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Research Paper

A PROPOSED APPROACH FOR IMAGE FUSION

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ABSTRACT

Ubiquitous nature of image fusion and ever expending usage of image fusion techniques becomes a potential source of crowd wisdom extraction especially in terms of analysis therefore image fusion is a significant task of current research purview. Major challenge in this area is to tame the images in terms of noise, relevance, fusion, an enhancement. This works is an effort to see the effect of image fusion for the fortification of classification especially in terms of fusion enhancement. The proposed method of image fusion relies on DWT, DCT and PCA and to check its significance. We proposed an image fusion scheme to find the impact of proposed methodology and to check the significance too. Experiments were carried out to observe the effect of proposed method on image fusion which clearly indicates the improvements in various metrics for evaluation.

KEYWORD: Image, Fusion, DCT, PCA, Sensors, DWT.

1. INTRODUCTION

Image fusion is a process to merge relevant information from two or more images into a single image. The resultant image will contain all the vital information as compare to input images. The new image will extract all the information from source images. Image fusion is a useful procedure for merging the single sensor and multi-sensor images to enhance the information. The objective of image fusion is to merge information from multiple images in order to produce an image that conveys only the useful information Image fusion can process the images obtained from different sensors by a specific algorithm so that the resultant image is more reliable, clear, and understandable. The discrete cosine transformation (DCT) based method of image fusion is more appropriate and time-saving in real-time systems. An efficient approach for fusion of multi-focus images is based on variance calculated in DCT domain. In all sensor networks, every sensor can obtain, generate and transfer data. Visual Sensor Networks (VSN) refers to a system with a large number of cameras that are used to geographically expand the resources and monitoring of numerous points. In VSN, sensors are cameras which can record either video sequence or images. Therefore, the processing of output information is related to image processing.

1.2 levels of image fusion:

Image fusion techniques combine data from different sources collectively. The main objective of image fusion is to produce a fused result that provides the most detailed and reliable information possible. Fusion of multiple information sources together also produces a more proficient representation of the data. There are three different categories of image fusion:

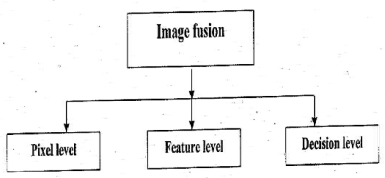


Fig 1.2: Three levels of image fusion

2. RELATED WORD

Grimier, D et al. (2011) [3] has discussed that the main objective of image enhancement is to improve some characteristic of an image to make it visually better one. This paper proposed a method for enhancing the colour images based on nonlinear transfer function and pixel neighbourhood by preserving details.

Mohamed, M et al.(2011) [7] explained that the Image fusion is a process which combine the data from two or more source images from the same scene to generate one single image containing more precise details of the scene than any of the source images.

Patil, U et al. (2011) [8] has proposed image fusion algorithm using hierarchical PCA. Authors described that the Image fusion is a process of combining two or more images (which are registered) of the same scene to get the more informative image.

Aribi, W et al. (2012) [1] explained that the quality of the medical image can be evaluated by several subjective techniques. However, the objective technical assessments of the quality of medical imaging have been recently proposed.

VPS Naidu (2012) [12] explained the Six different types of image fusion algorithms based on discrete cosine transform (DCT) were developed and their performance was evaluated.

Rajenda Pandit Desale (2013) [6] discussed 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.

Sruthy, S et al.(2013) [10] has discussed that the Image Fusion is the process of combining information of two or more images into a single image which can retain all important features of the all original images

Yong Yang et al. (2014) [18] author presented a novel discrete wavelet transform (DWT) based fusion technique with a novel coefficients selection.

Mostafa Amin Naji et at. (2015) [5] proposed a novel approach which sharpened the input images to make larger difference between the variance of the corresponding imput image's block.

Prabhdip Kaur et al. (2015) [11] proposed a novel technique which integrates the higher valued Alternating Current coefficients calculated in discrete cosine transform domain based fusion with illuminate normalization to reduce the artefacts which gets introduced due to the transform domain method. Principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components.

