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Fusion of two and three colored and gray scale images using modified – Laplacian Pyramid Technique

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ABSTRACT

Image fusion is a process of blending the complementary as well as the common features of a set of images, to generate a resultant image with superior information content in terms of subjective as well as objective analysis point of view. The goal of this exploration work is to build up some novel picture combination calculations and their applications in different fields, for example, split identification, multi-spectral sensor picture combination, restorative picture combination and edge location of multi-centre pictures and so forth. The initial segment of this exploration work manages a novel break identification system dependent on Non-Destructive Testing (NDT) for splits in dividers smothering the assorted variety and multifaceted nature of divider pictures. It pursues diverse edge following calculations, for example, Hyperbolic Tangent (HBT) sifting and shrewd edge recognition calculation. The combination of locator reactions are performed utilizing Haar Discrete Wavelet Transform (HDWT) and most extreme guess with mean-detail picture combination calculation to get increasingly noticeable identification of split edges. In the proposed framework we have performed picture combination for two just as for three pictures. The proposed framework gives improved edge location in pictures with unrivalled edge confinement and higher PSNR.

Keywords— *Image fusion, Laplacian Pyramid Technique, Discrete Wavelet Transform (DWT)*

1. INTRODUCTION

Picture handling is a wide territory of investigation for understudies. It offers the option of quantities of fields and zone in which examination work can be completed. Picture combination is one such field inside the zone of picture handling amid which fluctuated investigates are being done to show signs of improvement results. Picture combination is the method of acquiring a great deal of useful and best quality picture from at least 2 pictures. the pictures that are melded are all the more likely to be taken of the same point of view and same sensors anyway these likely could be of different locators, totally extraordinary modular, shifted centrally and fluctuated transient. In the technique for picture combination, the data of the considerable number of pictures to be melded is considered thus combination is done with the end goal that the resultant picture will be progressively enlightening and subjective. The prerequisite of picture combination is to get a resultant picture of high spatial and high phantom data. The calculations that are produced for picture combination are input subordinate. The strategy for picture combination discovers its utilization in different administration and investigation activities for residential and non-common objectives. Utilizations of picture combination incorporate territories like satellite imaging; victimize vision, object disclosure and recognizance. Picture combination can even use in therapeutic conclusion and medications. This is frequently done by consolidating or overlaying totally unique pictures of a patient to get the progressively right information.

The procedure of picture combination is utilized for deciding the case by consolidating the learning from shifted sensors. Differed calculations are intended for picture combination that has Laplacian Pyramid, essential segment examination, discrete wavelet Fusion and so forth. The methods created for picture combination ought to have high exactness, high reliableness, and dimensionality. Picture combination is alluded to like the way toward getting an unrivalled picture from the info pictures by removing certain highlights of the information pictures. The essential target of the combination is getting a more educational and preferable quality picture over the info pictures.

The following diagram is showing the various techniques for image fusion:

