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Fuzzy Type Image Fusion Using SPIHT Image Compression Technique

Shyam Sundar, Mahendra Kumar, Gaurav Sharma
M.Tech Scholar with the Department of Electronics & Communication Engineering, Mewar University Chittorgarh, India
Faculty with Department of Electronics & Communication Engineering, University College of Engineering, RTU, Kota, India.
HOD with the Department of Electronics & Communication Engineering Mewar University Chittorgarh, India

Abstract
This paper presents a fuzzy type image fusion technique using Set Partitioning in Hierarchical Trees (SPIHT). It is concluded that fusion with higher single levels provides better fusion quality. This technique can be used for fusion of fuzzy images as well as multi model image fusion. The proposed algorithm is very simple, easy to implement and could be used for real time applications. This is paper also provided comparatively studied between proposed and previous existing technique and validation of the proposed algorithm as Peak Signal to Noise Ratio (PSNR), Root Mean Square Error (RMSE).
Index Terms- Fuzzy type image, Set Partitioning in Hierarchical Trees (SPIHT), PSNR, RMSE.

I. INTRODUCTION

OFF late, multi sensor data fusion is found to play a vital role in defence as well as in civilian applications because diversity of sensors available and these working in different spectral bands. Image fusion, where multiple registered images are combined together to increase the information content, is a promising research area. Numerous image fusion algorithms such as multi-resolution [1, 2], multi scale [3] and statistical signal processing [4,5,6] based techniques are presented and evaluated.

The developments in the field of sensing technologies multi-sensor systems have become a reality in a various fields such as remote sensing, medical imaging, machine vision and the military applications for which they were developed.

The result of the use of these techniques is a increase of the amount of data available. Image fusion provides an effective way of reducing the increasing volume of information while at the same time extracting all the useful information from the source images.

Multi-sensor data often presents complementary information, so image fusion provides an effective method to enable comparison and analysis of data. The aim of image fusion, apart from reducing the amount of data, is to create new images that are more suitable for the purposes of human/machine perception, and for further image- processing tasks such as segmentation, object detection or target recognition in applications such as remote sensing and medical imaging. For example, visible-band and infrared images may be fused to aid pilots landing aircraft in poor visibility [3, 5,7].

Finally, the performance of the image fusion scheme is evaluated as tradeoffs between true image and fused image. In previous techniques when apply fuzzy type images, the performance criterion is poor, so this paper proposed a novel Set Partitioning in Hierarchical Trees image compression techniques which provide fused image with better quality. The remainder of the paper is organized as follows: In Section II, discussed Proposed Set Partitioning in Hierarchical Trees image compression techniques. Different Fusion Performance evaluation criterion presented in section III. Results and comparatively study of techniques is described in section IV and conclusions are presented in Sections V.

II. Proposed Set Partitioning in Hierarchical Trees (SPIHT) image compression technique

SPIHT is computationally very fast and among the best image compression algorithms known today. According to statistic analysis of the output binary stream of SPIHT encoding, propose a simple and effective method combined with Huffman encode for further compression. In this paper the results from the SPHIT algorithm are compared with the existing methods for compression like discrete cosine transform (DCT) and discrete wavelet transform (DWT).

The set partitioning in hierarchical tree algorithm is proposed [11] and utilized for lossless image compression nowadays. One of the most powerful wavelet based image compression techniques is

SPIHT. The main advantages of SPIHT method are it can provide Good Image quality with high PSNR and low RMSE. First, the image is decomposed into four sub-bands. The decomposition process is repeated until reach the final scale. Each decomposition consists of one low-frequency sub-band with three high-frequency sub-bands. The extension and efficient implementation of EZW-[Embedded Zero Wavelet] algorithm [12, 13] is SPIHT algorithm. it is represented by the equation as follows

$$S_n(x) = \begin{cases} 1, \max_{(i,j)\in x}\{|\ L_{i,j}\ |\} >= 2^n \\ 0 \qquad \qquad \textit{othrewise} \end{cases}$$

Where $S_n(x)$,is the importance of set of coordinate x.

$L_{i,j}$ is the coefficient value at each coordinate(i,j).

