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A new Integrated MAX-AC-DCT based Image Fusion using Gray World Constancy & Switching Median Filter

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Abstract— The major aim of image fusion is to merge information from various images of the similar scene so as to deliver only the helpful information. The DCT based techniques for image fusion are more appropriate and time-saving in real-time systems utilizing DCT based benchmarks of still images. In this paper a productive methodology for combination of multi-focus images focused on change calculated in DCT area is exhibited. This exploration work has proposed another method which will coordinate the higher esteemed Alternating Current (AC) coefficients figured in DCT domain based fusion with Gray world color constancy and switching median filter to diminish the color artifacts which will be acquainted due with the transform domain technique i.e. DCT. The fusion process may corrupt the sharpness of the fused images so to defeat this issue Gray world color consistency algorithm will overcome the issue of color artifacts. The utilization of Switching median filter is for lessen the any existing of noise in the output image because of quantization step while apply the inverse DCT.

Keywords— Image Fusion, MAX-AC-DCT, Gray World Constancy, Switching Median Filter.

I. INTRODUCTION

Image fusion is a process of combining two or more images into an image. In other words, image fusion is a technique to integrate information from multiple images. These images may come from one sensor or multiple sensors [6]. Image fusion provides a useful tool to integrate multiple images into a composite image that is more suitable for the purposes of human visual perception. It can extract features from source images and provide more information than one image can.

The aim of image fusion is to integrate complementary and redundant information from multiple images to create a composite image that contains a better description of the scene. By integrating information, image fusion can reduce imensionality. This results in a more efficient storage and faster interpretation of the images. By using redundant information, image fusion may improve accuracy as well as reliability. This leads to more accurate data, increased utility and robust performance.

When using the image fusion technique, some general requirements must be considered:

- The fusion algorithm should not discard any information contained in the source images.
- The fusion algorithm should not introduce any artifacts or inconsistencies that can distract or mislead a human observer or any subsequent image processing steps.
- The fusion algorithm must be reliable, robust and having the capability to tolerate imperfections such as noise or mis-registrations.

The aim of image fusion, is to reduce the amount of data during network transmissions, is to create a new image that is more suitable for the purpose of human or machine observation and for further image-processing tasks.

Image fusion takes place at three totally different levels i.e. pixel, feature and decision. Pixel level is a low down level of fusion that is employed to analyze and combine data from different sources before original information is approximated and acknowledged. Feature level is a middle level of fusion that extracts a crucial characteristic from an image like shape, length, segments, edges and direction. Decision level is a very high level of fusion that purpose to associate actual objective.

In the Image Fusion methods the good information from each of the given images is fused together to form a resultant image whose quality is superior to any of the input images. Image fusion methods can be classified into two methods i.e.

- Spatial domain fusion method.
- Transform domain fusion method.

In spatial domain techniques, we directly deal with the pixel value of an image. The pixel values are manipulated to attain the required result. In frequency domain methods the pixel value is first transferred into domain methods by applying DCT and DFT based fusion methods.

II. LITERATURE SURVEY

Sekhar, et al. (2011) [1] has explored the removal of the ringing or aliasing effects and makes the image smoother depend upon the wavelet technique. Wavelet based fusion extracts spatial details from high resolution bands and makes the image appears alike to a high pass filtered image. Hence a new algorithm is introduced to improve the wavelet based fusion method by integrating with PCA transforms. Firstly, the wavelet transform fusion is more formally defined by considering the wavelet transforms of the two registered input images together with the fusion rule .Then, the inverse wavelet transform is computed, and the fused image is reconstructed. The statistical result analysis wavelet integrated method provides the high resolution image with as much details as possible.

Naidu, et al. 2011 [2] has evaluated multi-resolution image analysis by Fast Fourier Transform algorithm for pixel level image fusion. The presentation of this algorithm is compared with fine known wavelets based image fusion technique. The scheme is to apply simple and verified technique of FFT to image fusion. It could be well matched for real time applications. It is observed that image fusion by MFFT perform slightly improved than wavelet based image fusion algorithm.

