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Image Fusion Based on Edge Preserving Decomposition, Guided Filter, Gabor Wavelet Techniques

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ABSTRACT: Image process could be a major analysis space principally it's applications within the areas of medical image process, remote sensing and satellite communications as a result of drawback of less clarity. Image fusion is combining feature of two or additional pictures, either from same source or additional sources into one image. The largely used image fusion methodology is exploitation edge preserving decomposition that provides sensible results however this methodology specifically WLS, however while not introducing vital blurring because of the sharpening of the image. The projected methodology relies on edge preserving decomposition by sharpening filter, guided filter, Dennis Gabor wavelet.

The 3 totally different strategies used for fuse of images from different sources and preserve edges. Experimental results demonstrate that the projected methodology will get progressive performance for fusion of same sensing element images, completely different sensing element images, multi modal images. Compare the higher than 3 strategies performance based mostly image quality metrics parameters.

KEYWORDS: Image fusion, Edge Preserving Decomposition, Guided filter, Gabor Wavelet.

I. INTRODUCTION

The merging of applicable data from 2 or additional same source image into solitary image is understood as image fusion. The extra data may be gathering from the consequence image than the input supply images. From the many algorithmic rule of image fusion will increase the motivation for area sensing element in the main within the remote sensing areas. Within the consolidated output of single image contains the high spectral and spatial data in several conditions. Compared to alternative tool the image fusion provides the higher and realistically information results. By the mix of various supply data the techniques of image fusion may be developed.

The resolution of Spectral and also the spatial distinctiveness may be balanced by the image fusion. At a similar time whereas merging of multispectral information, it alters in sequence of the spectral commonly within the usual techniques of image fusion.

A. Multi modal Fusion:

Pictures completely of various modalities or different sensors.
Example: PET, CT, MRI, visible, infrared, ultraviolet, etc.
Goal: To decrease the number of knowledge, to emphasise band-specific info
Method: Weighted average picture element wise, Fusion in remodel domain, Object level fusion

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B. Multi view fusion:
Images of a similar modality, taken at a similar time however from totally different places or below different conditions or different viewpoints.
Goal: To provide complementary data from totally different views

C. Sensors employed in Remote Sensing:

Remote sensing applications, i.e., fusion of multi-spectral (MS) and panchromatic (PAN) pictures, and fusion of multi-spectral and hyper spectral images. The primary fusion application is a vital drawback in remote sensing, that is understood as pansharpening.

A multi spectral image is one that captures image information at specific frequencies across the spectrum. The wavelengths could also be separated by filters or by the utilization of instruments that square measure sensitive to specific wavelengths, as well as light-weight from frequencies on the far side the light vary, like infrared.

Panchromatic emulsion may be a form of black-and-white coat that's sensitive to all or any wavelengths of light. A panchromatic emulsion produces a sensible replica of a scene because it seems to the human eye.

The remainder of this paper is organized as follows. a short introduction to the edge preserving decomposition supported smoothing are given in Section a pair of. The planned fusion schemes are represented in Section three. Quality metrics and experimental results are given in Section and therefore the last section provides some terminal remarks.

II. EDGE PRESERVING DECOMPOSITION

The edge preserving decomposition has smoothing algorithmic rule that effectively smoothen extremely contrasted oscillations whereas preserving salient edges. By applying this algorithmic rule recursively on the smoothened image, we tend to reason a multi scale decomposition of associate input image into layers at completely different scales of coarseness.

A. Our algorithmic rule is predicated on 2 key observations:
(1) Detail (even if high-contrast) is characterised by an oversized density of native extremal;
(2) Salient edges (even if low-contrast) area unit characterised by an oversized variation in their neighboring extremal values.

B. Smoothing:

We outline detail as oscillations between native minima and maxima .We extract detail by subtracting a smoothened image, that we have a tendency to decision the mean, from the input. The smoothing algorithmic rule uses the native extrema to find oscillations at their finest scale, locally. By interpolating the minima and maxima independently, we have a tendency to construct two extremal envelopes, that sandwich the information, and propagate data concerning native oscillations to all or any pixels within the image.

