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Application of Guided Image Filter and NSST for Contrast Enhanced Multi Sensor Image Fusion

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Abstract

This project's major goal is to develop an image fusion technique that produces fused images with excellent contrast and little structural deformation. The gradient reversal artefacts are efficiently suppressed by the guided image filter (GF), an image smoothing filter. It may provide edge contours with a nice appearance. Therefore, GF is employed for edge profile extraction as well as picture smoothing. The fusion of smoothed source pictures, however, must avoid information loss and structural deformation. NSST is used to do this. The SSIM, Entropy, PSNR, MSE, and Time were used to assess the process' performance. An image fusion algorithm's primary goal is to produce high-quality images. Tom makes the process go more efficiently. The technique of fusing images has a purpose to produce images of the highest possible quality. As an illustration, consider the following two medical images: an MRI and a CT scan. Both photos have some areas with high quality and some areas with low quality. So when we merge those two photographs, the image's quality will be rich as a result of combining the best parts of two images.

1. INTRODUCTION

The technique of image fusion combines the finest information in each of the provided photos to create a final image whose quality is superior to either of the input images. Fusion is a method that may be used to improve the accuracy of information from a collection of photographs. The multi-sensor data may contain many photographs of the same scene that each provide a distinct piece of information in the fields of remote sensing, computer vision, medical imaging, machine vision and robotics. Image fusion is necessary because It is not feasible to construct a single image that has to include every bit of details on the goods in the image. There are two ways to combine images: Methods of Spatial Domain Fusion and Transform Domain Fusion. The spatial fusion approach deals directly with the pixels of the input pictures, while the frequency domain image is first altered in the transform fusion method. Picture fusion techniques is capable of being separated into pixel, feature, plus decision levels depending on the stage at which image information is fused. With the use of a collection of pixels from the source pictures, pixel-level fusion creates a fused image in which each pixel's information content is identified. The retrieval of special features that depend on their surroundings that is pixel intensities, edges, or textures is necessary for feature-level fusion. The input images' comparable features are combined. Fusion at the decision-level is a greater degree of fusion. Each input picture is analysed separately for information retrieval. These strategies could often be divided into two categories: transform domain fusion and spatial domain fusion. There are transform methods of the SWT, DWT, and DCT types. Therefore, the majority of us are adopting PCA, which uses spatial domain approaches, as well as simple minimum, simple maximum, and simple average types of basic picture fusion techniques. When utilising the transform domain, we must utilise variables like PSNR, EN, etc. In the SWT approach, SF and SD are used for wavelet transformations. This ratio is determined by the various outcomes of the various techniques. The collection of non-linear procedures that are connected to the form or morphology of features in a picture is what is known as morphological processing. It is displayed using a tiny form or template known as a structuring element. It has fundamental controls like erosion, dilation, opening and shutting, filling and cleaning, etc. Overall, SWT is used with this strategy. Thus, everything is tied to the combination of high-resolution, high-quality images.

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2. LITERATURE SURVEY

In order to "improve" the ability to understand or perceive information, images are enhanced in pictures by providing "better" input. The input of the picture is processed using a variety of histogram equalisation techniques, such as CHE, GHE, BBHE, DSIHE, RMSHE, and Multi-HE, to improve the output. This document offers an overview of the modifications made to the histogram equalisation method to enhance brightness and contrast preservation. Histogram equalisation was examined in 2004 and it was suggested that HE is a straightforward yet powerful picture enhancing method. However, it has a propensity to expressively change the brightness of a picture, resulting in annoyance, artificial contrast augmentation, and artifacts. Researchers suggested the minimal mean brightness error bi-histogram equaliser, an unique addition to BBHE (MMBEBHE) MMB EBHE can sustain brightness more effectively than BBHE and DSIHE, according to simulation. Visually appealing, devoid of artefacts, and natural-looking outcomes were obtained. For the purpose of enhancing contrast, a brand-new local brightness preserving dynamic histogram equalisation (LBPDHE) technique is presented. It adds a straightforward but crucial local mean brightness maintaining mechanism to the DHE method. According to experimental findings based on eighty test photos, their suggested LBPDHE approach not only achieves the best brightness retention but also has high contrast improvement. The primary finding of that study was that, unlike earlier research ideas, brightness preservation could be carried out locally and separately for each division as opposed to globally throughout the whole histogram. Experimental findings from 80 test photographs show that their suggested approach, when weighed against the most recent cutting-edge techniques, not only achieves the best mean brightness preservation but also produces good contrast enhanced images. It adds a straightforward but crucial local mean brightness maintaining mechanism to the DHE method. Experimental findings based on eighty test photos demonstrate that our suggested LBPDHE approach not only achieves the greatest brightness retention but also has high contrast improvement. When used in consumer electronic items, their proposed solution has reduced power consumption more than the other contrast enhancement techniques [1].

