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Hybrid Algorithm for Image De-Noising

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Abstract: The search for efficient image de-noising methods still is a valid challenge at the crossing of functional analysis and statistics. In spite of the sophistication of the recently proposed methods most algorithms have not yet attained a desirable level of applicability. In this study, a hybrid denoising method is proposed to find the best possible solutions, so that, PSNR (Peak Signal Noise-to-Ratio) value of the image after denoising process is optimal. The proposed model is based on morphologic filter which has been successfully used in noise removal and hybrid with proposed mathematical algorithm which exploits the potential features of both morphologic filter and mathematical algorithm at the same time their limitations are overcome. Three types of noise inserted on colored image and then removed by suggested filters to check the relation between the noise type and noise removing methods. The types of noise amplifier noise (Gaussian noise), salt and pepper noise, speckle noise. The quality performance of these methods was checked by visual checking of the resultant images and determining the PSNR value.

Key words: De-noising, morphology, logarithm function, expansional function, image processing, methods

INTRODUCTION

Image de-noising restores the details of an image by removing unwanted noise. Digital images become noisy when these are acquired by a defective sensor or when these are transmitted through a noisy channel. Noise may be classified as substitutive noise (impulsive noise, e.g., salt and pepper noise, random valued impulse noise, etc.), additive noise (e.g., additive white Gaussian noise) and multiplicative noise (e.g., speckle noise). In general, the goal of any noise removal scheme is to suppress noise as well as to preserve details and edges of image as much as possible. Many de-noising methods have been proposed over the years such as the wiener filter, wavelet thresholding, anisotropic filtering, bilateral filtering total variation method and non-local methods (Perona and Malik, 1990). An image containing salt and pepper noise will have dark pixels in bright regions and bright pixels in dark regions (Portilla *et al*., 2003). This type of noise can be caused by dead pixels, analog-to-digital converter errors, bit errors in transmission, etc. This can be eliminated in large part by using dark frame subtraction and by interpolating around dark/bright pixels (Ramanath *et al*., 2002).

The main focus of this study is to analyses, examines and compares various filters and denoising methods such as morphology de-noising, a new proposed mathematical algorithm and hybrid methods which combine two methods.

The aim is to embark on the study of three types of noises such as gaussian, salt and pepper and speckle noise. The resulted images after de-noising are evaluated visually and by using some performance evaluation methods such as PSNR.

Literature review: Lal and Chandra (2014) proposed an efficient algorithm for contrast enhancement of natural images. The contrast of images is very important characteristics by which the quality of images can be judged as good or poor. The proposed algorithm consists of two stages. In the first stage the poor quality of an image is processed by modified sigmoid function. In the second stage, the output of the first stage is further processed by contrast limited adaptive histogram equalization to enhance contrast of images. In order to achieve better contrast enhancement of images, a novel mask based on input value together with the modified sigmoid formula that will be used as contrast enhancer in addition to contrast limited adaptive histogram equalization (Lal and Chandra, 2014).

Kaur and Singh (2015) discuss about various image de-noising and their features. Some of these

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techniques provide satisfactory results in noise removal and also preserving edges with fine details present in images.

Firoz *et al*. (2016) carried out morphological transform operation on medical images to enhance the contrast and quality. A disk shaped mask is used in top-hat and bottom-hat transform and this mask plays a vital role in the operation. Different types and sizes of medical images need different masks, so that, they can be successfully enhanced. The method shown in this study takes a mask of an arbitrary size and keeps changing its size until an optimum enhanced image is obtained from the transformation operation. The enhancement is achieved via. an iterative exfoliation process. The results indicate that this method improves the contrast of medical images and can help with better diagnosis (Firoz *et al*., 2016).

Sarath and Sreejith (2017) develop and compare two types of image enhancement method using fuzzy logic. Fuzzy logic and histogram based algorithm for enhancing low contrast color images and another contrast enhancement technique using the concept of homomorphic filtering with fuzzy logic. These two methods have been compared with conventional contrast enhancement techniques. These methods are computationally fast compared to conventional and other advanced enhancement techniques (Sarath and Sreejith, 2017).

MATERIALS AND METHODS

The current research presents two main methods for noise removing which are morphologic filter in addition to new proposed mathematical method where this method combines two of the main mathematical equations (which are log and exp.).

In the current study, we compare between these two methods and how the noise removing is affected when these two methods are combined.

Three types of noise are inserted on colored image and then removed by suggested methods to check the relation between the noise type and noise removing methods. The types of noise are following:

- Amplifier noise (gaussian noise)
- Salt and pepper noise
- Speckle noise

The performance of these methods checked by visual checking of the resultant images and by determining the PSNR.

