IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⋇ Impact Factor 7.39 ⋇ Vol. 11, Issue 7, July 2022

DOI: 10.17148/IJARCCE.2022.11738

Comparative Analysis of various Image Fusion Techniques

Dhanya M S[1], Harshitha D[2], Mounitha T S[3], Shreya M [4], Seema Srinivas [5]

[1,2,3,4] Student, Department of Electronics and Communication Engineering,

Global Academy of Technology, Bengaluru-60

[5]Seema Srinivas: Assistant Professor, Department of Electronics and Communication Engineering

Global Academy of Technology, Bengaluru-60

Abstract: Image fusion is a technique used to extract significant information from a set of input images and combine it to get a single output image to create a more informative and useful image than any of the input images. The primary usage of image fusion in multi-focus cameras is to retrieve the multi-focused image by combining data from various images of the same scene. The review of various image fusion methods, including the Averaging Method, Select Maximum/Select Minimum, Discrete Wavelet transform-based fusion, and Principal Component Analysis (PCA)-based fusion, is presented in this paper. All of the methods are compared to determine which method is the most effective for further study.

Keywords: IF,PCA, DWT, DCT, Spatial, Frequency, colour distortion.

1. INTRODUCTION

Image fusion is the process of fusing the pertinent data from a number of input images into one image, with the end result being a more comprehensive and useful image than any of the input images. It is a practical method for combining images from single and multi-sensors to improve the data. Effective image fusion keeps important information by extracting all pertinent data from the images without introducing any inconsistencies into the final image. The merged image is better suited to machine and human perception.

The quality and applicability of the data are enhanced by the image fusion process, which provides more information than any of the input images. Depending on the particular application area, "quality" has several meanings. The methods for acquiring images have significantly improved in recent years. The most recent technologies enable us to extract a wide range of information from an image. This data can be "fused" collectively to create a far more informative image. The four methods of image fusion are multi-view, multi-temporal, multi-modal, and multi-focus. On a set of images taken by the same sensor but from several angles, multi-view image fusion is carried out. A group of images that were taken using several sensors are combined using multiple modalities. Images of the same scene taken at several times are combined using multi-temporal fusion. Images taken at various focal lengths are combined using multiple focus lenses.

Image fusion (IF) is a developing field that combines images from many sensors to create an informative image that may be used for decision-making [5].

Pixel, feature and decision levels are where image fusion occurs. Before original information is calculated and recognized, data from many sources is combined and analyzed at the pixel level, a low level of fusion. A crucial feature is extracted from an image at the feature level, which is the middle level of fusion. These characteristics include shape, length, edges, segments, and direction. High-level fusion at the decision level identifies a precise target.

Medical imaging, computer vision, microscopic imaging, remote sensing, and robotics are a few of the significant uses of image fusion. Currently, the multi-resolution analysis is a very effective method for studying remote sensing images. In addition to lowering the amount of data, image fusion aims to provide a single augmented image that is more suited for future image processing tasks such as object detection, segmentation, and target recognition in remote sensing and medical imaging.

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified ⁙ Impact Factor 7.39 ⁙ Vol. 11, Issue 7, July 2022
DOI: 10.17148/IJARCCE.2022.11738

1.1 OBJECTIVE

The objective of this paper is to:

- Combine data from various photos to create a single image that only contains important information.
- Comparison between various image fusion techniques with their advantages and disadvantages.
- To get a fused image with the integration of information from more than one image.
- Obtain resultant image that is more advanced as compared to any other individual source images.

2.1 IMAGE FUSION TECHNIQUES

The necessary data from each of the input images is combined throughout the image fusion process to create a final image whose quality is better than any of the input images. Two main categories can be of image fusion techniques are :
• Spatial domain fusion
• Frequency domain fusion

In the spatial domain, we deal directly with an image's pixel value. To get the desired output, the pixel values are altered. The Fourier Transform of the image is computed first in the frequency domain approach. The Fourier transformed image is subjected to all Fusion procedures, and the Inverse Fourier transform is used to produce the final image. Every industry that requires the analysis of images uses image fusion. For instance, computer vision, remote sensing applications, satellite image analysis, medical image analysis, microscopic imaging, and war field monitoring.

