International Journal of Scientific & Engineering Research, Volume 6, Issue 7, July-2015 793
ISSN 2229-5518

Image Fusion using Transformation & Edge Detection & Filtering

Priyanka Kaurav, Asst. Prof. Richa Chouhan, Prof. Mohd. Ahmed

Abstract— Fusion of images is an important concept and can be used in a wide variety of applications, especially in the enhancement of images taken from satellites. Although there are various techniques through which images can be fused. Image Fusion is an integration of more than two images so that the invisible or blurred part of the images is visible in the resultant image. Guided filtering is a technique of filtering images so that the fused image is an enhanced image. But the technique implemented for the image fusion is not efficient in terms of fused ratio and the technique is not feasible for all type of images. Hence an efficient technique is implemented here which uses the concept of image enhancement using DWT and canny edge detection, after both the images gets enhanced the resultant images are fused to get the final fused image.

The proposed technique implemented here is an efficient technique as compared to the existing technique of fusion using guided filtering. The proposed and the existing technique is applied on various datasets including Multiexposure dataset, Multimodal images dataset and Multifocus image datasets. The proposed technique gives efficient results as compared to the existing technique.

Index Terms— Multifocus Images, DWT, DCT, Fusion, LDR, Haar Wavelet.

1 Introduction

The utility of digital images is very much common for all kinds of display gadgets. Unfortunately, the input images that are captured by these devices are sometimes not really in good brightness and contrast. Therefore, a process known as digital image enhancement is normally required to increase the quality of these low brightness images. Digital images are gradually used in current digital life. Rapidly growth in field of image enhanced also going on. Various kinds of techniques are there to refine images. Image fusion is one of them. Image fusion is a technique to combine or merge multiple same scene images to form a new single image. This can be done for enhancing the quality of image. The combined or fused image may provides more comprehensive information about the scene more than original image. This comprehensive information is useful to human as well as machines. Image fusion is required for various images processing devices and computer application based on image vision like feature extraction and target recognition system [1].

Image improvement fabricates a production image that instinctively looks enhanced than the original image by altering the pixel's intensity of the participation image. The reason of image enhancement is to improve the interpretability or perception of information contained in the image for individual viewers, or to make available an improved input for other automated image processing systems. The superiority of an image can be measured on its spatial and spatial-frequency resolutions along with clarity and sharpness. Numerous image processing systems may require both high spatial and high spectral information in a single image. Capturing device are not enough capable to capture image with fine quality hence additional image processing required. In this respect numerous image fusion based techniques were suggested by researchers [2], [3], [4], [5]. Some of these methods are more successful like multiscale image fusion [3], data-driven image fusion [4]. These techniques are capable to preserve source information also. Such methods are used to produce brightness and color distortions in the fusion process.

Generalized random walks [6], and Markov random fields [7] based methods are focused on estimating spatially smooth and edge aligned weights. These techniques use energy function and weighted average pixel value to fusing the source image. Image fusion can reduce uncertainty, maximize the relevant information particular to application and minimize redundancy. DWT includes any wavelet transform for which the wavelets are discretely sampled. Some of the mostly used wavelets include Haar Wavelet, Daubechies Wavelets (DB), Symlets. After applying the DWT, the image is subjected to histogram equalization. Sometimes, the parts of the image that contains the useful data are represented by low contrast values. Using histogram equalization method the contrast of these areas is enhanced which provides improved image quality. Wavelets-based approach is efficient performer as far as image fusion is concerned. It is a multiscale scheme best suited for manipulation of different image resolutions. The discrete wavelets transform or DWT permits the image decomposition with different coefficients preserving the image information. These coefficient are obtained from various images and then they are merged to produce fused image [3].

The Canny edge detection algorithm is used to detect edges of an image. Edge detection is one of the important aspects of the image processing to better understand the image. Edge detection method was used to detect various areas of an image so that it can be separated in some common area to better understand the image. Sometimes using this technique it is easy to reduce noise and enhance the performance of the image quality. Canny edge detection method is one of the methods used to detect edges among images in efficient manner. It is one of the best edge detection methods. It can efficiently detect edges and avoid the false edge detection. Wavelets-based methods are also efficiently used in enhancing the quality of images. The Discrete Wavelet Transform or DWT is discrete in nature in terms of time and scale. Coefficients used in DWT have real in nature that means floating point values are used while time and scale values used to index these coefficients are integers. DWT decomposed the signal in to one or more resolution levels know as octaves. The DWT can be 1- Dimensional, 2-D, 3-D, etc. depending on the signal's dimensions. Wavelet transform earlier used to image compression.

