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Image Fusion Analysis Using HPF, PCA, HIS, Wavelet, Wavelet + DCT and Contrast for MS/PAN and Multi-focus Images

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Abstract: ***Image fusion is the process of combining two or more source images to generate the new image having the combined information. This combination of the source images is generally performed to improve the information and the quality of images. The fused image obtained after the fusion of various images into the single image contains not only the common features but the complementary features of all the images. With the development of the technology multi sensor system are being used in various fields such as remote sensing, vision of the machine, medical imaging and military application. The proposed method has performed the fusion of multiple images get the fused image. Performance of the proposed system is compared with the other fusion techniques using the various set of the parameters.***

Keywords: ***fusion, wavelet, PCA, HPF***

INTRODUCTION

Image fusion is the important area of research in the image processing field. Image fusion deals with combining the relevant information of various set of images, to form a single image, the obtained single image is more informative as it is obtained from the combination of various images. The fused image obtained from the combination of various images is more complete than the original images. Images are integrated to generate the fused image without introducing the distortion into the images. As it is impossible to get the image of all objects being focused in image so to deal with such kind of problems image fusion is the best solution. By image fusion pictures of different focus are fused to generate the image that contains the extended depth of the field to improve the quality of the image. Quality and the application area of the images are being increased by the image fusion. Image registration is the important step that needs to be performed before starting the image fusion process.

Image registration deals with the defining the transformation of the coordinates of the images with reference to the other images. Usually the fusion algorithms are dependent on the input.

Various applications of the medical field, detection and recognition of objects, navigation area, security purpose, surveillance of military and civilians. Image fusion is widely used for various purposes navigation and surveillance. Since the image fusion improves the visual information about the images so the assessment of images is improved. Image assessment is improved by the use of various multiple sensors for improving the visual information of the system. Fusion algorithms for the image can be categorized into various levels such as low level, middle level, high level, feature level, decision level and the pixel level. Pixel level method of image fusion generally work under two domain spatial domain and the transform domain. Pixel level method usually works on the pixels of the image and the feature level method of fusion is based on the extracted features of the source or the input images. Image is divided into the contiguous regions and the fusion of these regions is performed on the bases of the properties under the feature level algorithms. Features may be calculated independently for the each image or they may be extracted simultaneously for all the processing images. Decision level fusion deals with using the output of classification and the detection of objects for providing this output as the input to the fusion algorithm to perform the integration of the data. Usually feature level and decision level algorithm for image fusion produces inaccurate and incomplete transfer of information

APPLICATIONS OF IMAGE FUSION

Object identification:

Features are enhanced by the image fusion techniques. Objects are easily identified from the fused image since the quality of the fused image is more than the original image. Maximum amount of information can be extracted from the satellite images to generate the decision regarding the information contained in the images. Objects are identified for various applications based on the object extraction.

Intelligent Robots:

Image fusion is widely used in the robotic environment to extract the information regarding the motion, recognition of various objects and exploring the environment of the area. Image fusion is widely used in the various applications such as computer vision, geospatial distribution of data system, human-robot interaction, planetary mapping and the function of the various robotic softwares.

Medical Image:

Medical field uses the image fusion for the various purposes, these deals with efficiently analyzing the

each part of medical image. Medical image are carefully analyzed to examine the problem faced by the patients and then prescribing them the right medicine. Various transforms have been used to deal with fusion of medical images are Intensity, hue saturation model and wavelet transform. Various examples of the medical imaging are MRI, Xray and the surgergy.

Manufacturing:

Image fusion is widely used for manufacturing field. It deals with the processing of the tools, machine and labor for generation of the various goods that are to be sent for the sale. Image fusion allows the proper view of the goods to take the decision regarding to them.

Remote Sensing:

Remote sensors deal with the collection of data on the basis of remote devices. Remote sensors collect the information reflected from the earth. Various features like radar or infrared photography are used to collect the data for remote sensing. Fusion techniques used for image fusion are based on the numerical and photographic methods of the image fusion.

LITERATURE SURVEY

Mohamed M, et al. [25] discussed in their work about the fusion of the multiple images to generate the new image which contains the more precise information than the original image. Various techniques for the fusion of images are pyramid transform, artificial neural network, discrete wavelet transform and discrete cosine transform. Various methods are analyzed for the fusion of the multiple images.

Haghighat, M et al.[22] discussed in their work about the image fusion technique that is used for combining the information of the multiple images so that useful information can be extracted out of them. Discrete cosine transform is efficiently used for the fusion of the multiple images into the single image. This transform is very suitable for the real time applications as it uses less time to perform the fusion of the images and results achieved by this technique are very productive.

