ISSN (O): 2455-5738
GADL Journal of Inventions in Computer Science and Communication Technology (JICSCT)
Available Online at: www.gadlonline.com
Volume –4, Issue – 2, March– April - 2018, Page No. : 43 - 53

Wavelet based Image Enhancement using Fusion

Shashi Kant
Department of Computer Science & Engineering
Dr.A.P.J. Abdul Kalam Technical University
Lucknow, India
shashikant3245@gmail.com

Prabhishek Singh
Department of Information Technology
Babasaheb Bhimrao Ambedkar University
Lucknow, India
prabhisheksingh88@gmail.com

Madan Kushwaha
Department of Computer Science & Engineering
Bansal Institute of Engineering & Technology
Lucknow, India
kushwaha.86@gmail.com

Abstract

Image fusion is an image enhancement approach for increasing the visual perception from two or more image into a single image. Each image is obtained from different object in focus. This process is now broadly used in various application of image processing such as medical imaging such as MRI, CT [18] and PET, remote sensing, satellite imaging, in design of intelligent robot etc. In this paper we have gone through the literature work done by the various researchers to obtain high quality improved image by combining important and desirable features from two or more images into a single image. Different image fusion rules, like maximum selection scheme, weighted average scheme and window based verification scheme are discussed. We also discuss about the image fusion techniques using DWT. Distinct blurred images are fused using DWT, SWT and using local correlation and their results are compared. The role of fusion in image enhancement is also taken into consideration. The results of different fusion technique are also compared, which are furnished in pictures and tables.

Keywords: Discrete Wavelet Transform, Complex Wavelet Transform, Stationary Wavelet Transform , Principal Component Analysis.

1. Introduction

With the advent of various image-capturing devices, it is not possible to obtain an image with all the information. Due to heterogeneous distance of objects from camera and limited depth-of-focus of the camera lens, not all the objects can be focused upon simultaneously. However, it is possible to obtain a number of images, each with a different object in focus, which can be combined together using image enhancement techniques to get a final image with all the scene objects in focus [1]. Thus, image enhancement means combining relevant information acquired from two or more images into a single image. The final image will be enhanced one from the input images. It helps to obtain an image with all the information which forms a new image that is more informative than its constituent images. This concept is wide used in the field of medicine, remote sensing, machine vision, automatic change detection, bio metrics etc [1].

The first DWT [2] was introduced by Hungarian mathematician Alfréd Haar in 1909. The Haar wavelet transform accept the input values in a set of 2n numbers in pair, stores the difference and passes the sum. The process is to be iterated which leads to 2n -1 differences and a final sum. The most common DWT was given by the Belgian mathematician Ingrid Daubechies in 1988. The concept was based on the use of recurrence relations to output successive excelling discrete samplings of an implicit mother wavelet function [25]. The most recent enrichment to the DWT is dual-tree complex wavelet transform (DCWT) with supplementary features: provides a high degree of shift-invariance in its magnitude and directionally selective in two and higher dimensions. DWT broadly applied in the area of science, engineering, mathematics, and computer science. Most particularly it is used for signal coding; to represent a discrete signal in a more redundant form [24].The wavelet can be constructed from a scaling function which describes its scaling attributes. Scaling function must be orthogonal to its discrete translations implicates mathematical conditions on them. So, wavelet transforms are multi-resolution image decomposition tool that provide a variety of channels representing the image attribute by different frequency sub-bands at multi-scale. The DWT uses a discrete set of the wavelet scales and translations rules. In other words, DWT decomposes the signal into mutually orthogonal set of wavelets [21].In contrast with other wavelet transforms, a major advantage it has over Fourier transform is temporal resolution that is it captures both frequency and location information[23], [25].

The rest of the paper is organized as follows: Section II is about image enhancement using DWT. Section III is the related work /literature survey. Section IV entails the associated fusion schemes for image enhancement. Section V describes importance of image fusion in image enhancement. Comparative analysis has been done in Section VI and results are elaborated in section VII. Final section VIII is the references.

