IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 9, Issue 5, Ver. V (Sep - Oct. 2014), PP 17-22
www.iosrjournals.org

Implementation of Hybrid Model Image Fusion Algorithm

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Abstract: *This paper represents Hybrid model image fusion algorithm based on combination of pyramid method and Wavelet method .To improve the Quality of output image an Algorithm is proposed by using Laplacian pyramid and Gradient pyramid methods from pyramid method and, Haar wavelet from Wavelet method. This algorithm creates new images for further image processing applications like Enhancement, Segmentation, etc. This Algorithm has several applications in Intelligent robots, Manufacturing industry Military and Remote sensing applications, etc. This algorithm was accessed based on the development of some Image quality metrics like Mean square error, Peak signal to noise ratio, etc.*

Keywords: *Image fusion, laplacian pyramid, Gradient pyramid, Haar wavelet.*

I. Introduction

Any piece of information makes sense only when it is able to convey the content across. The clarity of information is important. Image Fusion is a mechanism to improve the quality of information from a set of images By the process of image fusion the good information from each of the given images is fused together to form a resultant image whose quality is superior to any of the input images. This is achieved by applying a sequence of operations on the images that would make the good information in each of the image prominent. The resultant image is formed by combining such magnified information from the input images into a single image.

Image Fusion finds it application in vast range of areas. It is used for medical diagnostics and treatment. A patient's image in different data formats can be fused. These form scan include Magnetic Resonance Image (MRI),Computed Thermography(CT) ,and Positron Emission Tomography(PET), In radiology and radiation oncology ,these images server different purposes. For example, CT images are used more often to ascertain differences in tissue density while MRI images are typically used to diagnose brain tumors. Image fusion is also used in the field of remote sensing wherein multivariate images like thermal images.IR Images, UV Images ,ordinary optical image ,etc can be fused together to get a better image taken from satellite.

Multi sensor data fusion has become a discipline to which more and more general formal solutions to a number of applications cases are demanded. Several situations in image processing simultaneously require high spatial and high spectral information in a single image; especially in the field of remote sensing. However, the instruments are not capable of providing such information either by design or because of observational constraints. One possible solution for this is data fusion. Image fusion techniques, though initially developed as an image quality enhancement technique.

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II. Image Fusion Algorithms

2.1 Basic Image Fusion Methods

The trivial image fusion techniques mainly perform a very basic operation like pixel selection, addition, subtraction or averaging. These methods are not always effective but are at times critical based on the kind of image under consideration. Following are some of the trivial image fusion techniques.

2.1.1 Average Method

As mentioned previously in this report, the very concept of information fusion arose from the idea of averaging the available information. Image Fusion also saw a similar background, wherein the most simplistic was to fuse a set of input image was to average the pixel intensities of the corresponding pixels. The fused image produced by this method projects both the good and the bad information for the input images. Due to the averaging operation, both the good and the bad information are minimized arriving at an averaged image. Thus the algorithm does not actually fuse the images perfectly. The algorithm, being the simplest one, can be put in one step as the following.

2.1.2 Select Maximum Method

The Selection method is also one of the trivial methods of image fusion. But unlike averaging method, instead of averaging every corresponding pixel, a selection process if performed here. The criterion of selection is self explained by the name of the method. Of every corresponding pixel of the input images, the pixel with maximum intensity is selected and is put in as the resultant pixel of the fused image. Thus, effectively, every pixel of the fused image will be the pixel with maximum intensity of the corresponding position pixels in the input image. One advantage of this method over averaging method is that there is no compromise made over the good information available in the input images. A Straight forward selection of the better pixel intensity is made here. But of course, it is combined with the disadvantage that higher pixel intensity does not always mean better information. It depends on the type of image under consideration. Thus you either take the whole of the information or totally avoid the same.

2.1.3 Select Minimum Method

The minimum selecting method, being yet another trivial image fusion method, is very similar to the Maximum selection method; except for, here, the selection criteria differs as the pixel with minimum density is picked up. Thus, for every pixel position, the pixel of fused image will be the pixel of the corresponding position from the input set of images having the least pixel intensity value. Similar to the Maximum selection method, this method to either completely considers the information from an input image or discards it fully. No averaging or any operation of the like is performed here. The quality of the fusion is specific to the type of image we are dealing with. In certain case, say, images with dark shades would generate a good fusion image with this method.