Blasch, et al. (2011) [3] has observed the targeting tracking to enhanced the ability to extract road networks based on a set of standardized metric used to test for image registration in image fusion process. The satellite imagery sensors record reflected and emitted energy from Earth invarious wavelengths of the electromagnetic spectrum to produce low-resolution multispectral images. The electromagnetic spectrum includes all forms of radiated energy from tiny gamma rays to huge radio waves, including the human visible wavelengths. The advantage of this fused image is to increase exposure of all areas and increase contrast to maximize the image content.

Patil, et al. (2011) [4] has recommended a model in this paper for improving multimodal images by introducing hierarchical PCA algorithm. Hierarchical multiscale and multi resolution image processing techniques, pyramid decomposition are the basis for the majority of image fusion algorithms. PCA is a well-known scheme for feature extraction and dimension reduction which isused for image fusion. A new algorithm, named Pyramid+PCA, which combines the advantages of Pyramid and PCA algorithms, is proposed. Thus by combining both methods the deficiencies of each other is overcome. The advantages of proposed image fusion algorithms improved quality parameters.

Yuan, et al. (2012) [5] has evaluated a real-time infrared and visible image fusion system based on FPGA and DSP hardware design. A "contrast stretching"grayscale fusion method and the "color transfer" color fusion method in YCrCb space is applied in this system. A color variety metric was proposed in order to evaluate both grayscale and color fusion images. This metric is based on color difference gradient in CIELAB color space. This system could improve target detection because fusion images have more information than source images.

Adhinarayanan, et.al 2012 [6] In this paper a modified simple edge preserved denoising algorithm for impulse noise removal in color images is presented. The algorithm has three steps: noisy pixel detection, replacement of noisy pixels, confirmation by comparing with a threshold. In order to improve the quality of the image, a median filtering is added. In the proposed algorithm the computational complexity is less with maximum edge preservation. Instead of converting the color images to gray for denoising and then reconstructing from the denoised gray image, they are denoised by extracting the R, G and B planes from the noisy image, denoised separately and are merged together to form the color image. The extensive experimental results show that the proposed algorithm achieves excellent performance in terms of quantitative evaluation and visual quality, even the noise ratio is high.

Hossny et al. (2013) [7] has studied the evolution of image fusion performance metrics and their subjective and objective validation. It evolves the description of fusion performance metrics starting with image dissimilarity metrics and realize into image fusion contexts, localized weighting factors and the validation process. Objective image fusion performance metrics rely primarily on measuring the amount of information transferred from each source image into the fused image. The generic fusion performance metric measures the average distance between the fused image and each source image for a two images fusion system. The presented framework for image fusion metrics, facilitates the design of image fusion performance metrics. This framework facilitates customizing fusion metrics on the wing and thus allowing a semi-automated fusion system to choose the appropriate dissimilarity metric, localization method and saliency functions, as well as tuning their parameters. Hence, the framework provides the more efficiency and accuracy based on image fusion metrics. Chang et al. (2013) [8] has proposed an improved color constancy approach based on the max-RGB algorithm. The proposed algorithm uses the chromaticity neutralization process to select the representative pixels for robust illuminant computing. This generates in no over-correction problem in the output color-corrected image. Firstly, soft clustering is performed to first separate the image pixels into several groups. Secondly, applying the illuminant estimation algorithm to reach the illuminant color of each cluster. Finally, the illuminant color specifically for each image pixel is obtained by combining these estimated illuminants based on the clustering weights. The proposed procedure apparently improves the color deviation performance.

Phamila, et al. (2013) [9] has proposed as simple and efficient multi-focus image fusion method clearly designed for wireless visual sensor systems equipped with resource constrained, battery etc. The fusion of multi-focus images is based on higher valued Alternating Current (AC) coefficients calculated in Discrete Cosine Transform (DCT) domain. It is time-saving and simple when the fused image needs to be saved or transmitted in JPEG format. This method improves the efficiency of image quality and energy consumption.

