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MULTI-EXPOSURE IMAGE FUSION: USING CANNY EDGE DETECTOR APPROACH FOR EFFICIENT ON VARIOUS MULTIFOCUS OR MULTIMODAL IMAGE

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Abstract—*During extraction of information from advanced quality of multiple image data and their functionality has led to search for various algorithms of enhancement which overcome the technology limitations. Image Fusion intends at the mixing of dissimilar and complementary data to improve the information perceptible in the images in addition to increase the consistency of the understanding. The proposed methodology implemented here performs better fusion as compared to the existing technique of fusion of the source images. The comparison between existing and proposed work is done on the basis of various parameters*

Index Terms—*Image fusion, Spatial resolution, Discrete Wavelet Transform (DWT), Principal Component Analysis (PCA).*

I. INTRODUCTION

Image fusion is the progression of combining information from two or more images of a view into a single composite image that is more revealing and to integrate different data in order to obtain more information than that can be consequent from each of the single sensor data alone , image fusion has been applied to accomplish a number of idea like image sharpening, improving geometric correction, complete data set for improved classification, change detection, substitute missing information, replace defective data. and it is more appropriate for visual observation or computer processing. The idea in image fusion is to decrease ambiguity and decrease redundancy in the output while maximizing appropriate information exacting to an application or task. Given the same set of input images, dissimilar fused images may be generated depending on the explicit application and what is considered relevant information.

The term "fusion" gets numerous words to become visible, such as merging, grouping, synergy, integration and several others that put across more or less the same idea have since come out in literature [1]. Different definitions of image fusion can be found in literature, each author understands this term in a different way depending his research importance's, such as [2-3]. A general definition of data fusion can be adopted as following "Data fusion is a formal framework which expresses means and tools for the alliance of data originating from different sources. Image fusion forms a subgroup within this definition and aims at the invention of a single image from multiple image data for the extraction of information of advanced quality. Having that in mind, the attainment of high spatial resolution, while sustaining the provided spectral resolution, falls precisely into this framework [4].

Recently, joint bilateral filter [7] has been proposed which is effective for detecting and reducing large artifacts such as reflections using gradient projections. More recently anisotropic diffusion [6] has been utilized for detail enhancement in exposure fusion [8], in which texture features are used to control the contribution of pixels from the input exposures. The guided filter is preferred over other existing approaches because; the gradients present near the edges are preserved accurately. We use guided filter [5] for base layer and detail layer extraction which is more effective for enhancing texture details and reducing gradient reversal artifacts near the strong edges in the fused image. Multi resolution approach is used to fuse computed base layers across all of the input images. The details layers extracted from input exposures are manipulated and fused separately.
Image fusion is a technique of obtaining images with high spatial and spectral resolution from low spatial resolution and high spatial resolution images. There is often an inverse relationship between the spectral and spatial resolution of the image. Due to the demand for higher classification accuracy and the need in enhanced positioning precision there is always a need to improve the spectral and spatial resolution of remotely sensed imagery.

Image fusion is performed on pixels, features, and decision levels [9]. Pixel-level methods fuse at each pixel and hence reserve most of the information [10]. Feature-level methods extract features from source images (such as edges or regions), and join them into a single concatenated characteristic vector [12]. Decision level fusion [10], [13] comprises of sensor information fusion, after each sensor has processed an image and a preliminary determination has been made (entity's location, attributes, and identity). Pixel-level methods include addition, subtraction, division, multiplication, minimum, maximum, median and rank as well as more complicated operators like Markov random field and expectation-maximization algorithm [14]. Besides these, pixel level also includes statistical methods (Principal Component Analysis

(PCA), linear discriminant analysis, independent component analysis, canonical correlation analysis and non-negative matrix factorization). Multi scale transforms like pyramids and wavelets are also types of pixel level fusion [10], [13]. Segment fusion, edge fusion [12] and contour fusion [11]. They are usually robust to noise and mis-registration. However, the method provides limited performance for noisy images due to the use of Gaussian filter and two level weight maps.