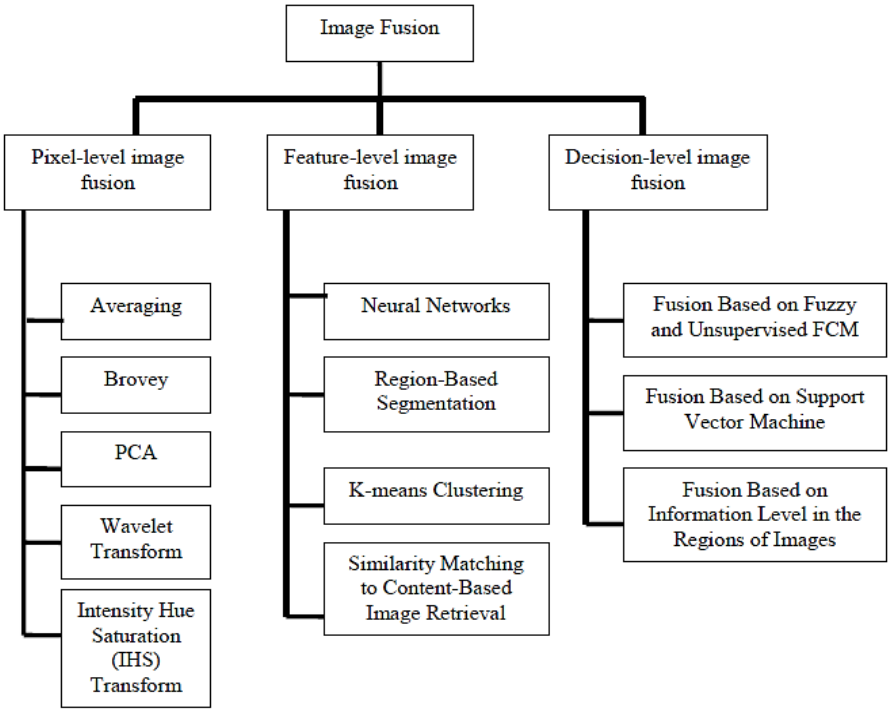


Fig. 1: Image fusion techniques

The above diagram shows the various image fusion techniques with various categories. Generally, image fusion techniques are divided into three main categories which are pixel-level image fusion, Feature-level image fusion and Decision - level image fusion. Further, these categories are divided into various levels as shown in the above figure.

1.1 Image fusion applications

Picture Fusion has turned into a generally utilized innovation to expand the visual understanding of the pictures in different applications like improved vision framework, restorative conclusion, mechanical technology, military and observation to give some examples. It has been generally utilized in numerous fields, for example, object distinguishing proof, characterization and change recognition.

(a) Object identification: So as to boost the measure of data separated from satellite picture information helpful items can be found in intertwined pictures.

(b) Classification: Classification is one of the key assignments of remote detecting applications. The characterization precision of remote detecting pictures is improved when numerous source picture information are acquainted with the handling.

1.2 Image fusion techniques

The method of picture blend the extraordinary information from all of the given pictures are merged to shape a resultant picture whose quality is superior to anything any of the data pictures. Image mix system can be thoroughly requested into two get-togethers.

In general, fusion techniques can be classified into different levels. They are signal level, pixel/data level, feature level and decision level.

Signal level fusion in signal based fusion, signals from various sensors are joined to make another flag with a superior flag to commotion proportion than the first signals.

Pixel/Data level combination is the blend of crude information from numerous sources into single goals information, which are relied upon to be more enlightening and engineered than both of the info information or uncover the progressions between informational indexes procured at various occasions.

Feature level combination separates different highlights, for example, edges, corners, lines, surface parameters and so forth., from various information sources and after that consolidates them into at least one component maps that might be utilized rather than the first information for further handling. It utilized as a contribution to preprocessing for picture division or change discovery.

Decision level combination consolidates the outcome from numerous calculations to yield a last intertwined choice. At the point when the outcomes from various calculations are communicated as confidences as opposed to choices, it is called a delicate combination.

Else it is called a hard combination. Strategies for choice combination incorporate casting ballot techniques, factual strategies and fluffy rationale based strategies.

2. LITERATURE SURVEY

Harpreet Kaur et al. (2015) [1] introduced an Image Fusion on Digital Images utilizing Laplacian Pyramid with DWT. Picture Fusion is a system of uniting of two pictures or more than two pictures or blending of the relating furthermore the fundamental segments of the set of near twisted, insufficient or noised pictures, to make a resultant picture. In this paper utilizing upgraded Laplacian pyramid method, mapped the neighbourhood binarized pixels of pictures inside the area which is pixel by pixel combination. The e-laplacian procedure takes a shot at dim scale pictures, shaded or RGB pictures and restorative pictures. The last stride performed is a converse DWT with the new band coefficients to build the combined picture. The Laplacian gives the improved consequences of intertwined pictures with more precision in PSNR, Entropy, SD, SSI, MI, and Average Gradient.

Manfred Ehlers [2] Current and future remote detecting projects, for example, Landsat, SPOT, MOS, ERS, JERS, and the space stage's Earth Observing System (Eos) depend on an assortment of imaging sensors that will give auspicious and dreary multi-sensor earth perception information on a worldwide scale. Unmistakable, infrared and microwave pictures of high spatial and ghostly determination will inevitably be accessible for all parts of the earth. It is fundamental that proficient handling procedures be produced to adapt to the vast multi-sensor information volumes. This paper talks about information combination systems that have demonstrated fruitful for synergistic converging of SPOT HRV, Landsat TM and SIR-B pictures. Illustrations are given for integrative correction, upgrade of cartographic element extraction and change of spatial determination.

