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Performance and Analysis of contourlet transform in satellite images using multispectral image fusion based on fuzzy logic

K.S.PRABHAKAR, Dr.M.ANTO BENNET

Lecturer, Department of Surveying Engineering JIGJIGA University, JIGJIGA, Ethiopia.
Professor, Department of Electronics and Communication Engineering, Vel tech, Chennai-600062

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ABSTRACT

The field of remote sensing is a continuously growing market with applications like vegetation mapping and observation of the environment. The increase in applications is due to the availability of high quality images for a reasonable price and improved computation power. However, as a result of the demand for higher classification accuracy and the need in enhanced positioning precision (e.g. for geoscience information systems) there is always a need to improve the spectral and spatial resolution of remotely sensed imagery. These requirements can be either fulfilled by building new satellites with a superior resolution power, or by the utilization of image processing techniques. The main advantage of the second alternative is the significantly lower expense. Remote sensing images are distinct in terms of imaging as the images are captured over a wide range of the electromagnetic spectrum such as the thermal infrared and the microwave spectrum. Also, interpreting the satellite images requires a previous experience and understanding of the nature of the Earth's surface and the target areas. Moreover, analysis of remote sensing images aims to extract the information about the land cover and sometimes present it as a graphic format (such as maps).The sensors launched on the satellites provide a variety of images with different specifications. Therefore, it is required to introduce an efficient technique that integrates the output of two or more sensors and produces more accurate images to meet the requirements of remote sensing applications including: environmental change detection agricultural monitoring and urban planning. Therefore, image fusion is a promising research area in the image-based application fields.

Keywords: quality metrics, edge detection algorithm, contourlet transform.

I. INTRODUCTION

Image fusion is a technique that integrates complementary information from multiple image sensor data such that the new images are more suitable for processing tasks. An image pyramid can be described as collection of low-or-band pass copies of an original image in which both the band limit and sample density are reduced in regular steps. The basic strategy of image fusion based on pyramids is to use a feature selection rule to construct a fused pyramid representation from the pyramid representations of the original data. The composite image is obtained by taking an inverse pyramid transform.In remote sensing applications, the increasing availability of space borne sensors gives a motivation for different image fusion algorithms.

Several situations in image processing require high spatial and high spectral resolution in a single image. Most of the available equipment is not capable of providing such data convincingly. The image fusion techniques allow the integration of different information sources. The fused image can have complementary spatial and spectral resolution characteristics. However, the standard image fusion techniques can distort the spectral information of the multi spectral data while merging.

PANCHROMATIC IMAGES

A panchromatic image consists of only one band. It is usually displayed as a grey scale image, i.e. the displayed brightness of a particular pixel is proportional to the pixel digital number which is related to the intensity of solar radiation reflected by the targets in the pixel and detected by the detector. Thus, a panchromatic image may be similarly interpreted as a black- and-white aerial photograph of the area. The Radiometric Information is the main information type utilized in the interpretation.

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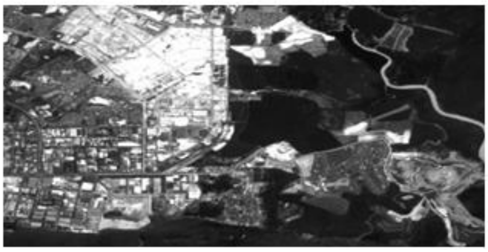
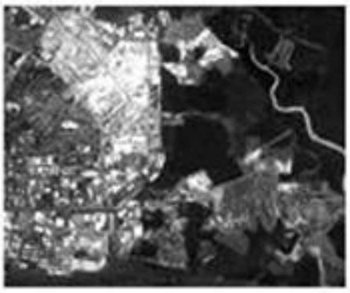


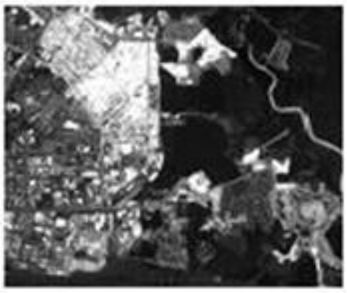
Figure 1 Panchromatic Image

Figure 1 shows a panchromatic image extracted from a **SPOT** panchromatic scene at a ground resolution of 10 m. The ground coverage is about 6.5 km (width) by 5.5 km (height). The urban area at the bottom left and a clearing near the top of the image have high reflected intensity, while the vegetated areas on the right part of the image are generally dark. Roads and blocks of buildings in the urban area are visible. A river flowing through the vegetated area, cutting across the top right corner of the image can be seen. The river appears bright due to sediments while the sea at the bottom edge of the image appears dark.