One of the most crucial uses for vision has been identified to be picture enhancement since it may make images more visible. The main goals of image enhancement are to increase the observation of information in pictures by certain viewers and a superior input source for additional image processing methods. The major goal of image enhancement is to change certain aspects of a picture to achieve more suited for a specific activity as well as an audience. A digital image may be enhanced using a variety of techniques without distorting it. Every pixel has the same shape of the nonlinear transfer function for brightness enhancement. However, not all areas of the image have the same level of light; some may be black, while others may be brilliant. It has been suggested to use dynamic histogram specification techniques to increase contrast without sacrificing the original histogram's properties. Every pixel has the same shape of the nonlinear transfer function for brightness enhancement. However, not all areas of the image have the same level of light; some may be black, while others may be brilliant. Thus, while improving a colour image, the image location must be taken into account. First, to increase the brightness of the image, the value component image in HSV image space was broken into smaller, overlapping blocks. Next, the nonlinear transfer function for each pixel was determined. The amount of enhancement for each pixel in the process of enhancing contrast has been computed based on the values of the central pixel and the pixels around it. It has been suggested to use dynamic histogram specification algorithms based on histogram specification (HS) techniques to improve contrast without sacrificing the original histogram's properties. The DHS retrieves the divergence data from the input histogram while preserving real histogram properties. On the contrary, it also uses other controls, like gain control value and frame direct current, to regulate the entire procedure [2].

Considering that the results of this approach provide both more knowledge and concealed information, which will subsequently be utilised for many different helpful reasons, researchers of various computer vision or machine vision have mostly concentrated on the subject of picture improvement. A variety of methods, including Histogram Equalization, Spatial Averaging, Median Filter, Un-sharp Masking, and High Boost Filtering, among others, were designed to improve images. Fuzzy Logic and Artificial Neural Networks are two strategies that we optimised to create a novel hybrid methodology in this study (ANN). A variety of measures, including Mean Square Error, Root Mean Square Error, Signal to Noise Ratio, along with Peak Signal to Noise Ratio, are used to compare the experimental findings. The findings demonstrate that Fuzzy Logic and Artificial Neural Networks are the best techniques for enhancing picture visibility and protecting important image elements, which can then be used for a variety of beneficial reasons. An image may be

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conceptualised as a two-dimensional function with the coordinates x and y standing for spatial (plane) coordinates, and the amplitude at any given pair of coordinates being the intensity or grey level of the image at that specific place. We refer to a picture as a digital image when the values of x, y, and the amplitude are all finite discrete numbers. A digital image is made up of a limited quantity of elements, each of which is located in a specific place and has a certain value. These components are also known as pixels, image components, and picture components. The most common name for the components of a digital image is "pixel". A group of approaches known as "image enhancement procedures" aim to enhance a picture's aesthetic appeal or change it into a format that is more suitable for either human or computer analysis [3].

In this research, researchers offer a unique adaptive fuzzy contrast enhancement method for low contrast grayscale photos based on the fuzzy entropy principle and fuzzy set theory. On several low-quality grayscale photos, they have experimented. The suggested method's performances are contrasted with those of the other approaches. According to the analytical outcomes, the suggested algorithm requires less processing time than the other approaches while also being quite successful at enhancing contrast. Image enhancement is a technique that modifies the input image's pixel intensity so that the final image should, in the opinion of the viewer, seem better than the original. The fundamental purpose of picture improvement is to make the information contained in the image more interpretable or visually appealing to human observers, or to provide other automated image processing a "better" input. A two-dimensional digital image of gray-level intensities is denoted by I to help us comprehend the notion of image enhancement. In software-accessible form, the image I is often represented as an MN matrix with indexed elements I(i, j), where 0 I M - 1, 0 j N - 1. The components I(i, j) indicate samples of the pixels, or image intensities (picture elements). We assume that they originate from a fixed integer-valued range in order to keep things simple. Every sector where pictures need to be comprehended and evaluated may apply image enhancement, including machine vision, satellite image analysis, medical image analysis, etc. Simply said, image enhancement is the act of converting a picture X into an image Y with the use of Transformation T in order to make it appear better. The symbols X(i,j) and Y(i,j), respectively, stand for the intensity of pixel (i,j) in pictures X and Y [4].