C .Our smoothing algorithmic rule consists of 3 steps:
1. Identification of native minima and native maxima of I;
2. Interpolation of the native minima and maxima to compute minimal and maximal extremal envelopes respectively;
3. Computation of the smoothened mean M because the average of the extremal envelopes.

The 3 steps of our smoothing algorithmic rule by plotting 1D slices of the Barbara input image (red), its extremal, envelopes (blue and magenta) and smoothened mean (black).

The detail layer is obtained as $D = I - M$.

D. Multi scale decomposition:

A single smoothing operation of I yields a detail image, D1, that contains the finest-scale native oscillations and a mean,M1, that represents a coarser trend. we have a tendency to get a multiscale decomposition of the input

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image by recursively extracting variety of detail layers from the mean. once n algorithmic smoothing operations, we have a tendency to get detail pictures D1,D2, ...,Dn at increasing scales of coarseness and a residual mean image:

$I(P) = \sum \text{DETAIL pictures} + \text{MEAN}$

Choosing k = three because the size of the extrema-location kernel for the primary smoothing step of I ends up in a detail D1 that captures oscillations of frequency up to 3/2 pixel−1.

E. Applications of The Median Filter:

Multi scale decompositions of pictures, into layers of variable distinction, are employed in many applications as well as deed and image abstraction

Hatch to tone:

Few techniques are ready to recover tone from pictures with hatching or stippling, whereas preserving edges. the issue lies in retentive edges represented by these techniques whereas smoothing high-contrast variation. Smoothing filters just like the bilateral filter or weighted method of least squares filter aren't very useful.

F. Drawback of the Median Filter:

1. Separating fine texture and coarse shading
2. Image exploit
3. High dynamic range (HDR) pictures

III. PROPOSED METHODS

A. EDGE PRESERVING DECOMPOSITION BY EXPLOITATION SHARPENING MASK:

The largely used image fusion methodology is exploitation edge preserving decomposition that provides sensible results however this methodology In particular; WLS permits tiny options to gracefully fade in magnitude, in order that they are doing not persist into coarse levels, however while not introducing vital blurring thanks to the sharpening of the image.

This project proposes a completely unique methodology to beat the drawbacks of edge preserving decomposition methodology for image fusion. In future work we'd prefer to investigate additional refined schemes for deciding the smoothness coefficients for the WLS formulation so as to additional improve the flexibility to preserve edges. This novel methodology relies jittery preserving decomposition by sharpening filter. Presently it's attainable to sharpen pictures (which could also be viewed as increasing the native distinction of the best scale details), moreover on modify the world distinction.

In future work we might prefer to investigate additional refined schemes for deciding the smoothness coefficients for the WLS formulation so as to additional improve the flexibility to preserve edges and extract details. Ultimately, we'd prefer to use our decompositions as a basis for a additional refined and additional automatic tool one click resolution for image enhancement.

B. GUIDED FILTER:

It is edge-preserving filters are an energetic analysis topic in image process. Edge-preserving smoothing filters like guided filter, weighted statistical procedure, and bilateral filter will avoid ringing artifacts since they're going to not blur robust edges with in the decomposition method. Among them, the guided filter maybe a recently projected edge preserving filter, and therefore the computing time of that is freelance of the filter size.