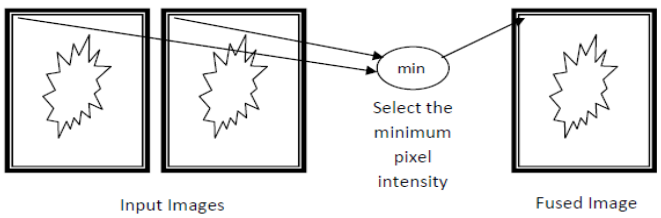

Figure1: The maximum of pixel intensities at every pixel is selected as the pixel of the fused image.

III. Pyramid Transforms

In 1980's a new concept developed in the field of image fusion-fusion in the transform domain. Pyramid transform[3] [5][6][7]proved to be a very efficient method for the same An image pyramid consists of a set of low pass or band pass copies of an image, each copy representing pattern information of a different scale. There are various types of pyramid transforms

- Gradient pyramid
- Laplacian pyramid
- Ratio pyramid
- Morphological pyramid

A Gaussian pyramid is the sequence of images in which each member of the sequence is the low pass filtered version of the previous. At every level of fusion using pyramid transform, the pyramid would be the lower spatial frequencies. The basic idea is to construct the pyramid transform of the fused image from the pyramid transforms of the source images and then the fused image is obtained by taking inverse pyramid transform.

Typically, every pyramid transform consists of three major phases:

- Decomposition
- Formation of the initial image for decomposition
- Recomposition

Decomposition is the process where a pyramid is generated successively at each level of the fusion is pre decided. The number of levels of fusion is based on the size of the input image. The recomposition process, in turn, forms the finally fused image, level wise, by merging thru pyramids formed at each level to the decimated input images .Decomposition consists of the following steps

- Low pass filtering. The different Pyramidal methods have a pre defined filter with which are the input images convolved/filtered with.
- Formation of the pyramid for the level from thru filtered/convolved input images using Burt's method or Lis method
- The input images are decimated to half their size, which would act as input image matrices for the next level of decomposition.

Merging the input images is performed after the decomposition process. This resultant image matrix would act as the initial input to the recomposition process. The finally decimated input pair of images is worked upon either by averaging the two decimated input images, selecting the first decimated input image or selecting the second decimated input image.

The recomposition is the process wherein, the resultant image finally developed from the pyramids formed at each level of decomposition. The various steps involved in the recomposition phase are discussed below. These steps are performed/number of times as in the decomposition process.

- The input image to the level of decomposition is undecimated
- The undecimated atrix is convolved/filtered with the transpose of the filter vector used in the decomposition process
- The filtered matrix is then merged, by the process of pixel intensity value addition, with the pyramid formed at the respective level of decomposition.
- The newly formed image matrix would act as input to the next level of recomposition.