A resolution technique for improving digital grayscale photographs is presented in this research. The interpolation of the high frequency sub-bands acquired by DWT along with SWT serves as its foundation. image resolution enhancement seeks to achieve around an image acquisition equipment constraint or an awkward acquisition situation. A Super Resolved picture is helpful in a variety of industries. Whether it's a satellite picture or a medical imaging, resolution has frequently been cited as a crucial aspect of an image. High quality satellite photos are crucial since they are used in many different sectors nowadays. A radiologist wants improved medical imaging to help with diagnosis and interpretation. Super improved resolution is being obtained through image processing. A technique for increasing the amount of pixels in a digital image called interpolation. Numerous image processing applications, including facial reconstruction, multiple description coding, as well as picture resolution improvement, frequently employ interpolation. Long-term usage of interpolation-based picture resolution augmentation has led to the development of several interpolation algorithms to improve the effectiveness of this job. The major goals of medical image enhancement are to address issues with a medical picture's low contrast and high level noise [5].

3. PROPOSED SYSTEM

We suggested an approach based on multi sensor image fusion for this procedure that produces a high contrast fused picture without structural bias and is less susceptible to different source picture formats. An intelligent combination of guided image filter, non-sub-sampled shearlet transform, texture energy measurements, plus morphological procedures is used to accomplish these goals. On infrared-visible, multi-focus, and medical pictures, the suggested approach has been validated. The qualitative and quantitative evaluation demonstrated the suggested method's superiority to contemporary picture fusion techniques. This approach offers rapid computation. It is more dependable since if the procedure is repeated numerous times, the image quality will be at its best. The improvement's performance is better and estimated by SSIM.

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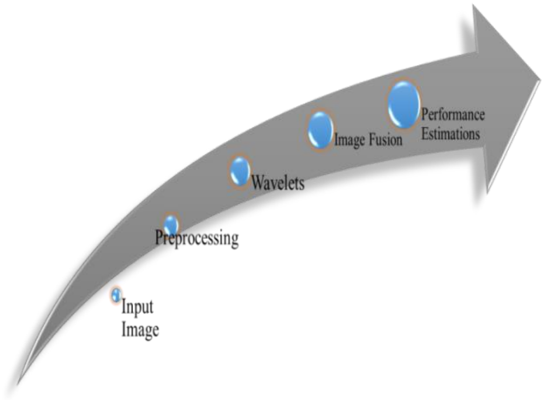

Fig 1: System Architecture

Following section explains several stages that are involved in putting the suggested technique into practice:

1. Input Image

Use the imread command to read an image into the workspace. The example takes one picture from the toolbox's sample image collection and puts it in an array called I.imread deduces from the file that the graphics file format is Tagged Image File Format (TIFF). In order to view the image, the imshow function is being used. The Image Viewer software also lets you see images. The imtool function launches the Image Viewer application, which offers a unified setting for viewing pictures and carrying out certain standard image-processing operations. In addition to offering all of imshow's picture display features, the Image Viewer app also gives users access to a number of other tools for examining and browsing photos, together with the Pixel Region tool, scroll bars, the Contrast Adjustment tool and Image Information tool.

2. Pre-processing

Image resizing is referred to as imagescaling in computer graphics and digital imaging. In video technology, upscaling or resolution enhancement are terms used to describe the enlargement of digital content. A vector graphic picture may be resized without sacrificing image quality by utilising geometric transformations a focus on the image's basic visual elements. Raster graphics images must be scaled by creating a new picture with more or less pixels. When the number of pixels is reduced (scaling down), there is typically a noticeable quality reduction. Two-dimensional sample rate conversion may be seen in raster graphics scaling from the perspective of digital signal processing, which is the transmission of a discrete signal from one sampling rate (the regional sample rate in this instance) to another. A type of edge-preserving smoothing filter is the guided filter. Similar to a bilateral filter, this picture filter may keep sharp edges while removing noise or texture. The guided image filter has two benefits over the bilateral filter, including: First, compared to guided image filters, which employ simpler mathematical computations and have linear computational complexity, bilateral filters have relatively high computational cost. Additionally, owing to the mathematical concept, bilateral filters can occasionally produce undesirable gradient reversal aberrations and distort images.