II. MULTISPECTRAL IMAGES

A Multispectral image consists of several bands of data. For visual display, each band of the image may be displayed one band at a time as a grey scale image, or in combination of three bands at a time as a colour composite image. Interpretation of a multispectral colour composite image will require the knowledge of the spectral reflectance signature of the targets in the scene. In this case, the spectral information content of the image is utilized in the interpretation. The following three images show the three bands of a multispectral image extracted from a SPOT multispectral scene at a ground resolution of 20 m. The area covered is the same as that shown in the above panchromatic image. Note that both the XS1 (green band) XS2 (red band) bands look almost identical to the panchromatic image shown above. In contrast, the vegetated areas now appear bright in the XS3 (near infra-red) band due to high reflectance of leaves in the near infrared wavelength region. Several shades of grey can be identified for the vegetated areas, corresponding to different types of vegetation. Water mass (both the river and the sea) appear dark in the XS3 (near IR) band shown in fig 2-4.





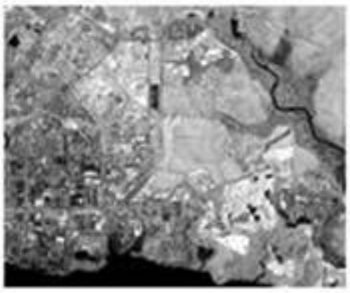


Fig 2 SPOT XES1 (green band) Fig 3 SPOT XS2 (red band) Fig 4 SPOT XS3 (Near IR band)