III. PROBLEM DEFINITION

The main objective of image fusion is to combine information from multiple images of the same scene in order to deliver only the useful information. The discrete cosine transforms (DCT) based methods of image fusion are more

suitable and time-saving in real-time systems using DCT based standards of still images. In this dissertation an efficient approach for fusion of multi-focus images based on variance calculated in DCT domain is presented. This research work propose a new technique which will integrate the higher valued Alternating Current (AC) coefficients calculated in Discrete Cosine Transform (DCT) domain based fusion with Gray world color constancy and switching median filter to reduce the color artefacts which will be introduced due to the transform domain method i.e. DCT. The fusion process may degrade the sharpness of the fused images so to overcome this problem Gray world color constancy algorithm will overcome the problem of color artefacts. The use of Switching median filter is for reduce the any existing of noise in the output image due to quantization step while apply the inverse DCT.

IV. PROPOSED ALGORITHM

Various steps applied on the input images in MATLAB for getting a resultant fused image whose quality is superior to any of the input images:-

Step I. Read the Input image.

Step II. Now Apply DCT fusion in order to fuse representation of multi focus images into single fused image.

Step III. Now Gray World Color Constancy comes in action so that it becomes easy to fused images with complex background.

Step IV. Now Switching Median Filter is applied as a post processing operation to enhance the brightness of the system.

Step V. Now the final proposed image is obtained.

A. Gray World Color Constancy

A well-known color constancy method is based on the Gray-World assumption which assumes that the average reflectance of surfaces in the world is achromatic. The gray world (GW) algorithm is based on the assumption that the color in each sensor channel averages to gray over the entire image. Any deviation from the gray value is due to the chromaticity shift of the illuminant. It is one of the important assumptions when trying to estimate the spectral distribution of the illuminant.

This technique is applied in three steps:

1. Firstly, perform the soft clustering on image pixels;
2. Then applying our illuminant estimation algorithm to reach the illuminant color of each cluster.
3. Finally, the illuminant color specifically for each image pixel is obtained by combining these estimated illuminants based on the clustering weights.

B. Switching Median Filter

Switching (or decision based) median filters is a common name for a group of filters that reduce number of pixels subjected to median filtration to those that are believed to be noisy. Pixels identified as uncorrupted are left unchanged. The main part of each switching filter is impulse noise detection method. The impulse detection method based on analysis of local intensity extrema detects noisy pixels with accuracy close to 99% for a wide range of noise densities. In consequence, corrupted pixels can be effectively corrected while preserving the detailed image information at the same time.

V. EXPERIMENTAL RESULTS

In order to implement the proposed algorithm, design and implementation has been done in MATLAB using image processing toolbox. In order to do cross validation, the proposed newly integrated algorithm is tested on various 12 images. The developed approach is compared next to well-known DCT based image fusion technique. This represents improvement in the objective quality of the image.

Fig. 1(a) is showing the left blurred image and Fig. 1(b) is showing the right blurred image. The overall objective is to combine relevant information from multiple images into a single image that is more informative and suitable for both visual perception and further computer processing.

Figure 1(a): Left blurred image

Figure 1(b): Right blurred image

Fig. 2 has shown the output image taken by Discrete Cosine Transform (DCT). The output image does not preserves the brightness of original blurred images to be fused and the color is imbalanced which have degraded the quality of the image.

Fig. 3 has shown the output image taken by integrating the higher valued DCT based image fusion with Grayworld color constancy algorithm and Switching median filter.

Fig 2: Fused image

Fig 3: Final proposed image

The image has contained the balanced color and brightness as the original images to be fused. The quality of output image is quite good with our proposed method.

VI. PERFORMANCE ANALYSIS

The algorithm is applied using various performance indices SSIM (Structural Similarity Index Measure), SF (Spatial Frequency) and EPI (Edge Preservation Index).

Table 1 is showing the comparative analysis of the Structural Similarity Index Measures (SSIM). As SSIM need to be maximized; so the main goal is to increase the SSIM as much as possible. Table 1 has clearly shown that the SSIM is maximum in the case of the proposed algorithm therefore proposed algorithm is providing better results than the existing method.