II. IMAGE FUSION METHODS

The most indispensable dispute concerning image fusion is to choose how to merge the sensor images. In current years, numerous image fusion methods had been discovered [16]. One of the prehistoric fusion techniques is pixel-by-pixel gray level average of the source images. This simplistic method often has severe side effects such as dropping the contrast. Some more sophisticated approaches began to extend with the launching of pyramid transform in mid-80s. Superior results were achieved with image fusion i.e. performed in the transform domain. The pyramid transform resolves this idea in the transformed domain. The basic suggestion is to carry out a multi resolution disintegration on each source image, then incorporate all these decompositions to build up a compound depiction and lastly rebuild the fused image by performing an inverse multi-resolution transform. The method of image fusion the good information from every specified image is fused collectively to form a resultant image whose quality is greater to any of the input images. Image fusion technique can be mostly categorized into two groups:

1. Spatial domain fusion method.
2. Transform domain fusion method.

In spatial domain techniques frankly deal with the image pixels. The pixel values are influenced to achieve preferred result. In frequency domain approach the image is first sent in to frequency domain. The Fourier Transform of the image is computed first. All the Fusion functions are executed on the Fourier transform of image and then the Inverse Fourier transform is performed to obtain the resulting image. Image Fusion useful in all fields where images are must be analyzed. For illustration, robotics, medical image analysis, microscopic imaging, remote sensing Application, computer vision, analysis of images from satellite etc [16] [17]. The fusion techniques like principal component analysis (PCA), averaging, Brovey method and IHS based methods collapse under spatial domain approaches.
Another significant spatial domain fusion technique is the high pass filtering based technique. The drawback of spatial domain approaches is that they generate spatial distortion in the fused image. Spectral distortion becomes a negative factor while they go for further processing like classification problem [17].
Spatial distortion can be splendidly handled by frequency domain approaches on image fusion. The multi resolution analysis has been converted into a very helpful tool for analyzing remote sensing images. The discrete wavelet transform has turn out to be a very useful tool for fusion. A number of other fusion approaches are also there for example Curvelet transform based, Laplacian- pyramid based, etc. These methods explain an enhanced performance in spatial and spectral quality of the fused image as compared to other spatial methods of fusion [11]. The categorization of some of the most famous image fusion algorithms based on the computation source is demonstrated in Figure: 2.1.

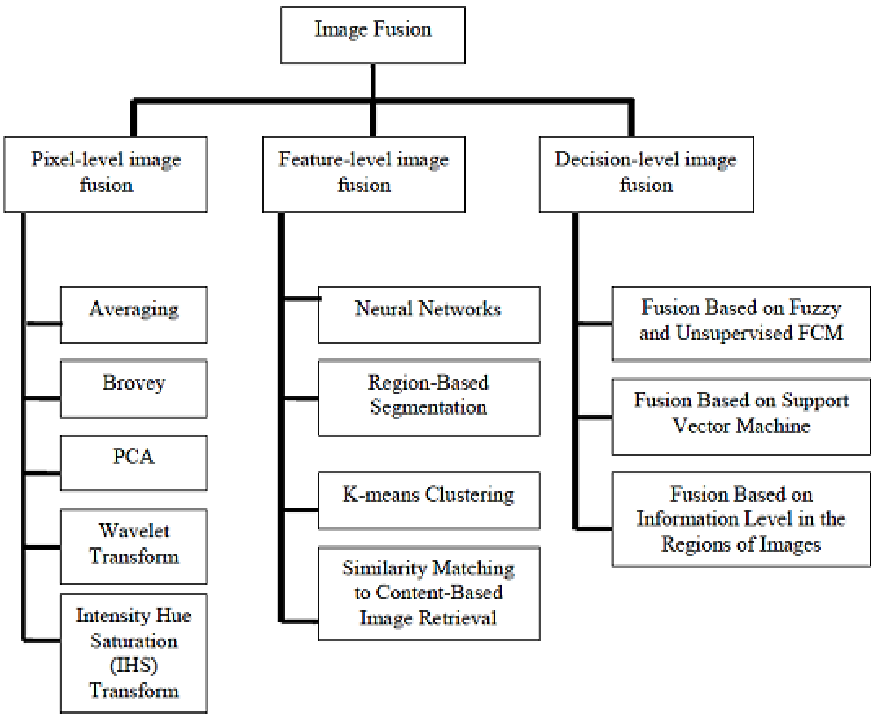


Figure-1: Level classifications of the diverse popular image fusion methods based on the computation source [15].