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PANSHARPENING

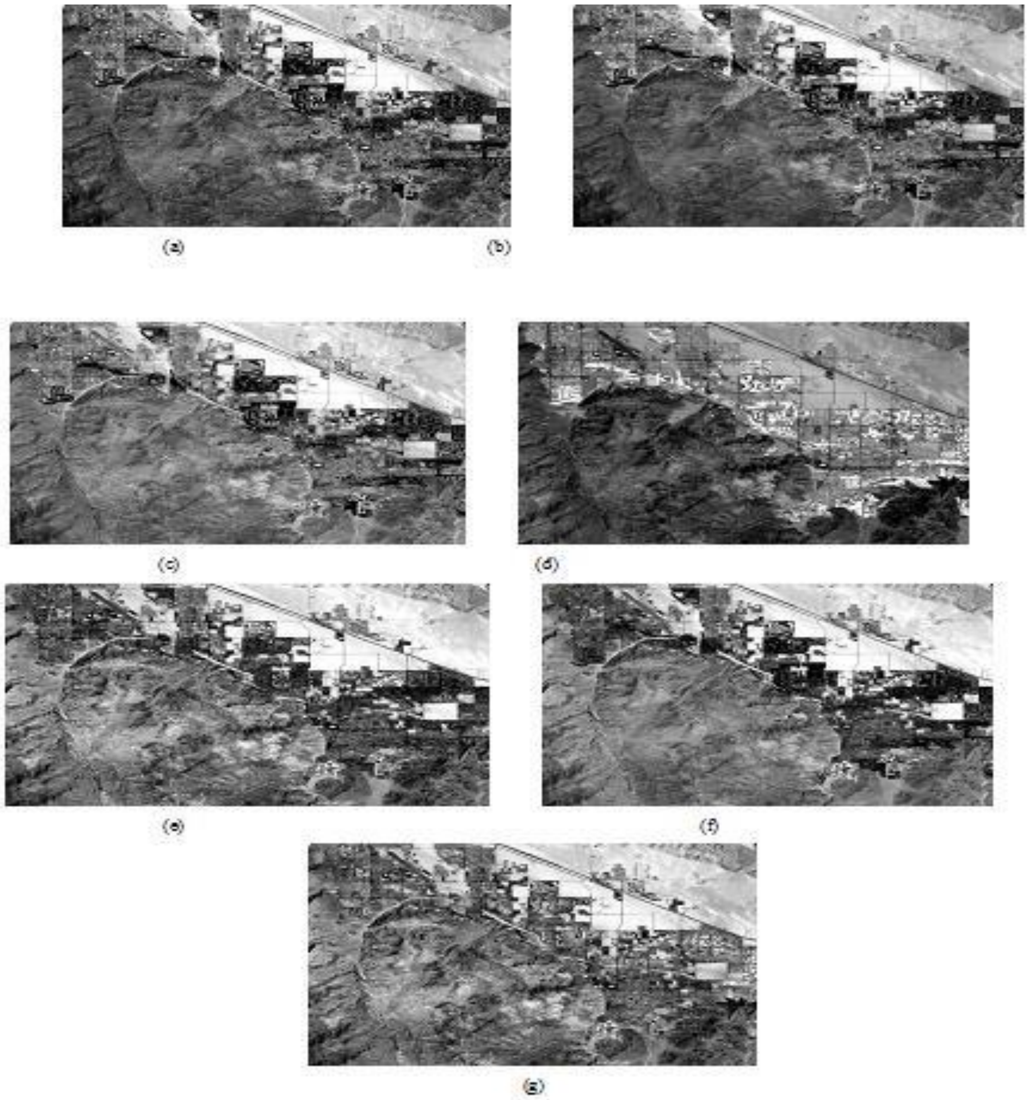

Figure 5 (a)-(f) Bands 1, 2, 3, 4, 5, and 7 of a Landsat TM image.

Figure 5 images are courtesy of NASA. Details in all images are fused into one image as shown in Figure The given images are already registered in image fusion technique. Pan sharpening is a process of merging high-resolution panchromatic and lower resolution multispectral imagery to create a single high-resolution color image. Google-maps and nearly every map creating company use this technique to increase image quality. Pan sharpening produces a high-resolution color image from three, four or more low-resolution multispectral satellite bands plus corresponding high-resolution panchromatic bands:Feature detection/extraction was done with a variety of methods, such as Laplacian operators, gradient operators, the Laplacian of Gaussians, difference of Gaussians, Canny detectors or anisotropic diffusion. However, wavelet transforms have come into light as a means of feature detection.

PROPOSED SYSTEM

The purpose of this work is to present a novel image fusion technique which could be applied to various domains, but focuses on the fusion of remote sensing images. The goal of this technique is to fuse the PAN image and MS image with RGB band separation. The second objective is to perform HIS transformation of MS image and fused with the PAN image to obtain high resolution image. The third objective is to calculate the entropy for both MS image and fused image and to obtain the standard deviation for both MS image and fused image. Finally, comparing all the

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parameters and to improve the remote sensing image resolution. First goal is to perform RGB transformation for the given MS image and applying it to Contourlet transform. Histogram matching is performed for the PAN image in order to obtain stretched PAN image. Fusing both the stretched PAN and MS image and applying inverse Contourlet transform to obtain high resolution fused image. Corresponding Entropy value for MS image and fused image is obtained for performance measure. In similar way the standard deviation for both the MS image and fused image is calculated by calling the corresponding function in MATLAB to perform the manipulation. Second objective is to perform RGB to HIS transformation and fusing the stretched PAN image with the HIS transformed image applying through the Contourlet transform, Contourlet decomposition and taking inverse Contourlet transform to obtain the fused high resolution image. Entropy value for MS image and fused image is obtained for performance measure. In similar way the standard deviation for both the MS image and fused image is calculated by calling corresponding function in MATLAB to perform the manipulation. Finally comparing the image obtained from the two algorithms is compared to evaluate the resolution of the given image and the corresponding entropy and standard deviation values should compare.

IMAGE FUSION ALGORITHMS

Step1: Stretched PAN Image with BAND Image

- Register the MS image to the same size as the PAN image.
- Use Image resizing using Interpolation Techniques
- For Image Interpolation bilinear Interpolation is used and it Surveys the 4 closest pixels, creates a weighted average based on the nearness and brightness of the surveyed pixels and assigns that value to the pixel in the output image.