In today's era there is lots of availability of multisensory data in variety of terms like remote sensing, satellite imaging and medical images. It might be possible that multiple image of same scene showing different information. This possibility comes when same scene is captured from different sensors. Image fusion is applied on such images to enhance their information content. Image fusion mixed these same scene images and produces a common or single image with full of information within the image. Due to various limitations of the capturing devices it is not possible to focus all the objects of the scene. Hence complete information of image is lacking. To create full scene with complete information content image fusion is used. The rest of paper is organized as follows. In Section II describes about related work of association rule mining. Section III describes about proposed method. Section IV describes about experimental result algorithm followed by a conclusion in Section V.

2 RELATED WORK

This section describes some related work to image fusion, DWT transformation and canny edge detection.

A novel image fusion method with guided filtering is proposed by Shutao Li et al [1]. They also suggested fast two-scale fusion scheme that does not depended on a specific image decomposition method. A weight construction method also employed to combine pixel saliency and spatial context for image fusion. Pixel saliency and spatial consistency measures are quite different while fusing different layers. These measures are used to control through adjusting the parameters of the guided filter. In image fusion with guided filtering method an average filter is utilized to get the two-scale representations. After that base layer and others layers were fused with guided filtering based weighted average method. The source images are decomposed with average filtering and produce two-scale representations. After that weight map is constructed using Laplacian filtering. Two scale reconstructions are performed to fused base and detail layers. Guided filter is capable to maintain correlation among neighborhood pixels for weight optimization. Experimental results show that this method is efficient to preserve the original and complementary information of multiple input images [1].

Gonzalo Pajares et al[3] presented a tutorial based on image fusion. In this tutorial they focused about various image fusion techniques. They can try to fuse images with different resolution. The main focus of this work is to use wavelet decomposition known as multi-resolution image fusion method. They are trying to fuse images with same resolution or different resolution. They can merge variety of images like remote sensing, medical images, infrared images, thermal images and visual CCD images [3]. Empirical mode decomposition method is used to fully decompose the signals in to natural scale components. It is a data driven time-frequency technique that decomposes a signal using sifting algorithm mostly used in Amplitude Modulation and frequency modulation. EMD is fully data driven techniques used to decompose the signal into narrowband oscillatory components called intrinsic mode functions abbreviated IMFs [4].

Total Variation or VT based approach suggested for pixel level fusion [5]. VT is used to fuse images captured using multiple sensors. In pixel level fusion scheme the fused pixel is derived from a set of pixels in the various inputs. Pixel-level fusion algorithms are computationally efficient and easy to implement. The VT semi norm has been adopted to fuse the pixels of the noisy input images. According to this method input images are split into several blocks. Within each blocks pixels are arranged lexicographically. This technique applied on various datasets and obtained results are much satisfactory [5].

A novel probabilistic model-based fusion technique for multi-exposure images was recommended by Shen et al [6]. This fork focused on multi-exposure and suggested a new efficient and effective image fusion algorithm. Direct fusion of multi-exposure images eliminates the requirements of obtaining intermediate HDR image. This algorithm is based on a probabilistic model and global optimization. A generalized random walks (GRW) method is used to calculate an optimal set of probabilities issue to two quality measures: local contrast and color consistency. The local contrast measure preserves details while the color consistency measure consistency in a neighborhood and consistency with the natural scene. GRW provides a general framework for solving problems that can be formulated as a labeling problem. This GRW fusion algorithm has low computational complexity and produces a final fused LDR image with fine details and an optimal balance among the two quality measures. By defining problem-specific quality measures, this algorithm may also be applied to other fusion problems. The initial probability that a pixel in the fused image belongs to each input image is estimated based on local features. Taking neighborhood information into account, the final probabilities are obtained by global optimization using the generalized random walks. These probability maps serve as weights in the linear fusion process to produce the fused image. In a probability map, the brighter a pixel is, the higher the probability [6].

Wang Zhijun et al [8] presented Comparative Analysis of various Image Fusion Methods. They compared representative methods dealt with IHS, BT, HPF, HPM, PCA, ATW, and MRAIM. Some of them are totally different from another and work on different applications. The IHS technique is a standard procedure in image fusion, with the major limitation that only RGB bands are involved. The IHS technique usually comprises four steps:

1) transform the red, green, and blue (RGB) channels to IHS components;

2) match the histogram of the panchromatic image with the intensity component;

3) replace the intensity component with the stretched panchromatic image; and

4) inverse-transform HIS channels to RGB channels.

