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A COMPARATIVE STUDY OF IMAGE FILTERING ON VARIOUS NOISY PIXELS

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Abstract:-This paper deals with the comparative study of research work done in the field of Image Filtering. Different noises can affect the image in different ways. Although various solutions are available for denoising them, a detail study of the research is required in order to design a filter which will fulfill the desire aspects along with handling most of the image filtering issues. An output image should be judged on the basis of Image Quality Metrics for ex-: Peak-Signal-to-Noise ratio (PSNR), Mean Squared Error (MSE) and Mean Absolute Error (MAE) and Execution Time.

Keywords: - *Neuro-Fuzzy SubDetector, Kurtosis & Skewness.*

INTRODUCTION

Image filtering, these days, has become an active research area in the domain of Image processing. Despite several researches has undertaken in number of different fields, Image filtering stands out uniquely with its own recognition. Today's world is globe of Internet wherein information is needed to be exchanged across this globe, within fraction of second. This information may be composed of text, videos, or images. Images while transmissions over the communication media, are get corrupted due to insertion of noise. In order to recover the original image, the noise should be removed. Hence discovered the concept of Image Filtering. The importance of image filtering is constantly growing because of ever increasing use of television and video systems in consumer, commercial, medical, and communication applications. Image filtering is not only used to improve image quality but is also used as a preprocessing step before most image processing operations such as encoding, recognition, compression, tracking and etc. In other words, without filtering as a preprocessing, the other processing would have inappropriate or even false results.

IMAGE PROCESSING

Image processing is an Electronic Domain wherein image is divided into small unit called pixel, and then various operation has been carried out.

In the Digital Image Processing field, Enhancement and removing the noise from the image is the critical issue. Gaussian noise (White noise) Salt & Pepper noise and Speckle noise are the types of noises which are generally found in Images, and also denoising them with the help of some efficient technique is of main concern. Noise when get added to image destroy the details of it. So in order to preserve the real image, noise should get removed from it. And for the purpose of enhancement the contrast of the image should be improved

TYPES OF NOISE

1) Gaussian Noise*:-*

Additive noise is one of the most common problems in image processing. Even a high resolution photo is bound to have some noise in it. For a high-resolution photo a simple box blur may be sufficient, because even a tiny features like eyelashes or cloth texture will be represented by a large group of pixels. Unfortunately, this is not the case with video where real-time noise reduction is still a subject of many researches.

2) Salt & Pepper Noise:-

Salt and pepper noise is a form of noise typically seen on images. It represents itself as randomly occurring white and black pixels. An effective noise reduction method for this type of noise involves the usage of a median filter or a contra harmonic mean filter. Salt and pepper noise creeps into images in situations where a quick transient, such as faulty switching, takes place.

3) Speckle Noise:-

The speckle noise is commonly found in the ultrasound medical images. It is a granular noise that inherently exists in and degrades the quality of the Active Radar and Synthetic Aperture Radar (SAR) images. Speckle noise in conventional radar results from random fluctuations in the return signal from an object that is no bigger than a single image-processing element. It increases the mean grey level of a local area. Speckle noise in SAR is generally more serious, causing difficulties for image interpretation. It is caused by coherent processing of backscattered signals from multiple distributed targets. In SAR oceanography, for example, speckle

noise is caused by signals from elementary scatterers, the gravity-capillary ripples, and manifests as a pedestal image, beneath the image of the sea waves.

