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Improving Quality of Image Using PCA and DSWT at Two Level Decomposition

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ABSTRACT: The fast development of digital image processing leads to the growth of feature extraction of images which leads to the development of Image fusion. The process of combining two different images into a new single image by retaining salient features from each image with extended information content is known as Image fusion. Two approaches to image fusion are Spatial Fusion and Transform fusion. Discrete Wavelet Transform plays a vital role in image fusion since it minimizes structural distortions among the various other transforms. Lack of shift invariance, poor directional selectivity and the absence of phase information are the drawbacks of Discrete Wavelet Transform. These drawbacks are overcome by Stationary Wavelet Transform and Dual Tree Complex Wavelet Transform and Principal Component Analysis (PCA). An image resolution enhancement technique based on interpolation of the high frequency subband images obtained by discrete wavelet transform (DWT), SWT, PCA and the input image. The edges are enhanced by introducing an intermediate stage by using stationary wavelet transform (SWT). DWT is applied in order to decompose an input image into different subbands. PCA maintains the high frequency subbands as well as the input image are interpolated. The estimated high frequency subbands are being modified by using high frequency subband obtained through SWT and DWT. Then all these subbands are combined to generate a new high resolution image by using inverse DWT (IDWT), inverse SWT and inverse of PCA. The quantitative and visual results are showing the superiority of the proposed technique over the conventional and state-of-art image resolution enhancement techniques HE and denoising using MDBUTMF filter. Parameters are also used to measure value such as PSNR, MSE, Normalized Correlation, CoC and Elapsed Time. Our proposed technique PCA with DSWT results better quality of visualization

KEYWORDS: Energy DWT, MDBUTMF, IDWT, SWT, Transform Fusion, PCA.

I. INTRODUCTION

Digital images play an important role both in daily life applications such as satellite television, magnetic resonance imaging, and computed tomography as well as in areas of research and technology such as geographical information systems and astronomy. Data sets collected by image sensors are generally contaminated by noise. Imperfect instruments, problems with the data acquisition process, and interfering natural phenomena can all degrade the data of interest. Furthermore, noise can be introduced by transmission errors and compression. Thus, denoising is often a necessary and the first step to be taken before the images data is analyzed. It is necessary to apply an efficient denoising technique to compensate for such data corruption. Image denoising still remains a challenge for researchers because noise removal introduces artifacts and causes blurring of the images. This paper describes different methodologies for noise reduction (or denoising) giving an insight as to which algorithm should be used to find the most reliable estimate of the original image data given its degraded version. Noise modeling in images is greatly affected by capturing instruments, data transmission media, image quantization and discrete sources of radiation. Different algorithms are used depending on the noise model. Most of the natural images are assumed to have additive random noise which is modeled as a Gaussian. Speckle noise is observed in ultrasound images whereas Rich in noises affects MRI images.
One of the fundamental challenges in the field of image processing and computer vision is image denoising, where the underlying goal is to estimate the original image by suppressing noise from a noise-contaminated version of the image. Image noise may be caused by different intrinsic (i.e., sensor) and extrinsic (i.e., environment) conditions which are often not possible to avoid in practical situations. Therefore, image denoising plays an important role in a wide range of applications such as image restoration, visual tracking, image registration, image segmentation, and image classification, where obtaining the original image content is crucial for strong performance. While many algorithms

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have been proposed for the purpose of image denoising, the problem of image noise suppression remains an open challenge, especially in situations where the images are acquired under poor conditions where the noise level is very high.

Image denoising problem is still a bottleneck for the researchers because removal of noise causes the artifacts and image blurring. Different methodologies for noise reduction are given to us that insights into the methods to determine which method will provide the reliable and approximate estimate of original image given its degraded version.