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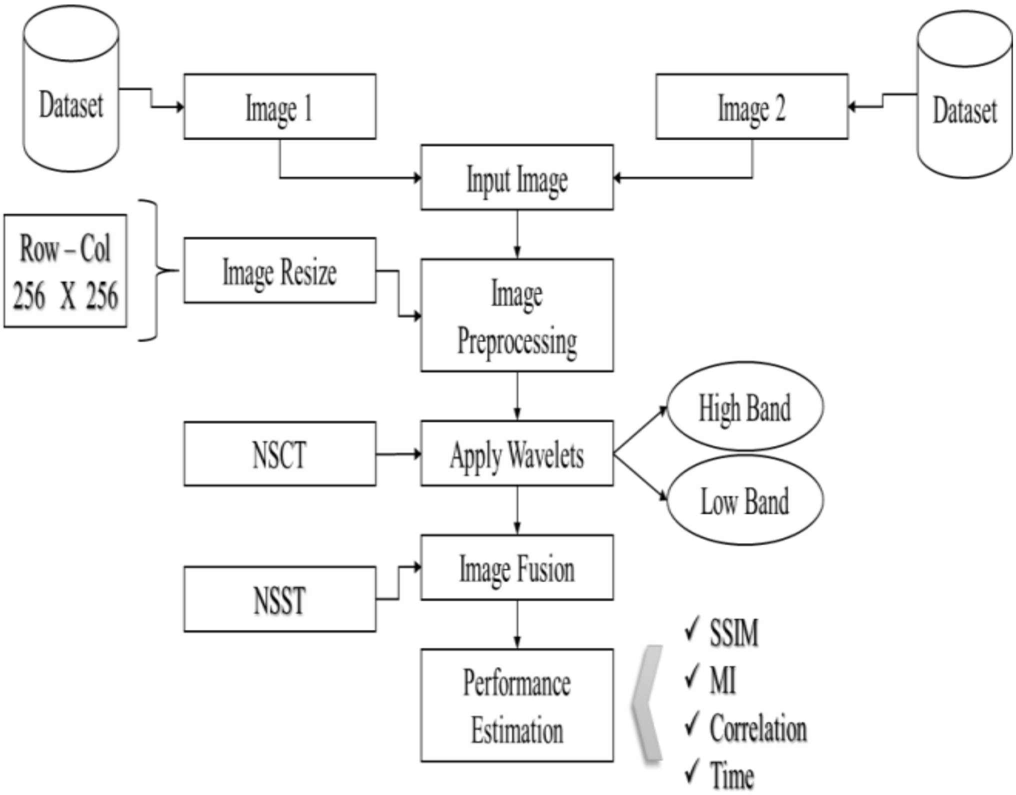

Fig 3: Flow Diagram

3. Wavelet Coefficient

In this procedure, a method based on wavelet coefficients in low-pass bands is suggested for the classification of images with flexible data structure organisation. The distribution of wavelet coefficient histograms can be used to describe the properties of a picture after wavelet decomposition. The x and y directions are correspondingly projected onto by the coefficients. The distribution of wavelet coefficient histograms in low-pass bands varies significantly for various pictures. High-pass bands, on the other hand, do not differ as much, making categorization performance unreliable.

4. Image fusion

Fusion of images is the technique of merging several photographs so that the final product has better visual qualities than the individual images that were used to create it. Thus, how can the quality of the fused image be assessed? To gauge the effectiveness of the experiment, many measures were developed. The mean square error is one such measure. MSE, which is frequently used to do these comparisons or calculate metrics that take into account picture disparities. To quantify the fusion of two pictures, a non-reference quality metric, however, was very recently developed. In this procedure, we suggest extending the fusion metric to be employed when more than two pictures are merged.

5. Performance Measures

We use different methods for performance measures and they are as follows:

- One way to gauge how similar two pictures are is with the Structural Similarity (SSIM) index.

$$SSIM(x, y) = [l(x, y)]^{\alpha} \cdot [c(x, y)]^{\beta} \cdot [s(x, y)]^{\gamma}$$

- In probability theory and information theory, the mutual information (MI) of two random variables measures how dependent each variable is on the other. More specifically, it measures the "amount of information" (measured in bits or units like Shannons) one random variable was used to learn more about another random variable.

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- Picture entropy is a term used to characterize the "business" of an image, or the amount of data that a compression technique must account for.

$$\text{Entropy} = -\sum_{i} P_i \, \text{Log}_2 \, P_i$$

4. RESULTS

This research's major goal is to develop an image fusion technique that produces fused images with great contrast and no structural deformation. Achieving picture quality and enhancing process performance are the primary goals of an image fusion algorithm. For infrared-visible, multifocus, and medical pictures, the suggested approach has been validated. The qualitative and quantitative evaluation demonstrated the suggested method's superiority to contemporary picture fusion techniques. The suggested GF and PCNN dependent approach fuses pictures with any further alterations, making it acceptable for machine interpretations along with human visual perception, according to the visual inspection of fused images.