IMAGE FILTERING ON DIFFERENT IMAGES SINCE 1993

In 1993 [1] Farhad Esfahani & Mark Richardson used Median Filter in conjunction with Linear Filter to remove Impulsive noise from measurement data which had good minimization error but the computation time was very high. but this drawback was overcame by Harish Kundra , Monika Verma & Aashima in 2002 [3] when they denoised Salt & Pepper noise from image of Taj Mahal in 15 sec using 8-neighborhood method & also preserved the intricate features of the image. In similar way Dimitri Van De Ville, Mike Nachtegael, Dietrich Van der we ken in 2003 [5] removes Additive noise from Camera-man & Boat. This Filter was very feasible, fast, and simple & enabled fast hardware implementation. One year later, in 2004 [6] M. EminYüksel, Alper Ba¸stürk used same logic to remove Impulsive Noise from Baboon which also preserves image detail & texture. The filter was flexible & simple. At the end of the 2004(Dec) [7] M. Emin Yüksel, and Erkan Besdok introduced remarkable technique of Neuro-Fuzzy Sub Detector along with decision maker for removing Impulsive noise from the images of Baboon, Boats, cameraman and pentagon. This filter has reduced distortion effect due to noise removal operator and also reduced the blurring effect. M. Emin Yuksel & Alper Basturk again in the same year i.e. 2004 [8] modified their previous work by introducing Recursive Switching Median filter guided by Neuro-Fuzzy network which reduces Impulsive noise from Baboon, Blood ,Boats, Bridge ,Cameraman, Gold hill, Lena ,Pentagon, Peppers & Rice. The filter preserved the detail of the image.

A slight change over the methodology took place when in 2005 [10] Rami J. Oweis Muna J. Sunna T introduced a method, for classifying image pixels ,where Fuzzy sets are built on basis of the types of pixel. For ex-contour, regular and texture. They used images of hand & brain and it was seen that High Quality of classification was done for images of simple component. Again in the same year 2005 [11] Igor Aizenberg, Constantine Butakoff, and Dmitry Paliy came up with a new technique of Binary Slices of an image obtained by the threshold decomposition are processed by impulse detecting Boolean function. The advantage of this method was that it detects & replaces impulse at same time & shows good & convincing results .At the end of 2005 [12] Chang-Shing Lee, Shu-Mei Guo, and Chin-Yuan Hsu introduced a filter which used Image Knowledge Base for noise detection & Parallel Fuzzy Inference, Fuzzy mean process & Fuzzy decision process for impulse noise removal on the image of Lena, Albert, Baboon, Cameraman, Sailboat, Bridge, Boats, House, Pentagon. It has High quality of global restoration but did not handled Mix impulsive noise model and GFIF for color image. But in the year 2006 [13] Stefan Schulte, Mike Nachtegae, Val´erie De Witte, Dietrich Van der Weken and Etienne E. Kerre came up with the solution for mix Impulse noise using Noise detection method based on fuzzy gradient values which construct fuzzy set impulse noise & Membership function (which is fuzzy averaging of fuzzy pixel) for removal of Impulse noise for Lena. It was very fast and effective for reducing little as well as high noise, noise free pixel remain unchanged, easy, feasible and has low execution time.

In 2006 [14] Krishnan Nallaperumal, Justin Varghese, & K.Arulmozhi removes Impulsive noise from Lena, Boats, Pessers & Cameraman using Variable size detection window which forms flag image ,and for removal, Pixels are modified, identified and corrected using detected flag image. The filter retained the fidelity of the image, & was free from patchy effects. Some months later in Aug 2006 [15] Hamed Vahdat Nejad, Hameed Reza Pourreza, and Hasan Ebrahimi introduced feasible filter. where for detection ,they used Fuzzy rule base system associates a degree to each pixel & for removal, they used Weighting Contribution of neighboring pixel for removing Gaussian noise from Cameraman & Lena .In 2007 [16] V. S. Kodogiannis, M. Boulougoura in which Neuro-Fuzzy extracts a new texture feature from texture spectra Endoscopic image. Again in the same year, Feb 2007 [17] Nguyen Minh Thanh and Mu-Song Chen used Combination of multilayer Neuro-fuzzy structure which is combination of Madami & TS model for removing Impulsive noise from Lena which Preserves interpretability property of Madami model & robust local stability criteria of TS model & also feasibility/robustness, but fail to handle GFIF for color image & uniform distribution impulsive noise model. In Aug 2008 [18] M. T¨ulin Yıldırım, Alper Basturk
And M. Emin Y¨uksel used Type-2 Neuro-fuzzy operator (where membership function are also fuzzy) and then postprocessor for detection & for removal, Neuro-Fuzzy filter having Type-2 Neuro-fuzzy filter & Defuzzifier. They had removed impulsive noise from Baboon, Boats, and Bridge & Pentagon. And Preserved thin line edges & texture & other useful information in images

A new method in 2010 [21] by Mahmoud Saeidi, Ali Nazemipour was introduced which has used current, next and previous noisy frames for the purpose of detection & for removal, Weighted average pixel intensity & noise variance in image sequence (Spatiotemporal filter). It has removed

Gaussian noise from Moving Patrol image and preserves image structure.

