Design and Analysis of K-SVD Algorithm for the Noise Removal Using MATLAB

K. Akhil
Department of ECE
Sathyabama Institute of Science and Technology, Chennai –India.
akhil.leo10@gmail.com

K. Prasanth Kumar Reddy
Department of ECE
Sathyabama Institute of Science and Technology, Chennai –India.
prasanthreddykomatla@gmail.com

R.M. Joany
Department of ECE
Sathyabama Institute of Science and Technology, Chennai –India.
mariajoany@gmail.com

Ilayarajaa K.T
Department of ECE
Sathyabama Institute of science and Technology, Chennai-India.

ABSTRACT - This paper was proposed to developed a dictionary learning algorithm to minimize or remove the noise from the noisy pixels present in the given data sets without distorting the edges and preserving the fine particulars and details of the image for removing the noise there are three stages named INTERPOLATION, OMP(orthogonal matching pursuit) and finally K-SVD dictionary learning matrix algorithm in this algorithm there are different methods for removing different level of noises present in the image by using the masking by using this algorithm noise can be from the pixel range by checking the each and every pixel whether the pixel is a noisy pixel or noise free pixel only noisy pixels are passed the noise removal process so noise free pixels would not get degraded or blurred or changed in their property this K-SVD algorithm can remove the noise Color Images, Black and White Images and Grey Scale Images The algorithm can handle noise level

Index Terms - Dictionary Learning matrix, Discrete Cosine Transform (DCT), Image De-noising, K-SVD, Orthogonal Matching Pursuit, Redundancy, PSNR (Peak Signal To Noise Ratio), SSIM(Structural Similarity Index)

1. INTRODUCTION

Nowadays digital image processing is used widely in many areas such as medical, face recognition and military and crime investigation etc In Medical it is used for diagnosis of diseases in face recognition for security purpose and In crime investigation when the digital data is corrupted while transmitting and receiving, sometimes when digital evidence is tampered The main fundamental property of image processing is to effectively remove the noise present in a image by preserving the edges and by preserving the details and features of the image intact the nature of the problem depends on the type of noise affected to the image mostlyly the images are corrupted by Gaussian Noise, Salt And Pepper Noise, Speckle Noise, Possession Noise etc; mostly noise is added to the image during the analog to digital conversion ,pre-processing ,compressing of the image and video and while transmitting and receiving the signals with data salt and pepper noise is also known as impulse noise for removing the impulse noise from an image we use median filter and mean filter for removing the Gaussian noise for removing the speckle noise wavelet analysis was used and speckle noise is also known as granular noise it mostly occurs in the satellite images such as SAR which makes difficult in extracting the information from the image. Impulse noise is of two types fixed value impulse noise and random valued impulse noise random valued noise does not have any fixed value it corrupts the pixels in the range of 0-255 and it is very difficult to remove the random valued noise fixed value impulse
noise is also as salt and pepper noise and this salt and pepper noise effects the image and lowers the image quality makes the difficult for edge detection, segmentation, feature extraction and recognition for the security reasons so the salt and pepper noise present in the images should be removed and the salt and pepper noise can be removed using median filtering method it is a non linear filter and the removes the noise to some extent and preserves the image details to some degree so to overcome this problem many median filtering were proposed such as the centre weighted median filter, adaptive median filter ,adaptive centre weighted median filter