A. Ben Hamza [3], Pixel level picture combination alludes to the preparing and synergistic mix of data assembled by different imaging sources to give a superior comprehension of a scene. We plan the picture combination as an improvement issue and propose a data theoretic methodology in a multiscale structure to acquire its answer. A biorthogonal wavelet change of every source picture is initially computed, and another Jensen-R'enyi dissimilarity based combination calculation is created to develop composite wavelet coefficients as per the estimation of the data designs inalienable in the source pictures. The trial comes about on combination of multi-sensor route pictures, multi-centre optical pictures, multi-methodology therapeutic pictures and multi-unearthly remote detecting pictures are displayed to delineate the proposed combination plan.

Yang Jinghui et.al. [4], Image fusion is fit for incorporating distinctive symbolism to create more data that can be gotten from a solitary sensor. In this way, numerous pixel level combination strategies for remote detecting pictures have been introduced, in which the lower determination multispectral picture's auxiliary and textural subtle elements are improved by embracing the higher determination panchromatic picture relating to the multispectral picture. Consequently, it is likewise called Pansharpening. In this paper, we will list current circumstance of pixel level picture combination by isolating those strategies into three classifications, i.e., segment substitution procedure, regulation based system and multi-determination investigation based strategy as indicated by combination instrument. Likewise, the properties of the three classifications for applications are talked about.

3. PROPOSED METHODOLOGY

Here we develop a proposed method in the image fusion. For image fusion here we are using the E-Laplacian Pyramid and fuzzy will provide the good result in the image fusion. Initially, we generate the Laplacian rule in membership function. Images are in matrix form where each pixel value is in the range from 0-255. Use Gray C *o* I or map. Make the Comparison between the rows and columns of both of the input images. In the event that the two pictures are not of the same size, select the segment, which is of the same size.

Decide number and type of membership functions for both the input images by tuning the membership functions. Input images in antecedent are resolved to a degree of membership ranging 0 to *255.*

3.1 Modules

- Wavelet Transform
- Fuzzy Logic and E-Laplacian Pyramid
- Inverse Wavelet Transform
- Analysis

3.2 Module description

The E-Laplacian Pyramid implements a pattern selective approaches to image fusion so that the composite image is constructed not a pixel at a time. The basic idea is to perform a pyramid decomposition on each source image then integrate all these decompositions to form a composite representation and finally reconstruct the fused image by performing an inverse pyramid transform.

3.3 Wavelet transform

WT is performed first followed by predictive coding technique on the transformed image.
All these methods use Haar filter in the lifting scheme and the filter coefficients are given by:

h1= [-1 9 9 1]/ (16);
h2= [0 0 1 1]/ (-4);

Where h1 are the prediction filter coefficients and h2 are the update filter coefficients in the lifting scheme.

The reduced filter coefficients are given by:

h1= [-1 9 9 1]/ (16*1.5);
h2= [0 0 1 1]/ (-4*1.5);

In the wavelet transform, there is a mapping between integers to integers.

The simplest lifting scheme is the lazy wavelet transform, where the input signal is first to split into *even* and *odd* indexed samples.

$$(odd_{j-1}, even_{j-1}) = Split\,(S_j)$$

The examples are related, so it is conceivable to foresee odd specimens from even specimens which on account of Haar change are even values themselves. The contrast between the real odd examples and the expectation turns into the wavelet coefficients. The operation of getting the distinctions from the forecast is known as the lifting step. The upgrade step takes after the forecast step, where the even values are redesigned from the information even specimens and the overhauled odd examples. They turn into the scaling coefficients which will be passed on to the following phase of change. This is the second lifting venture.

$$d_{j-1} = odd_{j-1} - P(even_{j-1})$$
$$s_{j-1} = even_{j-1} + U(d_{j-1})$$

At long last, the odd components are supplanted by the distinction and the even components by the midpoints. The calculations in the lifting plan are done set up which spares parcel of memory and calculation time. The lifting plan gives whole number coefficients thus it is actually reversible. The complete number of coefficients when the change continues as before

By and large, the second request indicator is utilized which is additionally called Finite Impulse Response (FIR) channel. The easiest indicator is the past esteem, in this investigation, the anticipated esteem is the whole of the past two qualities with alpha and beta being the indicator coefficients.

