Enhanced Image Fusion Methodology for Low Light Visible and Infrared Images

Praveen Kumar K, Megha P Arakeri

Abstract: ***Image fusion is the mechanism in which at least two images are consolidated into a single image holding the imperative features from each one of the first images. Emerging images are upgraded and the image content is been enhanced in the entire context, this out coming image is much more preferable than the base images. Certain circumstances in image processing need both high dimensional and high spectral information in a solitary image, which is crucial in remote sensing. Image fusion procedure incorporates intensifying, filtering, and moulding the images for better results. Efficient and imperative approaches for image fusion are enforced here. The image fusion method comprises two discrete types of images, the visible image and the infrared image. The Single Scale Retinex (SSR) is applied to the visible image to obtain an upgraded image, simultaneously Principal Component Analysis (PCA) is been applied to infrared image to obtain an image with superior contrast and colour. Further these treated images are decomposed into a multilayer image by using Laplacian Pyramid algorithm. To end with Weighted Average fusion method aids in fusing the images to reproduce the augmented fused image.***

Index Terms**: *Liver Disorder, Deep learning algorithms, Rprop, SAG, CNN, K-fold validation***

I. INTRODUCTION

Image fusion is a methodology which is used to amalgamate the comparing features in an array of input images to a solitary fused image that retains all the significant characteristics of the input images. It is a strategy which helps in integrating and adding the geometric design of a high-resolution panchromatic (Pan) image and the information of shade of a low-resolution multispectral (MS) image for the creation of a high-resolution MS image. Image fusion requires raw images which are enhanced or used as they are. Visible light image and Infrared images are used for fusion process. Infrared recognition is important in numerous fields, and consistently infrared images overcome the drawbacks of visible images. At that point fusing visible and infrared image is significant in pragmatic use. The objective of taking the Infrared and the normal visible image is to incorporate them into one singular image, which consists of most information in the original source images without mutilation or loss. Although effectively influenced by illumination and camouflage, the visible light is much better in spatial resolution. By disparity, infrared images are not overwhelmed by illumination and camouflage, however endure from low resolution.

Revised Manuscript Received on June 05, 2019

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For intensifying visible light SSR is used. Retinex is an image enhancement algorithm which boosts the sharpness, illumination and contrast of an image. It plays out a non-linear spectral or special transform that gives synchronous unique range compression and colour consistency. It has been utilized for a wide assortment of applications ranging from avionics security to universally useful photography. Most of the potential applications are in need of retinex processing at video frame rates. At the same time, Infrared image enhancement is done by PCA. Principal component analysis is a factual analysis for dimension contraction. It fundamentally extends data from its original space to its Eigen space to expand the fluctuation furthermore, diminish the covariance by holding the segments corresponding to the biggest eigenvalues and disposing other components. PCA aids in reducing redundant data and feature the components with greatest impact in order to build the signal-to-noise proportion. PCA is likewise a straight transformation that is easy to be executed for applications in which immense data is to be dissected. It is commonly used in pattern matching and compression of data by asserting the information in a manner to feature the similarities and diversities without losing much information.

Enhancing the images follows decomposition of images for which Laplacian pyramid is used. The Laplacian pyramid isolates the surface and structure information from the image along with tending to the initial three research goals in the spatial domain. Presence of one structure segment demonstrates it as more computationally proficient than wavelets. An obscuring process diminishes the structural data in an image. At the point it frames the layers of a Gaussian pyramid, when a sub sampling process is done on it. The contrast of obscured variant and the image are relied upon to provide the auxiliary information. This is called as the Laplacian. These enhanced are now decomposed and weighted average technique is been applied on the images to obtain the desired output. Weighted average method is the easiest approach for multi-image fusion and it operates weighted handling on the corresponding pixel points in different original source images.