Image de-noising done by filtering. Filtering is divided in broad categories. De-noising of images in medical science is still a challenging problem. There have so many techniques and algorithms published. Each has their own assumptions, limitations and advantages. Methods of image de-noising are spatial domain and transform domain. Linear filter such as Weiner, non-linear threshold filtering, wavelet coefficient model, non-orthogonal wavelet transform, wavelet shrinkage, anisotropic filtering, trilateral filtering etc. example of spatial filtering are Mean filtering and Gaussian filtering. Linear filters result is not better because they destroy the fine details and lines and also blur the sharp edges. Bilateral filter recently used for de-noise the images. Its work effectively with high frequency areas but it fails to work at low frequency; it fails to remove salt and pepper noise and gives low performance to remove speckle noise. So each technique or filter or algorithm has its own advantages and limitations and drawbacks. So still there are so many filters for images de-noising.

II. RELATED WORK

Pravin R. Dabhi at el.(2015), author worked on satellite images which as many applications such as in meteorology, oceanography, fishing, agriculture, biodiversity conservation, forestry, landscape, geology, cartography, regional planning, education, intelligence and warfare. Images can be in visible colors and in other spectra. There are also elevation maps, usually made by radar images. Low resolution is the major drawback in these kinds of images. The resolution of satellite images varies depending on the instrument used and the altitude of the satellite's orbit. In order to exploit the information and to analyze the image the resolution of the image has to be enhanced. Various image processing techniques exist for resolution enhancement. The latest being application of wavelet techniques for resolution enhancement. In this, a comparison of two main wavelet techniques i.e. DWT & SWT are studied based on the image quality metrics and a new image quality enhancement technique had been worked based on wavelet fusion algorithm. The computation results of the image enhancement and image quality metrics of the proposed technique is compared with existing techniques. It is proved that the proposed technique have higher resolution enhancement capability than existing techniques. Mirajkar Pradnya P (2013), defined Image fusion is the procedure of combining two or more unlike images into a new single image retaining their main features from each part of images with extensive information content. Two approaches of image fusion, Spatial Fusion and Transform fusion. Here, proposed an image fusion approach based on Stationary Wavelet Transform (SWT) that is firstly applied with the original image to get the edge image information in level 1 and level 2 both. Next, both edge images are combined to get a complete edge image using Spatial Frequency Measurement, which is compared with a few simple fusion Methods. B Siva Kumar et al. (2013), proposed an image resolution enhancement technique based on interpolation of the high frequency subband images obtained by discrete wavelet transform (DWT) and the input image. The edges are enhanced by introducing an intermediate stage by using stationary wavelet transform (SWT). DWT is applied in order to decompose an input image into different subbands. Then the high frequency subbands as well as the input image are interpolated. The estimated high frequency subbands are being modified by using high frequency subband obtained through SWT. Then all these subbands are combined to generate a new high resolution image by using inverse DWT (IDWT). The quantitative and visual results are showing the superiority of the proposed technique over the conventional and state-of-art image resolution enhancement techniques. Kanagaraj Kannan et al. (2010), introduced the fast development of digital image processing leads to the growth of feature extraction of images which leads to the development of Image fusion. The process of combining two different images into a new single image by retaining salient features from each image with extended information content is known as Image fusion. Two approaches to image fusion are Spatial Fusion and Transform fusion. Discrete Wavelet Transform plays a vital role in image fusion since it minimizes structural distortions among the various other transforms. Lack of shift invariance, poor directional selectivity and the absence of phase information are the drawbacks of Discrete Wavelet Transform. These drawbacks are overcome by Stationary Wavelet Transform and Dual Tree Complex Wavelet Transform. This paper describes the optimal decomposition level of Discrete, Stationary and Dual Tree Complex wavelet transform required for better pixel based fusion of multi focused images in terms of Root Mean Square Error, Peak Signal to Noise Ratio and Quality Index. Haweez Showkat