LL1	**HL1**	
LH1	**HH1**	**HL**
LH		**HH**

Fig.1: 2 level Discrete Wavelet Transform

The complete SPIHT algorithm does compression in three steps such as sorting, refinement and quantization. The SPIHT algorithm encodes the image data using three lists such as LIP, LIS and LSP. LIP contains the individual coefficients having the magnitudes smaller than the threshold values. LIS contains the overall wavelet coefficients defined in tree structure having magnitudes smaller than the threshold values. LSP is the set of pixels having magnitude greater than the threshold value of the important pixels.

SPIHT is computationally very fast and among the best image compression algorithms known today. The statistical analysis of the output binary stream of encoding, propose a simple and effective method combined with Huffman encode for further compression transform as a branch of mathematics developed rapidly, which has a good localization property in the time domain and frequency domain, can analyse the details of any scale and frequency. so, it superior to Fourier and DCT. It has been widely applied and developed in image processing and compression.

III. PROPOSED IMAGE FUSION SYSTEM

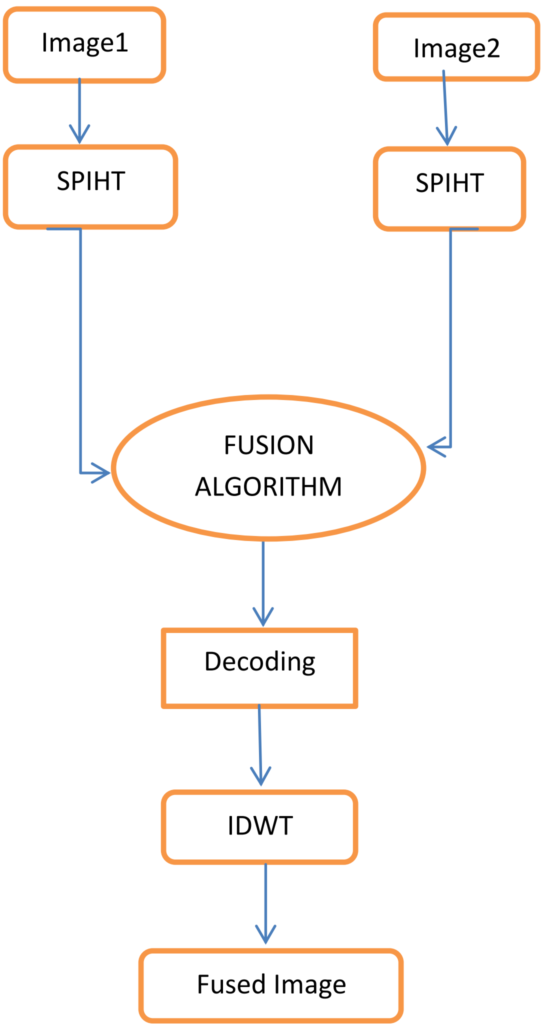

Fig.2: Proposed Image Fusion System

Consider image 1 as fuzzy type image 1 and image 2 as fuzzy type image 2 and image compression and feature extracted by SPIHT technique and apply Image fusion algorithm as averaging method for fused image and compare actual/true image with fused image and calculate PSNR and RMSE to check effectiveness of proposed system.

Pseudo code:

```
Im1=DWT (image1)
En1=encoding (Im1)
De1=decoding (En1)
Im1'=IDWT (De1)
Id1=Im1-Im1'
Im2=DWT (image2)
En2=encoding (Im2)
De2=decoding (En2)
Im2'=IDWT (De2)
Id2=Im2-Im2'
Id=abs(Id1)-(Idf)>=0;
```

Imf=Idf+Imf
Idfm=decoding(Imf)
Imf=IDWT (Idfm)
This pseudo code shows the implementation Process.