Step2: Perform the nonsubsampled Contourlet decomposition of the MS and PAN images. Step3: Replacing All the Details

- The low frequency coefficients of the fused high resolution multispectral (HRMS) image are obtained as $HRMS_{Bk1} = \alpha MS_{Bk1} + (1 - \alpha).PAN_1$. Where α is the scaling parameter and $½ \leq \alpha \leq 1$. B_k denotes the k^{th} spectral bands of the MS image.
- The high frequency coefficients of the fused image are substituted from the corresponding coefficients from the PAN image. $HRMS_{Bki} = PAN_{i,}$ Where i denote the high frequency coefficients and max (i) = $n_{levels} + 1$.

Step4: Take the inverse transform to obtain the fused high resolution multispectral image shown in fig 6.

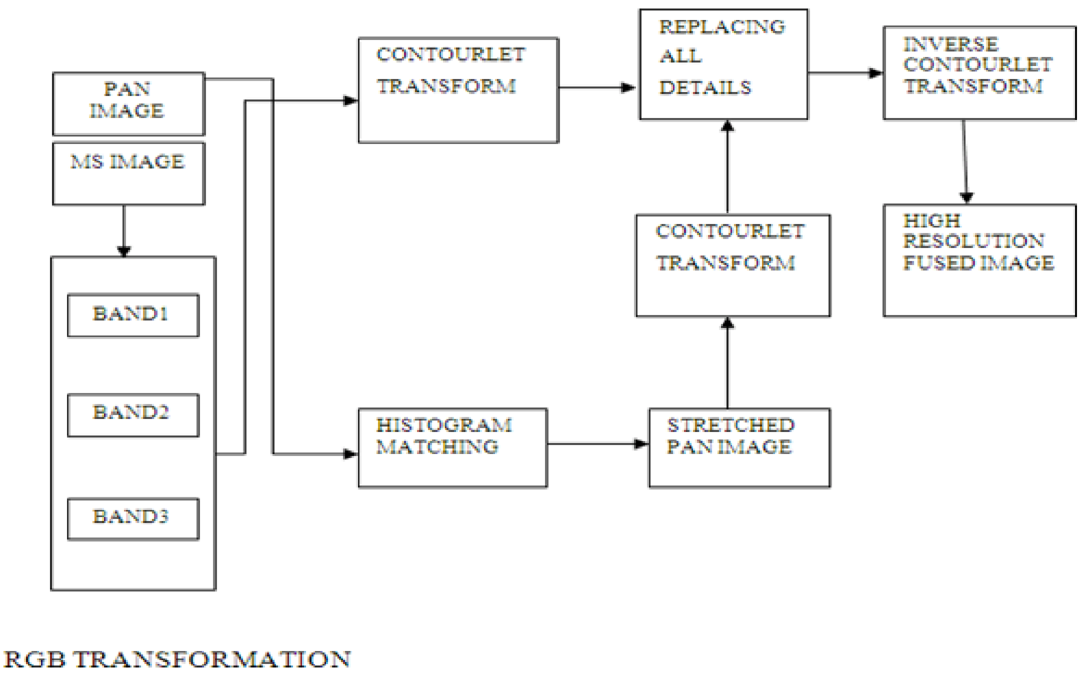

Figure 6 Block diagram for Fusion algorithm I

FUSION ALGORITHM II (HIS TRANSFORMATION)

Step1: Stretched PAN Image with MS (Multispectral) Image

Step2: Perform HIS on the Multispectral image and get saturation, hue and intensity components (Forward HIS Transform)

Step 3: Apply histogram matching between the original panchromatic image and Intensity Component to get a histogram-matched panchromatic image.

Step 4: Employ Contour on intensity and the histogram-matched panchromatic image, and get low frequent subband and high frequent subbands.

Step 5: Fuse the intensity and the histogram-matched panchromatic image. The fused low frequent data employ the low frequent coefficient of intensity. The fused high frequent coefficients adopt Maximum the region-energy for every coefficient of each subband of panchromatic image and intensity get by step 4.

