International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 05 | May 2019 www.irjet.net p-ISSN: 2395-0072

Salt and Pepper Noise Removal using Decision Based Filters

Vinayak C. Sakhare[1], Sachin V. Kamble[2], Jakia A. Alase[3], Anil P. Athane[4]

[1]*Assistant Professor, Department of Electronics, Textile & Engineering Institute, Ichalkaranji, Maharashtra, India*
[2]*Assistant Professor, Department of I.T., Textile & Engineering Institute, Ichalkaranji, Maharashtra, India*
[3]*Assistant Professor, Department of E.T.C., Textile & Engineering Institute, Ichalkaranji, Maharashtra, India*
[4]*Assistant Professor, Department of Electronics, Textile & Engineering Institute, Ichalkaranji, Maharashtra, India*

Abstract - *Images are often corrupted by salt and pepper noise causing loss of information. Hence its removal is important. Numerous filters like median filter, adaptive median filter, switching median filter, decision based filters and their variants have been proposed by various researchers. Noise detection scheme, quantitative & qualitative performance and execution time are important parameters for filters. Based on these parameters, decision based filters are performing well in terms of quantitative measures, quality of filtered image and execution time. In this paper review of decision based filters is carried out.*

Key Words: Salt, Pepper, Impulse, Median, Decision based

1. INTRODUCTION

An image carries large amount of information and is a tool of communication between people. However unfortunately sometimes image will be corrupted by parasitic information, which is called: Noise, an alteration of image, which may lead to loss of information. Hence removal of noise is important for extraction of reliable & accurate information and also before subsequent image processing operations like image segmentation, edge detection, object recognition etc. Digital images are corrupted by various types of noise such as Gaussian noise, Rayleigh noise, Erlang noise, exponential noise, uniform noise and impulse noise. Out of these types, the impulse noise has tendency of being either relatively high or relatively low and it is arising due to the errors in image acquisition (faulty sensors), faulty memory locations and transmission through noisy channel. Impulse noise is having two types viz; salt and pepper noise and random valued impulse noise. Salt-and-pepper noise is a type of impulse noise which alters some of the pixel values either at its extreme maximum (255) or at its extreme minimum (0) to make them as white and black dots. Instead of two fixed extreme values, random valued impulse noise is more realistically modelled as two fixed ranges that appear at both ends with a certain length.

The objective of digital filter is to identify corrupted pixels and replace them with a value which will be equal to close to the true value. Filters compute these values using some predefined relationship. Filters used for the removal of noise from corrupted image operate either in spatial domain or in frequency domain. The term spatial domain refers to the aggregate of pixels composing the image. Spatial domain methods are procedures that operate directly on the pixels. Large number of filters have been proposed to recover images corrupted by salt and pepper noise at various noise density levels. These filters are mainly of two types namely linear and nonlinear. Performance of nonlinear filters is found to be better than linear filters for removal of salt and pepper noise.

Standard median filter is a simple nonlinear and reliable filter to remove the salt-and-pepper without damaging edges. The main disadvantage of median filter is, it applies median filtering scheme to each pixel without considering whether pixel is corrupted or not. So Adaptive median filter (AMF) uses noise detection scheme. It provides good results for low densities of noise but for high density of noise window size is to be increased which may lead to blurring in image. In switching median filters the decision of corrupted image pixel is based on a pre-defined threshold value. As the threshold value affects the performance of impulse detection, it is necessary to derive an optimal threshold. In decision based filter, the pixel is deemed as corrupted if its value is either '0' or '255' otherwise the pixel is uncorrupted. Due to this simple noise detection scheme, decision based filter is faster and hence large number of variants of decision based filters have been proposed by various researchers. Review of such recent filters is taken in this paper.

2. REVIEW OF DECISION BASED FILTERS

A New Fast and Efficient Decision-Based Algorithm for Removal of High-Density Impulse Noises is proposed by K. S. Srinivasan et al. in [1]. In this algorithm, pixels having minimum (0) and maximum values (255) are deemed as corrupted. Such pixels are replaced by median of 3 * 3 neighborhood window provided that median itself is not noise (0 or 255) otherwise pixels are replaced by last processed neighborhood value. This filter performs well at low noise densities. At high noise density streaking occurs due to replacement with neighborhood pixel value [8].