Morphological filtering: Morphological filtering is conducted by considering compound operations like opening and closing as filters. They may act as filters of shape. These operations can filter out any details with size smaller than the structuring element from an image, e.g., opening is filtering the image at a scale defined by the size of the structuring element. Only the filter passes those portions of the image that fit to the structuring element; smaller structures are blocked and excluded from the output image. The size of the structuring element is most important to eliminate noisy details but not to damage objects of interest. Two morphological techniques ("opening by reconstruction" and "opening closing by reconstruction").

Proposed mathematical method: A useful family of functions that is related to exponential functions is the logarithmic functions. You have been calculating the result of bx and this gave us the exponential functions. A logarithm is a calculation of the exponent in the equation y = bx. Put another way, finding a logarithm is the same as finding the exponent to which the given base must be raised to get the desired value. The exponent becomes the output rather than the input.

Logarithm and expansional functions

Definition: Log (x) is defined as the function that takes any positive numberxas input and returns the exponent to which the base 10 must be raised to obtain x. The logarithmis theinverse operation to exponentiation. That means the logarithm of a number is the exponentto which another fixed number, the base must be raised to produce that number. In simple cases, the logarithm counts factors in multiplication.

Definition: ln x is defined as the function that takes any positive number x as input and returns the exponent to which the baseemust be raised to obtainx. Edenotes the number 2.7182818284590.

Definition: We define a function called the exp. functionthat takes an argument x and returns the value of raised to the power x (Fig. 1).

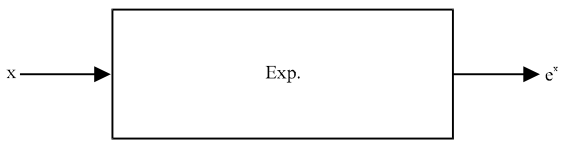

Fig. 1: Exp. function

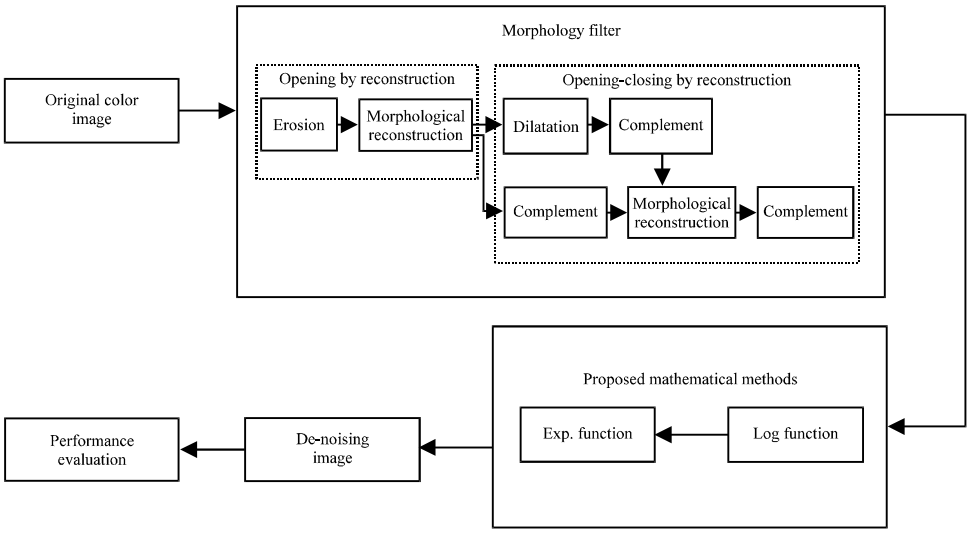

Fig. 2: Hybrid algorithm for image de-noising

Hybrid algorithm (morphology filter and proposed mathematical algorithm): A hybrid denoising algorithm is proposed to find the best possible enhancement, therefore, the PSNR of the image after denoising is optimal.

The proposed model is based on morphologic filter and hybrid with proposed mathematical algorithm where this algorithm is based on two equations (which are log and exp.).

Hybrid algorithm exploits the potential features of both morphologic filter and proposed mathematical algorithm at the same time their limitations are overcome. The proposed algorithm is shown in Fig. 2.

RESULTS AND DISCUSSION

To test these algorithms used many images in this paper we will show the colored lena image and colored Baboon image as example for the results Fig. 3 also used many types of noise (salt and pepper, speckle and gaussian noise).

The images will be inserted with these types of noise and the implement the de noising methods, the noisy images are shown in Fig. 3 and 4.

The salt and pepper has the more effect on the images. The images tested with noise concentration equals 0.1 which makes the image more noisy as shown in Fig. 4 and 5.

