Modern Techniques in Image Denoising: A Review

Prof.Gayathri.R¹, Dr.Sabennian.R.S²

Associate Professor, Dept. of ECE, AVS Engineering College, Ammapet, Salem-636 003, Tamil Nadu, India¹

Professor, Dept. of ECE, Sona College of Technology, Sona Nagar. Salem-636 005, Tamil Nadu, India²

Abstract: The main challenge in digital image processing in research field is to remove noise from the original image. With respect to various assumptions, advantages, applications and limitations, different denoising algorithms have been proposed. In this paper, some important denoising techniques are discussed and classification of such techniques is listed. The denoising procedure which can be applied to all the types of noises is discussed at the last.

Keywords: Image denoising, Image classification, Adaptive multi resolution, mean square error estimation, Image restoration and decomposition.

I INTRODUCTION

Research and Technology field requires the application of Image Processing Schemes. Digital images are very important in the areas of geographical information systems and astronomy. Satellite television magnetic resonance Imaging, computer tomography is some of the daily life applications wherein digital images play a vital role. All natural phenomena and transmission errors are degrading the image quality thereby noise is introduced in the image. Hence there is a need for image denoising procedure to reduce the noise level present in the image so as to produce the denoised image closer to the original image.

II EFFICIENT DEINOISING PROCEDURES

A system which introduces the linear minimum mean square error estimation framework proposed by Zhang L, Li X, Zhang D [1] for image denoising promises good image outputs. Image Acquisition process, Noise is introduced into the system. The denoised image is used for image interpolation. Image fine and edge structure may be spoiled due to image denoising thereby producing artifacts. A directional denoising algorithm is proposed which uses directional interpolator. The noiseless and missing samples are estimated for similar framework with optimal estimation. The estimation process is calculated by collective effort of adaptive calculation of local statistics. A more accurate output is obtained by combining various directional estimates computed in multiple directions. The missing sample interpolation uses the estimation parameters which are evaluated from the denoising process. This method reduces interpolation artifacts caused by the noise and the image edge structures are preserved well.

Two Complementary discontinuity measures are used in the proposed novel Bayesian image denoising algorithm [2].Due to the over-locality characteristics of spatial discontinuity, the significant discontinuities cannot be detected from noisy image. But the spatial discontinuity effectively preserves the edge image components. Hence there is an additional requirement on finding new discontinuity measure for feature preservation by detecting contextual discontinuities. The availability of degree of uniformity in small regions and the effective detection of significant discontinuities are the primary advantages of the local-in homogeneity measure proposed in this scheme. The prior probabilities of Bayesian denoising framework are created by employing the combined complementary discontinuity measures. This achieves high peak signal to noise ratio, reduction in noise effectively by edge components preservation.
III. IMAGE DENOISING ALGORITHMS

Three scales of dual tree complex wavelet coefficients are used for image denoising algorithm for removal of white Gaussian noise. The approximate shift invariance and the better directional selectivity are the two important features of dual tree complex wavelet transform. Chen G, Zhu W.P and Xie W [3] have proved that it is providing highly competitive outputs.

For three Dimensional magnetic resonance images, an innovative method is proposed [4] based on block wise non-local (NL)-means with adaptive multi resolution. With respect to the spatial and frequency contents present in the image, the amount of denoising is implicitly adapted in accordance with the adaptive soft wavelet coefficient mixing. Fig.1 shows the types of various image denoising procedures.

Fig.1. Classification of Image Denoising Techniques
The filter is applicable for both Gaussian noise and Rician noise. Compared to the latest technique called Rician NL means filter, this method (multi resolution filter) achieves highly competitive measures in the quantitative validation conducted using several quality metrics on Brain web datasets. The filter removes noise efficiently by preserving fine details in noisy and classical cases by conducting qualitative experiments on various images like anatomical and diffusion weighted MR images. This is applied in the field of fibre tracking.