Pei, Y et al. [28] discussed in their work about the use of the discrete wavelet transform for the fusion of the multiple images. Various principles of the discrete wavelet are studied to find its characteristics and principles for the fusion. Usually the high frequency region of the sub band is considered for the fusion of the images. The algorithm deals with the fusion of the multi sensor images by extracting the useful information from them. The algorithm can be used for many applications such as medical field and scientific field. Various quality assessment

metrics are applied on the algorithm to judge the performance of the system.

Li, H et al. [24] discussed in their work about the use of the wavelet transform for the fusion of the multiple images. The fused image is obtained by the taking the inverse of the wavelet transform by the wavelet coefficients. Various methods are used for the selection of the features on the basis of the area based maximum selection rule.

He D, et al. [23] discussed in their work about the image fusion techniques that are used to regroup the multiple images to generate the new image which contains the complementary information. Low resolution images are fused with the high resolution images to generate the fused image which contains the features of the both the images.

Shalima et al. [2] discussed in their work about the histogram equalization technique for the enhancement of the images in the image fusion Image fusion is widely used for the processing of the medical images and the radar signal processing. This technique suffers from the problem of the histogram equalization that deals with the flattening property of the algorithm for the fusion of the multiple images.

Ghimire Deepak et al. [21] discussed in their work about the image fusion techniques that are used to combining the multiple images into the single image. The relevant information about the features of the images is preserved after the fusion of the multiple images so it helps in the easy perception of the humans and the machine. Various fusion methods have been proposed for the fusion of the multiple images into the single image. The author have used the pixel based fusion technique for the fusion of the multiple images into the single image. Images are first registered for which the fusion is to be performed. Parameters may or may not be based on the reference to the original image or any standard images. The authors have analyzed the performance of their proposed algorithm with the early developed algorithms for the image fusion.

RESULTS

Image fusion deals with combining the relevant information of various set of images, to form a single image, the obtained single image is more informative as it is obtained from the combination of various images. The fused image obtained from the combination of various images is more complete than the original images. Figure1 shows the fused image. table shows the values of all the parameters analyzed.

Fig 1:Fused image using the PCA fusion technique

Fused images	Correlation between the original images	Mean values for the pixel changed Red, green and blue	Correlation between the fused image and original image
1	0.05	210.8404, 148.4179 and 121.0.675	0.94791
2	-0.157	203.7485, 126.5642 and 110.6282	0.96335
3	0.36	216.7608,173.3433 and 158.841	0.86599

Using wavelet transform

Wavelet transformation deals with decomposing the multi spectral image into the various resolution bands. For example wavelet transform is used to combine the multi spectral image and the pan chromatic image to generate the high resolution fused image. Figure 2 shows the fused image by the wavelet transform. Table shows the values of all the parameters analyzed.

Figure 2:fused image by the wavelet transform for the image fusion

Fused images	Correlation between the original images	Mean values for the pixel changed Red, green and blue	Correlation between the fused image and original image
1	0.017	217.9453, 189.6255 and 186.6415	0.72153
2	-0.157	207.2059,211.9797 and 208.9893	0.45709
3	0.36	233.6332,235.2853 and 220.4706	0.5614

Fusion by the HPF

High pass filtering techniques are used to obtain the multispectral images of the high resolution. High frequency information is from the panchromatic images having the high resolutions are added to the multispectral images having the low resolution. High pass filter is used to filter the panchromatic images having the high resolution. Figure 3: Shows the fusion by high pass filtering technique. Table shows the values of all the parameters analyzed

Figure 3: shows the fusion by the HPF technique

Fused images	Correlation between the original images	Mean values for the pixel changed Red, green and blue	Correlation between the fused image and original image
1	0.052	244.1153,234.3355 and 228.5897	0.52986
2	-0.157	224.4949,227.7821 and 226.4984	0.55164
3	0.365	244.8994,242.9737 and 239.3324	0.40354

Using DWT and DCT transform

Wavelet transformation deals with decomposing the multi spectral image into the various resolution bands. For example wavelet transform is used to combine the multi spectral image and the pan chromatic image to generate the high resolution fused image. Figure 3 shows the fused image by the wavelet transform. Table shows the values of all the parameters analyzed.