The accompanying screenshots demonstrate how the proposed method's fused images have high-quality visual data and information with additional specifics than those produced by existing methods according to a qualitative analysis of image fusion quality measures.

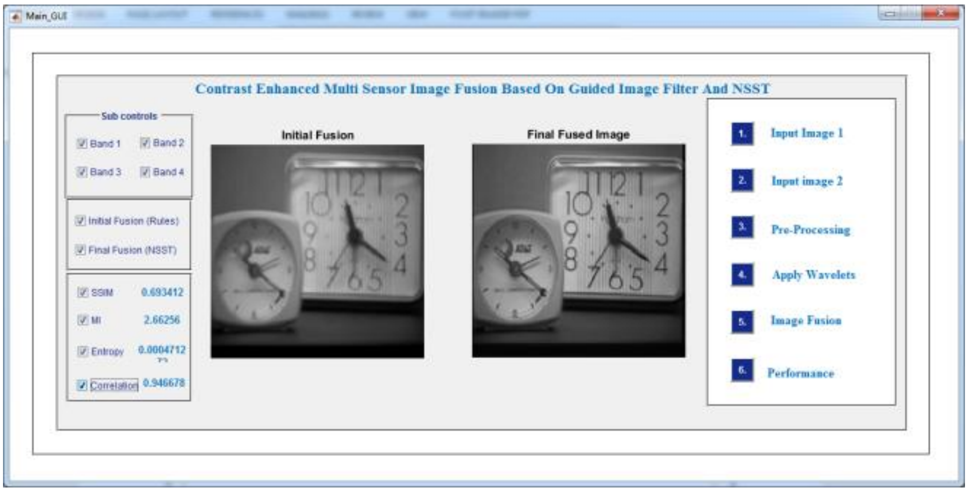

Fig 3: Final Focused Image

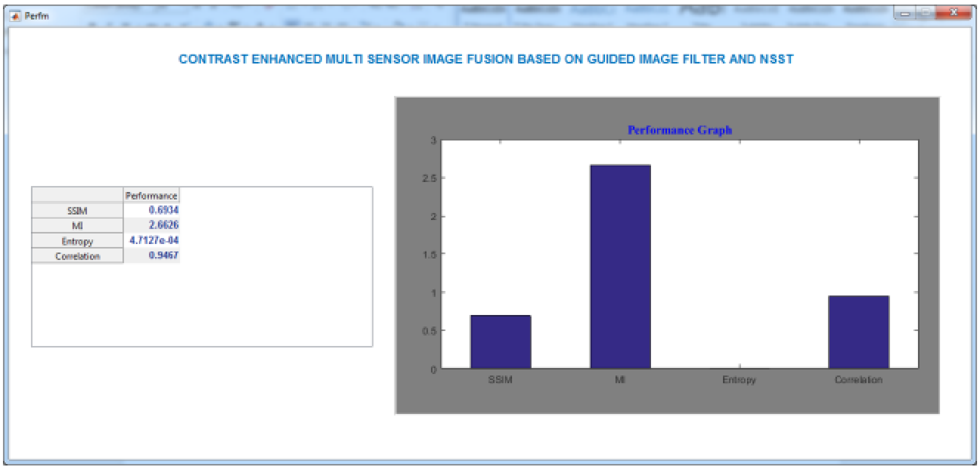

Fig 4: Performance Analysis

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5. CONCLUSION

It is suggested to use guided image filters and NSST in a multi-sensor picture fusion method. It has been tested on infrared-visible, multifocus, and medical pictures. The suggested method's novelty is demonstrated by comparison with modern image fusion techniques that use guided image filters, NSST, plus PCNN. The suggested GF and PCNN-based approach successfully fuses pictures by screating no distortions, according to visual assessment of the fused images. These fused photos feature excellent contrast. The suggested picture fusion technique is thus appropriate for both computer interpretations plus human visual perception. The suggested method's fused images have strong high-quality visual data and information with additional specifics than those created using previous approaches, according to a qualitative analysis of image fusion quality measures.

6. FUTURE ENHANCEMENT

The picture will be filtered using the spatial weighted mean filter approach using the weighted mean filter function. Only monochrome, 8 bit per bixel, and 24 bit per pixel pictures may be used with this function. In contrast to mean filters, weighted mean filters repeat certain pixels within a local neighbourhood a predetermined number of times to get the mean value. The weighted mean filter has the following definition:

WeightedMean(A)=Mean[Repeat StrMask(i,j) times A(x+i,y+j)]

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