For removal of random valued impulse noise, authors [5] have proposed an improved decision based detail preserving variational method. In highly corrupted images, it is necessary to improve the ability of detection. To obtain this, variable window technique is employed by adaptive centre weighted median filter. The difference noise marks are labeled with classification of noisy parts of the image by fast iteration strategy performed by improved ACWMF. A weight adjustable detail-preserving variational method is applied for restoring all the noisy parts as one time event. The noise marks decides the weights of DPVM’s convex cost function between data fidelity term and smooth regularization term. The restored image is retrieved after minimization. The version and quantitative measurements done by the proposed filter, outperforms all other existing algorithms. It is very faster and can be ported into practical and real time applications easily.

The following chart describes the comparison between the noise removing technologies applied for different kind of noises like impulse noise, Gaussian noise, Rician noise and speckle noise. Several noise models are discussed corresponding to their type of images like real, Synthetic, Satellite and Ultrasound images.

decomposition is presented in the form of new model. A non-convex, non-smooth regularization and Hilter Sobolev spaces of negative degree of differentiability [6] are applied in the new algorithm. This is capturing oscillatory patterns.

A proven pseudo solution is existing for the proposed model. Also the variable splitting and penalty techniques are used to solve the minimization problem by two different numerical algorithms. Various experiments are also conducted for image denoising, deblurring and decomposition for real and synthetic images.
<table>
<thead>
<tr>
<th>Algorithm/Method</th>
<th>Technique/Component used</th>
<th>Type of noise</th>
<th>Results</th>
<th>Applications</th>
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| Linear Minimum Mean Square Error Estimation Framework | Directional Interpolator                      | Gaussian Noise        | ▶ Reduces Interpolation Artifacts  
▶ Edge Structure Preservation  
▶ Accurate output.                                                      | All Image Acquisition systems          |
| Bayesian two complementary discontinuity measure    | Spatial and contextual discontinuity measures Local in homogeneity measure | Gaussian Noise        | ▶ Improved PSNR  
▶ Effective noise reduction  
▶ Edge structure preservation                                                      | Electron Microscopy                     |
| Wavelet based Three scales Dependency               | Dual tree complex wavelet coefficients       | Gaussian Noise        | ▶ Approximate shift Invariance  
▶ Good directional selectivity  
▶ Highly competitive                                                    | Multimedia applications                |
| Adaptive Multi resolution                           | Non-local Mean Filter                        | Gaussian and Rician Noises | ▶ Effective qualitative and quantitative noise  
▶ Classic fine detail preservation                                              | Magnetic Resonance Imaging  
Fibre tracking                               |
| Decision based variational method                    | Adaptive centre weighted median filter       | Impulse noise         | ▶ All the noisy parts are restored  
▶ Good vision measurement  
▶ Good quantitative measurement  
▶ Fast performance  
▶ Easy to implement                                                   | Real time applications                  |
| Non-convex, non-smooth Hilter-Sobolov Norm           | Variable splitting and penalty techniques    | Speckle noise          | ▶ Better denoising  
▶ Better deblurring  
▶ Better Decomposition                                                 | Real and Synthetic Images               |
| Wavelet domain processor                             | 2D GARCH-Two dimensional generalized autoregressive conditional Heteroscedastic model | Speckle noise          | ▶ Increased flexibility  
▶ Improved restoration  
▶ Improvement in image characteristics                                      | Ultra sound images                      |

Table 1: Comparison of various noise removing algorithms
With the statistical modeling of wavelet coefficients, the speckle noise is suppressed for ultrasound images. A two dimensional heteroscedasticity will be existing between the significant non-Gaussian statistics of log transformed ultrasound image which are categorized based on wavelet coefficients. Two dimensional GARCH [7] -2D.

IV DISCUSSION

All existing efficient denoising procedures are discussed and the various performance metrics are categorized. In all the types of denoising algorithms, the components used and the applications are also listed. Since every individual algorithm possesses its own merits and merits, it is suggested that two or more efficient techniques may be combined together to receive the desired results. A relevant algorithm is to be identified in such a way that it is providing the advantages of both the systems which are combined.