II. LITERATURE SURVEY

Dhirendra Mishra et al. [4] presents an analysis on numerous frequency domain and spatial domain fusion techniques such as block replace, min-max, averaging, Intensity Hue Saturation (IHS), Principal Component Analysis (PCA), pyramid based, brovey and transform based techniques. The performance measures of the image fusion are explained here.

The different techniques are compared based on their performance. Images fusion carried out by PCA have high spatial quality, sharpening ability and IHS. Saleha Masood et al. [5] discussed the image fusion sorting based on their systems. The two basic algorithms categories namely, Single Sensor Fusion System (SSFS) and Multi-Sensor Fusion System (MSFS) are analyzed and related to each other. The analysis has shown that every algorithms in this context has their own fortes and feebleness. Jiayi Ma et al. [6] conferred IR and visible image fusion methods, their applications and performance. The various methods are multi-scale transform, sparse representation, neural network, subspace and saliency based methods and hybrid models. The applications of these approaches are such as object recognition, tracking, image enhancement, surveillance, and remote sensing. Extensive experiments are conducted to evaluate the performances of different representative methods. Sneha J. Sonawane et al. [7] described diverse techniques and facets of image fusion for multimodal medical imaging. Methods used for medical image fusion are wavelet transforms modulus maxima, discrete wavelet transforms, curve let fusion of MRI and CT images and ripplet transform. The multimodality medical image fusion plays a precarious and vital role in many scientific applications. The fused results can support more comprehensive and accurate information than any individual source images. Vibha Gupta et al. [8] proposed 4 different stages for image fusion decision level, feature level, pixel level and signal level. A qualified study is done for these image fusion approaches and a few of image quality assessment parameters. An amalgamation of quantitative assessment and qualitative evaluation approach is precise way to discover which fusion technique is most suitable for an application. Raman Maini et al. [9] focused on image enhancement techniques like spatial domain, with precise reference to histogram processing and point processing method. The point processing method is most nascent, yet indispensable image processing operation and is used for contrast enhancement. Histogram equalization stretches the contrast by restructuring the gray-level values homogeneously. Poonam et al. [10] discussed image enhancement practices - spatial domain enhancement methods, Simple intensity transformation and Histogram processing. Simple intensity transformation contains four steps image negatives, contrast stretching, compression of dynamic range and gray level slicing. Histogram processing involves histogram equalization and local enhancement. These image enhancement processes try to find to increase the interpretability or perception of information in the images. Kuldeep Narayan Shukla et al. [11] proposed various techniques of image enhancement such as Adaptive histogram equalization, Fuzzy Logic Technique, Nuro Fuzzy System, Unsharp Masking, Contrast Stretching, Thresholding Transformations and Log Transformations. This work aids in choosing a technique on the basis of their advantages. Ruchika Mishra et al. [12] explained 2 main classes of image enhancement. They are spatial domain and Frequency domain techniques. Spatial domain technique operates on pixels of an image, thus it enhances the overall image contrast. Whereas Frequency domain technique operates on Fourier transform of an image, thus it assists in improving edges and other image information. The choice of technique depends upon the requirements. E. H. Adelson et al. [13] describe a variety of pyramid methods developed for image data decomposition. The pyramid methods are Laplacian pyramid and Gaussian pyramid. These methods suggest a convenient and flexible multi resolution setup that is equivalent to multiple scales originated in the visual scenes and then mirrors the multiple scales of human visual processing system. Kusum Rani et al. [14] proposed different pixel level image fusion algorithms such as Simple maximum method, Simple minimum Method, Simple average method and weighted average method. The resultant images are highly focused images here. To measure the possible benefits of fusion and as well as to compare results performance measures are utilized here. Yang Bo et al. [15] has examined pixel to pixel image fusion methods namely, Weighted Averaging (WA) and Multiscale-Based Schemes. These fusion methods for pixel level has been quickly emerging and progressively becoming mature. Some of the disparities and obstacles are analyzed in the existing works. Although the image fusion methods described above are computationally proficient, simple and fast, yet these algorithms result in colour distortion. The image enhancement approaches does not afford satisfactory perceivably and robustness. They do not enhance properly each portion of an image concurrently and the automation of image enhancement is very challenging. In case of decomposition, the number of decomposition levels affects the result. Pyramid method suffers from blocking artifacts and creates undesired edge. It is not possible to say which technique is good because the image enhanced by using such technique if it is looks good to user then it is good. Hence the combination of the techniques should be used to get efficient fused images.

