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Development of Hybrid Model Using Fuse Image Techniques

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Abstract- Humans have evolved very precise visual skills: they can identify a face in an instant; also they can differentiate colours; can process a large amount of visual information very quickly. An image is a single picture which represents something. It may be a picture of a person, of people or animals, or of an outdoor scene, or a microphotograph of an electronic component, or the result of medical imaging. Image fusion is and will be an integral part of many existing and future surveillance systems. The PCA technique of image fusion is very employed in various manufacturing processes in stamping. Principal Component Analysis (PCA) is used to transform original image into Eigen-space. By principal components with influencing Eigen-values, it reinstates the key structures in the original image and lessens noise level. Finally, split detection algorithm is made and planned to do online automotive stamping split detection. The integrated PCA based system for image fusion, stamping split detection is planned and tested on an automotive line. It is tested by online acquisitions which are thermal and visible and illustrates success. Image fusion is an integral part of many existing and future surveillance systems. However, little or no systematic attempt has been made up to now on studying the relative merits of various fusion methods and their efficacy on real multi-sensor imagery, a method is delivered for assessing the recital of image fusion algorithms.

Keywords: Image Fusion, PCA,HIS, Hybrid

1. INTRODUCTION

Humans are primarily visual creatures. They don't only glance at things to check and classify them, but they can also scan for differences in things, and obtain a rough idea for a scene with a quick glance. Humans have evolved very precise visual skills: they can identify a face in an instant; also they can differentiate colours; can process a large amount of visual information very quickly. An image is a single picture which represents something. It may be a picture of a person, of people or animals, or of an outdoor scene, or a microphotograph of an electronic component, or the result of medical imaging. Image fusion is and will be an integral part of many existing and future surveillance systems. However, little or no systematic attempt has been made up to now on studying the relative merits of various fusion techniques and their effectiveness on real multi-sensor imagery. The PCA technique of image fusion is very employed in various manufacturing processes in stamping. Principal Component Analysis (PCA) is used to transform original image into Eigen-space. By principal components with influencing Eigen-values, it reinstates the key structures in the original image and lessens noise level. Finally, split detection algorithm is made and planned to do online automotive stamping split detection. The integrated PCA based system for image fusion, stamping split detection is planned and tested on an automotive line. It is tested by online acquisitions which are thermal and visible and illustrates success. Image fusion is an integral part of many existing and future surveillance systems. However, little or no systematic attempt has been made up to now on studying the relative merits of various fusion methods and their efficacy on real multi-sensor imagery, a method is delivered for assessing the recital of image fusion algorithms.

2. IMAGES AND PICTURES

An image is a single picture which represents something. It may be a picture of a person, of people or animals, or of an outdoor scene, or a microphotograph of an electronic component, or the result of medical imaging.

2.1 Type of Images

1.1.1.1 Binary: In this case every pixel is black or white. These types of images are efficient for storage. Images for which a binary representation may be suitable include text (printed or handwritten), fingerprints, or architectural plans.
1.1.1.2 Greyscale: In this case every pixel is of grey shade, from 0 (black) to 255 (white) which means that each pixel can be constituted by eight bits.
RGB (or True) Images: In RGB images each pixel has a particular colour. The colour being described by amount of red, green and blue in it. If each of these components has a range0 to 255, this gives a total

colours 255^3 = 1, 67, 77,216 . This means that for every pixel there correspond three values.

Indexed: Every colour image only had a small sub set of more than seventeen million colours which are possible. For storage convenience and handling of file, the image had an associated map or colour palette. This is only the list of all the colours consist in that image. Every pixel had a value which does not tell its colour (as RGB image), but adds index to the colour in the image. It is more convenient if the map has 256 colours or less.

2.2 IMAGE PROCESSING

Image processing means change of the nature of an image either to

1. Enhance its pictorial data for human interpretation,
2. Provide more suitable environment for machine perception.

2.3 Aspects of Image Processing

Image enhancement: It is processing an image so that the result may be used for suitable application. Examples:

- Sharpening an out of focus image.
- Highlighting image.
- Improving contrast of an image.
- Removing random noise.

Image restoration: This is to reverse the damage which has been done to an image by a known reason. Example:

- Removing of blur caused by linear motion.
- Removal of optical noise.
- Removing periodic disturbance.

