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An Attempt For Comparing Different Techniques Of Image Fusion

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ABSTRACT

The goal of image fusion is to create an output picture that is more informative and valuable than any of the individual input images by combining information from all of the input photos. It raises the bar for how useful and accurate data may be. The quality of the resulting merged image changes with each use. Stereo camera fusion, medical imaging, monitoring production processes, electrical circuit design and inspection, sophisticated machine/device diagnostics, and intelligent robots on assembly lines are just few of the many applications of image fusion. Image filtering is one of the most fascinating uses of image processing. Size, shape, colour, depth, smoothness, etc. may all be tweaked with picture filtering. The basic idea is to use some kind of graphic design and editing software to manipulate the image's pixels until you get the result you want. This paper provides an overview of the many uses of image filtering methods.

Keywords: -Image, Techniques. Fusion, Objects, Application

I. OVERVIEW

To improve photos or create automated systems, researchers have been studying how to extract meaningful information from limited-capture still photographs and movies for decades. The processing of more complicated real-world scenarios, such as those with noise in data, rapid motion or lighting fluctuation, non-rigid or articulated movement of objects, backdrop variation, etc., has become necessary due to the rising need for intelligent automated systems in recent years. Real-world image sequences are processed in most intelligent automated systems, such as surveillance systems, intelligent cars, and so on, in order to recognise and track dynamic objects in a complicated environment. There are many established benchmark methods for detecting and tracking dynamic objects in complex environments thanks to the rise of advanced computational systems and efficient imaging devices that have made it possible to capture noise-free images and process high-dimensional data very efficiently.

To this day, it remains difficult to recognise and track objects in movies due to the presence of a constantly shifting background and other complicating factors. When a camera is mounted to a moving object (like a car), each pixel in a sequence of two frames will have different information, creating the illusion of motion in the background as well. Thus, it is a difficult challenge to distinguish between a pixel holding background information and a pixel containing foreground information; the standard techniques of extracting foreground using a backdrop template are impractical for movies with a dynamic background. Successful identification and tracking of moving objects against a dynamic backdrop is an active area of study, and some preliminary results have been published. In order to estimate global or camera motion, these algorithms typically compute optical flows, locate feature points or regions of interest in frames, and then compare the trajectories of these points or regions to a geometric or probabilistic model of motion. Extracting labelled foreground features or eliminating background features allows for the detection of moving objects.

II. CONCEPT OF IMAGE FUSION

The term "image fusion" refers to the method through which data from many photographs are combined into one. Remote sensing, medical imaging, the military, and astronomy are just few of the many fields that make use of image fusion techniques. Combining many photos into one larger image is known as "image fusion," and it can improve the usefulness of the data contained inside. Image fusion is crucial because it enhances the efficiency of object identification systems by combining data from several satellite, aerial, and ground-based imaging systems. In addition, it aids in picture enhancements including sharpening, geometric corrections, bringing out details that aren't present in either image, data replacement, and data complementation, all of which contribute to more informed decision-making. It takes the best features of two or more photographs and creates a new image that more accurately portrays the situation while still including relevant details from the original images. Due to the presence of both natural and man-made elements in the picture, a high resolution panchromatic image provides geometry features of the image, while a low resolution multispectral image provides colour information of the source image. Multisensor image fusion works to combine the visual data from many pictures with diverse geometric representations into a single, unified image with no loss of data. Image fusion's benefits include enhancing detail, creating more accurate categorization systems, and even generating stereo pairs of images. The advantages of multi-sensor image fusion include expanded operational capabilities, enhanced spatial and temporal features, enhanced system performance, less ambiguity, and more dependability.

Image fusion methods can be broken down further into subcategories according to the depths of processing they employ. Pixels, features, and symbols can all play a role in the final selection. The simplest and most popular technique is the pixel-level approach. With this technique, the majority of the original picture data is preserved when processing the source image's pixels. The accuracy of pixel-level picture fusion is superior than that of the other two approaches. An image's features are analysed by this technique. When used with the decision level method, this technique can successfully merge pictures. Smaller files make data transmission and compression simpler. The decision-making stage is the pinnacle of image fusion. It takes advantage of the data information gleaned from the pixel level fusion or the feature level fusion to arrive at the best possible option in order to accomplish the goal at hand. In addition, it lessens the occurrences of duplicate data and ambiguous details..