III. PROPOSED SYSTEM

The proposed system incorporates fusing 2 types of images namely visible image and infrared image. Combining these two images gives more imperative information in a single enhanced fused image. The fused image describes the vital features of individual raw images more efficiently. The diagram below shows the entire work is demonstrated in Fig 1.

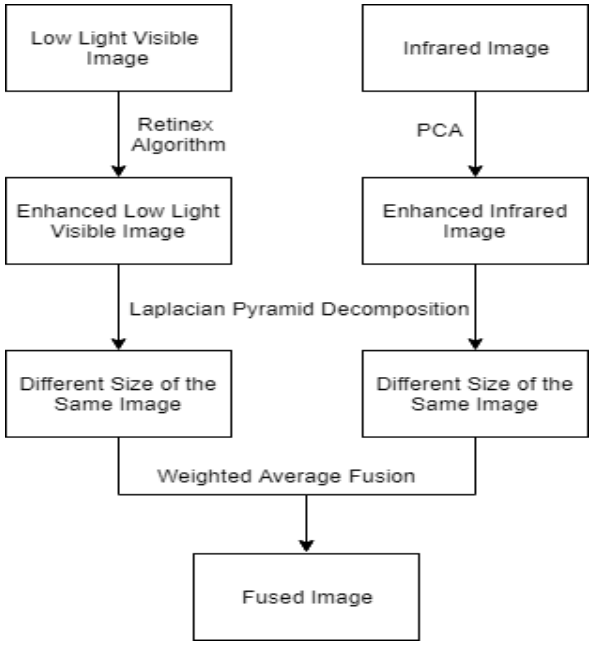

Figure 1: Flow diagram

Flow diagram interprets the different techniques used for enhancing, decomposing and fusing the images. Single Scale Retinex (SSR) intensifies visible image and Principal Component Analysis (PCA) enhances infrared image. Then both the images are decomposed using Laplacian Pyramid method which includes generating Gaussian pyramid. The enhanced and decomposed images are fused using weighted average mechanism which is the based on pixel to pixel image fusion.

Sequential Steps:

- Enhancing visible image and infrared image with SSR and PCA respectively.
- Decomposing the enhanced images using Laplacian Pyramid.
- Fusion of images based on weighted average pixel to pixel fusion.

IV. RESULTS

In this paper Low light visible image and Infrared images are taken from same point of view. In the visible image (fig: 2) there is smoke and the person lying on the ground with the gun is not been seen, but in Fig: 3 soldier lying on the ground with weapons is been easily noticeable.