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et al. (2014), presented a Robust Video watermarking become a challenge for researchers as it is used to sustain the copyrights of the owner. Most of the developed watermarking algorithm based on frequency domain because this approach provides better results as compare to spatial domain approach. In this paper we proposed a Graphical User Interface (GUI) based SVD-DWT Video Watermarking using Fused Images and Low-Middle frequency bands. In this work, two watermark images are used in fused manner using wavelet fusion. The basic approach used in this work is to utilize the benefits of Singular Value Decomposition (SVD) and Discrete Wavelet Transform (DWT). For embedding watermark Low and Middle frequency bands are used as they provide more robustness against geometric attacks such as cropping, rotation etc. The performance of the proposed algorithm has been evaluated using two parameters such as Peak Signal to Noise Ratio (PSNR) and Correlation Coefficient (CC) under various noise attacks like Gaussian and Salt & Pepper Noise attacks, geometric attacks – rotation and cropping. The simulation results shows that proposed method has better results as compared to SVD-DWT hybridization, DWT and SVD approaches [4]. G.Amar Tej (2015), pre-processing techniques hire filtration and resolution enhancement to remove noise and have good resolution is the main quality parameters in medical images. So as to preserve the edges and contour information of the medical images, an improved image enhancement technique and the efficient denoising is required. Here, concentrate on the average filtering, median filtering, wiener filtering and wavelet denoising for image denoising and an interpolation based Discrete and stationary Wavelet Transform technique for resolution enhancement is calculated on the base of some performance parameters such as PSNR which provides efficient denoising and resolution enhancement for image pre-processing. Ashishgoud Purushotham (2015), result of fusion is a new image which is more suitable for human and machine perception. Pixel level image fusion using wavelets and principal component analysis have implemented and worked on different performance metrics with and without reference image which concluded that image fusion using wavelets with higher level of decomposition showed better performance in some metrics and in other metrics PCA showed better performance. DWT in all parameters performs better than the PCA fusion algorithm so finally we can conclude that DWT is performs better than PCA. K.Prasad (2012), main work is of the image denoising. Corrupted image is called the noisy image, and the corrected is called the de-noised image. As we know different types of noises are there in the image processing like Gaussian noise, speckle noise, random noise, Salt & pepper noise etc. Among these the Salt and pepper noise is very dangerous noise compare to other noises. By using different algorithms we can reduce the noise from image. As color images in image processing is very widely as applications. So, a modified decision based unsymmetrical trimmed median filter algorithm for the restoration of gray scale, and color images that are highly corrupted by salt and pepper noise has worked out. Algorithm is worked which replaces the noisy pixel by trimmed median value when other pixel values, 0's and 255's as present in the selected window and when all the pixel values are 0's and 255's then the noise pixel is replaced by mean value of all the elements present in the selected window. Here algorithm shows better results than previous algorithm as tested against different grayscale and color images and gives better Peak Signal to-Noise Ratio (PSNR) and Image Enhancement Factor (IEF). So, MDBUTMF algorithm is effective for salt and pepper noise removal in images at high noise densities. Rajenda Pandit Desale and Sarita V. Verma (2013), this paper discusses the Formulation, Process Flow Diagrams and algorithms of PCA (principal Component Analysis), DCT (Discrete Cosine Transform) and DWT (Discrete Wavelet Transform) based image fusion techniques. The results are also presented in table & picture format for comparative analysis of above techniques. The PCA & DCT are conventional fusion techniques with many drawbacks, whereas DWT based techniques are more favorable as they provides better results for image fusion.