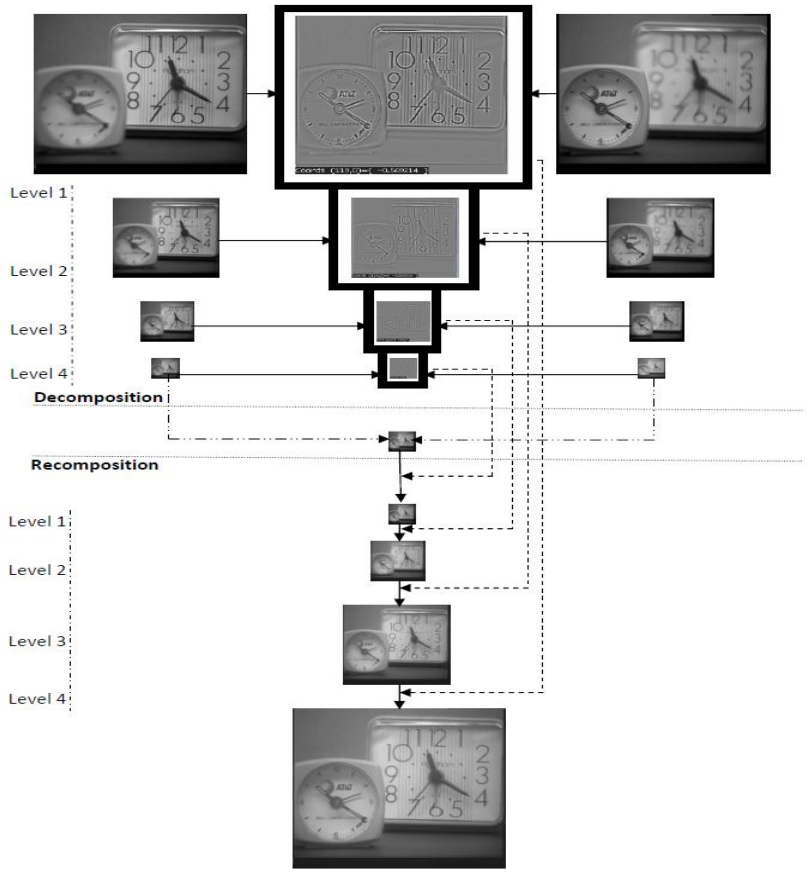

Figure2: Pyramid transform description with example

IV. Proposed Algorithm

An algorithm is proposed to perform fusion on pair of input images. These images are registered by using 'affine' [10] transform by defining control points. On both input image and base image. 'imtransform' is used to perform transformation successfully. These two registered images are now applied as the input images for laplacian and gradient pyramid methods. Output images of laplacian [11] and gradient pyramids [11] are treated as the input images for the haar wavelet method. The registered images are applied as the input images for the haar wavelet [9].

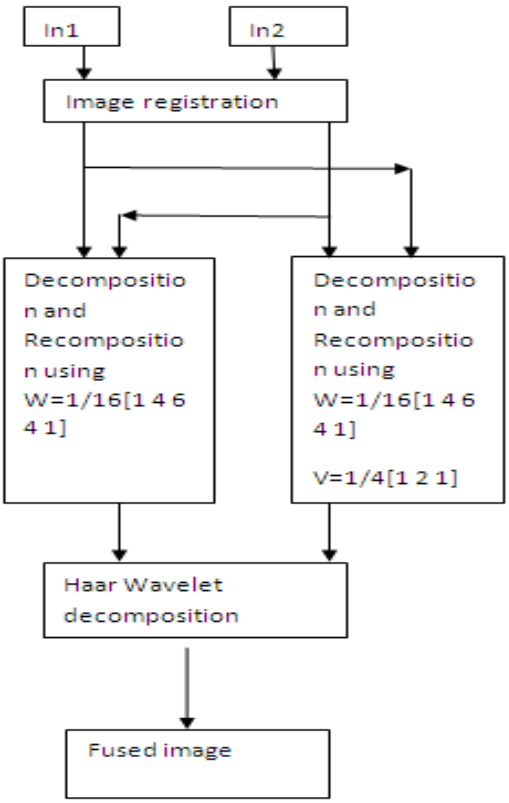

Figure3: Steps Involved in proposed algorithm

The output of the direct haar method and hybrid method is compared with respect to quality metrics like mean square error (MSE), Peak Signal to Noise Ratio(PSNR), Structural content(SC), Average Difference (AD), Normalized Cross Correlation(NCC), Maximum Difference (MD), Normalized Absolute Error(NAE).

V. Results

a) 

b)

c)

d)

figure4: a,b are input images, c is the output of direct haar ,d is the output of proposed method.

Table1: comparison of direct method and proposed method with quality metrics

Type of algorithm	MSE	PSNR	SC	AD	NCC	MD	NAE
Direct haar algorithm	28.0580	33.68	0.9968	4.3511	1.0010	122	0.0305
Proposed haar algorithm	9.1867	38.5332	0.9814	12.1759	1.001	142	0.0120

VI. Conclusion

From this paper, image fusion algorithm has been implemented. The results were implemented using MATLAB. There is also different image fusion techniques were carried out of which Proposed Algorithm gives better results i.e., less MSE, more PSNR etc.

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