Nishu Rani et al. (2016) [9] proposed an image resolution enhancement technique based on the interpolation of the high frequency sub-bands obtained by PCA + DSWT 2nd Level, correcting the high frequency sub- band estimation by using SWT high frequency sub-bands, 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 sub-bands, and then the high frequency sub-band images have been interpolated..

3 PROPOSED METHODOLOGY

3.1 Mathematical Model

Step 1: First of all two images which are partially blurred are passed to the system and find the size of the image.

$$[M, N, D] = size(I(x, y))$$

Step 2: Apply RGB2PCA to convert given image in PCA plane.

Step 3: Now differentiate PCA of image1 and image2 into their 3 planes as PCA1, PCA2 and PCA3 of Image1 and Image2 as image is assumed to be in RGB.

Step 4: For PCA (:,:, 1) of image 1 and image 2 will be passed for fusion using DCT. And also PCA (:,:,2) & PCA(:.:.3) of image 1 and image 2 will determine new components by taking their averages respectively also called fusion of chrominance.

Step5: Now concatenation of each output of step IV will be done by using following equation:

$$a = cat(3, opf, cf2, cf3) \dots \dots \dots \dots$$

Where cat represents concatenate function, opf represents final output image of dct based fusion of the first component of image1and image2. cf2, cf3 represents chrominance fusion of second and third component of image1 and image2 respectively.

Image name	Existing technique (DWT)	Existing technique (DCT)	Existing technique (PCA)	Proposed algorithm
image1	121	1561	3892	39
image2	787	1062	9351	192
image3	265	1566	5683	38
image4	191	1351	4588	50
image5	685	1903	7679	257
image6	732	1234	8667	165
image7	274	1077	4488	44
image8	320	1290	6224	39
image9	188	1141	3535	63
image10	588	1105	6016	85

Step6: Now PCA2RGB will be applied to get original fused image.

Step7: Now non-linear color enhancement will be applied to get clearer image. Color enhancement is done by following equation:

$$ef = stretchlim(imf)$$

Where ef represents equalization factor, stretchlim function is used to change the contrast or brightness value and imf represents fused image.

And finally an output fused image is obtained by following equation:

$$ffi = imadjust(imf, ef)$$

Step8: End

4. RESULTS AND COMPARISON

1. Mean Square Error Evaluation

Table 4.1 is showing the quantized analysis of the mean square error. As mean square error need to be reduced therefore the proposed algorithm is showing the better results than the available methods as mean square error is less in every case.

Table 4.1 Mean Square Error Evaluation

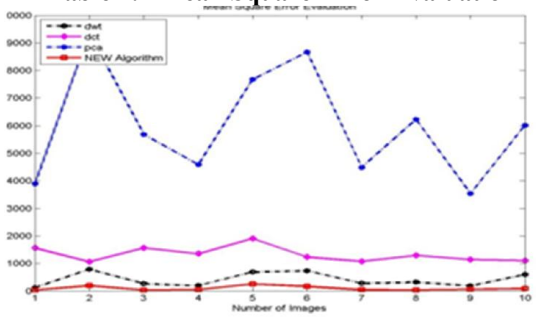


Figure 4.1 MSE of DWT, DCT, PCA& Proposed Approach for different images

Figure 4.1 has shown the quantized analysis of the mean square error of different images using fusion by DWT transform (Black Color), fusion by DCT transform (Magenta Color), fusion by PCA transform (Blue Color), fusion by Proposed Approach (Red Color). It is very clear from the plot that there is decrease in MSE value of images with the use of proposed method over other methods. This decrease represents improvement in the objective quality of the image.

4.2 Peak Signal to Noise Ratio Evaluation

Table 4.2 is showing the comparative analysis of the Peak Signal to Noise Ratio (PSNR). As PSNR need to be maximized; so the main goal is to increase the PSNR as much as possible.