2. IMAGE ENHANCEMENT USING DWT

The wavelet transform slice the image into low-low, low-high, high-low, high-high spatial frequency bands at different scales. DWT based image fusion provides better signal to noise ratio (SNR) and high quality spectral content. But it has less spatial resolution [26].

The image is sliced by vertical and horizontal lines and represents the first-order of DWT, and the image sliced into four parts: LL1, LH1, HL1 and HH1 as shown in fig. 1 [3], [27].

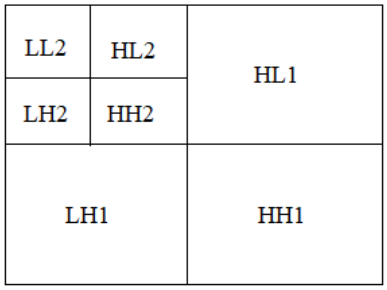

Fig. 1 Wavelet Decomposition

The LL frequency band records the approximation coefficients whereas the other frequency bands records directional information. LH band saves the horizontal detail coefficients. HL band saves the vertical detail coefficients. HH saves the diagonal detail coefficients and also the higher absolute values of wavelet coefficients correspond to prominent features such as edges or lines [28].

The prevailing process of image fusion using DWT has following steps:

Step 1: Implement DWT on both the input image to create wavelet lower decomposition.

Step 2: Fuse each decomposition level by using different fusion rule.

Step 3: Carry Inverse Discrete Wavelet Transform (IDWT) on fused decomposed level, which means to reconstruct the image.

The final image is the fused enhanced image [29].

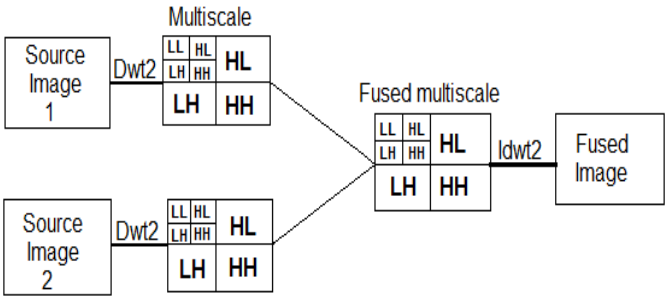

Fig. 2 Discrete Wavelet Transform based Image Fusion

Service Level Agreement (SLA): Although the Cloud users don't had to control over the fundamental of computing resources, and they do require to ensure the eminence, accessibility, dependability, and presentation of such resources where as users have migrate their core production and function onto that entrust the Cloudy [8]. Another we can say that, it is vital for users to get hold of guarantee from to provider on services release.

3. Related work/ literature survey

Wang, Wencheng and Chang, Faliang [4] proposed a multi-focus image fusion method based on laplacian pyramid. This method uses pyramid based decomposition. The input image is sliced into various pyramid levels using pyramid. The main advantage of this decomposition method is that it retains the edge information of image very well. Theoretically laplacian pyramid is obtained from a low pass gaussian pyramid using recursive refining process. Like DWT based image fusion this method also uses different operators to merge multiple pyramid levels and finally uses an inverse laplacian pyramid transform to regenerate the fused image as the final output image. The procedure used for this method is not very much efficient as conventional methods but the main advantage is it can identify shadows in image [30].

Li, Shutao and Kwok, JT-Y and Tsang, Ivor W and Wang, Yaonan [5] suggested image fusion with the use of support vector machines (SVM). Image fusion using SVM is another scheme for image fusion based on both wavelets and machine learning approach. It uses both SVM and discrete wavelet frame transforms (DWFT) scheme for image fusion. DWFT decomposes and retrieve feature coefficients of an image. The intensification in DWT based method is DWFT. The important difference of DWFT from DWT is that it offers a translation invariant image processing and representation pattern [31].