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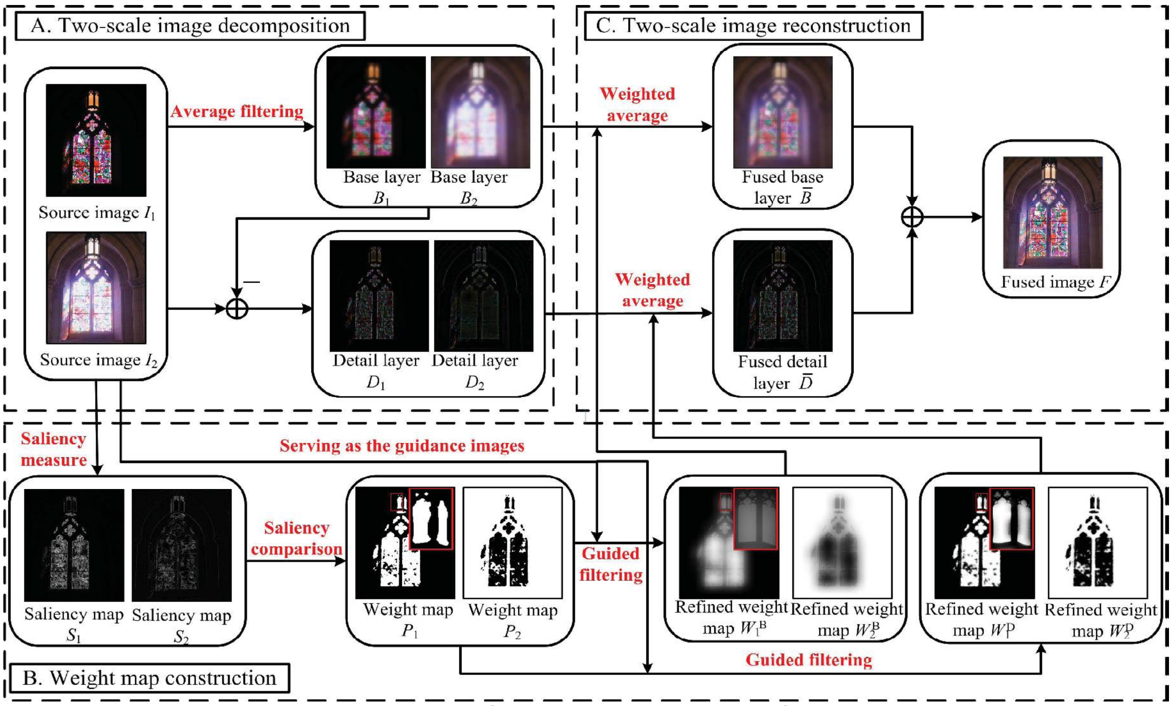

Fig 1: Image fusion based on the guided filter

In the projected methodology the image fusion are often done by victimisation the two scale decomposition method. during this method the two scale decomposition method area unit by victimisation the bottom layer that contain high options. The opposite technique of decomposition method is that the detail layer.

Step 1: **Averaging Filter**

Mean filter or averaging filter may be a easy linear filter and straightforward implementation methodology of smoothing pictures. Average filter is usually accustomed scale back noise and conjointly scale back the quantity of intensity variation from one picture element to a different.

H [i, j]=1M ∑(k ,l)ϵN f(k,l)

Where M is the total number of pixels in the neighborhood N and k, l =1, 2 .. For example, a 3x3 neighborhood about [i, j] yield

H[i,j]= 19k=i-1i+1 j=i-1i+1f(k+l)

Step **2: Weight Map Construction**

Saliency Measure:

Depending on however possible a salient closed contour passes through that edge, we are able to assign a prominence live for an edge. The principles of proximity and smooth- continuation will be conforms by a prominence closed contour.

Laplacian Filter:

The laplacian filter will be used to perform operation on the formation image. the edges will be highlight by exploitation laplacian filter and may be used for the sting detection. The convolving a kernel of weights will operate by the laplacian rule with every grid cell and its neighbor during a image. The kernel weights are

Example:

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0	-1	0
-1	4	-1
0	-1	0

Fig 2: Example of laplacian transform

Step 3**: Gaussian Filter**

By using the guided low pass filter, saliency map S_K can be constructed

$S_k = |G_k| *$ urg,σg

Here u is a size of guassian low pass filter of (2rg+1) (2rg+1) , here the parameters are rg and σg must set the value 5.

Step 4: **Guided Filter**

In this section, the projected guided filter will be used. during this section the guided filter operation will be done on the weighted maps that acquire from the prominence mapping and therefore the input of supply image then the guided output can shaped.

By exploitation the bound parameters the weighted output will be resulted

$W_k^B = H_{r1,\epsilon1}(Q_k, I_k)$

$W_k^D = H_{r2,\epsilon2}(Q_k, I_k)$

Here the parameters of guided filter area unit r1, ϵ1, r2, ϵ2. By victimisation this constant formula we have a tendency to get the weighted map resulted image of the bottom layer and therefore the detail layer.

C. *DENNIS GABOR WAVELET:*

The Fourier transform has been the foremost normally used tool for analyzing frequency properties of a given signal, whereas when transformation, the knowledge concerning time is lost and it's exhausting to inform wherever an exact frequency happens. to unravel this drawback, we will use forms of time-frequency analysis techniques learned from the course to represent a 1-D signal in time and frequency at the same time. there's forever uncertainty between the time and therefore the frequency resolution of the window operate employed in this analysis since it's well apprehend that once the time period get larger, the information measure becomes smaller.