The noisy images are de-noised using the morphology filter and the proposed mathematical algorithm, the results are shown in Fig. 6 and 7.

Also, the hybrid methods (morphology filter and proposed mathematical algorithm) and (proposed mathematical algorithm and morphology filter) are used for de-noising image, the results are shown in Fig. 8 and 9.

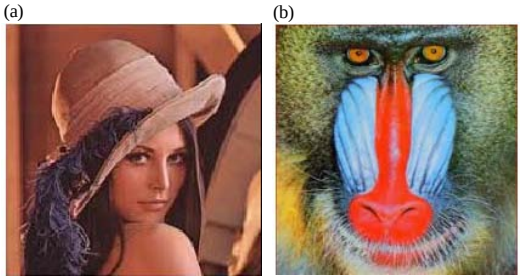

Fig. 3: Origin image: a) Lena image and b) Baboon image

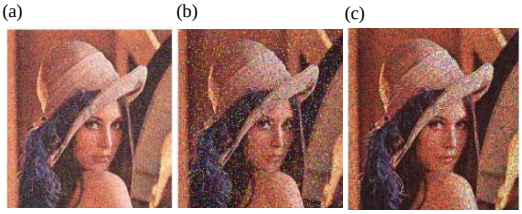

Fig. 4: Lena image with different type of noise: a) Gussian; b) Gussian and pepper and c) Speckle

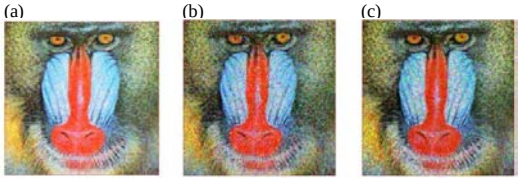

Fig. 5: Baboon image with different type of noise: a) Gussian; b) Gussian and pepper and c) Speckle

Table 1: PSNR for lena image and baboon image with two denoising methods

De-noising method image name	Morphology filter	Proposed mathematical algorithm
Lena	73.4673	75.7079
Baboon	73.4186	71.1161

Table 2: PSNR for lena image and baboon image with hybrid denoising methods

De-noising method image name	Morphology filter and proposed mathematical algorithm	Proposed mathematical algorithm and morphology filter
Lena	77.9147	75.9484
Baboon	77.5417	75.0748

Table 3: PSNR for the Lena image and baboon image when using hybrid method (morphology filter and proposed mathematical algorithm) for different types of noise

Type of noise image name	Gaussian	Speckle	Salt and pepper
Lena	67.5052	73.0467	77.9147
Baboon	66.3914	69.4436	77.5417

Table 4: PSNR for the Lena image and baboon image when using hybrid method (proposed mathematical algorithm and morphology filter) for different types of noise

Type of noise image name	Gaussian	Speckle	Salt and pepper
Lena	65.5216	71.1203	75.9484
Baboon	64.5078	67.5043	75.0748

Fig. 6: Results images for lena image from de-noising when using: a) Morphology and b) Proposed mathematical algorithm

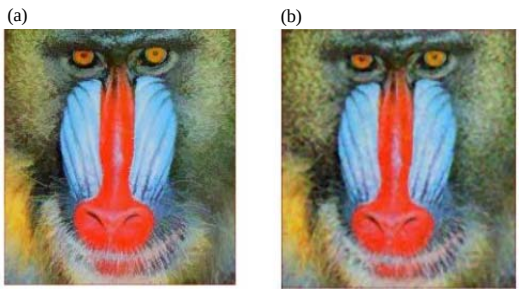

Fig. 7: Results images for baboon image from de-noising when using: a) Morphology and b) Proposed mathematical algorithm

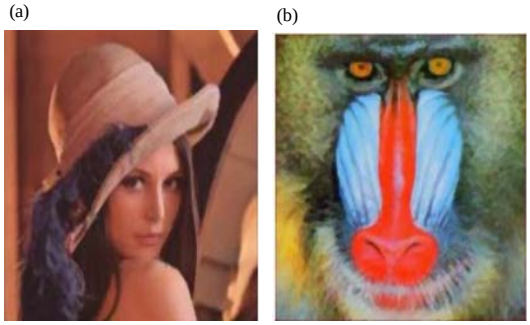

Fig. 8: Results image for lena image and baboon image from de-noising when using hybrid algorithm: a) Morphology filter and b) Proposed mathematical algorithm)