Liang, Junli and He, Yang and Liu, Ding and Zeng, Xianju, [6] suggested an image fusion using higher order singular value decomposition (HOSVD). HOSVD is data driven image fusion method. The HOSVD decomposes the input image into distinct tensors. The input image is originally divided into different patches for feature extraction. Such type of decomposition method is highly efficient in high dimensional data and in matrix based operations. Firstly, absolute pixel values are taken from the image patches. Special sigmoid function is used in this method for mixing the coefficients into fused image. A shrinking factor directs this sigmoid function. This sigmoid function use to select maximum scheme or averaging or smoothing functions based on some

shrinking criteria. By using any one of these sigmoid functions final fused image are regenerated. This varying sigmoid function makes this method efficient for image fusion [32].

Li, Shutao and Kang, Xudong and Hu, Jianwen [7] suggested a new approach of data driven image fusion based on guided filtering which uses two-scale image decomposition method. Image fusion with guided filter is capable to produce much better results. The primary advantage of this method is that it can well preserve the details of different source images. This method makes full use of spatial uniformity for image fusion. A successive combination of average, laplacian, gaussian and guided filter is used in this method. Since this method uses guided filter scheme so it can well preserve edge information. The important advantage of guided filter is it takes a guidance image to control over all filtering process.

He et al [8] suggested the combination of IHS and PCA to enhance the fusion quality. Numerous drawbacks have been existed with this as color distortion problem and sensitive pixel precision.

Li et al [9] explained a method based on redundant wavelet transform to overcome the shift variant problem and increase the authenticity of fusion results.

Yang et al [10] discussed composite method with fusion rules like local energy, weighted average, and selection to enhance the quality of the fused images.

Yoonsuk Choi, et.al. (2014) [11] discussed quality assessment of image fusion methods in transform domain using curvelet, contourlet, decomposition, non sub sampled contourlet, wavelet .

4. IMAGE FUSION SCHEME

The goal of the image fusion is to retain the most desirable attributes from image into a single fused enhanced image [14].Fusion method include the simplest approach of pixel averaging to more complicated methods such as principal component analysis (PCA) [3] and wavelet transform fusion. This method can take place at different levels of information representation [3]. A general order of image abstraction in distinct level is: pixel, feature and decision level [4]. In pixel level fusion, information is acquired from a set of associated pixels. In feature level fusion, information is acquired from features such as edges, regions having particular characteristic and pixel intensities etc. Decision-level fusion consists of fusing information at a higher level of abstraction, combines the results from multiple algorithms to yield a final fused decision.

Image Fusion Rules

Fusion techniques are widely categorized into two groups: spatial domain and transform domain. In spatial domain, operations are executed directly on pixels. The fusion methods such as averaging, brovey method [23], principal component analysis (PCA) and IHS based methods [22] fall under spatial domain approach. Spatial domain fusion method is the high pass filtering based technique. The disadvantage of this approach is that they produce spatial deformity in the fused image. Spectral distortion becomes a negative factor when we go for further processing such as classification problem. It can be very well managed by frequency domain approaches on image fusion.

Three very well-known fusion rules were implemented using DWT based image fusion:

1) *Maximum selection (MS) scheme*: This is the elementary

scheme in which the coefficient in each sub-band with the highest magnitude is selected.

2) *Weighted average (WA) scheme*: This scheme was proposed by Burt and Kolczynski [12] which is a standardized correlation between the two image's sub-bands over a small local area. The average coefficient value is selected for the regeneration of image.

3) *Window based verification (WBV) scheme*: This scheme

Was proposed by Li et al. [13] creates a binary decision map to select a coefficient between each pair of coefficients using a majority filter.

5. IMPORTANCE OF IMAGE FUSION IN IMAGE ENHANCEMENT: ROLE

Image fusion is a commonly used technology to enhance the visual interpretation of the images in various areas like enhanced vision system, medical diagnosis, robotics, military and surveillance, etc. It is now frequently used in various fields such as object identification, classification and change detection [22].

Object identification

In order to increase the amount of information extracted from satellite image data useful products can be found in fused images.

Classification

Classification is one of the primary tasks of remote sensing applications. With the help of classification correctness of remote sensing images can be improved when multiple source image data are used for the processing.