III. APPLICATIONS AND USES OF IMAGE FUSION

- As a result of a clear satellite perspective, it finds use in space and satellite applications.
- The frequency and spatial resolution of the imaging vision used in medical imaging for illness analysis.
- It is put to use in military contexts for the detection of threats and other types of task impediment.
- Fused images are typically employed in robotics applications for the purpose of identifying frequency divergences in the picture.
- It finds use in artificial neural networks, which use wavelength conversion to determine their central length.
- Improved road map extraction is one example of an image fusion application, and it plays a crucial role, especially in large cities, when employing high-resolution images and an edge-extraction method.

Standard fusion techniques include weighted average, arithmetic mean, minimum mean squared error, and maximum mean squared error. They are not suitable for usage in real-time applications due to the technique's noisy, blurry, and low-contrast output. Color distortion is an unintended side effect of commonly used statistical methods including principal component analysis (PCA), high-pass filtering (HPF), and Brovey. Using PCA to fuse a picture improves the spatial quality but degrades the spectral quality. It is based on Fusion methodologies that all pyramid theories provide about the same results. These procedures are frequently used for applications with several foci. In a real-time system, the Discrete Cosine Transform (DCT) technique is employed; however, it cannot be utilized with block sizes less than 88. The spectrum distortion of the DWT method is small and the Signal to Noise Ratio is rather high. However, wavelet approaches aren't well-suited for many uses because of their isotropic nature, which prevents them from capturing the image's long edge and curve. As opposed to the standard wavelet transform, the SWT technique is able to properly characterize the detailed components of pictures and breakdown them. As with any method, there are benefits and cons to using this one. This suggests that there is no superior fusion hypothesis. Hybridization of these approaches is required for some uses; for example, combining principal component analysis (PCA) with discrete wavelet transform (DWT) yields a decent final picture fusion.

IV. COMPARISION OF IMAGE FUSION TECHNIQUES

Image fusion is categorized into two parts as shown in figure 1:

1. Spatial domain.
2. Frequency domain.

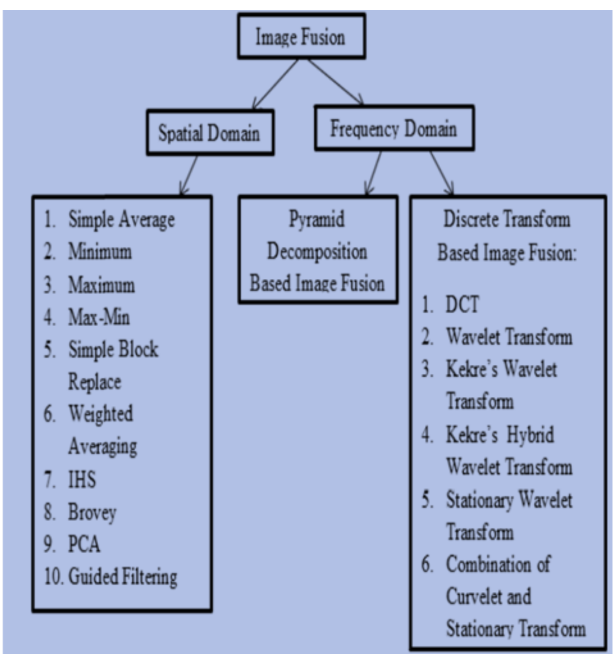

Figure 1: Image fusion techniques

Simple Image Fusion Technique

Averaging Technique:

The simplest module in the spatial domain. Using an average method results in a lower quality fused image due to the introduction of noise into the image. As a result, unintended consequences, such as diminished contrast, are mitigated. The equation 1 based on the resulting picture is then used.

$$F(i,j) = \frac{A(i,j) + B(i,j)}{2}$$

Where

A(i,j) ,B(I,j) are input matrixes and F(i,j) is the output matrix.

This technique does not give guaranteed to have a fine data from the group of images.

Greatest Pixel Value Technique:

This technique selects the greatest value from corresponding pixels .The fused image is obtained as

$$\mathrm{F(i,j)} = \sum_{\mathrm{i=0}}^{\mathrm{m}} \sum_{\mathrm{j=0}}^{\mathrm{n}} \max(\mathrm{A(i,j)B(i,j)})$$

Where

A(i,j) ,B(I,j) are input matrixes and F(i,j) is the output matrix.

The merged picture is an extreme zoomed-in version of the original. The blurring effect, which changes the contrast of the image, is a key factor in this method.