There are different methods that have been discovered to perform image fusion. Some well-known image fusion schemes are enlisted below [15]:-

(1) Principal component analysis (PCA) based fusion
(2) Intensity-hue-saturation (IHS) transform based fusion
(3) High-pass filtering method.
(a) Multi scale transform based fusion:-
(b) Pyramid method:-
 (i) Gaussian pyramid
 (ii) Laplacian Pyramid
 (iii) Gradient pyramid
 (iv) Morphological pyramid
 (v) Ratio of low pass pyramid.
(c) Wavelet transforms:-
 (i) Discrete wavelet transforms (DWT)
 (ii) Stationary wavelet transforms
 (iii) Multi-wavelet transforms.
(d) Curvelet transforms.

III. LITERATURE REVIEW

One method of achieving feature-level fusion [18] is with a region-based fusion scheme. An image is initially segmented in some way to produce a set of regions. Various properties of these regions can be calculated and used to determine which features from which images are included in the fused image. This has advantages over pixel-based methods as more intelligent semantic fusion rules can be considered based on actual features in the image, rather than on single or arbitrary groups of pixels.

This paper has demonstrated that comparable results can be achieved with region and pixel-based methods. While region-based fusion methods are generally more complex, there are a number of advantages of such schemes over pixel-based fusion. The advantages demonstrated here include novel more intelligent fusion rules and the ability to treat regions differently depending on a variety of properties such as average activity, size and position relative to other regions in the scene.

This paper explains [19] how Discrete Wavelet Transform (DWT) can be used for merging the lower frequency component of a multi-spectral image and its higher spatial resolution images by means of rules. Due to the demand for higher classification accuracy and the need in enhanced positioning precision there is always a need to improve the spectral and spatial resolution of remotely sensed imagery. In DWT the different parts of the image after decomposition, different fusion rules are adopted. The intensity of the high frequency information is merged with the low frequency In DWT the different parts of the image after decomposition, dissimilar fusion imperatives are assumed. The intensity of the high frequency information is merged with the low frequency information to match the intensity component to get the feasible and effective method for image fusion.

Since fused images [19] are used to enhance visual information for human users, performance assessment of image fusion should be first judged by the users, based on the mission of specific applications. In situations where it is hard to take decision about the quality of fused image objective measures are calculated. Quantitative measures should only serve as a useful tool to assist human users to make difficult judgments whenever necessary. The performance assessment of image fusion should continue to be shared between qualitative and quantitative methods, with increasing weight being placed with quantitative assessment techniques.

Improved guided image fusion for magnetic resonance and computed tomography imaging is proposed [20]. Existing guided filtering scheme uses Gaussian filter and two level weight maps due to which the scheme has limited performance for images having noise. Different modifications in filter (based on linear minimum mean square error estimator) and weights maps (with different levels) are proposed. The acquired medical images are usually of low quality (due to artifacts), which degrade the performance in terms of human visualization and quantitative analysis. The saliency maps are linked with detail information in the image. The main issue with 0 and 1 weight assignments arises in GFF when different images have approximately equal saliency values. In such cases, one value is completely thrown away. For noisy [24] MR images, the saliency value possibly higher at a pixel because of noise.

In this paper we propose [21] a novel detail-enhancing exposure fusion approach using non-linear translation-variant filter (NTF). With the captured Standard Dynamic Range (SDR) images under different exposure settings, first the fine details are extracted based on guided filter. Next, the base layers (i.e. images obtained from NTF) across all input images are fused using multi-resolution pyramid. Exposure, contrast and saturation measures are considered to generate a mask that guides the fusion process of the base layers. Multi-resolution approach is used to fuse computed base layers across all of the input images. The details layers extracted from input exposures are manipulated and fused separately. The final detail enhanced fused image is obtained by integrating the fused base layer and the fused detail layer. The framework is inspired by the edge-preserving property of guided filter that has better response near strong edges. The two layer decomposition based on guided filter is used to extract fine textures for detail enhancement.

