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High Density Impulse Noise Removal A Review

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Abstract*—*Image noise is random variation of brightness or color information in images. It is an undesirable by-product of image capture that adds spurious and extraneous information. Due to noise, quality of image is degrade. According to the effect of noise and pattern of noise the noises are categorized in different types. For improving quality of image filtering techniques are used. Various filtering techniques are reported in last few years. This paper investigates the recent contributions on the image filters for impulse noise detection and the correction methods proposed.

Keywords—Image de-noise, Gray-scale, impulse noise, comparative study, performance analysis.

1. INTRODUCTION

Image is a set of pixels defined in terms of a 2D vector. This 2D vector contains real world knowledge in form of colour distributions and pixel combination values. In order to refine the contents of this information image processing is performed on the image data. Image processing is a classical domain of image data manipulation and enhancement. Due to diversity of information storage and lightning effect the researchers and developers are attracted in this domain. There are huge contributions are available for enhancing the quality of images. For that purpose various kind of image processing techniques are developed in recent years. In this proposed work image processing based image filtering techniques are evaluated and issues and challenges over image filters are addressed. In addition of that for resolving these issues a new concept in image processing and image data correction is placed in this work.

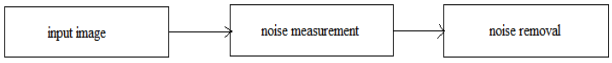

Figure 1 basic filter

In order to develop an enhanced and efficient de-noising technique, fundamental technology behind the images and images filters are required to understand first. Therefore, the next section includes basics of different image noise filters, recent development and investigations over the image filters. These techniques providing guidelines for addressing key issues in image filter design. In addition of that the recent development techniques provides guidelines for developing the effective image de-noising technique.

2. IMAGE NOISE

Noise can be understood as a barrier to the sense organs of the received source information to understand the factors. For example, a black and white picture, the surface brightness distribution is assumed to be f (x, y). Then the interference it receives from the brightness distribution of R (x, y) can be called image noise. However, the noise in theory can be defined as unpredictable. It can be used statistical methods to understand the probability of random error. Therefore, the image noise as a multidimensional random process is appropriate. So, it can be described noise is completely random process can borrow the description which uses the probability distribution function and probability density function. However, in many cases, this description is very complicated. The practical application is often unnecessary. That is mean-variance, correlation function and so on. Because the digital features can be reflected in some aspects of noise characteristics. [10]

In most of digital imaging systems, the input images are used to first freeze and then scanning the image into a one-dimensional multi-dimensional signal. Next its processing, storage, transmission and other processing transformation. Finally, it is necessary to make up the multi-dimensional image signal and image noise will be equally subject to such a decomposition and synthesis. In these processes affect the electrical system and the outside world will allow the precise analysis of image noise becomes very complicated. The other image can transmit visual information media. The image information of the knowledge to understand the human visual system is determined. Different image noise,

people have the different feeling. This is the so-called visual noise characteristics of the human subject. [10]

Image noise in digital image processing technology is growing in importance. Such as in high magnification of the interpretation of aerial photographs and X-ray imaging systems in the removal of noise has become an indispensable technical step. [10]

3. IMPULSE NOISE

The term impulse noise is also used for salt and pepper noise type of noise [5]. Other terms are spike noise, random noise or independent noise is also used for denoting the impulse noise. In this kind of noise Black and white dots appear in the image [6] as a result of this noise and hence due to noise image is viewed with the salt and pepper as noise. This noise arises in the image because of sharp and sudden changes of image signal. Dust particles in the image acquisition source or over heated faulty components can cause this type of noise. Image is corrupted to a small extent due to noise. Figure 1.2 shows the effect of this noise on the original image.

Figure 2 Image corrupted by impulse noise

During image acquisition or transmission, several factors are responsible for introducing noise in the image. Depending on the type of disturbance, the noise can affect the image to different extent. Generally our focus is to remove certain kind of noise. So we identify certain kind of noise and apply different algorithms to remove the noise.

4. IMPULSE NOISE FILTERING

Image de-noising is very important task in image processing for the analysis of images. Ample image de-noising algorithms are available, but the best one should remove the noise completely from the image, while preserving the details. De-noising methods can be linear as well as non-linear. Where linear methods are fast enough, but they do not preserve the details of the images, whereas the non- linear methods preserve the details of the images but they take longer time to process .

Hence, various research papers were investigated to find optimal method for removal of high density impulse noise.

In the same context,Tom Mélange et al [17], proposed a new fuzzy filter for the removal of random impulse noise in colour videos. By working with different successive filtering steps, a very good trade-off between detail preservation and noise removal is obtained. One strong filtering step that should remove all noise at once would inevitably also remove a considerable amount of detail. Therefore, the noise is filtered step by step. In each step, noisy pixels are detected by the help of fuzzy rules, which are very useful for the processing of human knowledge where linguistic variables are used. Pixels that are detected as noisy are filtered, the others remain unchanged. Filtering of detected pixels is done by block-matching based on a noise adaptive mean absolute difference. The experiments show that the proposed method outperforms other state-of-the-art filters both visually and in terms of objective quality measures such as the mean absolute error (MAE), the peak-signal-to-noise ratio (PSNR) and the normalized color difference (NCD).

Uncertainties are the major inherent feature of impulse noise. This fact makes image de-noising a difficult task. Understanding the uncertainties can improve the performance of image de-noising. *Zhe Zhou [21]* presents a novel adaptive detail-preserving filter based on the cloud model (CM) to remove impulse noise. It is called the CM-filter. First, an uncertainty-based detector identifies the pixels corrupted by impulse noise. Then, a weighted fuzzy mean filter is applied to remove the noise candidates. The experimental results show that, compared with the traditional switching filters, the CM filter makes a great improvement in image de-noising. Even at a noise level as high as 95%, the CM filter still can restore the image with good detail preservation.