Minimum Pixel Value Technique:

The minimum value of intensity is chosen and is inserted the resultant data in the fused image. The fused image can be calculated by the following equation.

$$\mathrm{F(i,j)} = \sum_{\mathrm{i=0}}^{\mathrm{m}} \sum_{\mathrm{j=0}}^{\mathrm{n}} \min(\mathrm{A(i,j)B(i,j)})$$

Where

A(i,j) ,B(I,j) are input data and F(i,j) is the output data

Max- Min Technique:

The minimum and maximum values of input images are chosen and the averages are calculated. The final value is saved as the values of the pixel in the output data

Weighted average Technique:

The different weights are allocating to all input images and the Pixels (x,y) of fused image are applied by computing weighted sum of all corresponding pixels in input images. It improves the detection reliability but increases the signal to noise ratio (SNR)of the fused image:

$$F(i,j) = \sum_{i=0}^{m} \sum_{j=0}^{n} W * A(i,j) + (1 - W) * B(i,j)$$

Where

A(i,j) ,B(i,j) are input data and F(i,j) is output data and W is the weight factor.

The Principal Component Analysis Technique (PCA):

Principal component analyses The principal component analysis (PCA) technique is used to reduce the dimensionality of information groups that exist in several dimensions by means of a vector space conversion. When it comes to eigenvector-based multivariate investigations, principal component analysis (PCA) is one of the most straightforward and helpful options available because of its ability to discover information's underlying structures in a fair and objective manner.

Using principal component analysis, we may transform the connected data into independent data. To begin, the PCA is employed to achieve the greatest possible change in a given direction. As a second point, the major components are described in a subspace that is perpendicular to the first; the first component dots the path of maximum variation. The third stage of principal components analysis is carried out in response to the direction of highest difference in a subspace that is orthogonal to the preceding two stages. Karhunen-Loève and the Hotelling transform are two more names for this method.

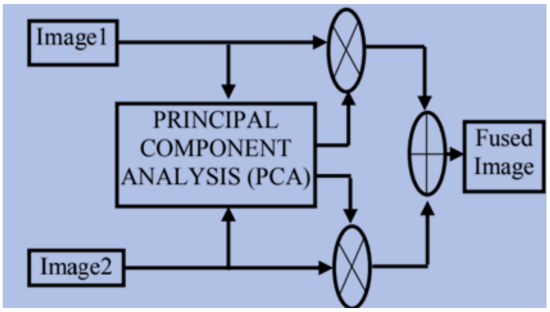

Figure 2: The flow diagram in image fusion scheme employing PCA.

<u>High Pass Filter Technique (HPF):</u>

When high pass filtering is used to create a multispectral image, the resulting "HPMI" has a high resolution. The fused 2D signals are acquired by the collection of high-frequency data from a High Resolution Panchromatic Picture (HRPI) and a low-resolution multispectral image. One way to implement this approach is to apply a high pass filter to the HRPI, while another is to subtract the Low Resolution Panchromatic Image (LRPI) from the original HRPI.

<u>Brovey Transform Technique:</u>

It is known as "the colour normalization transform "[46]. The mean advantage of Brovey Transform is the simplicity and grants attractive images and high contrast RGB image can be obtained by Brovey Transform [43]. This method is not applied for the original scene radiometry and bounded to only three bands [48]. Brovey Transform Technique can be applied by the following equation.

$$\mathrm{Fusion}_i = \frac{\mathrm{band}_i}{\sum \mathrm{band}_n} \text{ X PAN}$$

Where

Fusion_i is the output image, i=1,2,3.

Pyramid Technique

A pyramid method can operate a lot of data at various scales which is representing together the original image. In general, this method consists of three major stages