The proposed method [22] is based on a two-scale decomposition of an image into a base layer containing large scale discrepancy in intensity, and a specify layer confining small scale features. A new guided filtering-based weighted average method is proposed to create full use of spatial reliability for fusion of the support and specify layers. An experimental outcome shows that the proposed method can acquire modern concert for fusion of multispectral, multi focus, multimodal, and multi exposure images. A novel weight construction method is proposed to combine pixel saliency and spatial context for image fusion. Instead of using optimization based methods, guided filtering is adopted as a local filtering method for image fusion. An important observation of this paper is that the roles of two measures, i.e., pixel saliency and spatial consistency are quite different when fusing different layers. In this paper, the roles of pixel saliency and spatial consistency are controlled through adjusting the parameters of the guided filter.
More importantly, the guided filter is used in a novel way to make full use of the strong correlations between neighborhood pixels for weight optimization. In this researches illustrate that the proposed method can well maintain the original and corresponding information of multiple input images. Positively, the proposed technique is very robust to image registration. Additionally, the proposed technique is working out efficient, making it quite qualified for real applications.

In this paper,[23] here they proposed a new explicit image filter called guided filter. The filtering output is locally a linear transform of the supervision image. Alternatively, the guided filter has good edge-preserving smoothing properties like the bilateral filter, but it does not endure from the gradient reversal work of arts. Alternatively, the guided filter can be used ahead of smoothing: With the help of the guidance image, it can make the filtering output more arrangement and less smoothed than the input. Here they show that the guided filter executes very well in a huge range of applications, together with image flash/no-flash imaging, atting/feathering, dehazing, smoothing/enhancement, HDR compression, and joint up sampling. Furthermore, the guided filter physically has an O(N) time (in the number of pixels N) no estimated algorithm for both gray-scale and high dimensional images, not considering of the kernel size and the intensity range. Characteristically, our CPU implementation accomplishes 40ms per mega-pixel performing gray-scale filtering: so, this is one of the fastest edge preserving filters.

We propose a patch-wise approach for multi-exposure image fusion (MEF) [24]. A key step in our approach is to decompose each color image patch into three conceptually independent components: signal strength, signal structure and mean intensity. Upon processing the three components separately based on patch strength and exposedness measures, we uniquely reconstruct a color image patch and place it back into the fused image. Unlike most pixel-wise MEF methods in the literature, the proposed algorithm does not require significant pre/post-processing steps to improve visual quality or to reduce spatial artifacts. Additionally, the new patch decomposition permits us to handle RGB color channels mutually and thus creates fused images with more stunning color emergences. Extensive experiments show the advantage of the proposed algorithm both qualitatively and quantitatively.

IV. PROPOSED METHODOLOGY

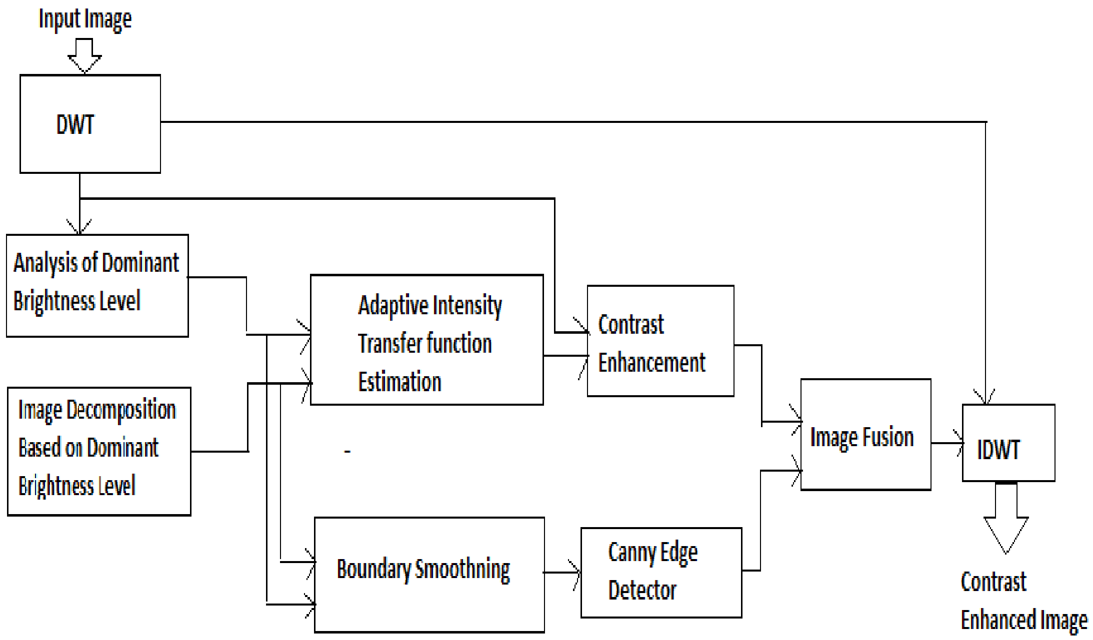
1. Take two images which need to be fused and filtered.
2. Apply DWT transformation of the input image.
3. Investigation of the Dominant brightness level of the LL band of the DWT is executed out.
4. Image Decomposition of image due to the dominant brightness level is carried out.
5. Concern Adaptive intensity transfer functions on dissimilar intensity levels of the decomposed image and then smoothened out.
6. Smoothen image is conceded to the canny edge detection techniques which is subsequently integrated through the Contrast enhancement techniques and is segmented out.
7. The inverse DWT is applied after that to the fusion image and HH, HL, LH bands to get the contrasted image.
8. Now the two enhanced contrast image can be fused to get the result fused image.