TABLE 1: STRUCTURAL SIMILARITY INDEX MEASURES EVALUATION

Image name	Existing Technique (DCT)	Proposed Algorithm
Image1	0.9657	0.9731
Image2	0.9896	0.9896
Image3	0.9170	0.9211
Image4	0.9763	0.9766
Image5	0.9638	0.9783
Image6	0.9041	0.9331
Image7	0.9646	0.9651
Image8	0.9378	0.9615
Image9	0.8196	0.9459
Image10	0.8795	0.9556
Image11	0.9358	0.9543
Image12	0.9405	0.9658

Figure 5 has shown the quantized analysis of the structural similarity index measures of different images using fusion by DCT transform (Blue Color), fusion by Proposed Approach (Green Color).

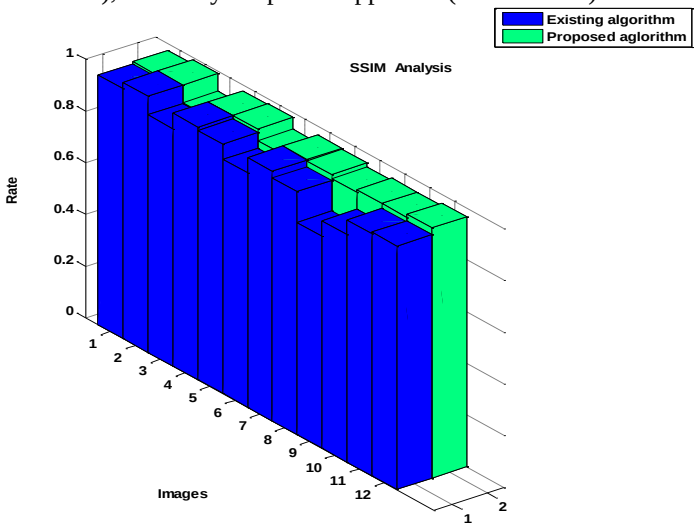

Figure 5: SSIM Graph between proposed and existing algorithm

It is very clear from the plot that there is increase in SSIM value of images with the use of proposed method over existing method. This increase represents improvement in the objective quality of the image.

Table 2 is showing the comparative analysis of the Spatial Frequency (SF). As SF need to be maximized; so the

TABLE 2: SPATIAL FREQUENCY EVALUATION

Image name	Existing Technique (DCT)	Proposed Algorithm
Image1	0.9657	0.9731
Image2	0.9896	0.9896
Image3	0.9170	0.9211
Image4	0.9763	0.9766
Image5	0.9638	0.9783
Image6	0.9041	0.9331
Image7	0.9646	0.9651
Image8	0.9378	0.9615
Image9	0.8196	0.9459
Image10	0.8795	0.9556
Image11	0.9358	0.9543
Image12	0.9405	0.9658

main goal is to increase the SF as much as possible. Table 2 has clearly shown that the SF is maximum in the case of the proposed algorithm therefore proposed algorithm is providing better results than the existing method.

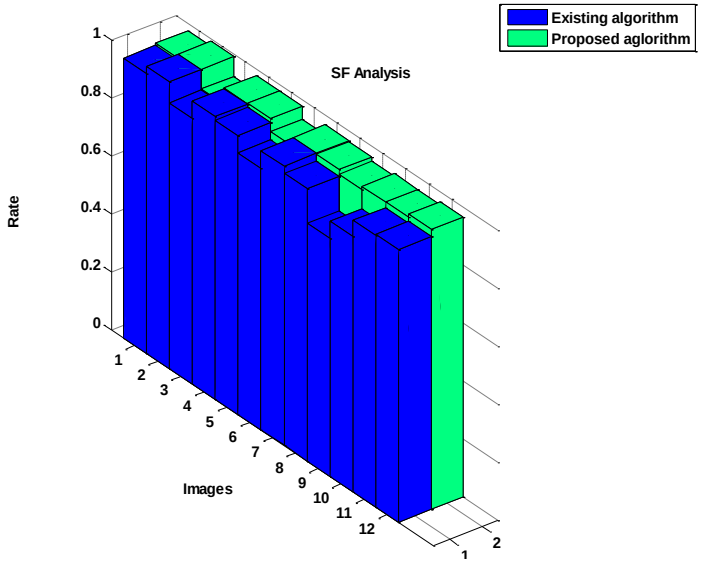

Figure 6: Spatial Frequency Graph between proposed and existing algorithm

Figure 6 has shown the quantized analysis of the SF of different images using fusion by DCT transform (Blue Color), fusion by Proposed Approach (Green Color).