Removal of Salt-and Pepper Noise in Images: A New Decision-Based Algorithm proposed by Madhu S. Nair et al. [2], utilizes impulse noise detection scheme of AMF and processes corrupted pixels by median of neighborhood window of 3 * 3 size or by mean of previously processed neighborhood pixels if median happens to be noisy pixels. This algorithm is faster and efficient at low noise density. At high noise density, it happens that median value is coming from a noisy pixel which leads to streaking effect [11].

Removal of High Density Salt and Pepper Noise through Modified Decision Based Unsymmetric Trimmed Median Filter (MDBUTMF) is proposed by S. Esakkirajan et al. in [3]. In this filter, every corrupted pixel is processed by 3 * 3 neighborhood window. If all neighboring pixels are 0's and 255's then current pixel is replaced by mean of neighborhood window else if not all neighboring pixels are 0's and 255's then current pixel is replaced by median of neighboring uncorrupted pixels. At high noise density, this algorithm fails if all the elements within the window are '0' or '255' then the mean value will be '0'or '255' hence noisy pixel will not be efficiently processed [5].

A Decision-based Filter for Removing Salt-and-Pepper Noise is proposed by Muhammad Mizanur Rahman et al [4]. This Non Linear Decision Based Filter (NDBF) also filters only corrupted pixels (pixels having values 0 or 255). It replaces corrupted pixel by median of 3*3 neighborhood window only if median value is not one of the extreme gray levels. If median value is 0 or 255, it checks value of Last Processed Pixel (LPP). If LPP is noise free then it takes neighborhood window of 10*10 size and calculates median and mode this window. If this median is noise free then current pixel is replaced by LPP else current pixel is replaced by mode. If LPP is noisy pixel, then eight 3*3 sized adjacent windows of current window are considered. Modes of these 9 windows are calculated and then current pixel is replaced by mode of these 9 mode values. In this way all corrupted pixels are filtered and finally robust estimator is applied on filtered image for enhancement.

Md Tabish Raza et al. have proposed High Density Salt and Pepper Noise Removal through Decision Based Partial Trimmed Global Mean Filter (DBPTGMF) in [5]. It overcomes drawback of MDBUTMF. It also uses 3 * 3 neighborhood window to filter each noisy pixel having value 0 or 255. If neighborhood window contains all elements as 0 then current pixel is replaced by salt noise (255) trimmed global mean value of image else if neighborhood window contains all elements as 255 then current pixel is replaced by pepper noise (0) trimmed global mean value of image else if neighborhood window contains all elements as 0 and 255 both then current pixel is replaced by salt and pepper noise (both 0 and 255) trimmed global mean value of image else current pixel is replaced by median of uncorrupted neighboring pixels. This methods give excellent result at low and medium noise densities. But at high noise density i.e. above 60% noise it has a poor IEF value and lead to blurring the image [8].

Satyabrata Biswall et al. have proposed decision based algorithm in [6]. In this algorithm, noisy pixel is replaced by mean of neighboring pixels if all neighbors are corrupted. If some neighboring pixels are 0 or 255 or both then these corrupted neighboring pixels are trimmed and current pixel is replaced by mean of remaining noise free pixels.

Fast and efficient median filter for removing 1–99% levels of salt-and-pepper noise in images is proposed by Mu-Hsien Hsieh et al. in [7]. Like other filters, this filter also deems pixels having very large value (positive impulse) or very small value (negative impulse) as noisy pixel. Then this filter calculates noise density to select type of neighborhood window to be employed for filtering. If noise density is less than 50% then it uses simplified type of window in which only horizontal and vertical neighbors of current pixel are considered. Above 50% noise density full type of neighborhood window having all neighbors is selected. Beginning with 3, size of neighborhood window is iteratively increased by 2 until it includes noise free pixels. Finally corrupted pixel is replaced by median of noise free neighborhood pixels.