The resultant color composite will then have a higher spatial resolution in terms of topographic texture information [9].

The Brovey Transform based on the chromaticity transform. It is a simple method for combining data from different sensors. It is also having the limitations of RGB color band. Its intention is to normalize the RGB multispectral bands used for RGB display and to multiply the result by any other desired data to add the intensity or brightness component to the image. High-Pass Filtering method preserves a high percentage of the spectral characteristics, since the spatial information is associated with the high-frequency information of the HRMIs. The principle of HPF is to add the high-frequency information from the HRPI to the LRMIs to get the HRMIs [8]. The working of High-Pass Modulation is to transfer the high-frequency information of the HRMI to the LRMIs, with modulation coefficients that are identical to the ratio among the LRMIs and the LRPI. The PCA method is analogous to the IHS method. The input LRMIs are first transformed into the same number of uncorrelated principal components. The first principal component image contains the information that is common to all the bands used as input to PCA, while the spectral information that is unique to any of the bands is mapped to the other components [10].

A Trous Algorithm-Based Wavelet Transform is based on the undecimated dyadic wavelet transform and is particularly suitable for signal processing since it is isotropic and shift-invariant and does not create artifacts when used in image processing [11]. Multiresolution Analysis-Based Intensity Modulation follows the GIF method, with the major advantage that it can be used for the fusion case in which the ratio is an arbitrary integer M, with a very simple scheme. The performance of the IHS, BT, and PCA methods relies on the correlation between the panchromatic image and the multispectral images. The BT method will get even worse results, since no histogram matching process is applied to narrow the difference between the LRPI and the HRPI. The similar HPM method will give slightly better performance because the color of the pixels is not biased toward the gray, provided that the low-pass filter is chosen as in the HPF method [9].

A pixel-level satellite image fusion method was recommended by Henrik Aanaes et al [12]. This method deal with the merging of low spatial and high spectral resolution satellite images with high spatial and low spectral ones with the aim of creating high spatial and high spectral images. This method concerns about pixel level fusion. The method is model based, and the fused images obtained spectrally are consistent by design. The problem of satellite image fusion is an ill-posed problem, and therefore, regularization is necessary for its solution. This method tested on various data sets and found efficient for satellite images [12].

In 2010 Hasan Demirel, Cagri Ozcinar, And Gholamreza Anbarjafari proposed technique which uses a new satellite image contrast enhancement technique that is based on the discrete wavelet transforms (DWT) and singular value decomposition. The technique uses DWT and decomposes the input image into the four frequency subbands and estimates the singular value matrix of the low–low subband image after that the image get deconstructed by inverse DWT. Standard general histogram equalization and local histogram. This technique proves itself than equalization, state-of-the-art techniques such as brightness preserving dynamic histogram equalization and singular value equalization [13].

Continuing with the research Demirel et. al. [14] proposed a new method for enhancement of satellite images contrast called Satellite Image Contrast Enhancement Using Discrete Wavelet Transform and Singular Value Decomposition. Their method was based on Discrete Wavelet Transform (DWT) and singular-value decomposition. They first applied DWT to the input image to divide it into four frequency sub-bands, then used singular value decomposition and then again applied inverse DWT to reconstruct the image. Their technique showed better results than conventional BPDHE [14].

In 2011 by Keqiang Ren and Huihuan Li given an oversized capability digital audio watermarking algorithmic program victimization twenty four bit true color image as watermarking, compared with algorithms victimization pseudorandom sequence, binary image or grey image as watermarking, the watermarking info capability was accrued considerably. The watermarking info was embedded into the moving ridge low frequency elements; the embedding strength was dynamically determined by the values of low frequency coefficients and might effectively resist the common attacks like resembling, low-pass filtering, median filtering, noise officious, denoising, and lossy compression, and so on. The algorithmic program has provided one quite answer for the big capability digital oftenness watermarking algorithmic program [15].

ISSN 2229-5518

Dynamic stochastic resonance is a concept of physics that is used to betterment of the image quality. In this method a DSR-based adaptive algorithm used in discrete-wavelet transform domain for betterment of very dark images. This algorithm can similarly be used for 2 or higher level DWT but DSR should be applied to approximation coefficients only at one of the levels, preferably at level 1 as that has best resolution. Application of DSR to approximation coefficients affects both brightness and contrast of image in totality. DSR on detail coefficients is conducive to enhancement of edges. If DSR is applied to higher levels, due to successive decrease in resolution, the computational complexity decreases, but best output is obtained on level-1 approximation coefficients. When compared with existing DSR-based technique using DFT, DWT-based technique is observed to give colored output with much less computational complexity [16].