Step 6: Apply Contourlet Reconstruction with new coefficient to obtain the new intensity.

Step 7: Perform the inverse HIS transform with new intensity to obtain the fused image shown in fig 7.

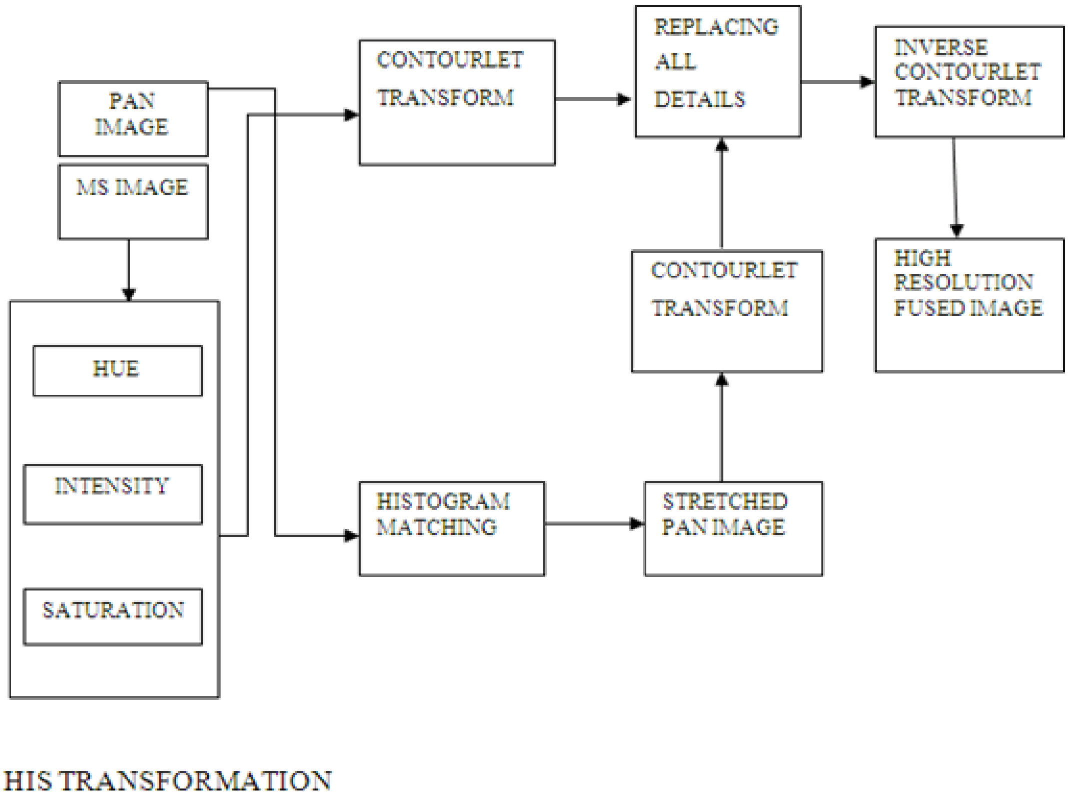

Figure 7 Block diagram for Fusion algorithm II

FUSION ALGORITHM III (HIS TRANSFORMATION FOR SUBBANDS)

Step1: Stretched PAN Image with MS (Multispectral) Image

Step 2: Perform IHS on the Multispectral image and get saturation, hue and intensity components (Forward IHS Transform)

Step 3: Apply histogram matching between the original panchromatic image and Intensity Component to get a histogram-matched panchromatic image.

Step 4: Employ Contour on intensity and the histogram-matched panchromatic image, and get low frequent subband and high frequent subbands.

Step 5: Fuse the intensity and the histogram-matched panchromatic image. The Contourlet coefficients of the fused image are constructed by averaging out the coefficient that result from the Contourlet transform of both the PAN and MS image.

Step 6: Apply Contourlet Reconstruction with new coefficient to obtain the new intensity.

Step 7: Perform the inverse HIS transform with new intensity to obtain the fused image shown in fig 8.