$$f^{\wedge}(n) = <f(n-1)>$$

3.4 Steps for decomposition using lifting

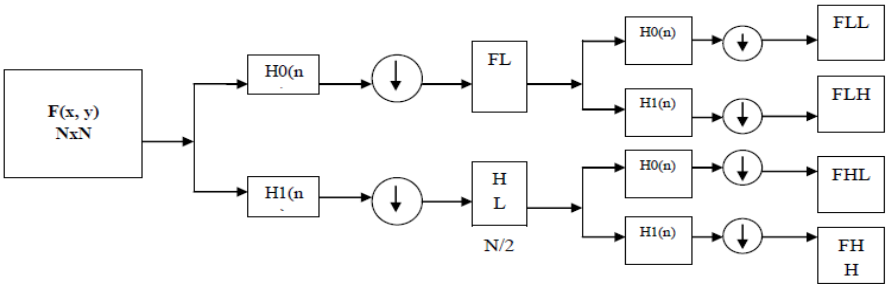
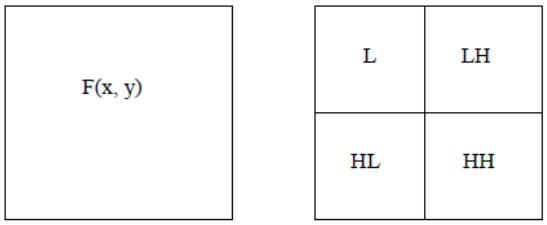


Fig. 2: Steps for decomposition using lifting

3.5 Input and outputs of the lifting scheme



(a) Original image **(b) Transformed image**

Fig. 3: Input and output of the lifting scheme

The changed picture is indicated diverse sub-groups of which the main sub-band is called LL which speaks to the low determination form of the picture, the second sub-band is called LH which speaks to the even vacillations, the third band is known as the HL which speaks to the vertical variances, and the fourth sub-band is known as the HH which speaks to the inclining changes. The same method can be taken after to acquire distinctive levels of picture deterioration by changing the data sources given to the lifting or channel bank execution systems.

4. RESULTS

We have assessed the execution of the proposed framework on Gray Scale and Colored pictures utilizing E Laplacian Pyramid and DWT Technique. Assessment the execution of the proposed framework dependent on different parameters which are MSE, PSNR, Mean, SD, Entropy, Covariance, CC, SSIM, MI.

Table 1: Results obtained by the proposed system on coloured images for 3 images

Image no.	Mean	SD	Entropy	Covariance	CC	SSIM	MI	PSNR	MSE
1.	61.12	73.87	7.43	3.35	1	3.16	0.34	72.58	0.13
2.	61.22	81.87	7.77	4.52	1	3.46	1.33	74.27	0.17
3.	62.32	82.80	7.88	2.98	1	3.34	1.43	74.59	0.12
4.	64.12	63.18	7.99	2.44	1	3.87	0.74	71.23	0.29
5.	64.12	99.62	7.79	2.87	1	3.21	6.22	96.52	0.013
6.	62.42	86.51	7.75	2.53	1	3.34	3.43	89.52	0.011

The above table shows the performance of the proposed system on different parameters which are Entropy, Covariance, Mean Square Error (MSE), Correlation Coefficient (CC), Structural Similarity Index for Measuring Image Quality (SSIM), Mutual Information (MI), Peak Signal to Noise Ratio (PSNR), Mean, Standard Deviation (SD).

Table 2: Comparison table of the existing system and proposed system on different parameters on tested images

Parameters	Existing	Proposed
PSNR	77.1143	79.66
MSE	0.0577	.012
Entropy	6.0249	7.76
SSIM	2.4379	3.396
MI	1.8017	2.248
SD	45.2701	48.235

5. CONCLUSION AND FUTURE SCOPE

The proposed image fusion system uses the Modified Laplacian pyramid technique to fuse two and three images. Existing systems can only fuse two coloured and 2 grayscale images, but in the proposed system we can fuse two as well as three images. Results of the proposed system are tested on various inputs and it is found that the proposed system generated very good results as compared to the existing systems for image fusion. The proposed system can be extended by fusing more than three images at the same time using the Laplacian pyramid technique.

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