Image segmentation: This means sub-dividing an image into parts, or seperating certain aspects of an image. For examples:

- Finding circles, lines, square or certain shape in an image.
- In an aerial photograph, recognising trees, buildings etc.

2.4 IMAGE FUSION

The concept of data fusion was developed with the aim for practical methods of merging images from various sources. It is to provide an image which can be used to identify natural and manmade things.

Image Fusion is a process of integrating the necessary information from a set of images into one image, where the resultant integrated image is more informative and complete than the input images. The aim of image fusion technique is to improve the quality and application of the data.

Image fusion can be divided into three categories:

1. **1.** Pixel level
2. **2.** Feature level
3. **3.** Decision level**.**

In pixel level fusion, the input images are integrated pixel by pixel and information extraction is done. Pixel level fusion is good for high quality images and is not suitable for low quality level images. The scheme of pixel level fusion is shown in Figure below

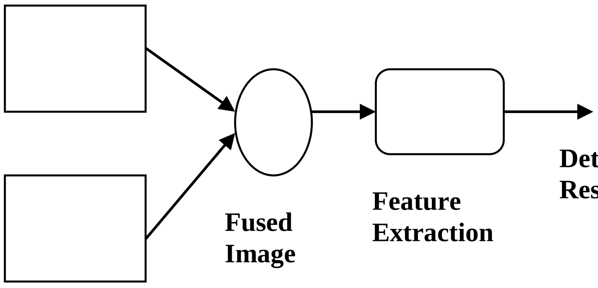

Figure: Pixel level fusion

In feature level fusion, the information is extracted from each source image separately and then integrated on the basis of features got from input images. The feature detection is done through edge enhancement algorithms, knowledge based approaches and artificial neural networks. Feature level fusion is effective for images with low quality level.

2.4.1 Image Fusion in Night Mode: An image fusion application research in night vision has been accomplished to track pedestrians and vehicles and then increase the driving safety in night driving scenarios. To increase night-time driving safety, Automotive Original Equipment Manufacturers (OEMs) have introduced different techniques.

These techniques are:

1. Laser based system
2. Far-infrared (FIR) passive system
3. Near-infrared (NIR) active system

The range of laser based and NIR system are 500 feet. They don't offer classifying ability for detected objects. But the passive FIR system provides range up to 5000 feet with high resolution objects. However, FIR system only detects thermal emitting (warm) objects but missing reflective (cold) objects such as head lamps and road signs. This might effect the drivers' awareness of heavily clothed pedestrians, traffic signs and other many obstacles. FIR modules and visible cameras both when combined, provides a better solution for tracking vehicles and non-emitting road features.

Both pixel level and feature level fusion algorithm are developed and applied on two driving scenarios (a passing vehicle scenario and an approaching vehicle scenario), to quantify their strengths and weaknesses for dynamic 50scenarios. The image fusion algorithms coupled with object tracking routines provide complete detection of both reflective and emitting objects with good shape and orientation extraction.

The source image sequences are from two channels, LWIR and visible. The LWIR thermal image sequence is acquired from an uncoiled, micro-bolometric array with 352×144 resolution and 30 Hz frame rate. The visible image sequence obtained from a Charged Coupled Device (CCD) detector with the same resolution and frame rate. Two important scenarios for night time driving, a passing vehicle scenario and an approaching vehicle scenario, are selected.

3. LITERATURE SURVEY

Sadjadi (2003) in paper entitledon "**Measures of Effectiveness and Their Use inComparative Image Fusion Analysis"**In this paper it is reported on the result of study to do acomparative analysis of various image fusion algorithms. As partof this study a set ofmeasures of effectiveness(MOE)for image fusion performance evaluation is defined and have usedthem to compare the performance of a variety of image fusionalgorithms on real multi-sensor imagery.

Sadjadi (2005) proposed**"Comparative Image Fusion Analysis"**Image fusion is and will be an integral part of many existing and future surveillance systems. However, little or no systematic attempt has been made up to now on studying the relative merits of various fusion techniques and their effectiveness on real multi-sensor imagery. In this paper a method is provided for evaluating the performance of image fusion algorithms. A set of measures of effectiveness for comparative performance analysis is defined and then they are used on the output of a number of fusion algorithms that have been applied to a set of real passive infrared (IR) and visible band imagery.