Table 4.2 Peak Signal to Noise Ratio Evaluation

Image name	Existing technique (DWT)	Existing technique (DCT)	Existing technique (PCA)	Proposed algorithm
image1	54.5734	32.3934	24.4570	64.2853
image2	38.3393	35.7343	16.8438	50.5532
image3	47.7830	32.3645	21.1696	64.5547
image4	50.6345	33.6457	23.0273	62.1757
image5	39.5392	30.6718	18.5553	48.0478
image6	38.9604	34.4325	17.5033	51.8916
image7	47.5015	35.6134	23.2192	63.2283
image8	46.1536	34.0485	20.3794	64.3267
image9	50.7683	35.1137	25.2934	60.1651
image10	40.8714	35.3883	20.6752	57.5898

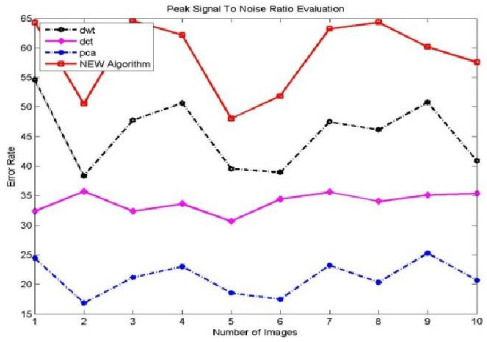


Figure 4.2 PSNR of DWT, DCT, PCA& Proposed Approach for different images

Figure 4.2 has shown the quantized analysis of the peak signal to noise ratio of different images using fusion by DWT transform (Black Color), fusion by DCT transform (Magenta Color), fusion by PCA transform (Blue Color), fusion by Proposed Approach (Red Color).

4.3 Average Difference Evaluation

Table 4.3 is showing the comparative analysis of the Average Difference. As Average Difference needs to be minimized; so the main objective is to reduce the Average Difference as much as possible. Table 4.4 has clearly shown that Average Difference is less in

our case therefore the proposed algorithm has shown significant results over the available algorithm.

Image name	Existing technique (DWT)	Existing technique (DCT)	Existing technique (PCA)	Proposed algorithm
image1	5.4463	-34.1605	54.3077	-0.0089
image2	19.8204	-21.6783	88.7193	-0.0189
image3	10.1252	-34.1009	67.3523	-0.0139
image4	5.9595	-31.0789	56.7556	-0.0308
image5	17.3406	-37.7623	82.3709	-8.3237
image6	18.8087	-24.9806	85.7172	2.2422
image7	10.1564	-25.4655	55.2988	0.0288
image8	11.3062	-29.7548	69.1999	0.0618
image9	6.1149	-26.0716	47.1729	0.0156
image10	19.2185	-27.8964	70.6153	2.0004

Figure 4.3 AD of DWT, DCT, PCA& Proposed Approach for different images

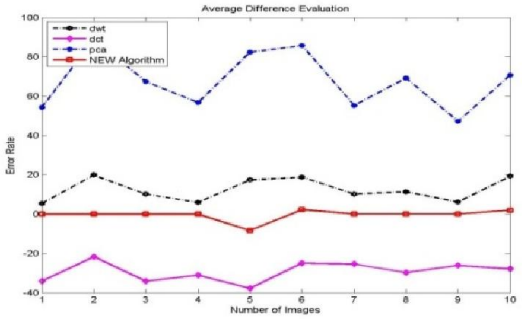


Figure 4.3 has shown the quantized analysis of the Average Difference of different images using fusion by DWT transform (Black Color), fusion by DCT transform (Magenta Color), fusion by PCA transform (Blue Color), fusion by Proposed Approach (Red Color).

4.4 Structural Content Evaluation

Table 4.4 is showing the comparative analysis of the Structural Content. As SC needs to be close to 1, therefore proposed algorithm is showing better results than the available methods as SC is close to 1 in every case.