Arabinda Dash et al. have proposed High Density Noise Removal by Using Cascading Algorithms in [8]. In order to remove salt and pepper noise at all noise density levels and to enhance image quality at high noise density level effectively, authors have cascaded two filtering stages. First stage is Decision based Median Filter wherein only corrupted pixels are replaced by median of 3 * 3 neighborhood window. The output obtained from first stage is given as input to second stage for further processing. In second stage either Modified Decision Based Partial Trimmed Global Mean Filter (MDBPTGMF) or Modified Decision Base Unsymmetric Trimmed Median Filter (MDBUTMF) is used. In MDBPTGMF, if all neighbors of corrupted pixel are 0 (pepper noise) then pixel is replaced by salt noise else if all neighbors of corrupted pixel are 255 (salt noise) then pixel is replaced by pepper noise else if some neighbors are 0 and others are 255 then pixel is replaced by mean value of window else if not all neighbors are 0 and 255 then 0 and 255 are eliminated and pixel is replaced by median of remaining values. In MDBUTMF, if all neighbors of corrupted pixel are 0 and 255 then pixel is replaced by mean of the window else 0 and 255 are eliminated and pixel is replaced by median of remaining pixels. It has been found that as the noise density increases this algorithms fails to preserve the texture details of the image i.e. the originality is lost at high noise density [10].

With the intention of maximize the speed without compromising denoising performance, an extremely fast adaptive high-performance filter to remove salt and pepper noise using overlapping medians in images is proposed by G. Balasubramanian et al. in [9]. This algorithm uses three stages of filtering. The first filtering stage is Overlapping Medians Filter (OMF) which is principally a systematic frame by frame merging of the estimations of standard medians of size M× N. The frame-based operations in the OMF has been designed and developed such that it should give the partially denoised image at an extremely fast rate. The second filtering stage is Running Average Filter (RAF) employs an estimation named as running averages (RA) using which the noisy samples available in OM, if any, will get denoised at a quicker rate. Third phase is mean filter which makes use of a simple 3 × 3 mean filter to fine tune the RA, if necessary, to get a final denoised image. At very high noise densities, this mean filter provides a significant contribution towards improving the correlations between the denoised samples to give out some visually pleasant denoised image.

Removal of Salt and Pepper noise from Gray-Scale and Color Images: An Adaptive Approach is presented by Sujaya Kumar Sathua et al. in [10] to preserve the edge and texture detail of

the image. It is variation of MDBPTGMF filter. In this filter, maximum neighborhood window size Wmax selected is 9. It starts with neighborhood window of size W= 3. It filters all corrupted pixel as follows. If number of uncorrupted neighboring pixels N is greater than or equal to W then current corrupted pixel is replaced by median of uncorrupted neighborhood pixels. If above condition is not satisfied, window size W is incremented by two up to Wmax iteratively. During each iteration, if W < Wmax and N ≥ W then current pixel is replaced by median of uncorrupted neighborhood pixels else if W = Wmax, N < W and N ≠ 0 then current pixel is replaced by mean of uncorrupted neighborhood pixels else if W = Wmax and all neighboring pixels are 0 and 255 then current pixel is replaced by mean of neighborhood pixels else if W = Wmax and all neighboring pixels are 255 then current pixel is replaced by 0 else if W = Wmax and all neighboring pixels are 0 then current pixel is replaced by 255.

3. CONCLUSION

Removal of impulse noise from noisy image is important to avoid loss of information. Various decision based filters are reviewed in this paper. Important parameters for selection of a filter for noise removal are noise detection scheme, quantitative & qualitative performance and execution time. Pixels corrupted with salt and pepper noise are taking maximum and minimum values. In decision based filters, pixels having values 0 and 255 are deemed as corrupted and then various filtering techniques are used to replace those pixels. Due to simple noise detection scheme decision based filters are faster than other types of filters and their performance varies as per filtering technique used. However if uncorrupted pixels are having values 0 and 255, these are also filtered unnecessarily leading to false alarms and these decision based filters are not useful for removal of random valued impulse noise.