Change detection

Change detection is the process of detecting differences in the state of an image by observing it at different times. The changes are detected by comparing multiple images of same scene acquired at different times usually. Some traditional change detection methods such as differencing and ratioing algorithms are used for the purpose.

Applications of image fusion in various areas:

1) Medical Imaging:

a) *Magnetic Resonance Imaging*: The MRI, which stands for magnetic resonance imaging" is widely used as non invasive diagnostic technique of various internal body organs disorder such as brain, spinal cord, etc.

b) *Computerized Tomography:* The CT [18], which stands for "Computerized tomography" are another medical image technique which provides very rich information about anatomical features and tissue density, allowing for the detection of tumors. CT imaging is used for broken bones, injury etc.

c) *Positron Emission Tomography*: PET which is described as positron emission tomography. It is a nuclear medicine imaging technique. Similar to MRI and CT, a major application of PET is for brain diagnosis and treatment.

Along with these modalities there are several other modalities used in medical image fusion such as Single Photon Emission Computed Tomography, Infrared, Microwave and Microscopic imaging.

2) Remote Sensing Imaging:

a) *Pan Sharpening:* This is a process of merging Pan-chromatic image [21] (single band) into multispectral image (more than one band). An enhanced pan sharpened

image gives the best of both image types, high spectral resolution AND high spatial resolution.

b) *Agriculture*: Agriculture plays an important role in economies of countries. We can receive field based information including crop identification, crop area determination and crop condition monitoring (health and viability). Satellite data are employed in precision agriculture to manage and monitor farming practices at different levels. The data can be used to farm optimization and spatially-enable management of technical operations. The images can help determine the location and extent of crop stress and then can be used to develop and implement a spot treatment plan that optimizes the use of agricultural chemicals.

c) *Forest Mapping*: Using remote sensing data we can

identify and delineate various forest types that would be difficult and time consuming using traditional ground surveys.

d) *Intra-urban land cover classification*: It is possible to

generate information for many applications, such as analysis of urban micro-climate and urban greening maps amongst others.

3) Computer Vision:

a) Automatic inspection, e.g., in manufacturing applications.
b) Assisting humans in identification tasks, e.g., a species identification system.
c) Controlling processes, e.g., an industrial robot.
d) Detecting events, e.g., for visual surveillance or people counting.
e) Interaction, e.g., as the input to a device for computer-human interaction.
f) Modeling objects or environments, e.g., medical image analysis or topographical modeling.
g) Navigation, e.g., by an autonomous vehicle or mobile robot.

4) Microscopic Imaging:

a) *Scanning Electron Microscope*: A Scanning Electron

Microscope (SEM) uses focused beams of electrons to render high resolution, three-dimensional images. These images provide information on topography, morphology and composition. SEM is used across a number of industrial, commercial, and research applications. SEMs are use for quality control, analysis of gunshot residue, jewellery examination, handwriting and print analysis, measuring the effect of climate change of species, vaccination testing, forensic evidence is soil quality, and toxins, identifying diseases and viruses.

6. COMPARATIVE ANALYSIS

The comparative analysis is performed on the Lytro Multi-focus Image Dataset available at open access database [24]: There are multiple images available in this database. The results are analyzed using fusion methods are presented on the selected data shown in the Fig. 3 (a) and 3(b).

Qualitative Analysis

The fusion result using DWT, CWT, DSWT and PCA are as shown in Fig. 4, Fig. 5, Fig. 6 and Fig. 7, respectively. By analyzing the fused image, it is observed that Fig. 4, Fig. 5, Fig. 6 and Fig. 7 are enhanced images as the quality of the fused image is better than two input images. The final fused image preserves relatively much information

than selected data set. This claim can be verified by the TABLE I. The performance of the fused image is evaluated on the visual perception of the image using qualitative measure such as non-generation of artifacts during fusion procedure, smoothness in homogenous area, preservation of fine details in heterogeneous areas, preservation of edges, corners, contrast and brightness of an image.