The proposed methodology implemented here provides efficient fusion as compared to the existing fusion techniques. The main reason behind the efficient fusion is enhancement of the image and the fusion of the two images using canny edge detection. The source images can be enhanced by applying DWT transformation and finding the pixel region having low intensities. The image when enhanced can be fused with the pixel regions with high intensity values.

DWT Transformation:
Apply DWT algorithm of level 2 in which we have applied HAAR wavelet transformation and can be given as:
```
cH = cell(1,no_of_Level);
cV = cell(1,no_of_Level);
cD = cell(1,no_of_Level);
for iLevel = 1: no_of_Level,[cA{iLevel},cH{iLevel},cV{iLevel},cD{iLevel}] = dwt2(original_image,'haar');
```

```
end
dwtimage = dwt2(original_image,'haar');
fast_ftkernel = dwt2(kernelimage,'haar');e
fast_ftkernel(find(fast_ftkernel == 0)) = 1e-6;
fast_ftblurimage = dwtimage.*fast_ftkernel;
blurimage = idwt2(dwtimage,cH{iLevel},cV{iLevel},cD{iLevel},'haar');
```

Proposed Architecture:



V. Experimental Results

SNAPSHOTS:

Figure 1: Enhanced Images

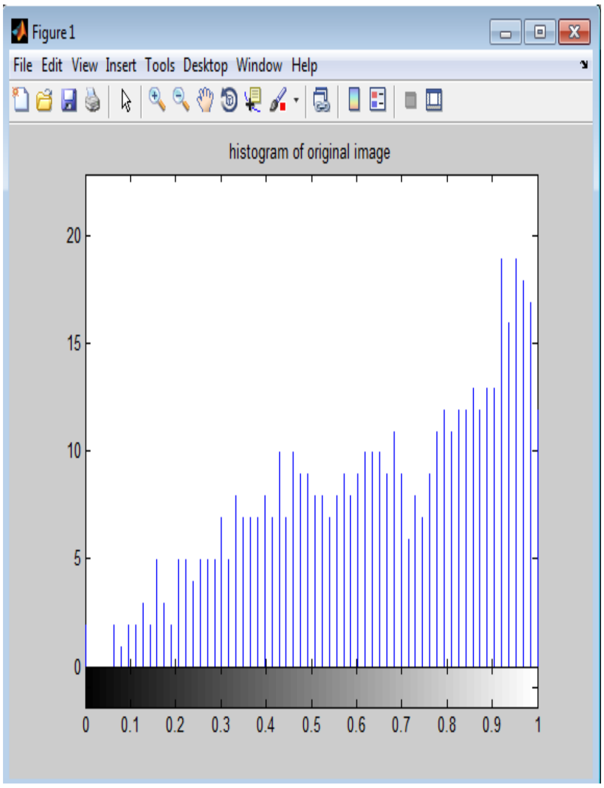


Figure 2: Histogram of Original Images

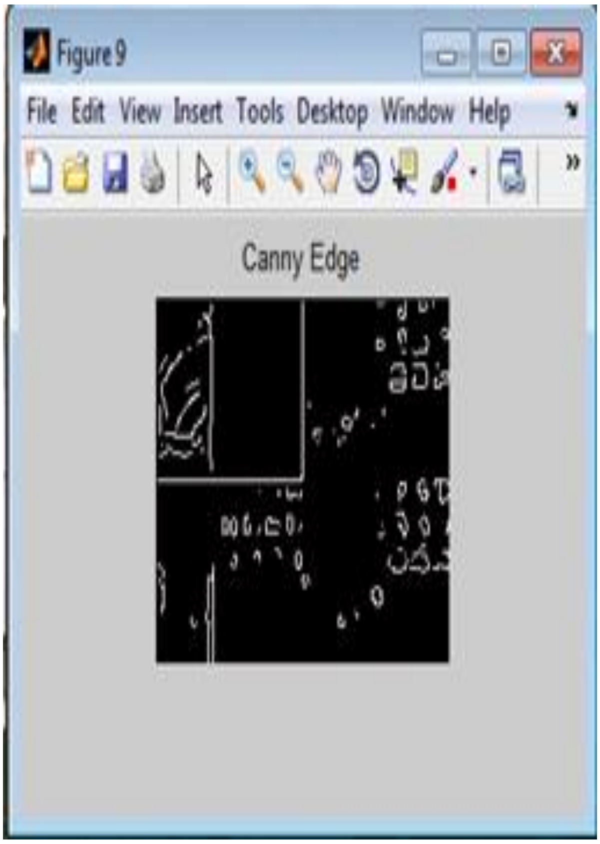


Figure 3: Applying Canny Edge Detection technique on enhanced Images

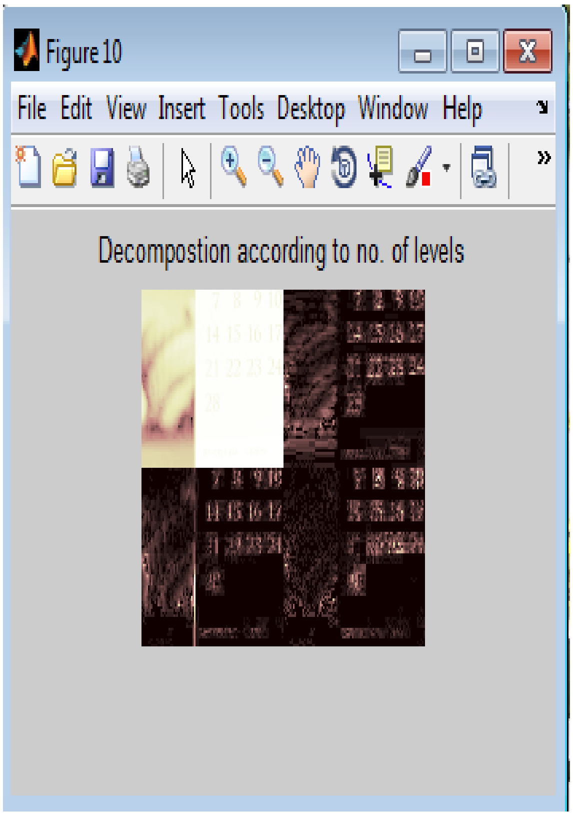


Figure 4: Applying Canny Edge Detection technique on enhanced Images.