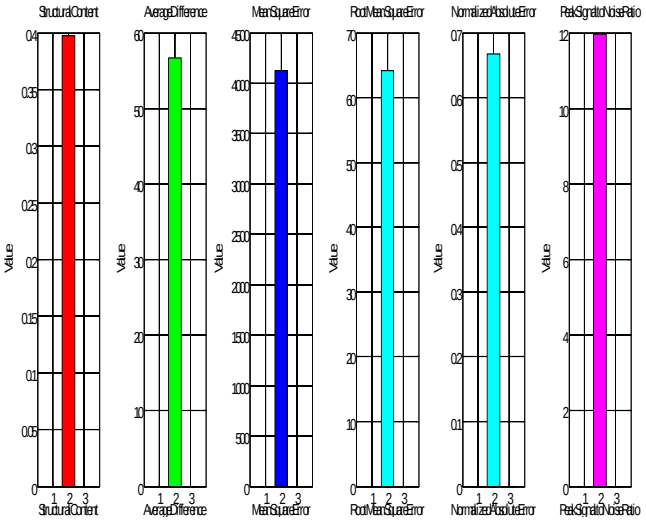

Figure 4: shows the fusion parameter graphical analysis under the DWT and DCT technique

Using DWT transform with DCT and Contrast

Wavelet transformation deals with decomposing the multi spectral image into the various resolution bands. For example wavelet transform is used to combine the multi spectral image and the pan chromatic image to generate the high resolution fused image. Figure 4 shows the fused image by the wavelet transform. Table shows the values of all the parameters analyzed.

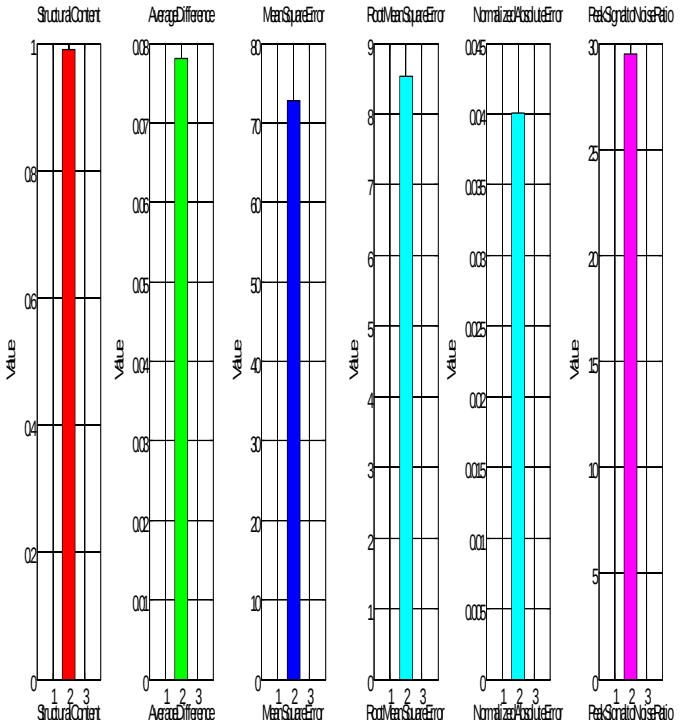

Figure 3: shows the fusion parameter graphical analysis under the DWT and DCT Contrast technique

Method	SC	AD	MSE	RMSE	NAE	PSNR	Mean x	Mean y	Mean z
I H S	0.396614	56.29922	4149.762	64.41865	0.662262	11.95057	199.4572	118.6568	105.4786
DWT DCT	0.397651	56.70328	4123.628	64.21548	0.667015	11.97801	201.0456	118.6536	104.7585
DWT DCT Contrast	0.990059	78.07922	728.2201	85.33581	0.040077	29.50818	128.1599	68.67723	55.29372

CONCLUSION

The research work deals with image processing of digital images in the domain of fusion based MS image enhancement, the methods of the past have given rise to combined level fusion systems involving multiple algorithm processing, and this also gave rise to the proposed system of wavelet up scaled filtering based fusion with Eigen covariance reference fusion estimation as proposed in an earlier system which combined with the DWT filtering, the new system outperforms the previous compared as it not only fuses the images for adapting high quality pixel values, but also reduces the noise from being reproduce due to nonlinear fusion of the image data. The DWT utilizes the high spectrum of values from its wide dimension filter bands and ensures frequency isolated fusion; this has been verified by various metrics of vision quality like PSNR, SD, MSE and Entropy indicating enhancement from all the viewpoints. In future the above research work can be further enhanced by hybridization of the DWT with DCT on the basis of singular valued decomposition for better structural preservation using the diagonal information matrix as reference to distortion reduction.

In conclusion, overall the proposed system performs best spectrally and the IHS performs best spatially. There is always a tradeoff in spectral and spatial quality, because of this the choice of method can depend on the how the fused image will be used. Also given the proposed metric results, it can be concluded that among the three different methods, the proposed method has shown overall improvisation to a noticeable degree. In conclusion, overall the proposed system performs best spectrally and the IHS performs best spatially. There is always a tradeoff in spectral and spatial quality, because of this the choice of method can depend on the how the fused image will be used. Also given the proposed metric results, it can be concluded that among the three different methods, the proposed method has shown overall improvisation to a noticeable degree.

In future the above research work can be further enhanced by hybridization of the RDWT with DCT

on the basis of singular valued decomposition for better structural preservation using the diagonal information matrix as reference to distortion reduction.

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