Martín et al (**2007)**in their paper entitled "**Comparative Analysis on Image Fusion Methods"** a new fusion methodology for Multispectral and Panchromatic images, has been proposed. This methodology is based on a joint multire solution-multi directional representation of the source images. For that an unique directional filters bank of low computational complexity has been used. This kind of image representation allows an appropriated selection of the information extracted from the source images, avoiding some of the limitations inherent to other multi resolution fusion methods. The final aim is to obtain fused images with a high spectral and spatial quality simultaneously. The high quality of the obtained results shows the potential of the joint multi resolution-multidirectional representation for images fusion.

Sasikala et al.**(2007)** proposed**"A Comparative Analysis of Feature Based Image Fusion Methods"** A comparison of various feature based fusion schemes is presented in this paper. Feature extraction plays a major role in the implementation of feature-level fusion approaches. Prior to the merging of images, salient features, present in all source images, are extracted using an appropriate feature extraction procedure. Then, fusion is performed using these extracted features.

Yang et al.(2007)in their paper entitled **"An Overview on Pixel-Level Image Fusion in Remote Sensing"** discussed that Pixel-level image fusion is an important part of image fusion algorithms which can combine spectral information of coarse resolution imagery with finer spatial resolution imagery. The objective of this paper is to present an overview of pixel-level image fusion algorithms used for effective information interpretation of remotely sensed imagery of various spatial and spectral characteristics. According to their different characteristics, these algorithms are categorized into four types, i.e., color space model algorithms, statistical/numerical algorithms, multi resolution decomposition algorithms and radiometric/spectral algorithms.

4. IMPLEMENTATION

4.1 PCA (Principal Component Analysis fusion):

For upgrading images resolution, two images which are used decomposed first into sub-images having unlike frequency and data fusion is accomplished. By using PCA of covariance matrix of input images, the weightage for each input image is found from the eigen-vector corresponding to the largest Eigen value.

4.2 Steps used in PCA:

1) Matrix is C of a matrix X, C=XXT expectation MEAN = cov(X).
2) Obtain eigen-vectors V and eigen value . Both V and D have 2 × 2 dimension.
3) Let us first column of V to compute component $P_1$and P_2

$$P_1 = \frac{V(1)}{\sum V} \text{and} \quad P_2 = \frac{V(2)}{\sum V}$$

4) The fused image I_f**(x,y)** is computed as below if the input images are I_1**(x,y)** and I_2**(x,y)**

$$I_f(x, y) = P_1 I_1(x, y) + P_2 I_2(x, y)$$

4.3 HIS (Hue Intensity Saturation):

The HIS technique is used for enhancing of the images. HIS system has merit of separate channels outline certain color belongings like intensity (I), hue (H), and saturation (S). The explicit colour space is often taken three components as orthogonal perceptual axes.HIS scheme is hence defined :

$$\begin{pmatrix} I \\ v1 \\ v2 \end{pmatrix} = \begin{bmatrix} 1/\sqrt{3} & 1/\sqrt{3} & 1/\sqrt{3} \\ 1/\sqrt{6} & 1/\sqrt{6} & -2/\sqrt{6} \\ 1/\sqrt{2} & -1/\sqrt{2} & 0 \end{bmatrix} \begin{pmatrix} R \\ G \\ B \end{pmatrix}$$

$$H = \tan^{-1}(v1/v2)$$

$$S = \sqrt{v1^2 + v2^2}$$

$$\begin{pmatrix} R \\ G \\ B \end{pmatrix} = \begin{bmatrix} 1/\sqrt{3} & 1/\sqrt{6} & 1/\sqrt{2} \\ 1/\sqrt{3} & 1/\sqrt{6} & -1/\sqrt{6} \\ 1/\sqrt{3} & -2/\sqrt{6} & 0 \end{bmatrix} \begin{pmatrix} I \\ v1 \\ v2 \end{pmatrix}$$

4.4 Steps used in HIS

1. Take two images first and second.
2. Alter the RGB channels (matching to 3 multispectral bands) of another image to HIS elements.
3. Separate this HIS components.
4. Convert I element to image form and calculate its histogram.
   Now separate all three components of first image into R, G, B layers.
5. Match the histogram of all three layers with the histogram of second image calculated above.
6. Restore the power element with the extend image or we can say that I component is changed by sequence of all three matched histogram components.