Fig 2: Low light visible image

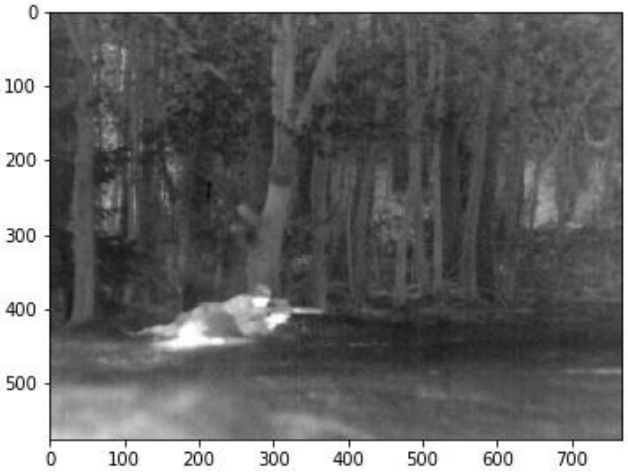

Fig 3: Infrared Image

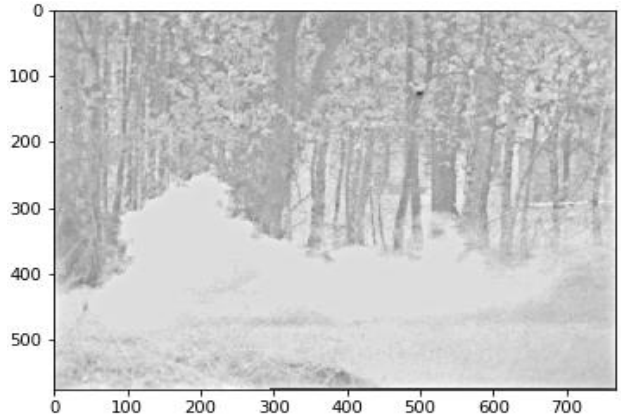

Fig 4: Retinex applied on Low light visible image

The retinex is been applied on the low light visible image. Fig 4 represents image after applying the retinex algorithm. Now the image will look similar to an image seen by the bare human eye. The colour and lighting is been enhanced to human perception.

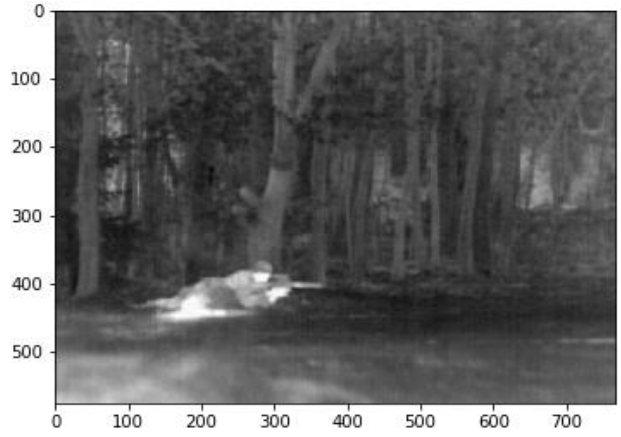

Fig 5: PCA applied on Infrared image

PCA is been applied on the infrared image. Fig 5 shows the image after applying the PCA. The person lying on the ground carrying harmful weapons is been capture very clearly. The person is been highlighted compare to Fig 3. The background i.e. except the person in the image is been darkened so that the target object is been focused evidently.

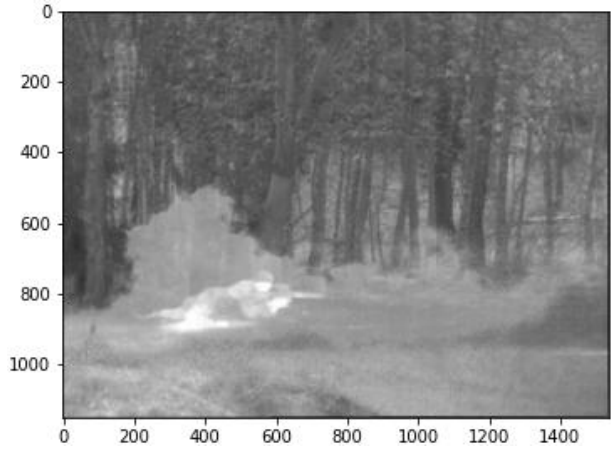

Fig 6: Final output of the project

Fig 6 shows the final outcome of the project where the person behind the smoke is been seen evidently. This image clearly depicts the outcome of both the images. Here the smoke and the man both are presented in the single image, it contains extract of visible and IR image. The output image is clear and noiseless.