Again in 2010 [22] Vladimir Crnojevi´c and Nemanja I. Petrovi´c used S-estimate of variance & pixel wise-s-estimator for removing impulsive noise from Lena which Increase detector accuracy & improve overall filtering performance. In the same year,2010 [26] Jagadish H. Pujar used Fuzzy noise detection method & Fuzzy median filter for dealing with Salt & Pepper noise in Lena which Preserve image detail very well, its smoothing rate is also preponderant. In 2011 [27] K.Ratna Babu, Dr K.V.N.Sunitha used Fuzzy 8- neighborhood pixel rule for detecting noise & Fuzzy membership function for removing Gaussian noise from Lena. It has reduced blurring. In the mid of the year Apr 2011 [28] a new relevant method was introduced by G. Vijaya & V. Vasudevan using Bilateral filter for removing Gaussian noise from the image of onion .Filter was Consistent and reliable.

Concurrently some work has been done regarding Speckle noise. In Apr 2011 [29] N. K. Ragesh, A. R. Anil, Dr. R. Rajesh worked for Ultrasound Image. Meanwhile in 2011 [30]Aneesh Agrawal, Abha Choubey, Kapil Kumar Nagwanshi has used Fuzzy derivates for 8-neighboring pixels for noise detection & Fuzzy smoothing using membership function for removing noise from ultrasound image. Filter was feasible but unable to handle color images. Again in the same year, Jul 2011 [31] Md. Robiul Hoque, Md. Rashed-Al-Mahfuz has used Average Filtering technique for removing Speckle noise from Source-Matlab7 toolbox. Some period of the year was contributed for Gaussian noise removal too. In Mar 2011 [32] M.Jayamanmadharao has used the method of Comparing pixel with all 8-neighbor pixel values for the purpose of noise detection. Fuzzy smoothing has made the use of previous knowledge of the pixel. It has removed Additive Gaussian noise from Lena .as it has found corrupted pixels so filtering has became very easy. Later on in the year 2011 [35] Karibasappa K.G, Shivarajkumar Hiremath, K. Karibasappa has used Kurtosis and Skewness for removing Salt & Pepper, Gaussian and Speckle noise. And the designed filter has Fast training process & accurate determinination of type of noise.

Again in Feb 2011 [36] Gnanambal Ilangoand R. Marudhachalam used Hybrid filtering technique for removing Gaussian noise from image of Brain Tumor. The method was Simple and easy to Implement. Again in 2011 [37] Shamik Tiwari, Ajay Kumar Singh & V.P. Shukla used Statistical feature of noise type & Feedforwad Back Propagation Neural Network for removing Salt & Pepper, Gaussian and Speckle noise. It has showed better identification of noise using Prelevant used image filter. Next [38] Stefan Schulte, Bruno Huysmans, Aleksandra used New fuzzy wavelet shrinkage method for removing Gaussian for Barabara and which has efficiently removed noise from image & has improved noise reduction.

Survey Table:

NO	TITLE	YEAR	AUTHOR	NOISE DETECTION MECHANISM	NOISE REMOVAL MECHANISM	NOISE HANDLED	IMAGES USED	ISSUES HANDLED	ISSUES NOT HANDLED
1	Impulsive noise removal from Measurement Data	1993	Farhad Esfahani Mark Richardson		Median Filter in conjunction with Linear Filter	Impulsive noise		Good error Minimization	Computation time (longer).
2	Image Processing - Enhancement, Filtering and Edge Detection Using the Fuzzy Logic Approach	1993	Ching-Yu Tyan and Paul P. Wang		Fuzzy Logic			Improving the images using Fuzzy rule	
3	Filter for Removal of Impulse Noise by Using Fuzzy Logic	2002	Harish Kundra , Monika Verma & Aashima	Using 8-neighborhood pixel method	Fuzzy membership function	Impulsive Noise	Taj Mahal	preserve intricate features of the image, execution time is 15 sec	
4	Neuro-fuzzy approach to processing inputs with missing values in pattern recognition problems	2002 Mar	Bogdan Gabrys						
5	Noise Reduction by Fuzzy Image Filtering	2003 Aug	Dimitri Van De Ville, Mike Nachtegael, Dietrich Van der Weken	Using 8-neighborhood pixel method	Weighting the contribution of Neighborhood pixels	Additive Noise	Camera-man & Boat	Filter is very feasible, fast, simple & enable fast hardware implementation	
6	A simple generalized Neuro-fuzzy operator for efficient removal of impulse noise from highly corrupted digital images	2004 Feb	M. EminYüksel, Alper Ba¸stürk	Using 8-neighborhood pixel method	Neuro-Fuzzy Filter	Impulsive Noise	Baboon	Good Noise removal ratio ,preserves image detail & texture, flexible & simple	
7	A Simple Neuro-Fuzzy Impulse Detector for Efficient Blur Reduction of Impulse Noise Removal Operators for Digital Images	2004 Dec	M. Emin Yüksel, and Erkan Besdok,	NF Sub detector with Decision maker & its training is done by computer generated Artificial image		Impulsive Noise	Baboon , Boats, camera man-n and pentagon	Reduces distortion effect due to noise removal operator and also reduces blurring effect	
8	Detail-Preserving Restoration of Impulse Noise Corrupted Images by a Switching Median Filter Guided by a Simple Neuro-Fuzzy Network	2004	M. Emin Yuksel & Alper Basturk	Recursive Switching Median filter guided by Neuro-Fuzzy network	Neuro-Fuzzy network	Impulsive Noise	Baboon , Blood ,Boats, Bridge ,Cameraman, Gold hill, Lena ,Pentagon, Peppers & Rice	Excellent detailed & texture preservation on performance & effective removal of noise	
9	The Research of Defect Recognition for Radiographic Weld Image Based on Fuzzy Neural Network	2004 Jun	ZHANG xiao-guang", XU jian-Jian', LI yu'	Fuzzy Neural network model	Fuzzy Neural network model			Improves accuracy of recognition & classification capabilities	