4.5 Proposed Hybrid Model

Here we are combining all three techniques for superior results.

4.6 Steps:

1. Register the two images which are to be fused together with two different names given to them.
2. Then convert this second registered image into HIS components.
3. Separate the Intensity component of it.
4. Calculate the histogram of this I (Intensity) component.
5. Match histogram offirst image with the histogram of I component.
6. Apply wavelet on Intensity layer and matched histogram equality layer

Apply the operation (0.5 × coefficient details)

7. Apply Inverse Discrete wavelet transform on the result obtained.
8. Then concatenate the three components H, I and S into one variable.
9. Convert this HIS image into RGB image
10. Now take two images 1) Resultant image of HIS 2) Concatenated image converted to RGB image above.
11. Separate R, G, and B layers of both the images.

5. RESULTS & DISCUSSIONS

In order to estimate the performance of the Image fusion techniques and its proposed hybrid model, the simulation is done with the help of the tool Image processing. The results of the simulation is showed and discussed here in this chapter.

The quality of Inputted images which are to be fused is checked by calculating the correlation coefficient between both the images.

First of all the three individual techniques of fusion (HIS, DWT, PCA) are implemented independently and the values of Red, Green and blue pixels are observed.

Then the correlation coefficient between the original image and fused image is calculated.

For displaying results, we are using Bar graphs with the use of MATLAB

Following two source images are fused:

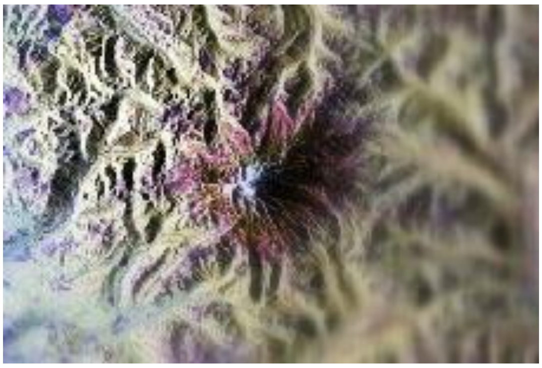

Figure**:** First source image

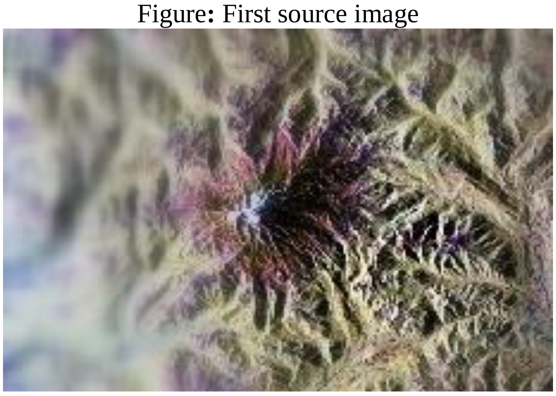

Figure: Second source image

5.1 HIS Fusion:

Subsequently doing simulation, the outcome got for HIS fusion as:

Connection elements of input images – **0.7872**
Red pixels Value -**134.3714**
Green pixels Value -**127.3711**
Blue pixels Value -**116.7029**
Correlation coefficient-**0.97078**