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III. PROPOSED ALGORITHM

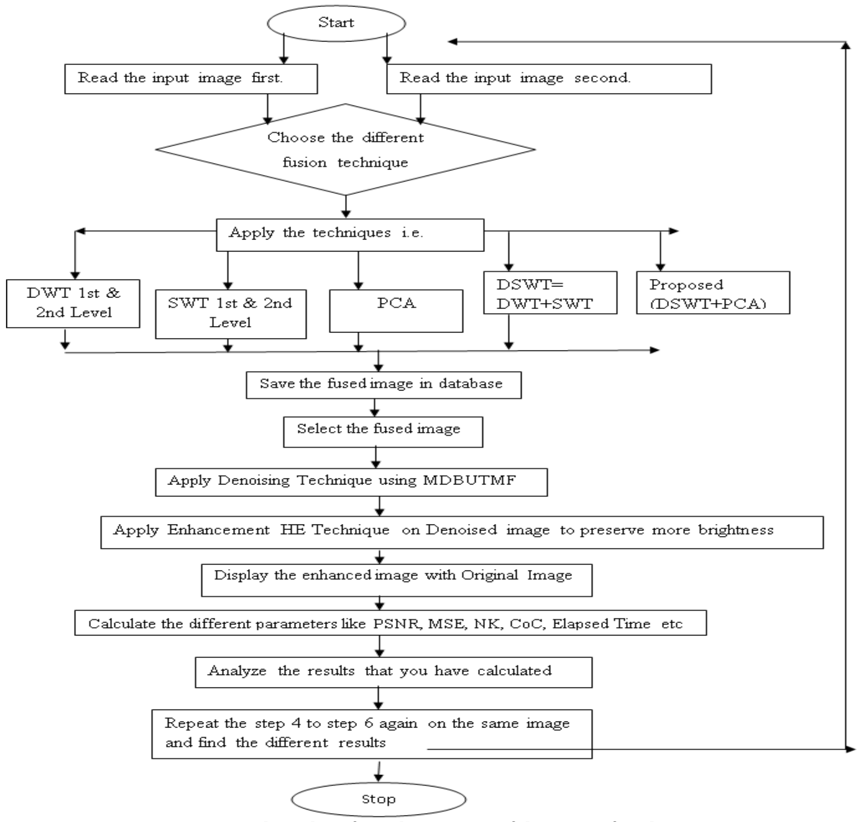

Figure 1.1: Flow chart for enhancement of denoising fused image

IV. RESULT SECTION

The GUI part is designed for Enhancement with denoised fused image working with various fusion techniques such as PCA, DWT-1st level, SWT-1st Level, DWT-2nd Level, SWT-2nd Level, DSWT-2nd Level and Proposed (2-DSWT + PCA) technique. We used to run the main program by clicking on the gui.m file in Matlab. As we have implemented our work in Matlab to enhance the fused denoised images.

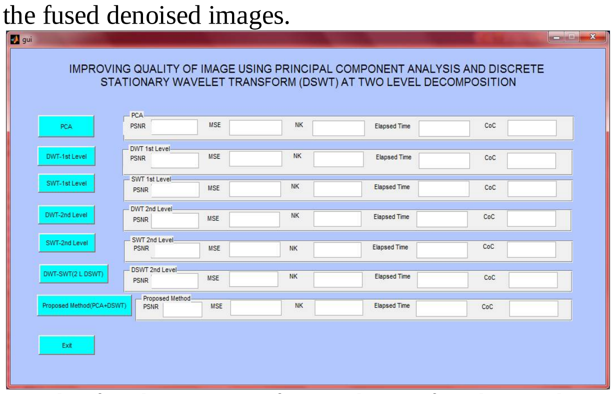

Figure 1.2: GUI Window for selecting various fusion techniques for enhancing denoised fused image.

Above figure state that we can select various fusion techniques such as PCA, DWT-1st level, SWT-1st Level, DWT-2nd Level, SWT-2nd Level, DSWT-2nd Level and Proposed (2-DSWT + PCA) technique on clicking button which you want to run and get result.

For below two browsing window figure 1.3 and 1.4 are common used for all fusion technique as above stated.

