_j |r_{i,j} - x_{i,j}|$$

Where $r_{i,j}$ and $x_{i,j}$ denote the pixel values of the restored image and the original image respectively and M x N is the size of the image.

B) Mean Square Error (MSE)

$$MSE = \frac{1}{MN} \sum_{i=1}^M \sum_{j=1}^N [I(i,j) - \hat{I}(i,j)]^2$$

Where M and N are the total number of pixels in the horizontal and the vertical dimensions of the image. I and \hat{I} denote the original and filtered image

B) Signal to Mean Square Error(S/MSE)

$$\frac{S}{MSE} = 10 \log_{10} \frac{\sum_{i=1}^N S_i^2}{\sum_{i=1}^N (\hat{S}_i - S_i)^2}$$

Where \hat{S}_i and S_i denote the pixel values of the restored image and original image respectively.

C) Peak Signal to Noise Ratio

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

After performing the proposed method, The MAE and MSE will be decreased. Because the amount of denoised pixels in the image will be increased. So that we will obtain a high PSNR and S/MSE ratio.

CONCLUSION

For the filtering of salt and pepper noise, a hybrid technique is proposed which combines a new adaptive weighted mean filter and a nonlocal means algorithm. The weighted mean filter is can be consider as an improved method based on

Adaptive median filter that can perform better in restoration of image. NLM attempts to take advantage of the redundancy and self similarity of the image. NLM provides a very efficient denoising procedure that preserves edges and texture while smoothing non-textured regions. Although the proposed method outperforms the existing denoising techniques at higher value of noise variances, but scope of improvement still exists. NL filter uses the repeated values in the image to remove the noise. But this algorithm suffers from some limitations. Noise artifacts are created on surrounding edges and regions with a small number of similarities in the image are not treated at all. So as an extension, The works will be for overcoming these drawbacks.

REFERENCES

- [1] Buades, Antoni and Coll, Bartomeu and Morel, Jean-Michel, "A non-local algorithm for image Denoising", volume-2, 2005
- [2] Buades, Antoni and Coll, Bartomeu and Morel, J-M, "A review of image denoising algorithms, with a new One", volume-4,2005
- [3] Sarker, Subhojit and Chowdhury, Shalini and Laha, Samanwita and Dey, Debika, "Use of Non-Local Means Filter to Denoise Image Corrupted By Salt and Pepper Noise", 2012
- [4] Zhang, Peixuan and Li, Fang, "A new adaptive weighted mean filter for removing salt-and-pepper noise", 2014