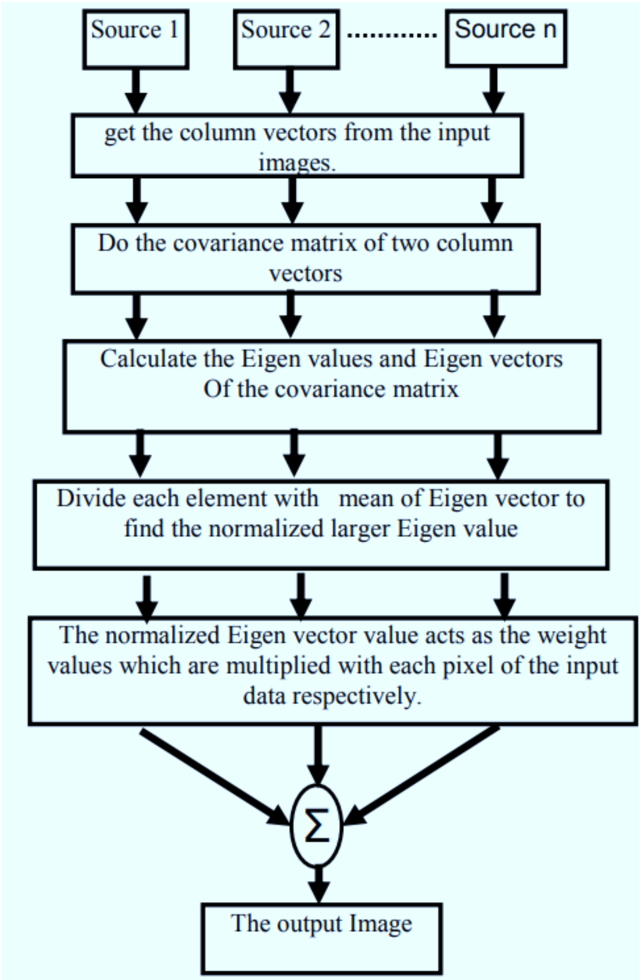

Figure 3The block diagram of PCA algorithm

Discrete Transform Based Fusion Technique

The Discrete Transform based fusion can be described by the following scheme in Figurebelow.

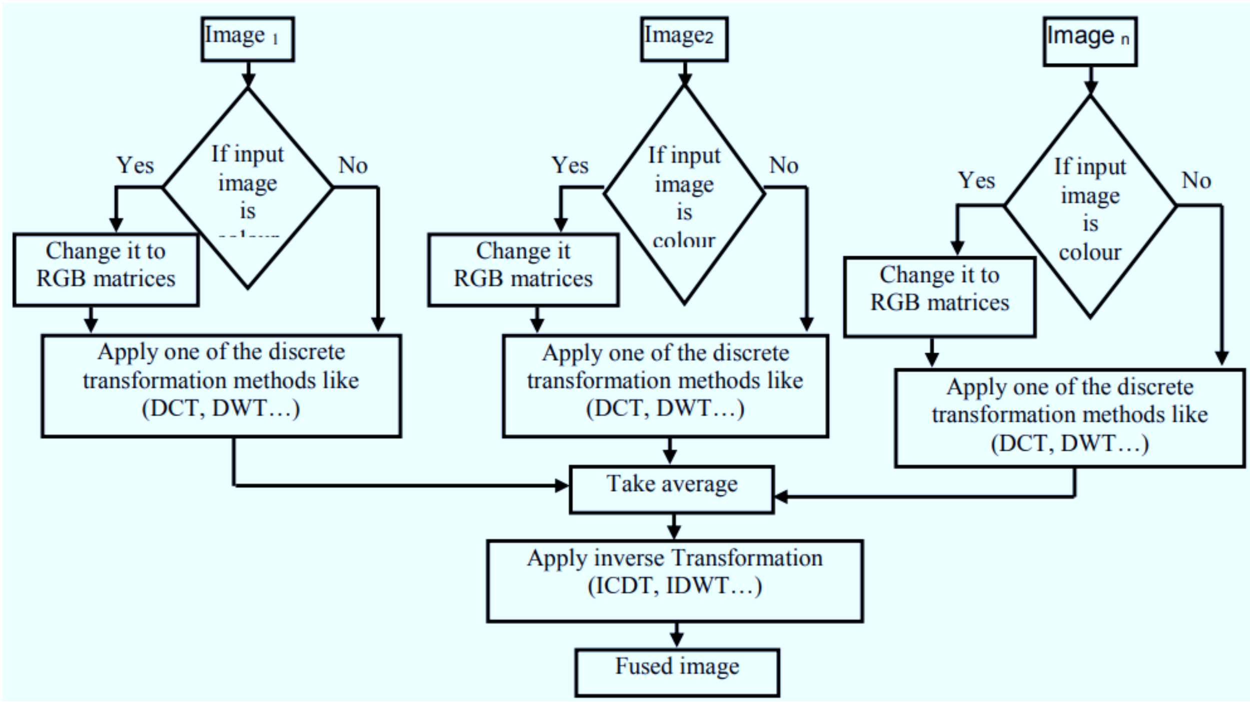

Figure 4The block diagram of Transform based pixel level mage fusion scheme.

In this paper, we take a look at various algorithms from the theories of the spatial and frequency domains. The primary objective of this research was to provide a road map for any expert interested in pursuing image fusion as a career path. The first step in selecting an appropriate image fusion method is identifying the specific use case that will benefit from the technique. Table 1 provides a quick comparison of the benefits and drawbacks of various image fusion methods, allowing for a more informed decision to be made.