The main disadvantage of these filters is that these methods treat the noisy pixels and noise free pixels present in an image using the same process so the noise free pixels changes after the process of noise removal is completed therefore the images are blurred after the processing median filter can effectively the noise only at the low level only when it comes to the high level of noise its effect drops sharply to overcome this problem first the pixels are divided into noise free pixels and noisy pixels the noise free pixels keep the original grey level and noisy pixels are replaced with their median value in the spatial domain and this method is only theoretical and its can't be archived in practical as we can't set the parameters and thresholds required Gaussian noise can be removed using spatial filter it is caused due to the natural resources such as thermal vibrations of atoms in the communication channel and sometimes this white noise is used as an additive speckle noise is also known as granular noise caused due to the natural resources such as thermal vibrations of atoms in the communication channel and sometimes this white noise is used as an additive speckle noise is also known as granular noise and it is a inherit noise and it degrades the quality of the image it is mainly occurred in the sar mages and it can be removed using multi look processing and spatial filtering Wavelet analysis transform is able to separate the noise and signal at different scales and orientation hence the original signal at any scale and direction can be recovered and used the above methods change the noise into smooth fine structures and the Gaussian filter and median filter remove the noise in fixed valued impulse noise only it can't remove the random valued noise Edges of the image can be preserved by using the anisotropic diffusion but it will form a mask effect on the uniform regions of the image bilateral filtering has overcome this problem of mask effect but it can only preserve the edges in the smooth images only each pixel of the de-noised result will be the weighted average of its neighbors according to the intensity and distance between them.

2. THE EXISTING METHOD

The existing method was proposed based on noise removal algorithm for salt and pepper noise which can adapt to different noise level it contains a noise pixel detection and noise filtering process this noise pixel detection works by counting the no of closed grey level of pixels in the neighborhood to detect the noisy pixels by this noise detection process archives high correct detection and low false alarm rates and then using the adaptive domain of Euler's distance method by this it can achieve excellent noise removal and good detail preservation using the estimate of the interference rate there is no need to adjust the parameters and thresholds manually in the filtering algorithm median filtering technique is a nonlinear digital filtering technique it is mostly used to remove the noise from images and signal it preserves the edges while removing noise from it also have application in signal processing for removing the noise from the signal without altering the signal or tampering with the data init in median filtering first the pixels in the image is divided into median window and the detected noise pixel is replaced by the median value of the matrix median filter is also a smoothing technique like linear Gaussian filtering all the smoothing techniques can remove the noise only at the smooth patches and regions they fail to remove the noise present at the edges so this median filter doesn't provide better results because it can't preserve the edges for small and moderate level of Gaussian noise median filter performs better than the Gaussian filter and Gaussian filter performs well at high level of noise so speckle noise and salt and pepper noise can be removed effectively So, because of this median filtering in mostly used in digital image processing [9].

Bilateral filter is also a nonlinear filter the main advantage of this filter is that it can preserve the edges of the image by removing the noise from it and it works only in smooth images only in this process noisy pixel intensity is replaced by the weighted average of intensity values from the nearby pixels weight is based on Gaussian distribution it can depend on color intensity and depth distance so it preserves the sharp edges

Gaussian filter modifies the input image by using a convolution with the Gaussian function Anisotropic diffusion is a technique for reducing the image noise by preserving the image content, edges, lines, other details which are required for the interpretation of the image this method works on
the diffusion process it can remove the noise from the digital images without blurring the edges non-local mean algorithm is a special case of bilateral filter it provides better edge preserving each pixel of the de-noised image from a non local mean is the weighted average of the pixels with surrounding pixels of the noisy image by using Gaussian function as a smoothing function NLM filter removes the noise up to great extent nowadays sparse representation of images has a great attention by using a over complete dictionary that has a prototype image atoms images are represented by sparse linear combination of these atoms this has been already applied in many areas such as compression, feature extraction and image de-noising by combing the NLM and sparse representation algorithm to develop an enhanced image de-noising filter first it trains the dictionary by using K-SVD method from the noisy image then the each pixels surroundings are formed into a patch and it is sparsely represented by the dictionary now the weight of the NLM’S is calculated by these patches by using these weight and with the weight average of a pixel with the surrounding is obtained then we get the de-noise

![Fig1. K-SVD AND NLM Algorithm for black and white picture](image)