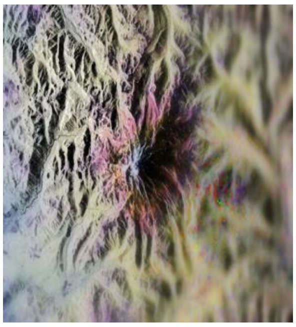

Figure: Outcome Image of HIS fusion

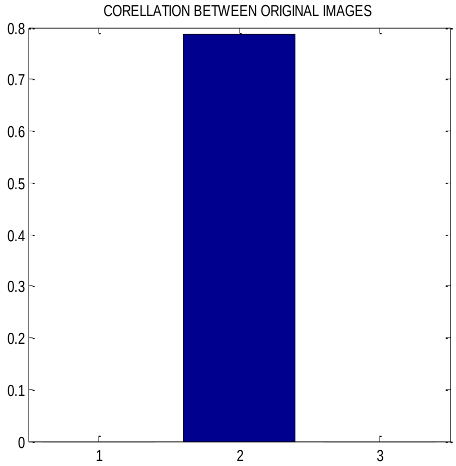

Figure : Graph appearing correlation of original images

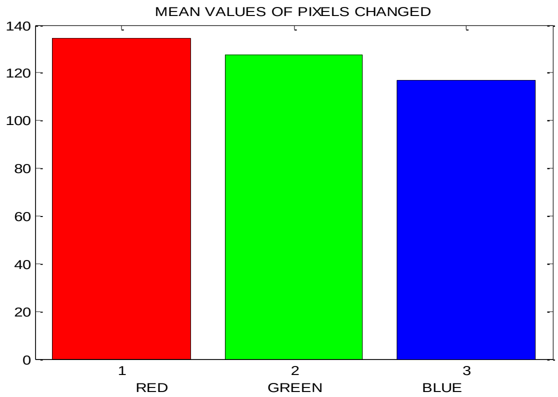

Figure: Graph appearing mean values of pixels after HIS

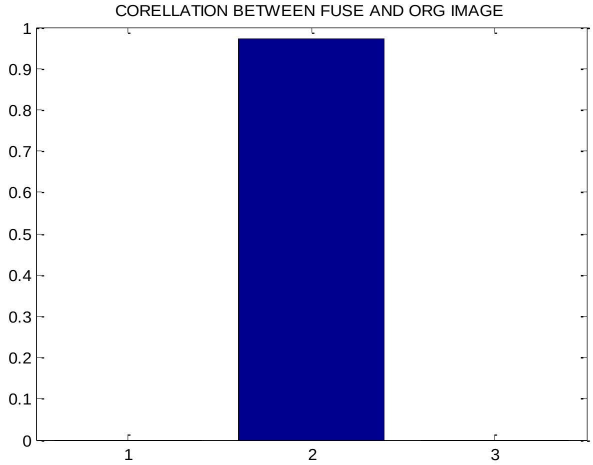

Figure: Graph appearing correlation after HIS fusion

5.2 WAVELET Fusion:
After doing the simulation, the outcome obtained for Wavelet fusion:
Correlation elements of input images – **0.7872**
Red pixels Value -**133.1244**
Green pixels Value -**127.1689**
Blue pixels Value -**118.285**
Correlation coefficient-**0.94946**