It is very clear from the plot that there is increase in spatial frequency value of images with the use of proposed method over existing method. This increase represents improvement in the objective quality of the image.

Table 3 is showing the comparative analysis of the Edge Preservation Index (EPI). As EPI need to be maximized; so the main goal is to increase the EPI as much as possible. Table 3 has clearly shown that the EPI is maximum in the case of the proposed algorithm therefore proposed algorithm is providing better results than the existing method.

TABLE 3: EDGE PRESERVATION INDEX EVALUATION

Image name	Existing Technique (DCT)	Proposed Algorithm
Image1	0.0219	0.0434
Image2	0.0246	0.0423
Image3	0.0532	0.0707

Image4	0.0367	0.0767
Image5	0.0590	0.0837
Image6	0.1418	0.2165
Image7	0.0327	0.0644
Image8	0.0632	0.1355
Image9	0.2882	0.3414
Image10	0.2299	0.3297
Image11	0.1220	0.1640
Image12	0.2063	0.2185

Figure 7 has shown the quantized analysis of the edge preservation index of different images using fusion by DCT transform (Green Color), fusion by Proposed Approach (Blue Color)

It is very clear from the plot that there is increase in EPI value of images with the use of proposed method over existing method. This increase represents improvement in the objective quality of the image.

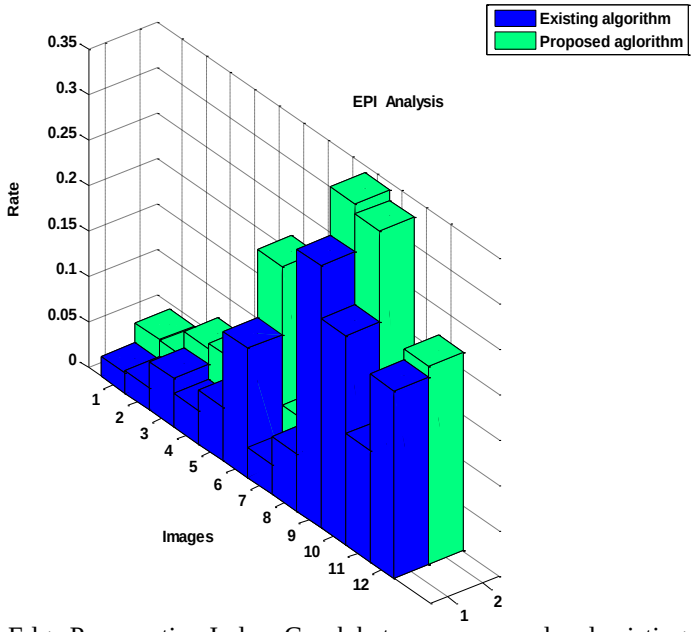

Figure 7: Edge Preservation Index Graph between proposed and existing algorithm

VII. CONCLUSION

This research work has proposed a novel method which will incorporate the higher valued Alternating Current (AC) coefficients calculated in DCT domain based fusion with Gray world color constancy and switching median filter to lessen the color artifacts which will be introduced due to the transform domain method i.e. DCT. The fusion methodology may corrupt the sharpness of the fused images so to conquer this issue . Gray world color constancy algorithm will defeat the issue of color artifacts. The utilization of Switching median fitler is for lessen the any existing of noise in the output image because of quantization step while apply the innverse DCT.

The comparison among MAX-DCT based fusion and proposed method has likewise been attracted to investigate the noteworthy change of the proposed algorithm to validate the proposed work. The relative analysis has demonstrated the noteworthy change of the proposed strategy over accessible image fusion procedures. Image fusion discovered to be the complex algorithms concerning the time unpredictability so in not so distant future we will propose another strategy that will utilize parallel computing to enhance the speed of the proposed algorithm. Likewise the image fusion can additionally be further enhanced by utilizing the fuzzy set theory to discover the best value for fused picture from the input images to improve the results further.

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