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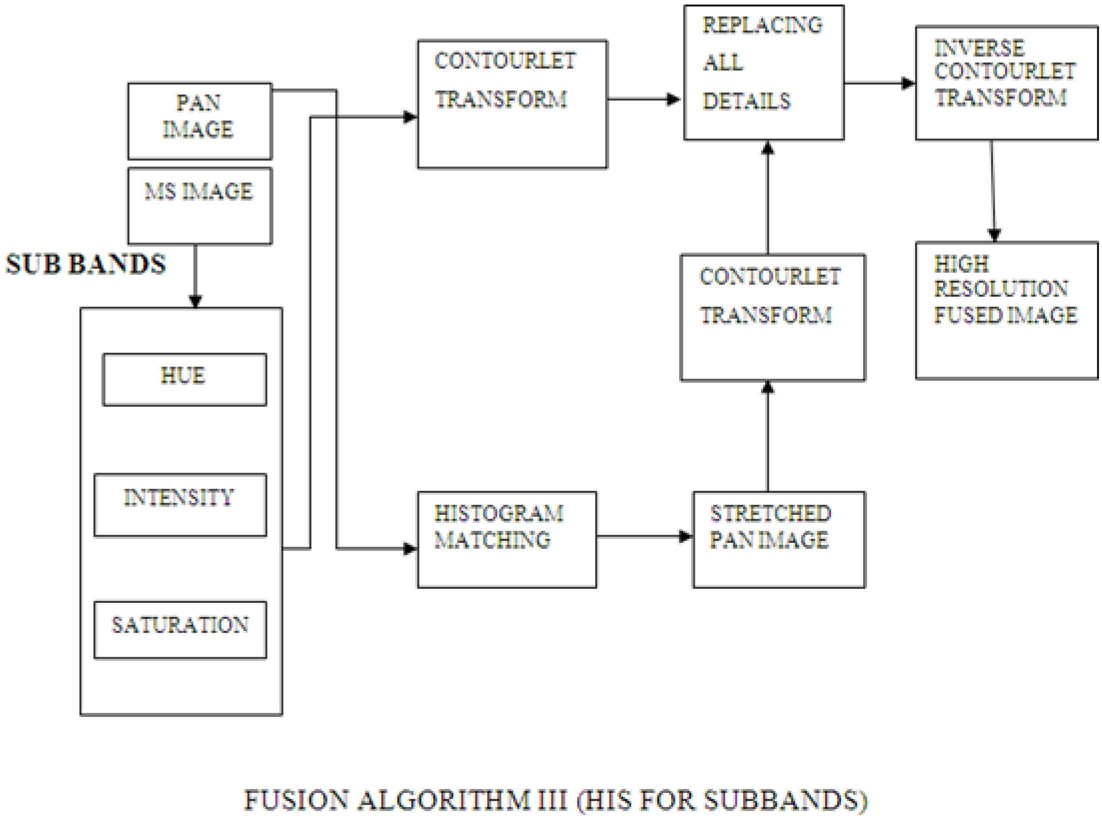

Figure 8 Block diagram for Fusion algorithm III

COMPARISON OF IMAGE QUALITY METRICES

Method	No of Bands	Correlation	Correlation between		Standard deviation		Entropy		Entropy Division Factor
			MS and Fused Images	PAN and Fused Images	MS Image	Fused Image	MS Image	Fused Image	
RGB	3		0.8193	0.9292	9.8928	10.7567	0.9014	7.5165	6.6151
HIS	3	0.9285	0.9285	0.8122	10.1065	11.0359	7.5833	7.6194	0.0361
HIS Sub Bands	3	0.9250	0.9185	0.9981	10.1065	9.0118	7.5833	7.4591	-0.1242

Table 1 Simulation Results for Input1

Method	No of Bands	Correlation	Correlation between		Standard Deviation		Entropy		Entropy Division Factor
			MS and Fused Images	PAN and Fused Images	MS Image	Fused Image	MS Image	Fused Image	
RGB	3		0.8138	0.3611	11.5301	12.7841	11.3557	12.7841	6.0731
HIS	3	0.9621	0.8543	-0.1017	7.969	9.7149	6.8827	6.4925	-0.3902
HIS Sub Bands	3	0.4274	0.6591	0.9439	7.969	3.5553	6.8827	5.6906	-1.1921