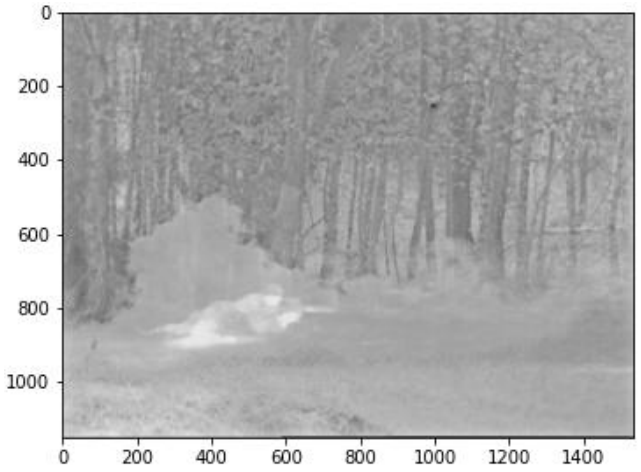

Fig 7: final output of the project without enhancing the Infrared image

Fig 7 represent the output of the project where the project is been carried out in a similar way but no enhancement is been done on the infrared image i.e. PCA is not been applied on the infrared image. Compared to Fig 6, Fig 7 shows lesser details and the visualization is also inferior to Fig 6.

Fig 8: Bare image fusion vs final output of the project

Here in fig 8 comparison of bare image fusion and the final outcome of the project is been done. Here the structural similarity index (SSIM) of both the images by keeping the bare image as reference image is 0.94. The Proposed methodology is 6 percent more enhanced than bare image fusion.

Fig 9: Output of the project without enhancing the Infrared image vs Final output of the project

Here in Fig 9 comparison between the outputs of the project without enhancing the IR image (Fig 7) and the final outcome of the project is been done. Here the SSIM of both the images by keeping Fig 7 as a reference is .96. The proposed methodology is 4 percent more enhanced than Fig 7.

Metrics	Final output vs Bare image fusion	Final output vs output without enhancing IR image
MSE	6.38	8.54
SSIM	0.94	0.96
PSNR	55.36 dB	42.90 dB

From the table a conclusion could be derived that SSIM of the final output to bare image fusion is 94% that means that both images are similar to each other up to 94 percent i.e. the final output is 6% more enhanced compared to bare image fusion. SSIM of final output to output without enhancing IR image is 96% that means both images are similar to each other up to 96 percent i.e. final output is 4% more enhanced.

V. CONCLUSION

Although immense work has carried out in image fusion domain, still there is colossal space for innovative and new discoveries in this background. Each approach in this context has its very own qualities and shortcomings. An Analyst may understand clearly, no image fusion technique is admirable over another; the determination and effectiveness of a specific strategy are subjected to its application. As indicated by research perspective, it tends to be reasoned that image fusion techniques based on PCA result in a superior-enhanced image without modifying the spatial or spectral subtleties of the image. Image Fusion peruses a few images of the similar objects or scene and recovers imperative data from them to place it into a solitary image. The resulting melded image is progressively enlightening and apt for visual recognition or computer handling than any of the input images which consequently improves relevance and quality of data. It is utilized in different fields like therapeutic imaging, remote sensing, and fabricating processes. Basic fusion techniques like max-min, averaging, maximum, minimum, and easy block replace methods produce blurred, noisy and low contrast image. Hence these are not used in real time applications. Brovery, IHS and PCA are computationally effective, simple and quick algorithms but these result in colour contortion. Images fused by PCA have high spatial quality yet it outcomes in spectral degradation. IHS additionally has high sharpening capacity. All pyramid Decomposition Based Fusion strategies gives much comparable output. Image fusion result is influenced by the number of decomposition levels. These techniques are commonly used for multi-focus images. The images can be used as they are for the fusion process. But enhancement adds up some vital characteristics to the image. So the efficient enhancement methods are chosen. The fused result can be compared with raw images to understand clearly the importance of image fusion. The resulting ideal image includes all the aspects of images without any loss of crucial information from the original source images.

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