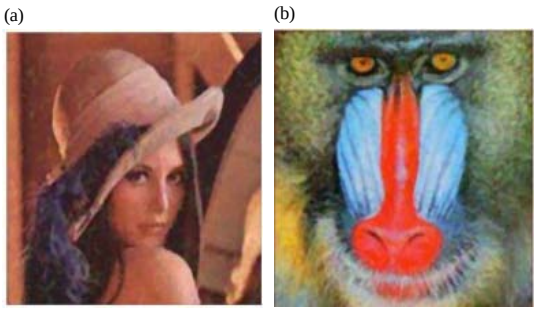

Fig. 9: Results image for lena image and baboon image from de-noising when using hybrid algorithm: a) Proposed mathematical algorithm and b) Morphology filter

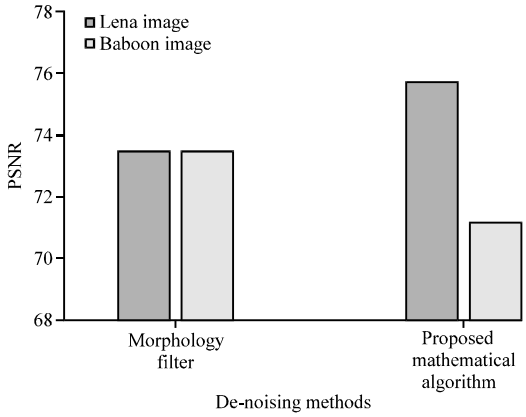

Fig. 10: PSNR with different denoising methods

Determined the PSNR for the images resulted from the previous methods as shown in Table 1, 2 and Fig. 10 and 11. The above two hybrid methods tested with images embarked with different types of noise as shown in Table 3, 4 and Fig. 11-13.

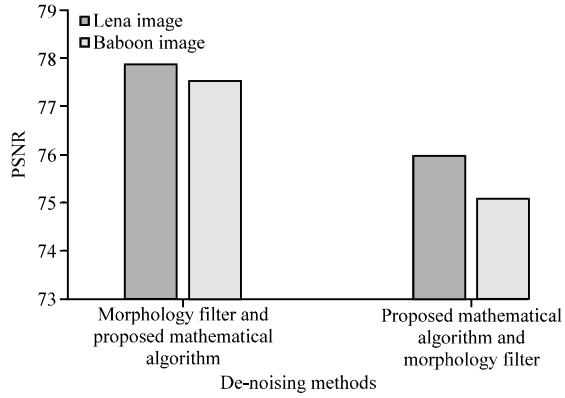

Fig. 11: PSNR with hybrid denoising methods

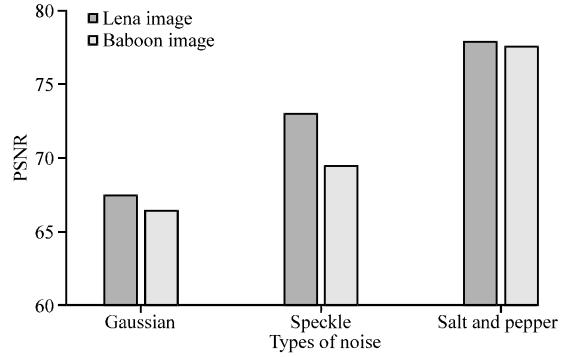

Fig. 12: PSNR for different types of noise using hybrid method (proposed mathematical algorithm and morphology filter) for different types of noise

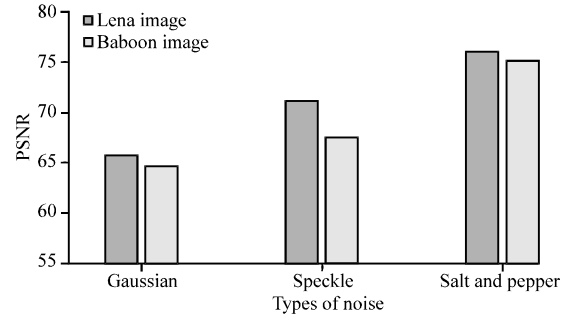

Fig. 13: PSNR for different types of noise using hybrid method (proposed mathematical algorithm and morphology filter) for different types of noise

CONCLUSION

In this study, we used color images of "jpg" format we adding three types of noise (speckle, gaussian and salt and pepper) for original image, enhancement all noisy images and we conclude that the salt and pepper has the more effect on the images. The images tested with noise concentration equals 0.1 which makes the image noisier. The performance of the hybrid method (morphology filter and proposed mathematical algorithm) as de-noising for all speckle, poisson and gaussian noise is better than using morphology or proposed mathematical algorithm alone. Also, the performance of the hybrid method (morphology filter and proposed mathematical algorithm) as de-noising for all speckle, poisson and gaussian noise is better than hybrid method (proposed mathematical algorithm and morphology filter). Using proposed mathematical algorithm as de-noising will not give good results if it used alone.

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