10	A combined Neuro–Fuzzy approach for classifying image pixels in Medical Applications	2005	Rami J. Oweis Muna J. Sunna' T	Fuzzy sets are built on basis of the types of pixel ex-contour, regular and texture			Hand & Brain	High Quality of classification for images of simple component	
11	Impulsive Noise Removal Using Threshold Boolean Filtering Based on the Impulse Detecting Functions	2005 Jan	Igor Aizenberg, Constantine Butakoff, and Dmitry Paliy	Binary slices of an image obtained by the threshold decomposition are processed by impulse detecting Boolean function		Impulsive Noise		Detect & replace impulse at same time & shows good & convincing results	
12	Genetic-Based Fuzzy Image Filter and Its Application to Image Processing	2005 Aug	Chang-Shing Lee, Shu-Mei Guo, and Chin-Yuan Hsu	Image Knowledge Base	Parallel Fuzzy Inference, Fuzzy mean process & Fuzzy decision process	Impulsive Noise	Lena, Albert, Baboon, Cameraman ,Sailboat Bridge, Boats, House , Pentagon	High quality of global restoration	Mix impulsive noise model, and GFIF for color image
13	A Fuzzy Impulse Noise Detection and Reduction Method	2006 May	Stefan Schulte, Mike Nachtegae, Val´erie De Witte, Dietrich Van der Weken and Etienne E. Kerre	Noise detection method based on fuzzy gradient values which construct fuzzy set impulse noise	Membership function(which is fuzzy averaging of fuzzy pixel)	Impulsive Noise	Lena	Very fast and effective for reducing little as well as high noise, noise free pixel remain unchanged, easy, feasible and low execution time.	
14	Salt & Pepper Impulse Noise Removal using Adaptive Switching Median Filter	2006	Krishnan Nallaperumal, Justin Varghese, Justin Varghese, & K.Arulmozhi	Variable size detection window forms flag image	Pixels are modified, identified and corrected using detected flag image	Impulsive Noise	Lena, Boats, Pessers &Cameraman	Retain the fidelity of the image ,free from patchy effects	
15	A Novel Fuzzy Technique for Image Noise Reduction	2006 Aug	Hamed Vahdat Nejad, Hameed Reza Pourreza, and Hasan Ebrahimi	Fuzzy rule base system associate a degree to each pixel	Weighting Contribution of neighboring pixel	Additive Gaussian	Cameraman & Lena	feasibility	
16	An Adaptive Neuro-fuzzy Approach for the Diagnosis in Wireless Capsule Endoscopy Imaging	2007	V. S. Kodogiannis, M. Boulougoura	Neuro-Fuzzy extracts new texture feature from texture spectra			Endoscopic image	feasibility	
17	Image Denoising Using Adaptive Neuro-Fuzzy System	2007 Feb	Nguyen Minh Thanh and Mu-Song Chen	Combination of multilayer Neuro-fuzzy structure which is combination of Madami & TS model		Impulsive Noise	Lena	Preserves interpretability property of Madami model & robust local stability criteria of TS model feasibility/robustness	GFIF for color image & uniform distribution impulsive noise model
18	Impulse Noise Removal From Digital Images by a Detail-Preserving Filter Based on Type-2 Fuzzy Logic	2008 Aug	M. T¨ulin Yıldırım, Alper Basturk and M. Emin Y¨uksel	Type-2 Neuro-fuzzy operator(where membership function are also fuzzy) and then postprocessor	Neuro-Fuzzy filter having Type-2 Neuro-fuzzy filter & Defuzzifier	Impulsive Noise	Baboon, Boats, Bridge & Pentagon.	Preserves thin line edges & texture & other useful information in images	

19	Design of Hybrid Filter for Denoising Images Using Fuzzy Network and Edge Detecting	2009	J. Najeer Ahamed & V. Rajamani	Neuro-Fuzzy filter combined with Spatial domain filtering		Salt & Pepper and Gaussian Noise	Lena	Excellent line, edge detail & texture preservation	
20	Removal of Speckle Noise from Ultrasound Medical Image based on Special Filters: Comparative Study	2009 Jun	K. Than gavel, R. Manavalan, I. Laurence Aroquiaraj	Statistical Method		Speckle Noise	Ultrasound image	Performance is better	
21	Adaptive Weighted Averaging Filter Using the Appropriate Number of Consecutive Frames	2010	Mahmoud Saeidi, Ali Nazemipour	Uses current, next and Previous noisy frames	Weighted average pixel intensity & noise variance in image sequence(Spatiotemporal filter)	Gaussian noise	Moving patrol	Preserves image structure	
22	Impulse Noise Filtering Using Robust Pixel-Wise S-Estimate of Variance	2010	Vladimir Crnojevi´c and Nemanja I. Petrovi´c		S-estimate of variance & pixel wise-s-estimator	Impulsive Noise	Lena	Increase detector accuracy, improve overall filtering performance	
23	A Comparative Study of Removal Noise from Remote Sensing Image	2010 Jan	Mr. Salem Selah Alamri, Dr. N.V. Kalyankarand Dr. Khamitkar S.D		Using standard filter such as standard Median , Adaptive median	Salt & pepper noise and Gaussian Noise	Saturn Image	Reduces Blurring effect	
24	Noise Reduction by using Fuzzy image filtering	2010 May	Mahesh t r, Prabhajan s, M Vijaybabu	Using 8-Neighborhood pixel method	Weighting Contribution of neighboring pixel			Feasibility and obtained image is better	
25	Performance Comparison of Median and Wiener Filter in Image De-noising	2010 Nov	Suresh Kumar, Papendra Kumar, Manoj Gupta, Ashok Kumar Nagwat		Apply Weiner and median filter for Salt & Pepper, Gaussian and Speckle noise	Salt & Pepper, Gaussian and Speckle noise	Flowertitlee		
26	Robust Fuzzy Median Filter for Impulse Noise Reduction of Gray Scale Images	2010	Jagadish H. Pujar	Fuzzy noise detection method	Fuzzy median filter	Salt & Pepper noise	Lena	Preserve image detail very well, its smoothing rate is also preponderant.	
27	A New Fuzzy Gaussian Noise Removal Method for Gray-Scale Images	2011	K.Ratna Babu, Dr K.V.N.Sunitha	Fuzzy 8-neighborhood pixel rule	Removing noise using Fuzzy membership function	Gaussian Noise	Lena	Reduces blurring	
28	Image Denoising based on Soft Computing Techniques	2011 Apr	G. Vijaya & V. Vasudevan		Bilateral filter	Gaussian Noise	Onion	Consistent and reliable	