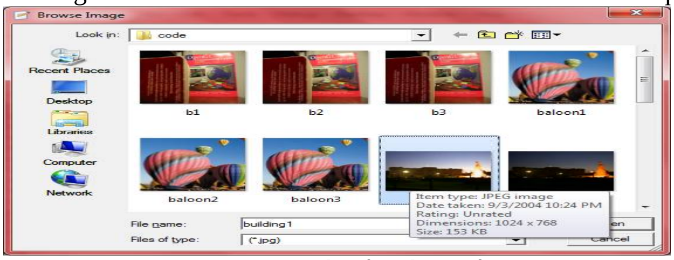

Figure 1.3: Browsing window for selecting first image.

Figure 1.3, above shows the browsing window for selecting the first image as for various fusion techniques. Any color image is selected. First and second image both which we are browsing should of same size and of same pixels for fusion.

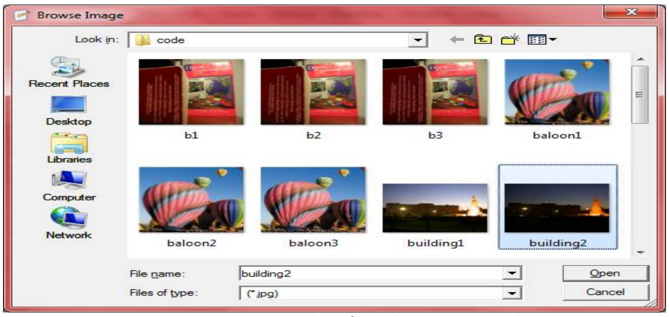

Figure 1.4: Browsing window for selecting Second image.

Figure 1.4, above shows the browsing window for selecting the Second image as for all fusion techniques. Second image which we are selecting should be of previous size and pixel image.

A. PCA TECHNIQUE RESULT

Below mentioned figure shows the result of PCA technique.

Figure 1.5: Window with fused image using PCA

Figure 1.5, shows the fused image which we have browsed in figure 1.3 and 1.4 as first and second image respectively. The fused image after using PCA fusion technique.

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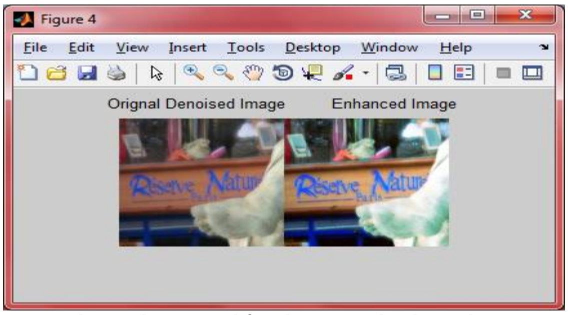

Figure 1.6: Window with Denoised fused image and Enhanced image using PCA

Figure 1.6, shows the denoised fused image and Enhanced image using PCA fusion technique. In this, PCA fused image is selected and MDBUTMF is used for denoising or removing the unwanted noise from this fused PCA image and results in Denoised Fused image. This Denoised image is selected on which Histogram Equalization technique for enhancing is applied getting better quality image.

B. DWT-1ST LEVEL TECHNIQUE RESULT

Below mentioned figure shows the result of DWT-1st Level technique.

Figure 1.7: Window with fused image using DWT-1st Level

Figure 1.7, shows the fused image which we have browsed in figure 1.3 and 1.4 as first and second image respectively. The fused image after using DWT-1st Level fusion technique.

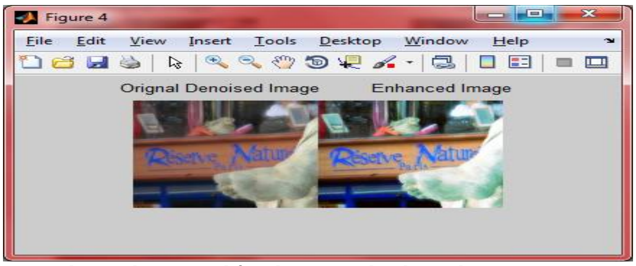

Figure 1.8: Window with Denoised fused image and Enhanced image using DWT-1st Level

Figure 1.8, shows the denoised fused image and Enhanced Image respectively using DWT-1st Level fusion technique. In this, DWT-1st Level fused image is selected and MDBUTMF is used for denoising or removing the unwanted noise from this fused DWT-1st Level image and results in Denoised Fused image. This Denoised image is selected on which Histogram Equalization technique for enhancing is applied getting better quality image.