Table 2 Simulation Results for Input2

Method	No of Bands	Correlation	Correlation between		Standard Deviation		Entropy		Entropy Division Factor
			MS and Fused Images	PAN and Fused Images	MS Image	Fused Image	MS Image	Fused Image	
RGB	3		0.8838	0.9679	11.3557	12.2723	0.9986	6.8612	6.8109
HIS	3	0.9092	0.9581	0.8741	11.0314	11.952	7.7649	7.7818	0.0169
HIS Sub Bands	3	0.9576	0.95	0.9757	11.0314	9.8131	7.7649	7.6187	-0.1463

Table 3 Simulation Results for Input3

III. CONCLUSION

The main objective of this work was to present a reliable and robust image fusion algorithm that deal with the limitations of traditional image fusion methods. The presented region based fusion technique combined the information presented in the input images and provided more accurate images about the target areas. It also fused the fine lines and details presented in the high resolution panchromatic image with the color information presented in the low resolution colored image. A combination of the contourlet transform and RGB color system was used to build the presented region-based fusion technique. This combination facilitated capturing fine details and lines due to the high directionality of the contourlet transform. Moreover, this approach preserves the chromaticity information of the input images. The contourlet transform was used to ensure that the directional information is captured efficiently, which is a big advantage when fusing remote sensing images that contain fine roads and contours. The presented contourlet-based fusion technique confirms the advantage of the presented fusion approach over the conventional methods such as PCA, IHS, and Wavelet techniques. Thus the RGB transformation was performed using algorithm1 and corresponding outputs were compared with the other two fusion algorithms i.e HIS transformation and HIS transformation for subbands

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REFERENCES

[1]. C. Pohl and J. L. van Genderen, "Multisensor image fusion in remote sensing: concepts, methods and applications," International Journal of Remote Sensing, vol. 19, no. 5, pp. 823–854.

[2]. H. Kwon, Z. D. . Sandor, and N. M. . Nasrabadi, "Adaptive multisensor target detection using feature-based fusion," Optical Engineering, vol. 41, pp. 69–80, 01-2002.

[3]. Y. Shi, H. Ji, and X. Gao, "A radar target multi-feature fusion classifier based on rough neural network," Second International Symposium on Neural Networks Advances in Neural Networks, vol. 3497, pp. 375–380, 2005.

[4]. B. Kayani, A. Mirza, A. Bangash, and H. Iftikhar, "Pixel & feature level multiresolution image fusion based on fuzzy logic," Innovations and Advanced Techniques in Computer and Information Sciences and Engineering, pp. 129–132, 2007.

[5]. M. Mansoorizadeh and N. M. Charkari, "Hybrid feature and decision level fusion of face and speech information for bimodal emotion recognition," 2009 14th International CSI Computer Conference, CSICC 2009, pp. 652–657, 2009.

[6]. Dr. AntoBennet, M, Sankar Babu G, Natarajan S, "Reverse Room Techniques for Irreversible Data Hiding ", Journal of Chemical and Pharmaceutical Sciences 08(03): 469-475, September 2015.

[7]. Dr. AntoBennet, M , Sankaranarayanan S, Sankar Babu G, " Performance & Analysis of Effective Iris Recognition System Using Independent Component Analysis ", Journal of Chemical and Pharmaceutical Sciences 08(03): 571-576, August 2015.

[8]. Dr. AntoBennet, M, Suresh R, Mohamed Sulaiman S, "Performance &analysis of automated removal of head movement artifacts in EEG using brain computer interface", Journal of Chemical and Pharmaceutical Research 07(08): 291-299, August 2015.

[9]. Dr. AntoBennet, M "A Novel Effective Refined Histogram For Supervised Texure Classification", International Journal of Computer & Modern Technology , Issue 01 ,Volume02 ,pp 67-73, June 2015.

[10]. Dr. AntoBennet, M, Srinath R,Raisha Banu A,"Development of Deblocking Architectures for block artifact reduction in videos", International Journal of Applied Engineering Research, Volume 10, Number 09 (2015) pp. 6985-6991, April 2015.

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