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An Enhanced Implementation of Image Fusion for Multifocus Images Using Nihs Transform and DC

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Abstract: Image fusion is a process of mixing the complementary as well as the common features of a set of images, to generate a resultant image with high quality information content in terms of subjective as well as objective analysis point of view. The objective of the research work is to develop some novel image fusion algorithm and their application in various fields such as medical image fusion and edge detection of multi-focus images etc. The process of fusing two or more images to obtain another individual image will contain exact kind of sequence. Then propose the fusion technique with the combination of Improved IHS and DCT. Using IHS (intensity, hue, saturation) color space and related color transformation can solve the problem of color clipping. The spatial frequencies are applied to each individual block and the blocks with the immense spatial frequencies compose the DCT presentation of the output image. The performance analysis of this method is analyzed by the parameters like RMSE, CC, Entropymethod improves the output image quality visually and outperforms the previous DCT based techniques.

Key words: Discrete cosine transform · Improved intensity · Hue · Saturation · Image fusion · Multifocus · Spatial frequency

INTRODUCTION

Image fusion is the process of blending relevant information from two or more images into a single image. The resulting image will be highly informative than any of the input images. The clarity of information is important. Image Fusion is a mechanism to improve the quality of information from a set of images. In the literature of image fusion. Three main fusion methods have been deal with pixel level, feature level and decision level. Pixel-level is low level of image fusion, deals with pixels acquire at imaging sensor output. Features extracted from source images are performed by Feature-level fusion operation. Decision-level deals with image descriptors. As a result of the limited depth of focus in optical lenses, it is difficult to describe the complex situation with a single image accurately [1]. In wireless visual sensor networks, multiple sensors are applied to obtain images of the same scene, and a centralized fusion centre combines source images from multiple sensors into a single image, which is more suitable for human visual and machine perception [2].

Multi-Focus Image Fusion: In image acquisition process, the image quality depends on the focal length or focus of the optical system. If the lens focusing is faulty the resultant image will suffer from blurring. Also it is not possible to focus all the objects in a scene equally. Therefore Multi-focus fusion techniques are essential to create an image which contains all the objects will be in-focus from two or more images. Sharp images contain more details when compared to blurred images. In many situations great variations are present in scene's depth; it is difficult to obtain an image in which all the areas of scene appear sharp. The scene areas which are in-focus will be sharp and has higher contrast. Areas which are out of focus i.e. in front of or behind the focus plane will be blurred. The key challenge of image fusion process is to identify the relevant information such as contrast/ high local energy and areas that are possess high sharpness from the best-focused images and combine this useful information to produce a highly informative image.

DCT Definition: The discrete cosine transform (DCT) constitute an image as a sum of sinusoids of varying magnitudes and frequencies. The dct2 function calculate

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the two-dimensional discrete cosine transform (DCT) of an image. For a typical image, The DCT has the property that the most of the visually significant information about the image is concentrated in just a limited number of coefficients of the DCT. For this reason, the DCT is frequently used in image compression applications. For example, the DCT are at the heart of the international standard lossy image compression algorithm known as JPEG. (The name comes from the working group that has been developed the standard: the Joint Photographic Experts Group.)

IHS (Intensity Hue Saturation) Fusion Method: IHS explains the popularity of perceptual color space and overpowers the limitation of commonly used RGB color space which does not relate intuitively to the attribute of human color perception. Intensity means total amount of light that reaches the eye. Hue can be defined as the predominant wavelength of a color and saturation can be defined as purity of total amount of white light of a color.

Methodology: The Improved Nonlinear Intensity-Hue-Saturation (iNIHS) transform along with Discrete Cosine Transform (DCT) avoid gamut problem, color distortion and improves spatial content respectively. A gamut problem is said to be a subset of color. Certain colors which cannot be expressed within a given color space is said to be gamut problem. Image acquisition is the first step in work flow sequence, without image no processing is possible. It is an action of retrieving image from source. The input Multi-focus image undergoes Improved Nonlinear IHS transform (iNIHS), which calculates intensity, hue and saturation value of each pixel to detect the pixel is in RGB color space or CMY color space.