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C. SWT-1ST LEVEL TECHNIQUE RESULT

Below mentioned figure shows the result of SWT-1st Level technique.

Figure 1.9: Window with fused image using SWT-1st Level

Figure 1.9, shows the fused image which we have browsed in figure 1.3 and 1.4 as first and second image respectively. The fused image after using SWT-1st Level fusion technique.

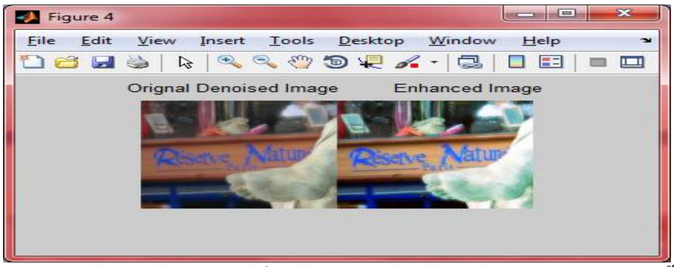

Figure 1.10: Window with Denoised fused image and Enhanced image using SWT-1st Level

Figure 1.10, shows the denoised fused image and Enhanced Image respectively using SWT-1st Level fusion technique. In this, SWT-1st Level fused image is selected and MDBUTMF is used for denoising or removing the unwanted noise from this fused SWT-1st Level image and results in Denoised Fused image. This Denoised image is selected on which Histogram Equalization technique for enhancing is applied getting better quality image.

D. DWT-2ND LEVEL TECHNIQUE RESULT

Below mentioned figure shows the result of DWT-2nd Level technique.

Figure 1.11: Window with fused image using DWT-2nd Level

Figure 1.11, shows the fused image which we have browsed in figure 1.3 and 1.4 as first and second image respectively. The fused image after using DWT-2nd Level fusion technique.

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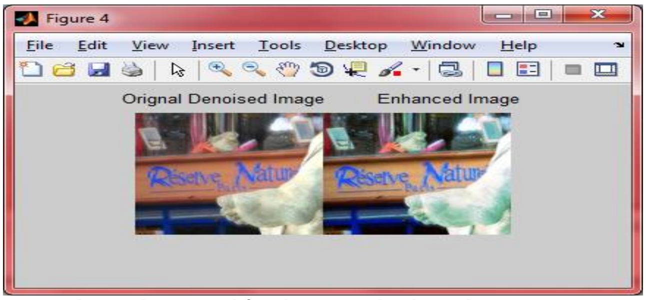

Figure 1.12: Window with Denoised fused image and Enhanced image using DWT-2nd Level

Figure 1.12, shows the denoised fused image and Enhanced Image respectively using DWT-2nd Level fusion technique. In this, DWT-2nd Level fused image is selected and MDBUTMF is used for denoising or removing the unwanted noise from this fused DWT-2nd Level image and results in Denoised Fused image. This Denoised image is selected on which Histogram Equalization technique for enhancing is applied getting better quality image.

E. SWT-2ND LEVEL TECHNIQUE RESULT

Below mentioned figure shows the result of SWT-2nd Level technique.

Figure 1.13: Window with fused image using SWT-2nd Level

Figure 1.13, shows the fused image which we have browsed in figure 1.3 and 1.4 as first and second image respectively. The fused image after using SWT-2nd Level fusion technique.