(a)

(b)

Fig. 3 Image fusion dataset

Fig. 4 Image fusion by (one level) discrete wavelet transform

Fig. 5 Image fusion by (one level) complex wavelet transforms

Fig. 6 Image fusion by (one level) discrete stationary wavelet transforms

Fig.7. Image fusion by PCA

Quantitative Analysis

In order to analyze the quality of fused image in terms of quantitative analysis, there are certain metrics available in past literature. These metrics are Peak Signal to Noise Ratio (PSNR) [17], Signal to Noise Ratio (SNR), Structured Similarity Index Metric (SSIM), Universal Image Quality Index (UIQI), Correlation Coefficient (CC), Mean Square Error (MSE) [17], Root Mean Square Error (RMSE) and Entropy. The resultant fused image performance is evaluate against two standard metric i.e. image fusion using PSNR and image fusion using SSIM on both images. TABLE I compares the fused image with DWT, CWT, SWT and PCA using PSNR and SSIM. As shown in TABLE I PSNR wrt Fig. 3 (a) and Fig. 3 (b) using DWT is 15.2397 and 15.6491 which is more informative than the original input image. On comparing fused image wrt Fig. 3 (a) and Fig. 3 (b) in terms of PSNR, CWT method gives better result than input image but preserves lesser information than DWT. On applying SWT, the PSNR wrt Fig. 3 (a) and wrt Fig. 3 (b) is 16.7878 16.9342 which preserve the image information more effectively as compared to DWT and SWT. PCA returns the best result in terms of PSNR wrt Fig.3 (a) as 17.8646 and wrt Fig. 3 (b) as 17.9893. On applying DWT, the resultant fused image obtained has better image quality in terms of SSIM which is 0.7983 and 0.7846 wrt Fig. 3 (a) and Fig. 3 (b), respectively. The SSIM of image wrt Fig. 3 (a) and Fig. 3 (b) is 0.7786 and 0.7865 using CWT which is lesser in quality as compared to DWT. Analyzing the SWT method for enhancing image quality result in better fused image compared to DWT and CWT. The SSIM of fused image wrt Fig. 3 (a) and Fig. 3 (b) is 0.8131 and 0.8236 respectively. The PCA method gives the best fused image as a result among all the fusion techniques. The SSIM of resultant image is 0.8957 and 0.9127 wrt Fig. 3 (a) and Fig. 3 (b).

TABLE I. PSNR AND SSIM OF FUSED IMAGES

		PSNR wrt Fig 3 (a)	**PSNR wrt Fig 3 (b)**	**SSIM wrt Fig 3 (a)**	**SSIM wrt Fig 3 (b)**
	DWT	15.2397	15. 6491	0.7983	0.7846

Dataset Fig. 3.	CWT	15.1326	15.4957	0.7786	0.7865
	SWT	16.7878	16.9342	0.8131	0.8236
	PCA	17.8646	17.9893	0.8957	0.9127