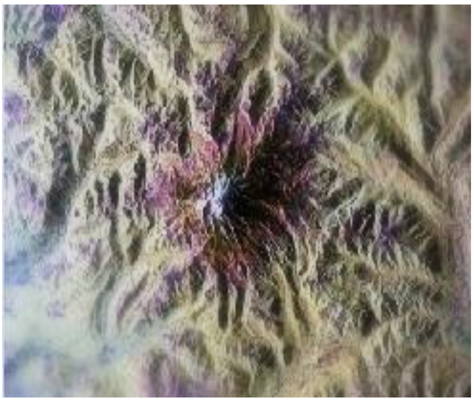

Figure: Outcome Image of Wavelet fusion

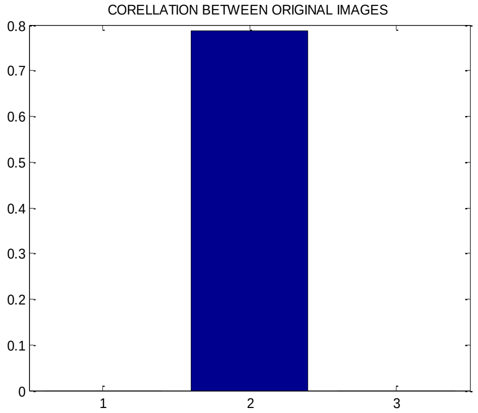

Figure: Graph appearing correlation of original images

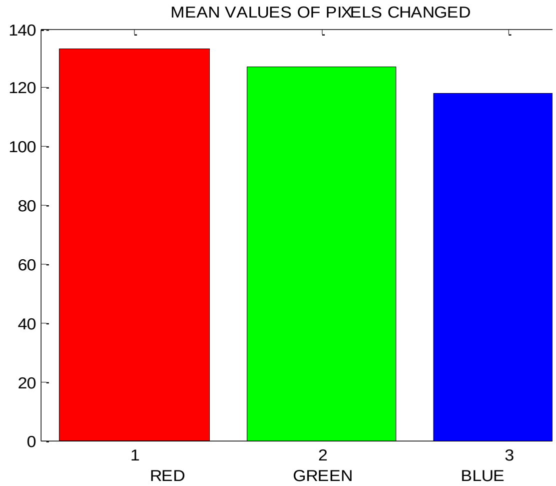

Figure: Graph appearing mean values of pixels after wavelet fusion

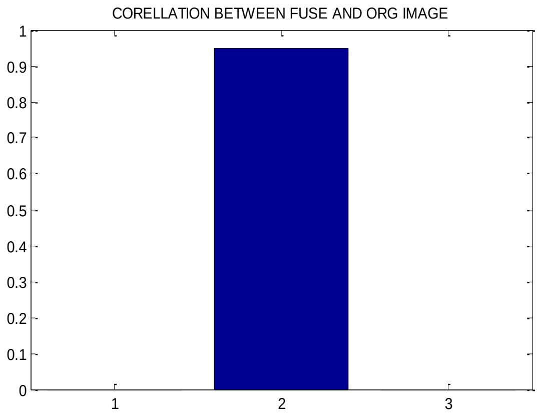

Figure: Graph appearing correlation after wavelet fusion

5.3 PCA Fusion:
After doing the simulation, the outcome obtained for PCA fusion:
Correlation elements of input images – **0.7872**
Red pixels Value -**133.0904**
Green pixels Value -**127.1195**
Blue pixels Value -**118.1923**
Correlation coefficient-**0.95455**

Figure: Outcome Image of PCA fusion

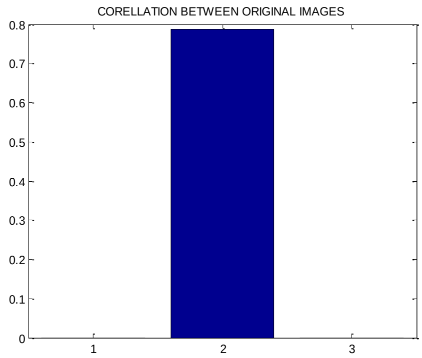

Figure: Graph appearing correlation of original images

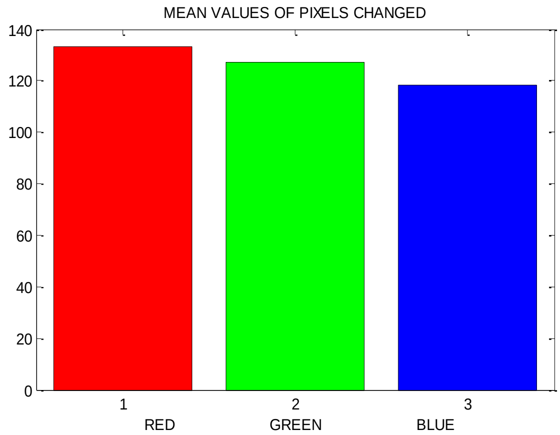

Figure: Graph appearing mean values of pixels after PCA fusion

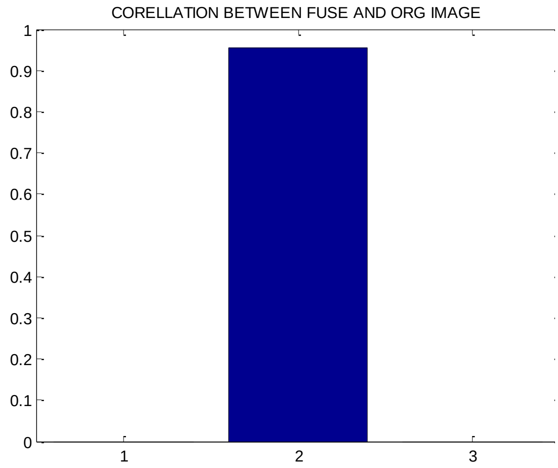

Figure : Graph appearing correlation after PCA fusion

5.4 Hybrid Fusion:
After doing the simulation, the outcome obtained for PCA fusion:
Correlation elements of input images – **0.7872**
Red pixels Value -**132.3796**
Green pixels Value -**136.468**
Blue pixels Value -**146.015**
Correlation coefficient-**0.99979**