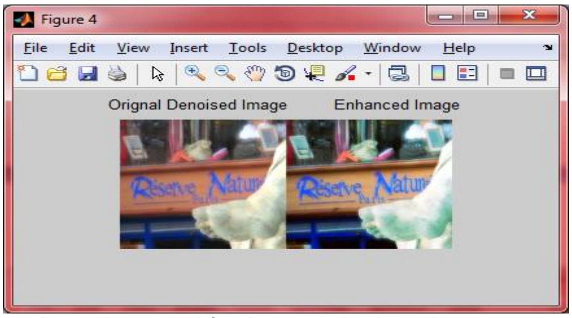

Figure 1.14: Window with Denoised fused image and Enhanced image using SWT-2nd Level

Figure 1.14, shows the denoised fused image and Enhanced Image respectively using SWT-2nd Level fusion technique. In this, SWT-2nd Level fused image is selected and MDBUTMF is used for denoising or removing the unwanted noise from this fused SWT-2nd Level image and results in Denoised Fused image. This Denoised image is selected on which Histogram Equalization technique for enhancing is applied getting better quality image.

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F. DSWT-2ND LEVEL TECHNIQUE RESULT

Below mentioned figure shows the result of DSWT-2nd Level technique.

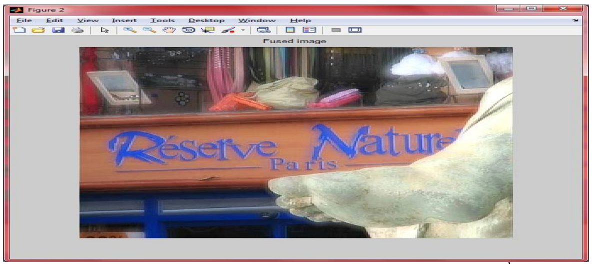

Figure 1.15: Window with fused image using DSWT-2nd Level

Figure 1.15, shows the fused image which we have browsed in figure 1.3 and 1.4 as first and second image respectively. The fused image after using DSWT-2nd Level fusion technique.

Figure 1.16: Window with Denoised fused image and Enhanced image using DSWT-2nd Level

Figure 1.16, shows the denoised fused image and Enhanced Image respectively using DSWT-2nd Level fusion technique. In this, DSWT-2nd Level fused image is selected and MDBUTMF is used for denoising or removing the unwanted noise from this fused DSWT-2nd Level image and results in Denoised Fused image. This Denoised image is selected on which Histogram Equalization technique for enhancing is applied getting better quality image.

G. PCA + DSWT-2ND LEVEL TECHNIQUE RESULT

Below mentioned figure shows the result of PCA+DSWT-2nd Level technique.

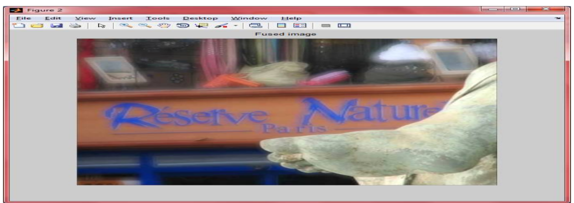

Figure 1.17: Window with fused image using PCA+DSWT-2nd Level

Figure 1.17, shows the fused image which we have browsed in figure 1.3 and 1.4 as first and second image respectively. The fused image after using PCA+DSWT-2nd Level fusion technique.

Figure 1.18: Window with Denoised fused image and Enhanced image using PCA+DSWT-2nd Level

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Figure 1.18, shows the denoised fused image and Enhanced Image respectively using PCA+DSWT-2nd Level fusion technique. In this, PCA+DSWT-2nd Level fused image is selected and MDBUTMF is used for denoising or removing the unwanted noise from this fused PCA+DSWT-2nd Level image and results in Denoised Fused image. This Denoised image is selected on which Histogram Equalization technique for enhancing is applied getting better quality image.

V. RESULTS AND DISCUSSION

Below figure 1.19 shows the images on which test is performed as input and output comes. Figure 1.19 shows the fused images with denoised and enhanced images with various working of fusion techniques and hybriding them.