Improved Nonlinear Intensity-Hue-Saturation transform (INIHS) is applied to the color image. And Discrete Cosine Transform (DCT) is applied to the gray scale image, because Discrete Cosine Transform (DCT) is said to be a 1-Dimensional and 2-Dimensional transform. So, only gray scale image can apply to Discrete Cosine Transform (DCT). Mostly, 2-Dimensional Discrete Cosine Transform is used in digital image processing.

Intensity-Hue-Saturation, defines colors mathematically, using cylindrical or spherical coordinates. Hue component refers to the dominant wavelength 0 and 360º. Intensity refers to the total brightness or dullness of a color. Saturation refers to purity of color. Both saturation and Hue ranges between 0 and 1. Image fusion using linear IHS transform and nonlinear IHS transform produces gamut problem. Linear IHS color space is said to be in a cube model. After the image fusion, the resulting color point will not be the same as which is present inside RGB cube. It is said to be a gamut problem. Usually gamut problem is resolved by using either one of three types of clipping techniques.

The nonlinear IHS color space is said to be in cylindrical model with collapsed top, if the color point of the image after backward nonlinear transformation falls into the collapsed portion causes gamut problem. It can be by clipping method. But when the collapsed top of the nonlinear cylinder is repaired to a complete cylinder, it is possible to avoid the gamut problem without going for clipping method. To completely overcome the high spectral distortion in the resultant fused image, Improved Nonlinear Intensity-Hue-Saturation transform (iNIHS) is proposed with the Discrete Cosine Transform.

The operation of the iNIHS is as follows:

- iNIHS color space is divided into upper and lower portions such as H_{upper} and H_{lower} (H_{upper} is said to be a CMY color space, whereas H_{lower} is a RGB color space)
- To decide pixel is in RGB color space or CMY color space, calculate intensity, Hue and Saturation value of each pixel by using the following equation.

$$I=\{R/3+G/3+B/3\} \quad (1)$$

$$H=R-mean(R+G+B)*std(I)+mean(I) \quad (2)$$

$$S=RGB-H-I \quad (3)$$

$$Hnormalised=max(IHS) \text{ or } min(IHS) \quad (4)$$

The intensity, hue and saturation values of each in image 1 are added to the each pixel in image 2. Hence the resultant fused image is obtained.In focus measuring, there will be two focusing content i.e., low focusing content and high focusing content. Focus measuring has been used to check particular content in the image has been focused.

Majority filter [3] has been used to avoid artifacts present in image.