REFERENCES


Prof. R. Gayathri M.E., M.I.E.T.E., (Ph.D) is currently working as Associate Professor in Electronics and Communication Engineering Department in AVS Engineering College, Salem, Tamil Nadu. She is having more than 13 years of teaching experience in various Engineering colleges and Deemed universities. She was previously working as Lecturer in Oxford Engineering College, Trichy and SC SVMV, Deemed University, Kancheepuram, as Senior Lecturer in Sona College of Technology, Salem and Assistant Professor in Chendhuran College of Engineering and Technology, Pudukkottai. She completed her Bachelor of Engineering in Electronics and Communication Engineering in Manonmaniam Sundaranar University and Master of Engineering in Communication Systems in Anna University, Chennai. Presently she is pursuing PhD in Digital Image processing in Anna University, Chennai under the guidance of Dr. R.S. Sabeenian. She has been honored by number of awards like TAMIL NADU STATE TALENT AWARD, ARIGNAR ANNA AWARD, AND KALAI KAVALAR AWARD for best academic performances. She is an active member of IETE, INSTITUTE OF ELECTRONICS AND TELECOMMUNICATION ENGINEERS. She has been elected the HONORARY SECRETARY OF IETE SALEM SUB CENTRE for 4 years from 2008 to 2012. She has presented number of research papers in National and International Conferences. She has been invited as the chief Guest and keynote speaker for number of National Seminars and Symposiums. Prof. R. Gayathri has been the Technical committee and Advisory Committee member for many number of National Conferences. She has delivered lot of Guest lectures on Digital Image Processing. She has conducted workshops on Matlab and Scilab for Engineering Faculty and Students of various Colleges. She has attended and organized lot of Seminars, Workshops, National and International Conferences. Her area of interest includes Digital Image Processing, Image Denoising and Communication Systems.
Dr. R.S. Sabeenian is currently working as a Professor in ECE Department in SonaCollege of Technology, Salem, Tamil Nadu, and India. He received his Bachelors in Engineering from Madras University and his Masters in Engineering in Communication Systems from Madurai Kamaraj University. He received his Ph.D. Degree from Anna University, Chennai in the year 2009 in the area of digital Image processing. He is currently heading the research group named Sona SIPRO (SONA Signal and Image PROcessing Research Centre) centre located at the Advanced Research Centre in Sona College of Technology, Salem. He has published more than 65 research papers in various International, National Journals and Conferences. He has also published around seven books. He is a reviewer for the journals of IET, UK and ACTA Press Singapore. He received the “Best Faculty Award” among Tamil Nadu, Karnataka and Kerala states for the year 2009 given by the Nehru Group of Institutions, Coimbatore and the “Best Innovative Project Award” from the Indian National Academy of Engineering, New Delhi for the year 2009 and “ISTE Rajarambapu Patil National Award” for Promising Engineering Teacher for Creative Work done in Technical Education for the year 2010 from ISTE.

He has also received a Project Grant from the All India Council for Technical Education and Tamil Nadu State Council for Science and Technology, for carrying out research. He received two “Best Research Paper Awards” from Springer International Conference and IEEE International Conference in the year 2010. He was also awarded the IETE Biman Behari Sen Memorial National Award for outstanding contributions in the emerging areas of Electronics and Telecommunication with emphasis on R&D for the year 2011. The Award was given by Institution of Electronics and Telecommunication Engineers (IETE), New Delhi. He is the Editor of 6 International Research Journals Research Journal of Information Technology, Asian Journal of Scientific Research, Journal of Artificial Intelligence, Singapore Journal of Scientific Research, International Journal of Manufacturing Systems and ICTACT Journal of Image Processing. He is also associated with the Image Processing Payload of the PESIT Pico Satellite Project which is to be launched by the end of Feb, 2013. He is the External Expert Member for Board of Studies of Adhiyaman College of Engineering, Hosur and M.Kumarasamy College of Engineering, Karur. He is the Honorary Treasurer of IETE Salem Sub Centre from 2010 onwards. He is the Co-ordinator for AICTE-INAE DVP Scheme. His areas of interest include texture analysis, texture classification and pattern recognition. He delivered more than 50 guest lectures and chaired more than 25 national and international conferences.