The non-orthonormal wavelets might give an entire illustration only if they type a frame. The ideas of the frame area unit on the far side the scope of this report as a result of it's too theoretical, whereas in most of the applications, we have a tendency to don't very care concerning these non-orthonormal properties if the Gabor wavelets area unit used for "feature extractions". Once extracting options for pattern recognition, retrieval, or computer vision purpose, the reworked coefficients are used for distance measure or compressed illustration however not for reconstruction, that the orthogonal constraint can be omitted.

An odd Gabor perform (sine function) may be understood as a partial differential operator of an odd order, whereas an excellent Gabor operate (cosine function) may be understood as a partial differential operator of an excellent order.

So as to beat all the restrictions that area unit mentioned above, i might prefer to propose one technique referred to as Featured based mostly data fusion victimisation Gabor wavelet transform. The Gabor filter finds its application in feature extraction, face recognition, object detection etc. The given input image is subjected to scale and orientation in order that all the options area unit focused for the elaborate analysis.

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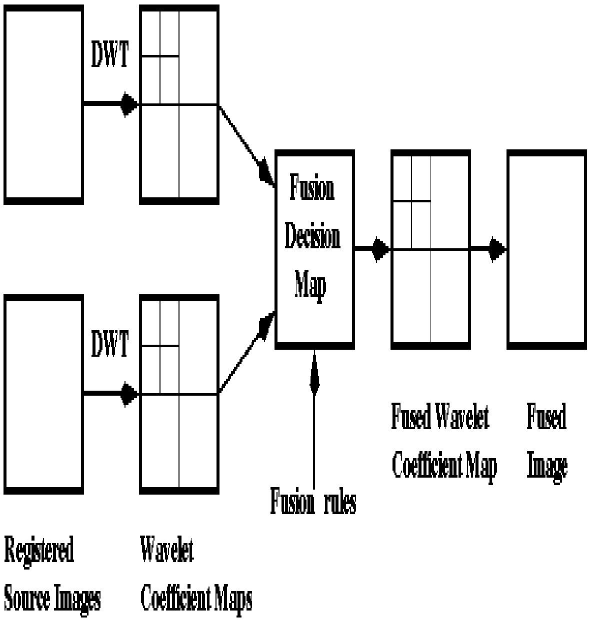

Fig 3: Gabor wavelet image fusion

IV. OBJECTIVE FUSION ANALYSIS METRICS

Generally, a good fusion algorithmic rule should have the subsequent properties:

(1) The consolidated image should be ready to preserve most of the complementary and helpful data from the input images.

(2) The fusion algorithmic rule doesn't produce any visual artifacts which can distract the human observer or the more process tasks.

(3) The fusion algorithmic rule should be strong to some imperfect conditions like mis registration and noise. Objective analysis metrics requiring a reference image.

In some applications, AN “ideal” consolidated image could also be on the market or manually made, which may then be used as a ground- truth to check the performance of image fusion. for instance, in remote sensing image fusion, the input multi-spectral (MS) and panchromatic (PAN) images may be 1st degraded. Then, the degraded pictures area unit consolidated and compared with the first discovered MS pictures to guage the fusion performance. In some special cases of multi-focus image fusion, a reference all-in-focus consolidated image may be made by performing manual segmentation and combination of the centered regions of every input image. once the reference consolidated image is offered, varied objective fusion metrics can be used (known as full-reference quality metrics).

The root-mean-square error (RMSE) and therefore the peak-signal-to- noise-ratio (PSNR) area unit two classical ones. However, the two ways are demonstrated to be not well correlate with human perception in some special cases. Throughout the last decade, variety of latest objective metrics are proposed as higher alternatives.