2.1.1 SIMPLE AVERAGING

This method uses the average intensity of related pixels from the two input images to create the fused image. Equation [1] provides the formula used to determine the average value.

$$p(i,j) = \frac{x(i,j)+y(i,j)}{2} \quad \text{------------------}(1)$$

Where, X (i, j) and Y (i, j) are the two input images.
It is a known fact that in focus areas of image typically have higher pixel intensities. This method is an easy way to get an output image with every region in focus.

2.1.2 SELECT MAXIMUM

For each corresponding pixel in the input images, a selection procedure is carried out, and the pixel with the greatest intensity is chosen in turn and added as the last pixel of the fused image [6].

$$P(a,b) = \sum_{a=0}^{i} \sum_{b=0}^{j} \max[X(a,b)Y(a,b)] \ldots (2)$$

The higher the pixel values, the more in focus the image. This method chooses the in-focus regions from each input image by choosing the greatest value for each pixel, resulting in a highly focused output.

2.1.3 HIS TRANSFORM

This fusion is based on the RGB-HIS conversion paradigm, in which the I-intensity parameter refers to the total amount of light that enters the eye and the H-hue parameter refers to the main wavelength of a colour. According to IHS, all the information included in the high-resolution image are directly incorporated into the intensity component due to the assumption that the intensity is created by an even contribution from the RGB bands. Combining the image elements to produce an image with high spatial quality is a pretty simple process.

2.1.4 PRINCIPAL COMPONENT ANALYSIS (PCA)

A mathematical procedure called principal component analysis (PCA) turns a large number of correlated variables into a large number of uncorrelated variables .It determines the best way to describe the data set. The majority of the data variation is explained by the first principal component. The first principal component must be in the subspace perpendicular to the second, and the third principal component must be in the subspace perpendicular to the first two in

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified ⁂ Impact Factor 7.39 ⁂ Vol. 11, Issue 7, July 2022
DOI: 10.17148/IJARCCE.2022.11738

the greatest variance direction. A subspace method called principal component analysis breaks down multidimensional data sets into smaller dimensions for study. The fused image has good spatial quality and is very simple to use.

2.1.5 LAPLACIAN PYRAMID BASED

The laplacian pyramid of the two input images is first built in laplacian pyramid fusion. Sum up the two pyramids that correspond to each level's average. Two low resolution images at each level are simply averaged to produce the final image. The process of decoding an image involves first extending, then adding up all the layers of the fused pyramid, which is created via straightforward averaging. The image is first divided into frequency-based segments, and the segments are then combined. The image is separated into two layers, with the top layer serving as the overall representation and the lower layer serving as storage for the individual image features.

2.1.6 DISCRETE WAVELET TRANSFORM (DWT)

An image x is processed through a number of filters in order to calculate the Discrete Wavelet Transform Method (DWT) [3]. To simultaneously deconstruct the signal, a high-pass filter h is applied after a low-pass filter impulse response g. The outputs provide detail coefficients (from the high-pass filter) and approximation coefficients (from the low-pass filter). Approximation coefficients are decomposed by low and high pass filters, followed by down sampling, in order to increase the frequency resolution further. To create a fused image, an Inverse discrete wavelet transform (IDWT) is applied to the fused decomposed level.

When using a higher level of decomposition for image fusion, this method performs well. It also minimizes colour distortion better than spatial domain fusion techniques.

2.1.7 DISCRETE COSINE TRANSFORM(DCT)

A finite sequence of data points is described in terms of the sum of cosine functions that oscillate at different frequencies using the wavelet technique known as the discrete cosine transform. In order to create a higher-quality fused image, DCT divides images into non-overlapping blocks of size N*N, computes the DCT [4] coefficients for each block, and then applies the fusion rules. It simplifies things and breaks down visuals into a series of waveforms. Real-world applications can make use of this technique.

2.1.8 CURVELET TRANSFORM METHOD

In graphics applications, the curvelet transform is a tool for depicting curved shapes. Then, it was expanded to include edge detection and image denoising. Curvelets' ability to express curves as a collection of overlaid functions with varying lengths and widths is their fundamental advantage. Contrary to wavelets, the curvelet transform is a multiscale transform that also includes directional features. In order to divide an image into distinct scales, curvelets are built on multiscale ridgelets and bandpass filtering. In comparison to other transformations, the curvelet transformation has more benefits for the analysis of curved edges, high accuracy approximation, and describing scattering and directions.