Table 4.5 Structural Content Evaluation

Image name	Existing technique (DWT)	Existing technique (DCT)	Existing technique (PCA)	Proposed algorithm
image1	1.1357	0.5871	4.0069	1.0015
image2	1.3020	0.8334	4.0060	0.9990
image3	1.2071	0.6618	4.0103	1.0023
image4	1.1514	0.6478	4.0128	1.0045
image5	1.2660	0.6871	3.9997	0.9206
image6	1.3001	0.8046	3.9861	1.0126
image7	1.2415	0.6793	3.9960	1.0004
image8	1.2249	0.7120	3.9887	0.9987
image9	1.1871	0.6342	4.0102	1.0021
image10	1.3528	0.7091	4.0035	1.0147

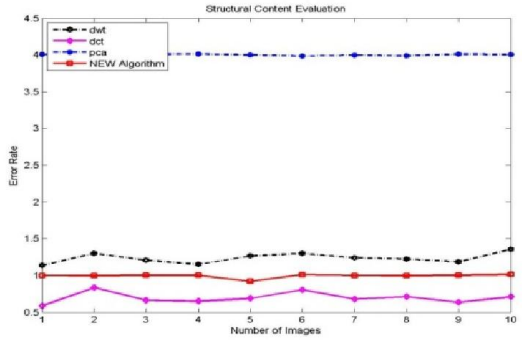


Figure 4.5SC of DWT, DCT, PCA& Proposed Approach for different images

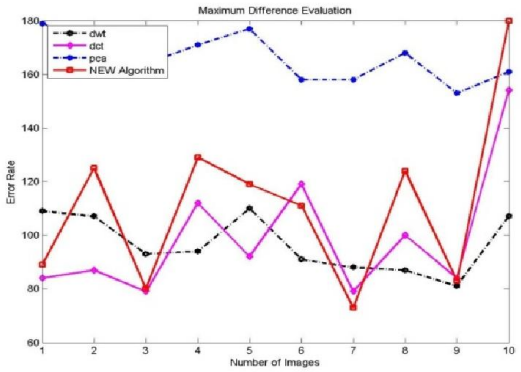
Figure 4.4 has shown the quantized analysis of the Structural Content of different images using fusion by DWT transform (Black Color), fusion by DCT transform (Magenta Color), fusion by PCA transform (Blue Color), fusion by Proposed Approach (Red Color).

4.6 Maximum Difference Evaluation

Table 4.6 is showing the comparative analysis of the Maximum Difference. As Maximum Difference needs to be minimized; so the main objective is to reduce them Maximum Difference as much as possible.

Table 4.6 Maximum Difference Evaluation

Image name	Existing technique (DWT)	Existing technique (DCT)	Existing technique (PCA)	Proposed algorithm
image1	109	84	179	89
image2	107	87	171	125
image3	93	79	164	80
image4	94	112	171	129
image5	110	92	177	119
image6	91	119	158	111
image7	88	79	158	73
image8	87	100	168	124
image9	81	84	153	83
image10	107	154	161	180



Graph 4.6 MD of DWT, DCT, PCA& Proposed Approach for different images

Figure 4.6 has shown the quantized analysis of the Maximum Difference of different images using fusion by DWT transform (Black Color), fusion by DCT transform (Magenta Color), fusion by PCA transform (Blue Color), fusion by Proposed Approach (Red Color).

CONCLUSION

The image fusion methods using discrete cosine transform (DCT) are considered to be more appropriate and time-saving in real-time systems using still image or video standards based on DCT. But it is found that most of the existing researchers have neglected some of the popular issues of vision processing like image de-noising, image enhancement, and image restoration. So to overcome these problems a new algorithm is proposed in this paper. The proposed work integrates PCA with DCT based fusion technique using nonlinear enhancement to give better results than the older techniques. The integrated technique has successfully reduced the limitations of the existing fusion technique. Comparative analysis has shown the significant improvement of the proposed algorithm over the available algorithms. In near future we will extend this work to use guided filters to enhance the DCT base fusion in more efficient manner. Also to take the full benefits of the proposed algorithm we will extend this work to use it in smart cameras by using the embedded systems. Maximum difference of error has not shown significant results so will modify the proposed algorithm further for enhancing this parameter.

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