Table 1:Comparison of Image fusion Techniques

FUSION METHOD	ADVANTAGE	DISADVANTAGE	DOMAIN
Technique	All these techniques are very simple, easy to calculate d and implemented	Decrease the quality of resultant image fusion because this technique added a noise into fused image.	**Working on Spatial domain**
Maximum Pixel Value Technique		These techniques introduced blurred output which is affect to the	

Minimum Pixel Value Technique		contrast of image , so these methods are not applied into real time applications	
Max-Min Pixel Value Technique			
Weighted average technique	Improves the detection reliability	Increasing SNR of resultant image.	
Principle Component Analysis Algorithm	Very simple, fast processing, time, high spatial quality and efficient for computational	Spectral degradation and colour distortion	
Brovey technique	Very simple, fast processing, time, and efficient for computational. It introduced RGB image with high contrast degree.	Colour distortion	
Laplacian / Gaussian Pyramid	Good visual qualities of multi focus images.	All these techniques produce more or less similar output image. The number of decomposition level effect on the result of fused image	**Working on Frequency domain**
Gradient Pyramid			
Ratio of low pass Pyramid			
Morphological Pyramid			
Discrete cosine Transform (DCT)	This method decreases the complexity and analysis the image into series of waveform. This	Provide not good quality on image fusion if block based smaller then 8X8 or	

	technique can be applied on real applications.	the image size itself.	
Discrete wavelet transform (DWT)	Introduce good quality resultant image fusion and high SNR and decreases the spectral noise	The resultant image is less than spatial resolution.	**Working on Frequency domain**
Kekr' Transform	Generate various variable of KW transform depending on the size of Kekre transform		
Stationary wavelet transform (SWT)	**Provide a good result in second level of decomposition.**	**This method consume a lot of time for calculation.**	

V. CONCLUSION

Combining many photos and then drawing out relevant details from them is what image fusion is all about. Specifically, the Fuzzy Interference system is employed by the Fuzzy let Fusion Algorithm to accomplish the aforementioned image fusion. This system performs well because it combines the best features of a SWT with a fuzzy logic system. It also provides excellent PSNR and RMSE values. These figures are more accurate than those obtained by using SWT and Fuzzy logic separately. For this reason, it has a wide range of potential uses in the field of image processing.

REFERENCES: -

[1] Desai, Bhishman&Kushwaha, Utkarsh&Jha, Shivam. (2020). Image Filtering - Techniques, Algorithm and Applications. Applied GIS. 7. 101.

[2] Y.Sun and L.Jiang, ''Color multi-focus image fusion algorithm based on fuzzy theory and dualtree complex wavelet transform'', Journal of Algorithms & Computational Technology, Vol.11,Issue:2, pp.163-9, 2017.

[3] A.Dogra, B.Goyal and S.Agrawal, ''From multiscale decomposition to non-multi-scale decomposition methods: a comprehensive survey of image fusion techniques and its

applications'', IEEE Access, Vol.5, pp.16040-67, 2017.

[4] M. - C. Chuang, J. - N. Hwang, J. - H. Ye, S. - C. Huang, and K. Williams, ”Underwater Fish tracking for moving cameras based on deformable multiple kernels”, IEEE Trans. Syst., Man, Cybern., Syst., vol. PP, no. 99, pp. 1 - 11, Feb. 2016.

[5] Mishra, Dhirendra&Palkar, Bhakti. (2015). Image Fusion Techniques: A Review. International Journal of Computer Applications. 130. 7-13. 10.5120/ijca2015907084.

[6] K. Zhang, L. Zhang, Q. Liu, D. Zhang, and M. - H. Yang, ”Fast visual tracking via dense spatio-temporal context learning”, in Proc. European Conference on Computer Vision, 2014, pp. 127 - 141.

[7] Kusum Rani, Reecha Sharma,” Study of Different Image Fusion Algorithm,” International Journal of Emerging Technology and Advanced Engineering (IJETAE), Vol. 3, Issue 5, May 2013

[8] T. Lim, B. Han, and J. H. Han, ”Modeling and segmentation of floating foreground and background in videos”, Pattern Recognition, vol. 45, no. 4, pp. 1696 - 1706, Apr. 2012

[9] Mitchell, Harvey. (2010). Image Fusion: Theories, Techniques and Applications. 10.1007/978-3-642-11216-4.

[10] N.Mitianoudis, T.andtathaki, ''Pixel-based and regionbased image fusion schemes using ICA bases'', Information Fusion, Vol. 8, Issue:2,pp. 131- 142,2007.

[11] Michael. J. Smith "Bayesian Sensor Fusion a framework for using multi-modal sensors to estimate target location and identities in a battlefield scene" PhD thesis, Florida state University, 2003.