TABLE 1: COMPARISON OF IMAGE FUSION TECHNIQUES

Fusion Technique	Domain	Advantage	Dis advantage
Simple Average	Spatial	This is the simplest method of image fusion	It reduces the resultant image quality by introducing noise into fused image. It leads to unwanted side effects like reduced contrast.

© IJARCCE This work is licensed under a Creative Commons Attribution 4.0 International License

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 7.39 ⁜ Vol. 11, Issue 7, July 2022

DOI: 10.17148/IJARCCE.2022.11738

Select Maximum	Spatial	Simple, more efficient and highly focused image.	It produce blurred output which in turn affects the contrast of the image. Therefore this technique are not suitable for real time application.
HIS	Spatial	Efficient, simple, high sharpening ability and Fast Processing.	Results in color distortion
PCA	Spatial	Fast processing time and high special quality.	Spectral degradation and colour distortion.
Laplacian pyramid	Frequency	It offers multi-focus images with good visual quality.	The number of decomposition levels affects image fusion result and it needs high processing time.
DCT	Frequency	It decomposes images into series of waveforms and reduces complexity. Real-world applications can make use of this technique.	The fused image won't be of good quality if the block size is less than 8x8 or equal to the picture size.
DWT	Frequency	Compared to pixel-based approaches, it offers a higher signal-to-noise ratio.	There is reduced spatial resolution in the fused image.
Curvelet transform	Frequency	Preserver spectral characteristics	Time consuming

4. CONCLUSION

The comparative analysis of image fusion techniques is done in this research. In this article, different Image Fusion techniques that may be used to combine several images into one improved image that is better suited for human visual perception, object identification, and target recognition have been explored along with their benefits and drawbacks. The best method among all the currently used Image Fusion approaches is determined by this review's conclusion. This review comes to the conclusion that spatial domain approaches offer great spatial resolution but also have issues with image blurring, even though the choice of fusion algorithm is problem-dependent. Simple fusion methods, such as averaging and choose maximum methods, don't work well for real-time applications since they result in noisy, blurry, and poor contrast images.
Although principal component analysis (PCA) and HIS are highly straightforward, quick, and computationally efficient techniques, they cause colour distortion. Fusion techniques based on Laplacian Pyramid Decomposition generate results that are somewhat comparable. Although the DCT Method can be employed in real-time applications, blocks smaller than 88 cannot be utilised. The Wavelet transform is a particularly effective method for fusing images and offers high-quality spectral material. The benefits of both are maintained by the curvelet fusion technique, which successfully avoids the block effect while retaining image features and profile information like edges.

Each algorithm has various benefits and disadvantages. Therefore, we conclude that no fusion algoithm outperforms the others.. Finding the best fusion algorithm for a given application may require a combination of qualitative and quantitative assessment methods. This leads to the conclusion that each image fusion approach has a specialised use and can be combined in different ways to get superior results.

© IJARCCE This work is licensed under a Creative Commons Attribution 4.0 International License

ISSN (O) 2278-1021, ISSN (P) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified ⁜ Impact Factor 7.39 ⁜ Vol. 11, Issue 7, July 2022
DOI: 10.17148/IJARCCE.2022.11738

5. REFERENCES

[1] Gonzalo Pajares , Jesus Manuel de la Cruz "A wavelet-based image fusion tutorial" 2004 Pattern Recognition Society
[2] M .Chandana,S. Amutha, and Naveen Kumar, " A Hybrid Multi-focus Medical Image Fusion Based on Wavelet Transform". International Journal of Research and Reviews in Computer Science (IJRRCS) Vol. 2, No. 4, August 2011, ISSN: 2079-2557.
[3] Rajiv Singh and Ashish Khare, "Multiscale Medical Image Fusion in Wavelet Domain", Hindawi Publishing Corporation, The Scientific World Journal, Volume 2013, Article ID 521034, 10 pages, http://dx.doi.org/10.1155/2013/521034
[4] Y. Asnath Victy Phamila and R. Amutha. ―Discrete Cosine Transform based fusion of multi-focus images for visual sensor networks.‖ Signal Processing 95 (2014).
[5] Ma J, Ma Y, Li C (2019) Infrared and visible image fusion methods and applications: a survey. Inf Fus 1(45):153–178
[6] Shih-Gu Huang, Wavelet for Image Fusion, National Taiwan University.

© IJARCCE This work is licensed under a Creative Commons Attribution 4.0 International License