3 Proposed Algorithm

1. Take two images which need to be fused and filtered.
2. Apply DWT transformation of the input image.
3. Investigation of the Dominant brightness level of the LL band of the DWT is executed out.
4. Image Decomposition of image due to the dominant brightness level is carried out.
5. Concern Adaptive intensity transfer functions on dissimilar intensity levels of the decomposed image and then smoothened out.
6. Smoothen image is conceded to the canny edge detection techniques which is subsequently integrated through the Contrast enhancement techniques and is segmented out.
7. The inverse DWT is applied after that to the fusion image and HH, HL, LH bands to get the contrasted image.
8. Now the two enhanced contrast image can be fused to get the result fused image.

The proposed methodology implemented here provides efficient fusion as compared to the existing fusion techniques. The main reason behind the efficient fusion is enhancement of the image and the fusion of the two images using canny edge detection. The source images can be enhanced by applying DWT transformation and finding the pixel region having low intensities. The image when enhanced can be fused with the pixel regions with high intensity values.

4.2.1 DWT Transformation

Apply DWT algorithm of level 2 in which we have applied HAAR wavelet transformation and can be given as:

```
cH = cell(1,no_of_Level);
cV = cell(1,no_of_Level);
cD = cell(1,no_of_Level);
for iLevel = 1:no_of_Level,[cA{iLevel},cH{iLevel},cV{iLevel},cD{iLevel}] = dwt2(original_image,'haar');
end
dwtimage = dwt2(original_image,'haar');
fast_ftkernel = dwt2(kernelimage,'haar');e
fast_ftkernel(find(fast_ftkernel == 0)) = 1e-6;
fast_ftblurimage = dwtimage.*fast_ftkernel;
blurimage = idwt2(dwtimage,cH{iLevel},cV{iLevel},cD{iLevel},'haar');
```

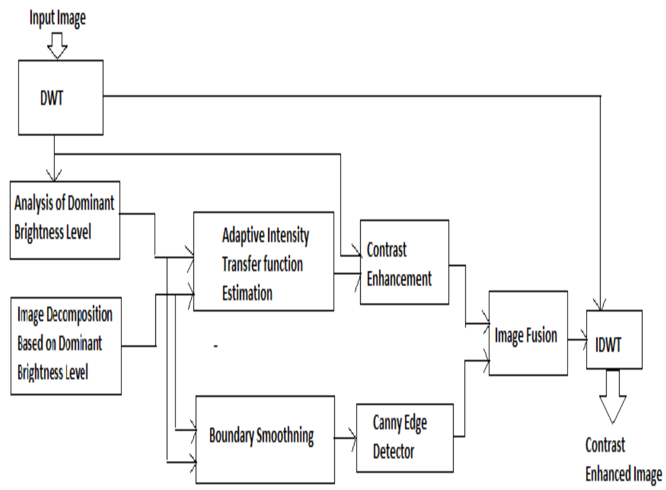

Figure 1 Outline of the Proposed Work

As shown in the above figure is the outline of the proposed technique. The proposed techniques contains transformation of image using DWT whose low sub band value is used for the improvement of the level of brightness and its contrast can be enhanced which is smoothed out and the canny edge detector is used for the sharpness of the images pixel boundaries and this images get fused with high sub band values to get contrast improved image.

The canny edge detector is used for the improvement of images edges which is hard to smoothen using other technique, hence using canny edge detector is used for the better smoothen of the images which is then fused with the other part of the images so that the overall effect of the image gets smoothen.

4 Simulation Results

The figures shown below are the various outputs when proposed methodology is applied on the first input image to be fused. The histogram of the image is first created and then the input is decomposed into a number of bands using DWT and then the low intensity region is smoothened and canny edge detection techniques is applied on the low intensity region and finally it is fused with the high intensity region to get the enhanced image.