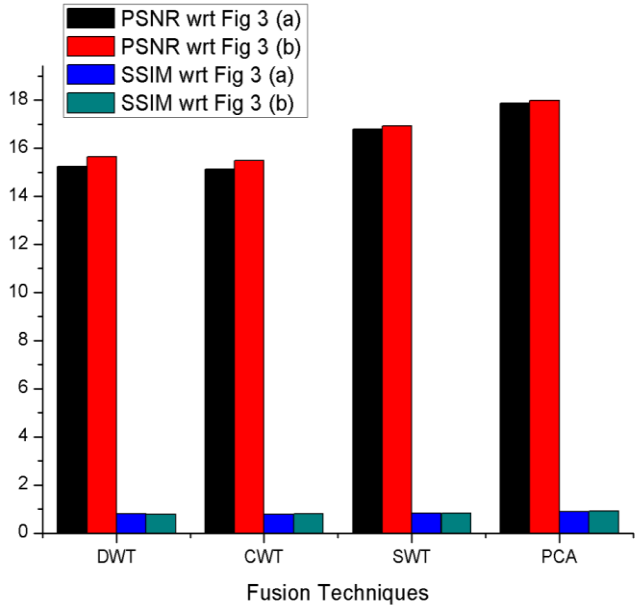

Fig.7. PSNR and SSIM of fused images

7. CONCLUSION

In this paper, the role of fusion in image enhancement using DWT is studied. A blurred image stores less information required for image analysis and does not provide appropriate and relevant information regarding the object. So, multiple images of same scene are fused to obtain a high quality enhanced image for better understanding of the object. The technique of generating new improved image is image fusion. In this paper we have gone through many wavelet transform technique such as DWT, CWT, SWT and PCA to in order to analyze the quality of fused image with respect to the original images. The performance of various fusion methods is tested against the original images and other fusion methods. The image fusion performance is evaluated quantitatively and qualitatively measurement criterions. Through the experimental results, it is found that the image fusion method preserves more sharp information while eliminating artifacts and has shown better performance magnitude. The Enhancement of the bandwidth and the competence had to required, which is implies to require for a privileged an occurrence and to recovered spatial shadowlike reuse. The Huge magnitude the Cloud Computing of the SAAS model had another challenging feature in the near expectation which could be already foreseen.

References

[1] Shutao Li, Bin Yang, “Multifocus image fusion using region segmentation and spatial frequency”, Image and Vision Computing, Volume 26, Issue 7, 2 July 2008, Pages 971-979.

[2] G. Pajares and J. Manuel de la Cruz, "A wavelet-based image fusion tutorial," Pattern Recognition, vol. 37, pp. 1855-1872, September 2004.

[3] Desale, Rajenda Pandit, and Sarita V. Verma. “Study and analysis of PCA, DCT & DWT based image fusion techniques. IEEE, 2013. ." (ICSIPR), on pp. 66-69

[4] Wang, Wencheng and Chang, Faliang, “A multi-focus image fusion method based on Laplacian pyramid”, Journal of Computers, 2011.

[5] Li, Shutao and Kwok, JT-Y and Tsang, Ivor W and Wang, Yaonan, “Fusing images with diff erent focuses using support vector machines”, Neural Networks, IEEE Transactions on. IEEE, 2004, pp. 1555–1561.

[6] Liang, Junli and He, Yang and Liu, Ding and Zeng, Xianju, “Image fusion using higher order singular value decomposition”, Image Processing, IEEE Transactions on, vol. 31, no. 12, pp. 2898–2909, 2012 2013.

[7] Li, Shutao and Kang, Xudong and Hu, Jianwen, “Image fusion with guided filtering”, IEEE transactions on image processing: a publication of the IEEE Signal Processing Society, IEEE, vol. 27, no. 2, pp.2864–2875, 2013.

[8] Hel, Q, Liu,"multi-modal medical image fusion based on HIS and PCA, procedia Engineering 7(2010) 280-285.

[9] L.Wang,"multi-modal medical image fusion using inter scale and intrea scale dependencies between image image shift variant coefficients, information fusion"19(2014) 20-28.

[10] L.Yang, B.Guo,"multi-modal medical image fusion based on multi-scale geometric analysis of contour let transform,nero computing 72(1-3)(2008)203211.

[11] Yoonsuk Choi,et.al., "Quality assessment of image fusion methods in transform domain" ,University of Nevada, Las Vegas 4505 Maryland Parkway, Las Vegas, NV 89154-4026, International Journal on Information Theory (IJIT), Vol.3, No.1, January 2014.

[12] Burt, P.J., Kolczynski, R.J. Enhanced image capture through fusion. In: Proc. 4th Internat. Conf. on Computer Vision, Berlin, Germany, pp. 173–182,1993.

[13] H. Li, B.S. Manjunath, and S.K. Mitra. Multisensor image fusion using the wavelet transform. Graphical Models and Image Processing, 57:235–245, 1995.

[14] Yocky, D.A., 1995. Image merging and data fusion by means of the discrete two-dimensional wavelet transform. J. Opt. Soc. Am. A: Opt., Image Sci. Vision 12 (9), 1834– 1841.