29	Digital Image Denoising in Medical Ultrasound Images: A Survey	2011 Apr	N. K. Ragesh, A. R. Anil, Dr. R. Rajesh			Speckle Noise	Ultrasound Image		
30	Development of adaptive fuzzy based Image Filtering techniques for efficient Noise Reduction in Medical Images	2011	Aneesh Agrawal, Abha Choubey, Kapil Kumar Nagwanshi	Fuzzy derivates for 8-neighboring pixels	Fuzzy smoothing using membership function	Speckle Noise	Ultrasound image	Feasible	For color image
31	A New Approach in Spatial Filtering to Reduce Speckle Noise	2011 July	Md. Robiul Hoque, Md. Rashed-Al-Mahfuz		Average Filtering technique	Speckle Noise	Source-Matlab7 toolbox		
32	Filtering Noise on two dimensional image Using Fuzzy Logic Technique	2011 Mar	Anita Pati, V. K. Singh, K. C. Mishra	Impulse detection	Spatial filtering Double derivative method & Fuzzy logic method			Better filtering potentially & computational complexity	
33	Implementation of Object Oriented approach for noise Reduction using Fuzzy Logic	2011 Mar	M.Jayamanmadharao	Comparing pixel with all 8-neighbor pixel values	Fuzzy smoothing using previous knowledge of the pixel	Additive Gaussian noise	Lena	It finds corrupted pixels so filtering becomes easy	
34	Analyzing Image Filtrations by Enhanced Fuzzy Logic with Multi Quality Inputs	2011 May	Ramesh Tiwari & Renu Dhir	Fuzzy derivative for neighboring pixel ex-3*3, 9*9	Fuzzy Smoothing	Salt & pepper	cameraman		
35	Neural Network Based Noise Identification in Digital Images	2011	Karibasappa K.G, Shivarajkumar Hiremath, K. Karibasappa	Using Kurtosis and Skewness		Salt & Pepper, Gaussian and Speckle noise	Flower	Fast training process, accurate determine type of noise	
36	New Hybrid filtering techniques for removal of Gaussian Noise from Medical Images	2011 Feb	Gnanambal Langland R. Marudhachalam		Hybrid filtering technique	Gaussian	Brain Tumor	Simple and easy to Implement	
37	Statistical Moments based Noise Classification using Feed Forward Back Propagation Neural Network	2011	Shamik Tiwari, Ajay Kumar Singh & V.P. Shukla	Statistical feature of noise type Feedforwad Back Propagation Neural Network	Prelevant used image filter	Salt & Pepper, Gaussian and Speckle noise		Shows better identification of noise	
38	A New Fuzzy-based Wavelet Shrinkage Image Denoising Technique		Stefan Schulte, Bruno Huysmans, Aleksandra		New fuzzy wavelet shrinkage method	Gaussian Noise	Barbara	Efficiently remove noise from image	Improve noise reduction performance

CONCLUSION

This paper provides a detailed history/survey of image filtering for removing Salt & pepper, Gaussian and Speckle noise from the standard images. It gives us the track of how the issues were faced while designing a filter and when, how and by whom it was resolved. We are planning to handle three different noises in the same image. And the execution time should be taken care of which was not handled in [19] by J. Najeer Ahamed & V. Raja man

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