ISSN 2229-5518

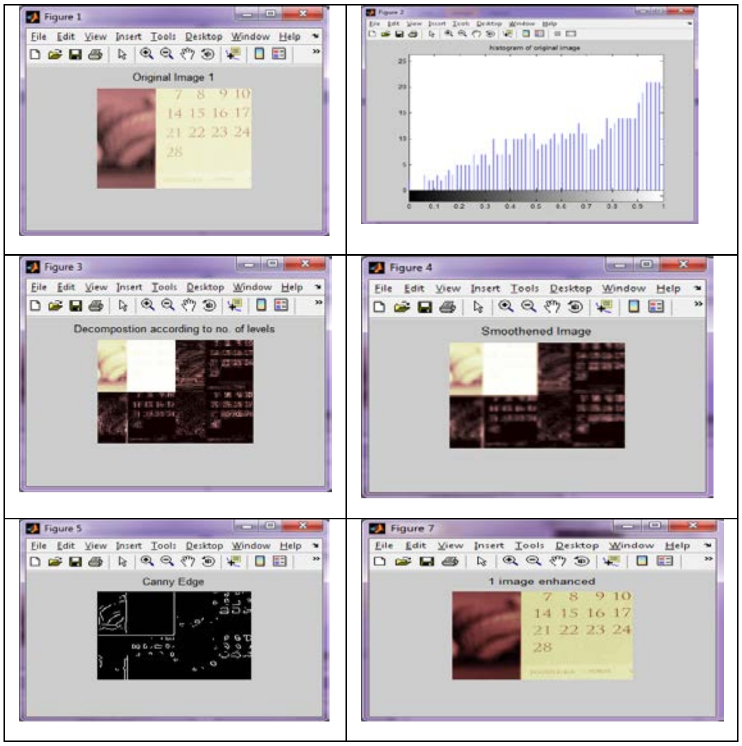

Figure 2 a) Input Image b) histogram of the input Image c) Decomposition of Image d) Smoothening of image e) Canny edge of image f) final enhanced image

The figures shown below are the various outputs when proposed methodology is applied on the second input image to be fused. The histogram of the image is first created and then the input is decomposed into a number of bands using DWT and then the low intensity region is smoothened and canny edge detection techniques is applied on the low intensity region and finally it is fused with the high intensity region to get the enhanced image.

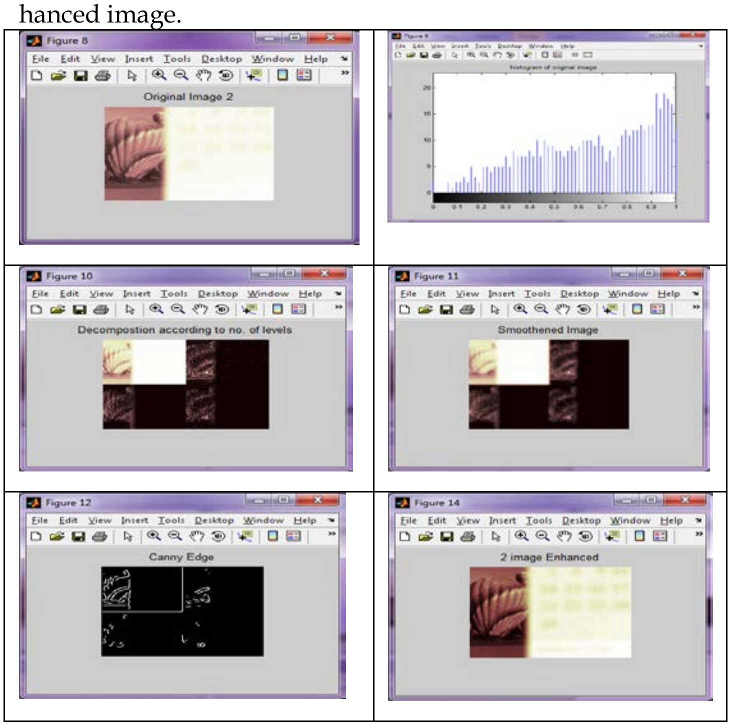

Figure 3 a) Input Image b) histogram of the input Image c) Decomposition of Image d) Smoothening of image e) Canny edge of image f) final enhanced image

The table shown below is the comparison of the existing and proposed work when applied on multifocus and multiexposure dataset. The Analysis also shows the performance of the methodology and the number if pairs on which the technique is applied.

Source Image	Index	Existing work	Proposed Work
MultiExposure Dataset	Qy	0.5384(6)	0.7843(6)
	Qc	0.6483(4)	0.9654(4)
	Qp	4.6721(6)	7.89463(6)
	Qmi	1.5743(2)	2.5483(5)
MultiFocus Dataset	Qy	0.8653	0.9743
	Qc	0.6748	0.8641
	Qp	0.7431	0.9742
	Qmi	0.7612	0.8973

Table 4 Techniques applied on pairs.