[15] R.singh, M.vasta,"multi-modal medical image fusion using redundant discrete wavelet transform, in: seventh international conference on advances in pattern, pp.232-235, 2009

[16] Sweta K. Shah, Prof. D.U. Shah, "Comparative Study of Image Fusion Techniques based on Spatial and Transform Domain", R.K. University, Rajkot, Gujarat, India, Vol. 3, Issue 3, March 2014.

[17] Prabhishek Singh, Raj Shree, Quantitative Dual Nature Analysis of Mean Square Error in SAR Image Despeckling, in International Journal on Computer Science and Engineering (IJCSE), Volume 9 Number 11 Nov, Page: 619-622, 2017.

[18] Manoj Diwakar, Manoj Kumar, "A review on CT image noise and its denoising", Biomedical Signal Processing and Control, Volume 42, Pages 73-88, April 2018

[19] Manoj Diwakar, ManojKumar, "CT image denoising using NLM and correlation-based wavelet packet thresholding", IET Image Processing, DOI: 10.1049/iet-ipr.2017.0639, 2018.

[20] Prabhishek Singh, Raj Shree, "A Comparative Study to Noise Models and Image Restoration Techniques", International Journal of Computer Applications (0975 – 8887)Volume 149 – No.1, September 2016.

[21] Pellemans, A.H., Jordans, R.W., Allewijn, R. Merging multispectral and panchromatic SPOT images with respect to the radiometric properties of the sensor. Photogrammetric Engineering and Remote Sensing, Vol. 59, No. 1, pp. 81-87, 1993.

[22] Leila Fonseca1, LaercioNamikawa, EmilianoCastejon, LinoCarvalho, Carolina Pinho and AyltonPagamisse "Image Fusion for Remote Sensing Applications", Image Fusion and Its Application, pp 153-173.

[23] Nupur Singh , Pinky Tanwar "Image Fusion Using Improved Contourlet Transform Technique", IJRTE Volume-1, Issue-2, 2012.

[24] https://www.researchgate.net/profile/Mansour_Nejati/publication/291522937_Lytro_Multi-focus_Image_Dataset/data/56a3debb08aef91c8c12eafe/LytroDataset.rar.

[25] Prabhishek Singh, Raj Shree, "Statistical Quality Analysis of Wavelet Based SAR Images in Despeckling Process", Asian Journal of Electrical Sciences (AJES), Volume 6 No.2 July-December 2017 pp 1-18.

[26] Prabhishek Singh, Raj Shree, A new homomorphic and method noise thresholding based despeckling of SAR image using anisotropic diffusion. Journal of King Saud University – Computer and Information Sciences (2017), http://dx.doi.org/10.1016/j.jksuci.2017.06.006

[27] Prabhishek Singh, Raj Shree, Manoj Diwakar, A new SAR image despeckling using correlation based fusion and method noise thresholding. Journal of King Saud University – Computer and Information Sciences (2018), https://doi.org/10.1016/j.jksuci.2018.03.009

[28] Prabhishek Singh, Raj Shree, "Speckle Noise: Modelling and Implementation", published in International Journal of Control Theory and Applications, 9(17) 2016, pp. 8717-8727 © International Science Press.

[29] Prabhishek Singh, Raj Shree, "Importance Of DWT In Despeckling SAR Images And Experimentally Analyzing The Wavelet Based Thresholding Techniques", in International Journal Of Engineering Sciences & Research Technology, 5(10): October, 2016.

[30] Prabhishek Singh, Raj Shree, Statistical Modelling of Log Transformed Speckled Image, 380 Vol. 14 No. 8 AUGUST 2016 International Journal of Computer Science and Information Security, (pp. 426-431).

[31] Prabhishek Singh, Raj Shree, A New Computationally Improved Homomorphic Despeckling Technique of SAR Images, International Journal of Advanced Research in Computer Science, Volume 8, No. 3, March April 2017.

[32] Prabhishek Singh, Raj Shree, Analysis and effects of speckle noise in SAR images, IEEE International Conference on Advances in Computing, Communication, Automation (ICACCA) 2016.