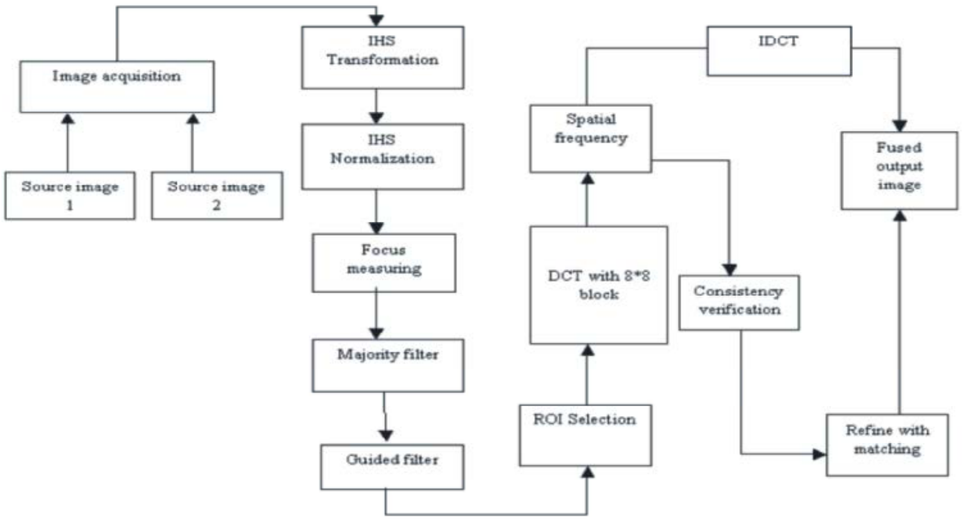

Fig. 1: IHS along with DCT transformation of fused output

Guided filter is edge preserving filter, in decomposition process it will not blur strong edges. ROI selection is processing only single sub region of image, while leaving other regions unchanged. Then Discrete Cosine Transform (DCT) is used to divide an image into blocks of 8x8 pixels. The spatial frequencies are applied to each individual block [4] and the blocks with the immense spatial frequencies compose the DCT presentation of the output image

WhenWhen the source images is coded in Joint Photographic Experts Group (JPEG) standard or when the fused image is saved or transmitted in JPEG format, the fusion approaches will be applied in DCT domain will be very efficient. To execute the JPEG coding, an image (in color or grey scales) is then first subdivided into blocks of 8x8 pixels. The Discrete Cosine Transform (DCT) is then performed on each individual block. This generates 64 coefficients which are then quantized to reduce the magnitude. Then the coefficients are reordered into a one-dimensional array in a zigzag manner before further entropy encoding. There are two stage of compression: the first is during quantization and the second during the entropy coding process. JPEG decoding will be the reverse process of coding.Output images of two cameras are denoted as A and B that have been compressed in JPEG coding standard in the sensor agent and then transmitted to fusion agent of VSN. In the case of using spatial domain method these images must be decoded and transferred in spatial domain. Then after applying fusion procedure, the fused image must be coded in order to be stored or transmitted to an upper node. In order to reduce the complication for the real-time applications and also improve the quality of the output image, an image fusion technique in DCTdomain. From DCT coefficients, the variance of 8×8 blocks calculated. It is used as a contrast criterion for the activity measure. The discrete cosine transform (DCT) is used in image compression applications [5]. Several commercial standards widely used such as JPEG still image coding standard [6], Motion-JPEG, MPEG and the H263 video coding standards [7] are based on DCT.

Using vector processing, the output matrix of a two-dimensional DCT for an input matrix is given by:

$$F = C.f.C^t \quad (5)$$

Where C is an orthogonal matrix consisting of the cosine coefficients and C^t are the transpose coefficients

$$C^{-1} = C^t \quad (6)$$

The inverse DCT (IDCT) is also defined as

$$f = C^t.F.C \quad (7)$$

The total spatial frequency (SF) of a block in the spatial domain is calculated as:

$$SF^2 = RF^2 + SF^2 \quad (8)$$

The row frequency (RF) and column frequency (CF) of an 8x8 image block are given by

$$RF^2 = \frac{1}{8\times 8}\sum_{x=0}^{7}\sum_{y=1}^{7}(f(x,y) - f(x,y-1))^2 \quad (9)$$

$$CF^2 = \frac{1}{8\times 8}\sum_{x=1}^{7}\sum_{y=0}^{7}(f(x,y) - f(x-1,y))^2 \quad (10)$$

IDCT has been performed after spatial frequency. Finally fused output image is obtained. Cameras suffer from limited depth offield and this causes the image to be focused only on selected area. The main intention of Multifocus image fusion is to overcome the problem of depth of field [DOF] of cameras and to get an all-in focusimage. The key challenge of multi-focus image fusion is to obtain the fused image without blurring Consistency verification has been applied to improve the quality of an output image.ex: suppose an image 1 has [4 3 2 1] and image 2 has [1 2 3 4], will obtain [1 1 -1 -1].