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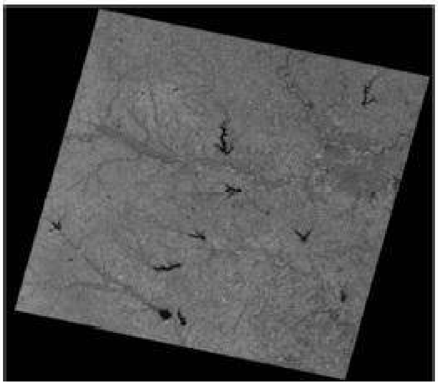
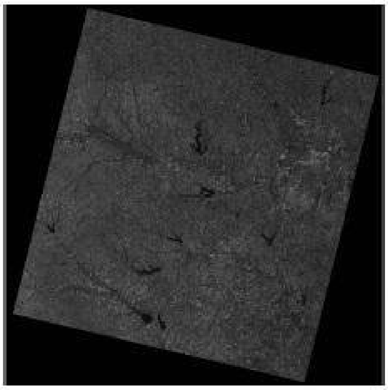
V.RESULTS

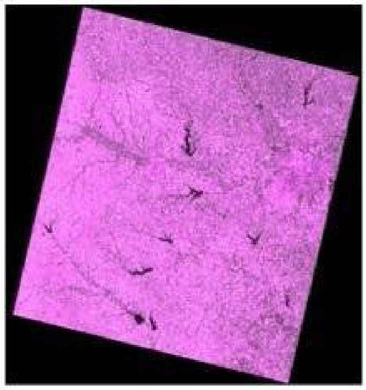
The simulation using MATLAB 2012 version both multi view and multi modal techniques implemented by using existed and edge preserving decomposition by exploitation sharpening mask guided filter dennis gabor wavelet and image fusion quality metrics also calculated by MATLAB software

A. RESULT ANALYSIS FOR MULTI VIEW IMAGE FUSION:

Input images of same sensor i.e panchromatic sensor and also fused images of existed and proposed methods. The simulation results are taken by using MATLAB.



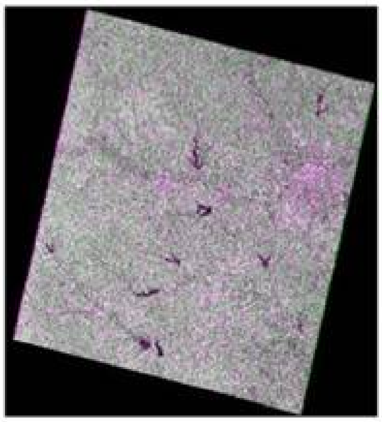


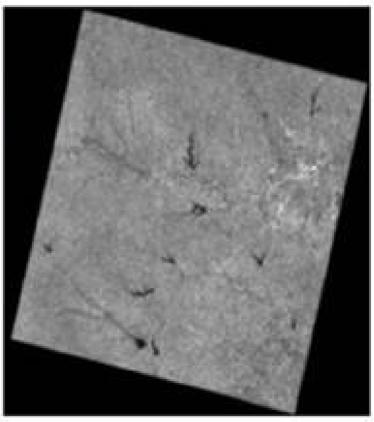


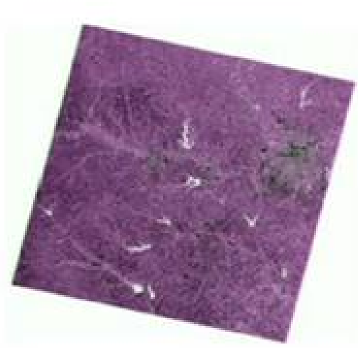
a. First image of same sensor

b. Second image of same sensor

c. Edge preserving decomposition Using smoothing filter fused image(existed method)







d. Edge preserving decomposition using sharpening filter fused image (proposed method 1)

e. Guided filter fused (proposed method 2)

f. Gabor wavelet fused (proposed method 3)

Fig 4: Multi View Image Fusion

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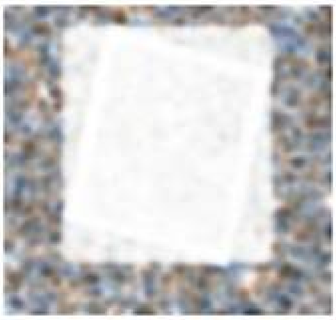
A. SSIM FOR MULTI VIEW IMAGE FUSION:

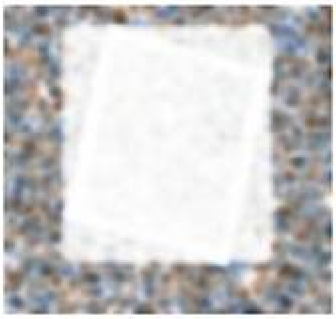
It is one type of quality metrics in image fusion which is mainly employed to calculate the similarity of two images.

a.Edge preserving decomposition using smoothing filter (existed method)

b. Edge preserving decomposition using sharpening filter (proposed method 1)



c.Guided filter fused (proposed method 2)



d. Gabor wavelet fused image(proposed method 3)

Fig 5:SSIM for Multi View Image Fusion

B. QUALITY METRICS FOR MULTI VIEW IMAGE FUSION:

	Edge Preserving Decomposition Using Smoothing Filter(Existed Method)	**Edge Preserving Decomposition Using Sharpening Filter(Proposed Method 1)**	**Guided Filter(Proposed Method 2)**	**Gabor Wavelet(Proposed Method 3)**
MSE	**1.999e+06**	**5.8291e+05**	**2.2506e+05**	**1.9708e+06**
RMSE	**1.4141e+03**	**1.1428e+03**	**1.2620e+03**	**1.4039e+03**
SNR	**16.8514**	**15.9788**	**7.6795**	**19.3987**
PSNR	**20.8868**	**21.1278**	**21.2183**	**20.7330**
SSIM	**0.8726**	**0.8705**	**0.4229**	**0.7743**
AD	**0.6655**	**0.5647**	**0.6720**	**0.7855**
SC	**1.0195**	**1.0176**	**1.0186**	**1.0190**
NCC	**1.0013**	**1.0014**	**1.0003**	**1**
NAE	**0.0107**	**0.0103**	**0.0110**	**0.0111**

Table 1: comparison of existed and proposed methods

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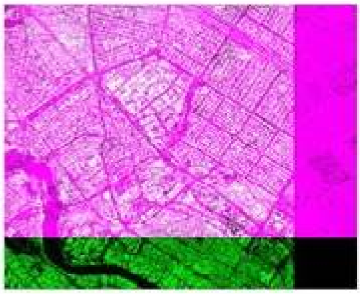
C. RESULT ANALYSIS FOR MULTI MODAL IMAGE FUSION:

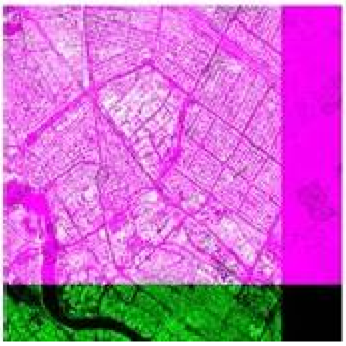
Input images of different sensor i.e panchromatic sensor, multi spectral sensor and also fused images of existed and proposed methods. The simulation results are taken by using MATLAB.

a. Panchromatic image of sensor

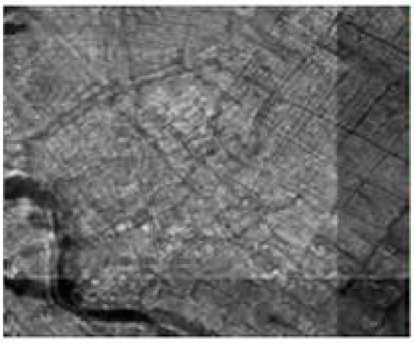
b. Multi spectral image of sensor



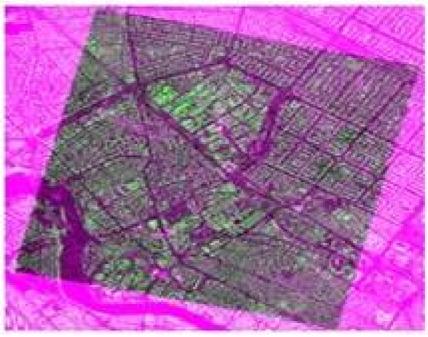
c. Edge preserving decomposition using smoothing filter fused image(existed method)



d. Edge preserving decomposition using sharpening filter fused image(proposed method 1)



e. Guided filter fused image(proposed method 2)