IV. FUSION PERFORMANCE EVALUATION

The performance of image fusion algorithms can be evaluated when the reference image is available using the following metrics [3, 5, 8, 9]:

Root Mean Square Error:

It is computed as the root mean square error (RMSE) of the corresponding pixels in the reference image I_r and the fused image I_f. It will be nearly zero when the reference and fused images are alike and it will increase when the dissimilarity increases.

$$RMSE = \sqrt{\frac{1}{MN}\sum_{x=1}^{M}\sum_{y=1}^{N}\left(I_r(x,y) - I_f(x,y)\right)^2}$$

Peak Signal to Noise Ratio:
This value will be high when the fused and reference images are alike and higher value implies better fusion.

$$PSNR = 20\log_{10}\left(\frac{L^2}{\frac{1}{MN}\sum_{x=1}^{M}\sum_{y=1}^{N}\left(I_r(x,y) - I_f(x,y)\right)^2}\right)$$

where, L in the number of gray levels in the image.

V. RESULTS AND COMPARATIVELY STUDY

Fig 3: Reference fuzzy type Image

Fig 4: Fuzzy type Image 1

Fig 5: Fuzzy type Image 2

Reference Fuzzy type image mahi.jpg of size 420x342 is shown in Fig-3. The two images to be fused are generated from the Fuzzy type truth image using fuzzy type as shown in Fig-4&5. The fused image is almost similar to reference image and the error image is almost zero. It shows that the fused image contains all information coming from the complementary source images [10].

The fusion quality evaluation metrics are shown in Table-1. The metrics showed in table with bold font are better among others. Fusion with 3 level pyramid or above are giving almost similar performance.

Table 1 Proposed Hybrid Technique

	Pyramid levels				
	Techniques	1	3	5	7
RMSE	DCTPT	10.0311	**9.3924**	9.4921	12.7680
	FFTPT	7.9812	**7.8937**	7.9885	8.0075
	SPIHT	**6.4560**			
PSNR	DCTPT	38.1513	**38.4370**	38.3912	37.1036
	FFTPT	39.1441	**39.1920**	39.1402	39.1298
	SPIHT	**40.0651**			

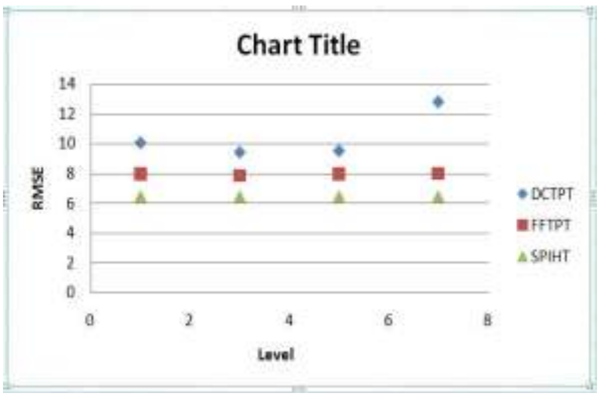

Fig 6: Comparatively study for RMSE between DCT based Pyramid Transform and Proposed Method

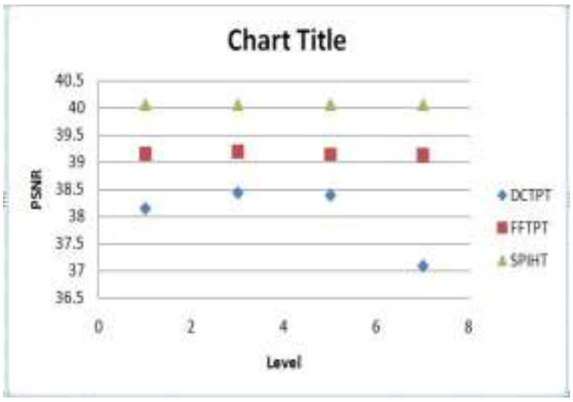

Fig 7: Comparatively study for PSNR between DCT based Pyramid Transform and Proposed Method

VI. CONCLUSION

A novel image fusion technique using SPIHT based has been presented and its performance evaluated. It is concluded that fusion with three level provides better fusion quality. This technique can be used for fusion of fuzzy type images as well as multi model image fusion. The proposed algorithm is very simple, easy to implement and could be used for real time applications. This paper is also provided comparatively studied between proposed and DCT based Pyramid transform technique and validation of the proposed algorithm as Peak Signal to Noise Ratio (PSNR) and Root Mean Square Error (RMSE) in table 1 and plots also.

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