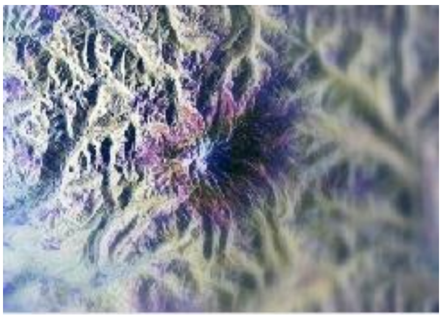

Figure : Outcome Image of Hybrid fusion

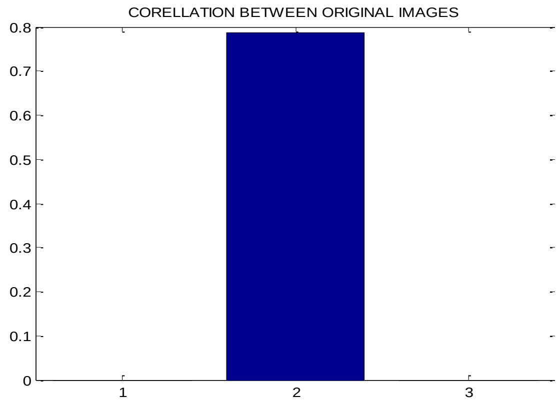

Figure :Graph appearing correlation of original images

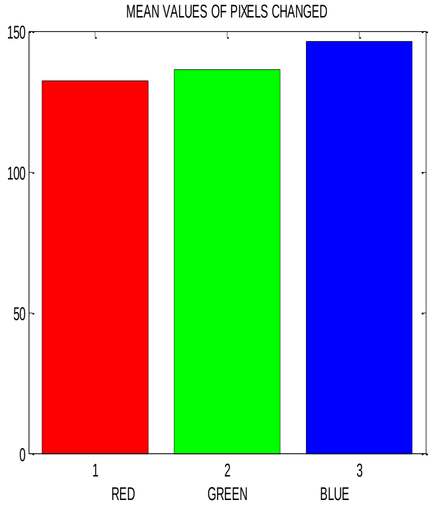

Figure: Graph appearing mean values of pixels after Hybrid fusion

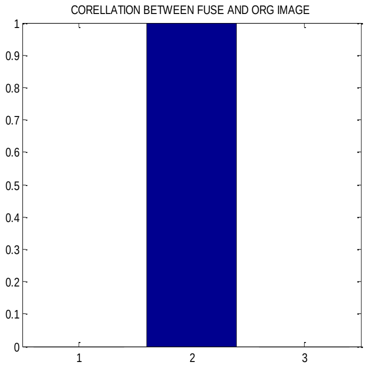

Figure : Graph appearing correlation **after Hybrid fusion**

5.5 Result Summary:
From all three techniques the superior results given by PCA fusion techniques. When these techniques are joined i.e. the Projected Hybrid Model, this model gives the best result in case of fusion.

S.NO.	Red Pixels	Green Pixels	Blue Pixels	Correlation Coefficient
HIS	**132.21**	**125.19**	**113.02**	**0.86**
Wavelet(DWT)	**131.32**	**125.89**	**115.28**	**0.87**
PCA	**131.30**	**125.55**	**114.13**	**0.88**
Proposed(HIS+ DWT+PCA)	**130.16**	**133.88**	**141.17**	**0.89**

Table : Appearance of the results obtained

6. CONCLUSION

- The image fusion done by various techniques &outputs obtained have different behavior on basis of various parameters.
- In the results, HIS technique shows better results as compared to PCA and wavelet fusion.
- The fusion technique selection depends on the application because each type has its own behavior.
- Different fusion techniques combined together for obtaining better results.
- The combination of three techniques is used and Hybrid model is implemented for the better quality of fusion and to obtain more informative image.
- The results obtained are better than the fusion with the combination of two techniques.

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