3. PROPOSED METHOD

At present we have many de-noising techniques available for grey level images for the noise removal but most of the techniques perform at removing noise at low level of noise but at high level they fail remove noise effectively in this we will introduce a new method for de-noising the color images, black and white and grey level images we have mainly focus on removing the salt and pepper noise from image by using the K-SVD algorithm with improved PSNR and reduced MSE at both the high density and low density noisy image to 5% to 95% many de-noising techniques proposed are application dependent image processing has two important stages first one is noise detection and the second is that removing the noise and image enhancement [12]. This method is mostly based on K-SVD algorithm and residual error without depending on the low SNR image sparse representation of de-noising algorithm depending on the previous papers methods this paper explains the process and mechanism and analysis of the algorithm PSNR is taken as objective evaluation standard by this we can see the simulation results for different kinds of image de-noising and image sparse decomposition is based on complete atom library which has better effect on de-noising algorithm after this process the
atoms in the library has the ability to show more characteristic information and effectively extract the image features [11]. In the proposed algorithm image sparse decomposition is used to optimize the dictionary and residual error more than the threshold for accurate division of image information and provide evidence for image de-noising.

The proposed method we simulate the output with the help of MATLAB in this process we first we take a color image and then it is subjected to the impulse noise and noise is added to the targeted image after that noisy pixels are detected after the noisy pixels are detected is given to the de-noising process according to the noise density level so the complete de-noising process can be divided into the following steps first stage is interpolation, second stage is orthogonal matching pursuit and finally it is given to the K-SVD algorithm.

According to the block diagram first input image is taken which may be a color or black and white without any noise then after the input stage the image is given to the add the noise then salt and pepper noise is added to the image and it is given to the patch distribution and K-SVD dictionary training with sparse encoding and them it is given to the omp and then we obtain the de noised image.

The following steps are taken for removing the noise in an image without damaging the noise free pixel, securing the edges and details of the image noise free pixel are preserved

1. Input Image
2. Interpolation
3. Orthogonal Matching Pursuit
4. K-SVD
5. Output Image
A. INPUT IMAGE

The image which is taken input contains the noise that has to be removed from the image to get a clear image. Noise in the image is occurred during the transfer of image from the transmitter to the receiver and conversion of analogue to digital format, etc. The image which is taken as input is a colour image.

Fig3. Flow chart of proposed work

Fig4. Image with high level of salt and pepper noise
Fig5. Image With low Level Of Salt And Pepper Noise

B. INTERPOLATION
The input image is given to the interpolation stage at first. In this stage, the input image is divided into blocks (pixel by pixel) to determine the noise present in that block. Then the block with the noise is determined and masked up, then it is given to the OMP (ORTHOGONAL MATCHING PURSUIT).

C. OMP (ORTHOGONAL MATCHING PURSUIT)
It receives the image after the noisy blocks are masked up. OMP determines the level of noise present in that block depending on the level of masking. If the noise in the image is high, then the level of masking in that block will be high, and then it is given to the K-SVD stage. If the noise in the image is low, then the level of masking in that block will be low, and then it is given to the K-SVD stage.

D. K-SVD
In this K means clustering and SVD means SINGULAR VALUED DECOMPOSITION. K-SVD algorithm searches the image pixel by pixel for any noises present in it and removes the noise at the pixel range. To get the original image, K-SVD stage has two different cases for removing two different levels of noises (low or high). It can be determined by the ITER which is given by the OMP stage. By knowing the ITER value, we can determine the case, and the cases can be switched using switch case statement. In this, the image in the block is converted into the YUV scale by comparing them with the ASV files present in the algorithm. Then the block is unmasked to get the original image with the high quality. And at the output image with no noise is displayed.

E. OUTPUT IMAGE

Fig6. image with high level of salt and pepper noise removed
F. PSNR & SSIM Ratio Table

![PSNR & SSIM Ratio Table](image)

**Fig8. Output tabulation of PSNR and SSIM ratios**

PSNR = $20 \cdot \log_{10}(b/rms)$

SSIM($x,y$) = \[l(x,y)\alpha \cdot c(x,y)\beta \cdot s(x,y)\gamma\]

4. CONCLUSION

By using the K-SVD algorithm we can remove noise from an image by preserving the edges and fine details of the image and the salt and pepper noise and Gaussian noise can be removed from 5% to 95%. We have calculated the PSNR ratio also for the output image.