5 Conclusion & Future Work

The proposed methodology implemented here performs better fusion as compared to the existing technique of fusion of the source images. The comparison between existing and proposed work is done on the basis of various parameters such as Mutual Information, Covariance between two images, Structural Similarity, Computational Time and measure of enhancement of images. The proposed methodology can fused more pair of images as compared to the existing technique.

Although the technique is efficient and performs better as compared to the existing technique but further enhancements can be done in Quality index of the images and also alpha factor is calculated which indicates the ratio of fusion of the two source images.

References

[1] Li, Shutao, Xudong Kang, and Jianwen Hu "Image fusion with guided filtering." IEEE transactions on image processing: a publication of the IEEE Signal Processing Society, vol. 22, no. 7, pp. 2864-2875, 2013.

[2] S. Li, J. Kwok, I. Tsang, and Y. Wang, “Fusing images with different focuses using support vector machines,” IEEE Transactions on Neural Networks, vol. 15, no. 6, pp. 1555–1561, Nov. 2004.

[3] G. Pajares and J. M. de la Cruz, “A wavelet-based image fusion tutorial,” Pattern Recognit., vol. 37, no. 9, pp. 1855–1872, Sep. 2004.

[4] D. Looney and D. Mandic, “Multiscale image fusion using complex extensions of EMD,” IEEE Transaction on Signal Processing., vol. 57, no. 4, pp. 1626–1630, Apr. 2009.

[5] M. Kumar and S. Dass, “A total variation-based algorithm for pixellevel image fusion,” IEEE Transaction on Image Processing, vol. 18, no. 9, pp. 2137–2143, Sep. 2009.

[6] R. Shen, I. Cheng, J. Shi, and A. Basu, “Generalized random walks for fusion of multi-exposure images,” IEEE Transaction on Image Processing, vol. 20, no. 12, pp. 3634–3646, Dec. 2011.

[7] M. Xu, H. Chen, and P. Varshney, “An image fusion approach based on markov random fields,” IEEE Transactions on Geoscience and Remote Sensing, vol. 49, no. 12, pp. 5116–5127, Dec. 2011.

[8] Wang, Zhijun, Djemel Ziou, Costas Armenakis, Deren Li, and Qingquan Li. "A comparative analysis of image fusion methods." IEEE Transactions on Geoscience and Remote Sensing, vol. 43, no. 6, pp. 1391-1402, 2005.

[9] E. M. Schetselaar, “Fusion by the IHS transform: Should we use cylindrical or spherical coordinates?,” International journal of Remote Sensing, vol. 19, no. 4, pp. 759–765, 1998.

[10] J. Zhou, D. L. Civco, and J. A. Silander, “A wavelet transform method to merge Landsat TM and SPOT panchromatic data,” ?,” International journal of Remote Sensing, vol. 19, no. 4, pp. 743–757, 1998.

[11] F. Murtagh and J. L. Starck, “Image processing through multiscale analysis and measurement noise modeling,” Statistics and computing, vol. 10, no. 2, pp. 95–103, 2000.

[12] Aanæs, Henrik, Johannes R. Sveinsson, Allan Aasbjerg Nielsen, Thomas Bovith, and Jón Atli Benediktsson. "Model-based satellite image fusion", IEEE Transactions on Geoscience and Remote Sensing,vol. 46, no. 5, pp. 1336-1346, 2008.

[13] Hasan Demirel, Cagri Ozcinar, And Gholamreza Anbarjafari “Satellite Image Contrast Enhancement Using Discrete Wavelet Transform And Singular Value Decomposition” Ieee Geoscience And Remote Sensing Letters, Vol. 7, No. 2, April 2010.

[14] Hasan Demirel, Cagri Ozcinar, and Gholamreza Anbarjafari,” Satellite Image Contrast Enhancement Using Discrete Wavelet Transform and Singular Value Decomposition”, IEEE Geoscience and Remote Sensing Letters, vol. 7, no. 2, pp. 333-337, April 2010.

[15] Keqiang Ren & Huihuan Li, “ Large Capacity Digital Audio Watermarking Algorithm Based on DWT and DCT ” 2011 International Conference on Mechatronic Science, Electric Engineering and Computer (MEC), pp. 1765 – 1768, 2011.

[16] Chouhan, Rajlaxmi, C. Pradeep Kumar, Rawnak Kumar, and Rajib Kumar Jha. "Contrast Enhancement of Dark Images using Stochastic Resonance in Wavelet Domain." International Journal of Machine Learning and Computing, vol. 2, no. 5, 2012.