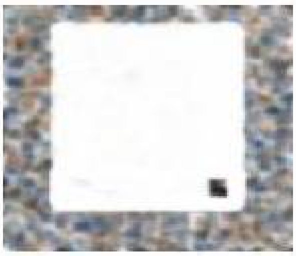


f. Gabor wavelet fused image(proposed method 3)

Fig 6: Multi Modal Image Fusion

D. SSIM FOR MULTI MODAL IMAGE FUSION:

It is one type of quality metrics in image fusion which is mainly employed to calculate the similarity of two images



a. Edge preserving decomposition using smoothing filter (existed method)

b. Edge preserving decomposition using sharpening filter (proposed method 1)

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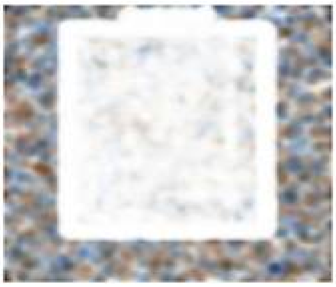
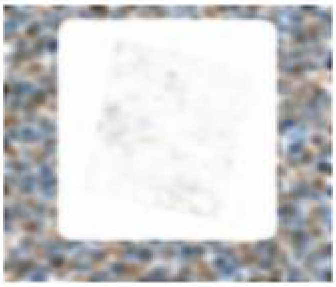


c.Guided filter
(proposed method 2)



d. Gabor wavelet
(proposed method 3)

Fig 7:SSIM for Multi Modal Image Fusion

E. QUALITY METRICS FOR MULTI MODAL IMAGE FUSION:

	Edge Preserving Decomposition Using Smoothing Filter(Existed Method)	**Edge Preserving Decomposition Using Sharpening Filter(Proposed Method 1)**	**Guided Filter(Proposed Method 2)**	**Gabor Wavelet(Proposed Method 3)**
MSE	**1.8648e+06**	**1.7026e+06**	**4.1231e+06**	**1.6070e+06**
RMSE	**1.4923e+03**	**1.5023e+03**	**1.2771e+03**	**1.2677e+03**
SNR	**18.4482**	**18.2759**	**17.7228**	**17.7383**
PSNR	**20.5015**	**20.6413**	**22.1222**	**21.8403**
SSIM	**0.9673**	**0.9659**	**0.9132**	**0.9632**
AD	**0.8501**	**0.8810**	**0.7118**	**0.7260**
SC	**1.0200**	**1.0208**	**1.0188**	**1.0200**
NCC	**1.0017**	**1.0028**	**1.0002**	**1.0053**
NAE	**0.0112**	**0.0115**	**0.0114**	**0.0118**

Table 2: comparison of existed and proposed methods

VI. CONCLUSION

The image fusion technique was implemented using Matlab. The fusion was performed on same sensor images and different sensor images. Multi modal image fusion and Multi view image fusion performed three different type of techniques used. A set of images metrics were developed to assess the fused image quality. The fused images of each set were also assessed based on their visual quality. The quality assessment based on the image metrics developed and visual perception was compared to assess the credibility of the image metrics.

The assessment based on the image metrics readings saw that the fused images produced by edge preserving decomposition using sharpening filter, guided filter, gabor wavelet methods were the most inferior in quality with respect to the perfect images considered in each of Multi view and Multi modal image fusion.

From the results, the PSNR has been improved and MSE has been decreased. The quality of the image also has been improved. Thus we can conclude that the results obtained by this Edge preserving decomposition using sharpening filter, guided filter, gabor wavelet techniques has been improved.

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VII. FUTURE SCOPE

Although various image fusion and objective performance evaluation methods have been proposed, at the present time, there are still many open-ended problems in different applications. In this section, the future trends in different application domains, i.e., remote sensing, medical diagnosis, surveillance, and photography, are analysed.

In remote sensing, the major problem is how to decrease visual distortions when fusing multi-spectral, hyperspectral, and panchormatic images. Furthermore, although the input images are usually captured with the same platform, different imaging sensors do not exactly focus on the same direction and their acquisition moments are also not precisely identical. In this situation, precise registration is challenging due to the significant resolution and spectral difference among the source images. At last, due to the fast development of remote sensing sensors, developing novel algorithms for fusion of images captured by novel aircraft or satellite sensors will be a hot research topic.

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BIOGRAPHY

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