Consistency verification= [1 1 -1 -1]

Refine with matching is obtained comparing the consistency verification value along with image 1 and image 2 value ex:[1 1 -1 -1] [4 3 2 1] [1 2 3 4]

Refine with matching = [4 3 3 4]

RESULTS AND DISCUSSION

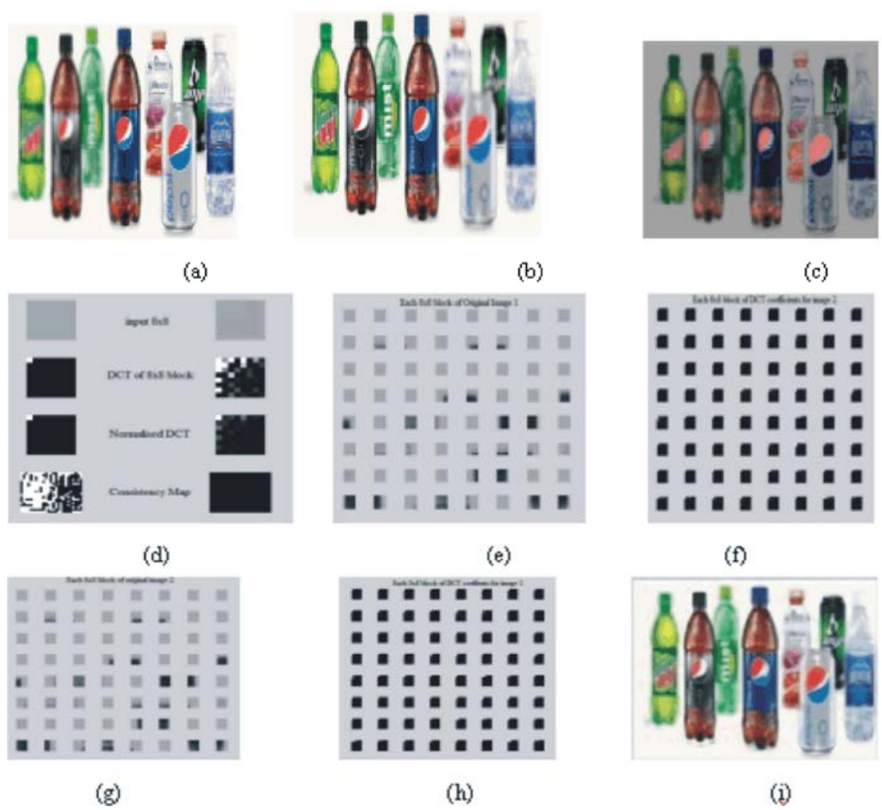

Fig. 2: (a) Source Image1 (b) Source Image2 (c) NIHS Transformed Image (d) 8*8 block, DCT of 8*8 block, normalised DCT, Consistency Map (e) Each 8*8 block of original Image 1 (f) Each 8*8 block of DCT coefficient for image 1 (g) Each 8*8 block of original Image 2 (h) Each 8*8 block of DCT coefficient for image 2 (i) fused output image

Performance Analysis: The root mean square error (RMSE) and structural similarity measure (SSIM) [8] are used for objective evaluation in the experiment. RMSE is the cumulative squared error between the fused and the reference image. SSIM is used to evaluate important information that has been transferred into the fused image [8].Piella metric(Q_ABF) [9] are also used. These metrics estimate the transfer of local structuresfrom source images into the fused image. The higher the value of these metrics, the better is the quality of the fused imageBased on the above analysis, the proposed method is effective and it outperforms the traditional image fusion approaches in terms of both subjective and objective evaluation.

Method	Images	PSNR	RMSE	SSIM	Q_ABF	API	SD	AG
DCT+IHS	Legs	20.4186	590.5055	0.9172	0.6819	96.7757	54.1101	15.8711
DCT+IHS	Drinks	22.6789	350.9072	0.9251	0.6159	116.3355	11.6920	15.2395
DCT+IHS	Flowers	31.8051	42.9108	0.9794	0.8399	80.4737	8.4975	10.5173

Fig. 2: Objective Evaluation of the Image Fusion

CONCLUSION

A new approach based on spatial frequency for fusion of multi-focus images has been proposed in the DCT domain along with nonlinear intensity hue saturation transform instead of the spatial domain. The performance of the proposed method with various evaluation metrics has been estimated and it is found that the performance of fusion in the DCT domain is superior to that of conventional approaches based on DCT. Moreover, the proposed method is simple to implement and computationally efficient when the source images are coded in JPEG format, especially in wireless visual sensor networks.

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