Effective cancellation of noise and preservation of colour/structural information are features of paramount importance for any filter devoted to impulse noise removal in colour images. *Fabrizio Russo [22]* proposes novel full-reference tools for analysing the behaviour of this family of filters are presented. The proposed approach is based on the classification of colour errors into two main classes that separately take into account the inaccuracy in removing noise pulses and the filtering distortion .The distortion errors are then classified into two subclasses for a deeper analysis of the filtering behaviour. Computer simulations show that the proposed method gives more accurate results than using other measures of filtering performance in the literature. Furthermore, the method can easily yield

the spatial location of the different filtering features in the image.

Now a days visual information transmitted in the form of digital images is becoming a major method of communication, but the image obtained after transmission is often corrupted with noise. Noise hides the important details of images. To enhance the image qualities, *Ramanaiah N et al [26]* have to remove noises from the images without loss of any image information. Image de-noising is one such powerful methodology which is deployed to remove the noise through the manipulation of the image data to produce very high quality images. There are different types of noises which corrupt the images. These noises are appeared on images in different ways: at the time of acquisition due to noisy sensors, due to faulty scanner or due to faulty digital camera, due to transmission channel errors, due to corrupted storage media. Impulse noise in image is present due to bit errors in transmission or induced during the signal acquisition stage. There are two types of impulse noise, like salt and pepper noise and random valued noise. Salt and pepper noise can corrupt the images where the corrupted pixel takes either maximum or minimum gray level. Several non-linear filters have been established as reliable method to remove the salt and pepper noise without damaging the edge details, each having their own merits and demerits. This paper presents a review on the existing non-linear Median Filters for the removal of high density salt and pepper noise. The basic nonlinear filter i.e. standard median filter (MF) and different variants such as adaptive median filters (AMF), and decision based median filters (DBMF) are shows better results at low and medium noise densities. At high noise densities, their performance is poor. In this paper, Modified Shear Sorting Method and Decision Based Un-Symmetric Trimmed Median Filter (DBUTM) are used for removal of high density salt and pepper noise in images and videos, because it has lower computation time when compared to other standard algorithms. Results of the algorithm are compared with various existing algorithms and this method has better visual appearance and quantitative measures at higher noise densities as high as 90%.

One potential issue in image de-noising methods is edge blurring and loss of sharpness , to improve the performance of traditional patch based filters that require multiple similar image patches Ruixian Wang et al [29] proposes a single-patch method to simultaneously detect and remove random valued impulse noise (RVIN) within a generalized joint low-rank and sparse matrix recovery framework. This paper aims to remove RVIN with varying sizes and irregular shapes .The proposed method is based on the observation that almost any optimally oriented small, noise-free image patch (a matrix) can be approximated by a low –rank patch with texture details well preserved. This patch method completely avoids searching for similar patches, and importantly, uses larger size patches (e.g. 40 × 40) to effectively detect and remove non-pointwise RIVN. It is assumed that the optimally oriented patch is low –rank, hence it is expected that the difference between the oriented patch and its low rank approximation will be minimum at the optimal orientation. As explained by the authors about the working methodology, RVIN with different sizes (e.g. 1×1 to 4×4 pixels) at a particular sparsity level (i.e. 0.1) was added to images respectively to generate the noisy images. The results of the performance of de-noising algorithm was measured by standard peak signal to noise ratio (PSNR). Five de-noising methods were chosen for comparison , median filtering method as the basic method , the NS-LI method [30], the ROLD-EPR method [31] ,the multi-patch low- rank matrix recovery method (MPLR) [32], and the proposed method without applying the weighting matrix. After the analysis of results for this proposed approach it was found that the PSNR values were higher than other methods that were used for comparison. Moreover, only 8% of the RIVN was present in the de-noised image by the proposed method.

5. CONCLUSIONS

This section draws the conclusion of the performed investigation In addition of that, based on the limitations future extension of the proposed techniques is also listed in this section.

A. Conclusion

Image is an organization of pixel values which consists the real world information. Using the different compositions and variations of these pixel values the real world objects are represented. This information source is produced using the digital cameras and sensors. During the capturing of images that can be affected by the impact of light source, sensors disturbance and transmission media, thus the actual composition of pixels are also affected. This phenomenon is known as noise in digital images. According to the effect of noise the image is manipulated in different ways and according to their effects that can be categorized in different types of noise. In order to remove the noise

from the captured images different noise filters are prepared. Thus according to these noisy patterns their filters are also different in effect.

In this presented study the impulse noise and their effect on digital images are investigated. In addition of that its de-noising techniques are evaluated for finding the optimum filter design for impulse noise affected images. Therefore a number of different image filtering techniques are explored and after evaluation of different research articles and papers, two more promising techniques are found in Ruxian Wang et al [29] and Zhe Zhou [21]. These techniques are efficient and effective techniques of impulse noise removal.

B. Future Work

The noise is major limiting factor of digital images. Therefore a number of filtering techniques are designed in recent years for improving the image quality. As it found techniques in [21] and [29] can be enhanced to get better performance and noise removal . In near future, the de-noising technique proposed in [29] can be applied using other mathematical methods for segregation of the corrupted and un corrupted pixel values as the proposed method is not very effective at high densities of impulse noise. Hence method [29] can be extended for developing more efficient technique that consumes less amount of time and less number of iterations during noise removal. In addition of that, it is desired to implement for other noise detection and removal technique.

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