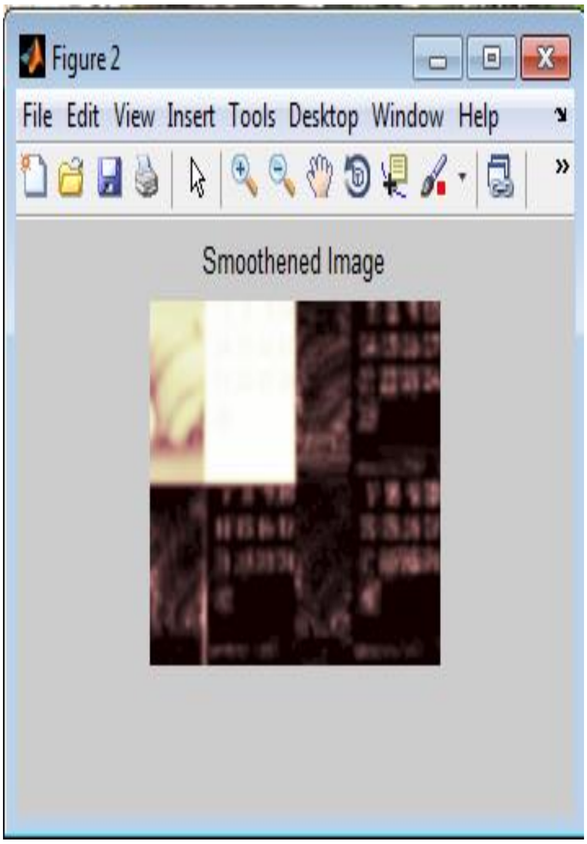


Figure 5: Smoothened Images

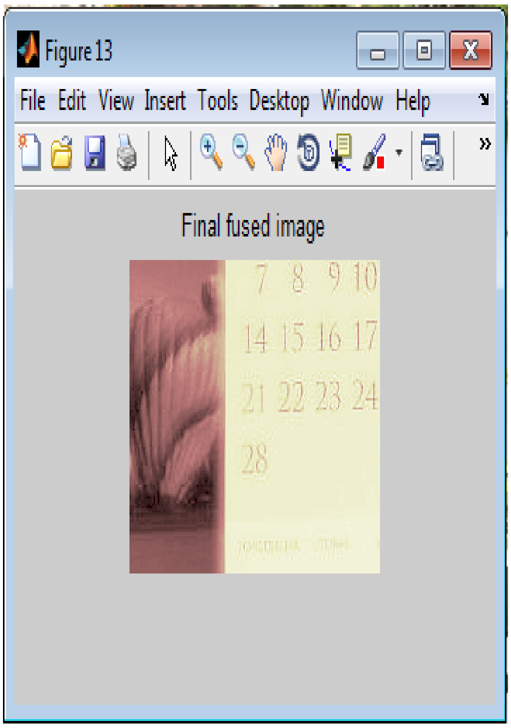


Figure 6: Fusion Images.

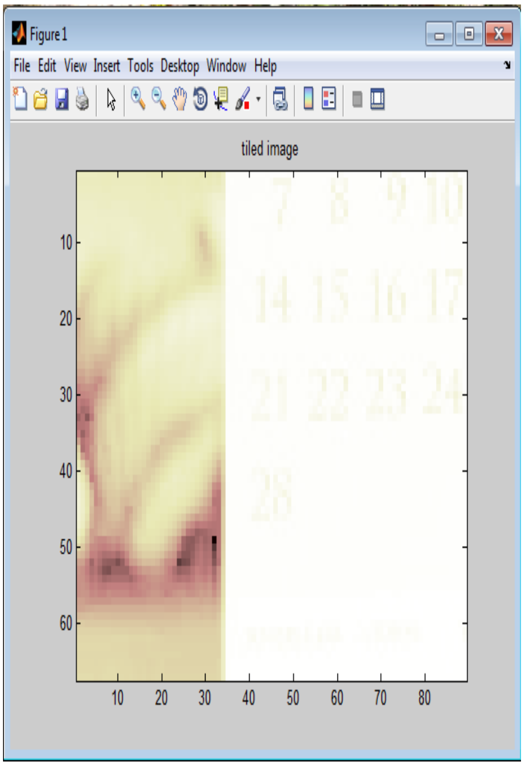


Figure 7: Tiled Images of given fused Image.

VI. CONCLUSION

Various methods of these image fusions can be computed and used to find out which characteristics from which images are consist of the fused image. Image Fusion intends at the mixing of dissimilar and complementary data to improve the information perceptible in the images in addition to increase the consistency of the understanding. The proposed methodology implemented here performs better fusion as compared to the existing technique of fusion of the source images. The comparison between existing and proposed work is done on the basis of various parameters such as Mutual Information, Covariance between two images, Structural Similarity, Computational Time and measure of enhancement of images. The proposed methodology can fused more pair of images as compared to the existing technique. This show the ways to more precise data and increased effectiveness in various application fields like segmentation and classification.

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