REFERENCES

[1] K. S. Srinivasan and D. Ebenezer, "A New Fast and Efficient Decision-Based Algorithm for Removal of High-Density Impulse Noises," IEEE Signal Processing Letters, Vol. 14, NO. 3, March 2007, doi: 10.1109/LSP.2006.884018.

[2] Madhu S. Nair, K. Revathy, and Rao Tatavarti, "Removal of Salt-and Pepper Noise in Images: A New Decision-Based Algorithm", Proceedings of the International MultiConference of Engineers and Computer Scientists 2008 Vol I, IMECS 2008, 19-21 March, 2008, Hong Kong, doi:

[3] S. Esakkirajan, T. Veerakumar, Adabala N. Subramanyam, and C. H. PremChand, "Removal of High Density Salt and Pepper Noise Through Modified Decision Based Unsymmetric Trimmed Median Filter", IEEE Signal Processing Letters, Vol. 18, No. 5, May 2011, doi: 10.1109/LSP.2011.2122333

[4] Muhammad Mizanur Rahmani, M. Abdullah-Al-Wadud and Chrysanthe Prezal, "A Decision-based Filter for Removing Salt-and-Pepper Noise", IEEE/OSA/IAPR International Conference on Infonnatics, Electronics & Vision 2012, doi: 10.1109/ICIEV.2012.6317513

[5] Md Tabish Raza and Suraj Sawant , "High Density Salt and Pepper Noise Removal Through Decision Based Partial Trimmed Global Mean Filter", 2012 Nirma University International Conference on Engineering (NUiCONE), doi: 10.1109/NUICONE.2012.6493236

[6] Satyabrata Biswall and Nilamani Bhoi, "A new filter for removal of salt and pepper noise", 2013 International Conference on Signal Processing, Image Processing and Pattern Recognition [ICSIPR], doi: 10.1109/ICSIPR.2013.6497990

[7] Mu-Hsien Hsieh , Fan-Chieh Cheng, Mon-Chau Shie, Shanq-Jang Ruan, "Fast and efficient median filter for removing 1–99% levels of salt-and-pepper noise in images", Engineering Applications of Artificial Intelligence 26(2013), pp. 1333-1338, doi: 10.1016/j.engappai.2012.10.012

[8] Arabinda Dash and Sujaya Kumar Sathua, "High Density Noise Removal By Using Cascading Algorithms", Fifth International Conference on Advanced Computing & Communication Technologies 2015, doi: 10.1109/ACCT.2015.100

[9] G. Balasubramanian, A. Chilambuchelvan, S. Vijayan and G. Gowrison, "An extremely fast adaptive high-performance filter to remove salt and pepper noise using overlapping medians in images", The Imaging Science Journal, 64:5, pp. 241-252, doi: 10.1080/13682199.2016.1168144

[10] Sujaya Kumar Sathua, Arabinda Dash and Aishwaryarani Behera, "Removal of Salt and Pepper noise from Gray-Scale and Color Images: An Adaptive Approach", International Journal of Computer Science Trends and Technology (IJCST) – Volume 5 Issue 1, Jan – Feb 2017, pp. 117- 126

[11] V.Jayaraj , D.Ebenezer and K.Aiswarya, "High Density Salt and Pepper Noise Removal in Images using Improved Adaptive Statistics Estimation Filter", IJCSNS International Journal of Computer Science and Network Security, VOL.9 No.11, November 2009, pp. 170-176

BIOGRAPHIES

Vinayak C. Sakhare has completed his ME Electronics Engineering in 2014 from Textile & Engineering Institute. His areas of interest are Image Processing, Embedded Systems.

Sachin V. Kamble has pursued his M. Tech. Computer Science and Engineering degree in 2014 from Rajarambapu Institute of Technology in 2014. His research area is scheduling and optimization algorithm, parallel computing.

Mrs. Jakia A. Alase has completed her M. E. Electronics and Telecommunication degree from Kolhapur Institute of Technology.

Anil P. Athane has completed M.E. Electronics Engineering degree from Rajarambapu Institute of Technology. His research area is image processing.