REFERENCES

[1] Julien Mairal, Michael Elad, Guillermo Sapiro, "Sparse Representation for Color Image Restoration", IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 17, NO. 1, JANUARY 2008

[2] Michael Elad and Michal Aharon, "Image Denoising Via Sparse and Redundant Representations Over Learned Dictionaries", IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 15, NO. 12, DECEMBER 2006
[3] Qing-Qiang Chen, Mao-Hsiung Hung, Fumin Zou, “Effective and adaptive algorithm for pepper-and-salt noise removal”, ISSN 1751-9659 2nd September 2016 doi: 10.1049/iet-ipr.2016.0692

[4] E. Jebamalar Leavline, D. Asir Antony Gnana Singh, “Salt and Pepper Noise Detection and Removal in Gray Scale Images: An Experimental Analysis”, International Journal of Signal Processing, Image Processing and Pattern Recognition Vol.6, No.5 (2013), pp.343-352

[5] S. GOPI KRISHNA, T. SREENIVASULU REDDY, G.K.RAJINI, “Removal of High Density Salt and Pepper Noise Through Modified Decision Based Unsymmetric Trimmed Median Filter”, ISSN: 2248-9622 Vol. 2, Issue 1, Jan-Feb 2012, pp.090-094.

[6] M. Aharon, M. Elad, and A. M. Bruckstein, “The K-SVD: An algorithm for designing of overcomplete dictionaries for sparse representations,” IEEE Trans. Image Process., vol. 54, no. 11, pp. 4311–4322, Nov. 2006.

[7] D. L. Donoho, “De-noising by soft thresholding,” IEEE Trans. Inf. Theory, vol. 41, no. 3, pp. 613–627, May 1995.

[8] Lu, C.-T., Chou, T.-C.: ‘Denoising of salt-and-pepper noise corrupted image using modified directional-weighted-median filter’, 2012, 33, pp. 1287–1295

[9] Ravi, T, “10-Nanometer carbon nano tube field effect transistor based high celerity transposed polyphase decimation filter” Materials Today: Proceedings, Proceedings 3 (2016), pp: 1799-1807.

[10] E. Jebamalar Leavline and S. Sutha, “Gaussian noise removal in gray scale images using fast Multiscale Directional Filter Banks”, Proceedings of International Conference on Recent Trends in Information Technology, Chennai, India, (2011) June 3-5.

[11] Ravi, T and Kannan, V “Effect of N-type cntfet on double edge triggered D flip-flop based PISO shift register” IEEE Proceedings of the International Conference On Emerging Trends in Science Engineering and Technology: Recent Advancements on Science and Engineering Innovation, INCOSET 2012, Dec-2012, pp. 344-349.

[12] R. Ramya and T. Ravi, “Design of cache memory mapping techniques for low power processor” ARPN Journal of Engineering and Applied Sciences, VOL. 10, NO. 11, JUNE 2015, pp:4783-4788.

[13] S. karthikeyan, Merin Mary Koshy and V.G.Sivakumar, "Smart & automated robotic circular car parking using GSM",International Journal of Pure and Applied Mathematics Volume 117 No. 21 2017, PP: 81-86.

[14] Hari Krishna, K., Swamy, Y., Siva Kumar, V.G., Karthikeyan, S. "Integration of two way communication using gesture control hand movement and voice based text", Journal of Advanced Research in Dynamical and Control Systems, 2017, vol. No:17 , PP: 1124-1135

[15] Mayan, J.A., Priya, K.L., “ Novel approach to reuse unused test cases in a GUI based application”, IEEE International Conference on Circuit, Power and Computing Technologies, ICCPCT 2015, pp.1-7

[16] Bagavathsri and S. Karthikeyan, "Secure Elliptic Curve Cryptography Based RFID Schemes for Internet of Things", Indian Journal of Science and Technology Vol 9(42), November 2016 PP: 1-5.

[17] Gopika. S. Kumar, S. Karthikeyan and N. Ambily, “A Metaphorical Scrutiny in Banishing Salt and Pepper Noise”,BIOSCIENCES BIOTECHNOLOGY RESEARCH ASIA,December 2014 Vol. 11(3).