Name of Fusion Techniques	**Fused Image**	**Denoised Image**	**Enhanced Image**	**Fused Image**	**Denoised Image**	**Enhanced Image**
PCA						
DWT-1st Level						
SWT-1st Level						
DWT-2nd Level						
SWT-2nd Level						
DSWT-2nd Level						
PCA + DSWT-2nd Level						

Figure 1.19: Fused image with denoised image and Enhanced Image

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Table 1.1: PSNR, MSE , NK, Elapsed Time and CoC as parameters for Fused and Denoised Enhanced image

Technique/Images Name	Temple					Buliding				
	PSNR	MSE	NK	CoC	Elapsed Time	PSNR	MSE	NK	CoC	Elapsed Time
PCA	60.9737	0.05218	1.48657	0.971	1.521	64.930	0.02137	0.85022	0.9932	1.431
DWT-1st Level	59.5946	0.07153	1.67935	0.965	2.582	63.584	0.02901	0.81950	0.9940	1.910
SWT-1st Level	59.5882	0.07168	1.68031	0.964	3.788	63.579	0.02906	0.81931	0.9938	2.412
DWT-2nd Level	61.4383	0.04693	1.418	0.969	2.587	59.950	0.06642	0.74186	0.9594	2.419
SWT-2nd Level	61.4354	0.04698	1.41869	0.969	4.994	59.882	0.06754	0.74669	0.9585	3.133
DSWT-2nd Level	61.4485	0.04681	1.41907	0.969	4.080	59.899	0.06726	0.74248	0.9593	3.076
PCA+DSWT-2nd Level	62.6796	0.03553	1.30635	0.974	4.525	65.115	0.02044	0.83764	0.9946	3.438

Above figures and table shows the result of enhanced denoised fused image using various fusion techniques and with new hybrid approach. İmages are tested on different parameters to get best results. PCA+ DSWT 2nd Level fusion technique which is proposed technique has been resulted best in quality among the parameters such as PSNR, MSE and Coc in some extended images. NK of the images is in range is maintained in our proposed techniques. Next to our proposed algorithm is DWT 2nd level or sometimes SWT at 2nd level. PSNR should be high in quality. MSE is difference in both image, so low should be there. NK stands for Normalized Correlation means Similarity of two images or signals should be maintained. Coc stands for Correlation of Coefficient means pixel quality of images are compared. Elapsed time is the total time taken by each technique to solve the problem.

VI. CONCLUSION AND FUTURE WORK

This work proposed an image resolution enhancement technique based on the interpolation of the high frequency subbands obtained by PCA + DSWT 2nd Level, correcting the high frequency subband estimation by using SWT high frequency subbands, and the input image firstly by DWT 2nd level after that PCA is applied on these images. The proposed technique uses SWT, DWT and PCA to decompose an image into different subbands, and then the high frequency subband images have been interpolated. The interpolated high frequency subband coefficients have been corrected by using the high frequency subbands achieved by SWT, DWT and PCA of the input image. Afterwards all these images have been combined using IDWT and Inverse of PCA to generate a super resolved imaged. An original fused image is denoising using MDBUTMF filter. Enhancement is done by Spatial filtering technique known as Histogram Equalization. Results can be measured by parameters such as PSNR, MSE, Normalized Correlation, CoC and Elapsed Time. We have not done any comparison but just hybrid the SWT, DWT and PCA 2nd Level fusion technique as to enhance the color images after denoising also as to preserve brightness more which results in better visualization.

Wavelet based features have appeared relatively recently. Further improvements in classification accuracy can be expected with more careful experimentation with the exact details of the parameters. We also plan to investigate the use of other wavelet families. Another interesting direction is combining features from different analysis techniques to improve classification accuracy with brightness. We can develop new techniques by hybrid, the different techniques of fusion as well denoising with enhancement techniques. DWT is combined with SWT as DSWT; PCA with DWT and SWT at 2-level, in future other fusion techniques can be combined to improve the enhancement. Also we can change the Enhancement technique from HE to other techniques.

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