IOP Conference Series: Materials Science and Engineering

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To cite this article: Basaad Hadi and Ahlam Majeed 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **571** 012114

IOP Conf. Series: Materials Science and Engineering **571** (2019) 012114 doi:10.1088/1757-899X/571/1/012114

Transform Infra- Red Image Using Discrete Wavelet Function

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Abstract: Many techniques used for providing better resolution and getting the best images feature for target recognition system because of the multi-resolution and good properties of time frequency analysis. Discrete Wavelet transform (DWT) is good performance for IR image field scheme based on pixel employs genetic algorithms to operate the traditional wavelet coefficients to study and analyze IR image and image resolution enhancement. Noticed that, the best quality for process image using DWT and IDWT will be used in day vision regarding to get enhance IR image. Comparing all output images with original one there is no noise because of getting the same IR images, four images getting from the DWT coefficients having good features of the object comparing with the original image. A good achievement of the best feature of the images observing, that can use for target recognition system and remote sensing.

Key words: IR image, DWT, Enhance multiple-band frequency IR images.

1. Introduction

IR technologies connected with controlling functions and night vision problems with earlier applications linked simply with detection of IR radiation and later by forming IR images from temperature and emissivity differences like systems for recognition and surveillance, tank sight systems, remote sensing and for medical applications.

Most IR image capturing by IR imaging system are based on three band of wavelength according to the atmospheric permeation characteristics, the bandwidth ranges (1.3-3) µm at near or short wave IR (SWIR), (3-5) µm at middle wave IR (MWIR) and (8-14) µm at long wave IR (LWIR)[1,2].

The features of the object, the primary necessary for acquiring the correspondence with the database images are indistinguishable in case of infrared image which as an individual does not provide high-resolution data [3].

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Discrete Wavelet transform (DWT) use for a good performance of IR image field scheme that based on pixel employs hereditary algorithms. Toward operate the traditional wavelet coefficients to decide how to combine IR with visible information [4, 5].To provide better solution and achieve the best feature of the images for target recognition system and because of the multi-resolution and good properties of time frequency analysis.

Image resolution enhancement is one of the first steps in image processing, is the process of deploying an image so that resultant image is more suitable than the original one for specific application can be done in various domains so a good quality image means high-resolution image.

Image resolution enhancement based on discrete wavelet and interpolation techniques will study here by using different IR images and quantitative results showing the dominance between two images resolution enhancement [6]. Mathematicians, quantum physicists, electrical engineers, and geologists developed wavelets independently, but associations among these fields during the last decade have led to new and varied applications [7].

Wavelets are functions that satisfy certain mathematical requirements and used in representing data or other functions. The mathematics worked out in unbearable detail, and wavelet theory is now in the refinement stage. This involves generalizing and extending wavelets, such as in extending wavelet packet techniques [8].

The aims of this project is to enhance characterization of IR image properties using wavelet analysis, reduce the dimension of necessary analysts and test the prediction capability of obtained wavelet coefficients in the estimation of IR image properties.

2. Proposed Method

2.1 The concept of coefficients of DWT

The convolution of the sampled signal and the wavelet-filter can generate by sampling a wavelet-function or a special structure. Request of wavelets for infrared images is image compression, DWT it only changes coefficients at high frequencies in ranges they themselves are high to amplify the contrast in images. Therefore, there is no additional effect like in amplifying high frequencies using the DWT.

By reducing the number of necessary wavelengths to the most significant minimum and filtering noise. This project applied wavelet analysis to spectral near infrared (NIR) and mid infrared (MIR) and by converting images from band to band

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by using a transformation method we can obtain output image in any wavelength [9]. The First step is applying a one-level of DWT along the rows of the image. Then the same process along the columns of image. The result of these two sets of operations is a transformed image with four divergent bands: (1) LL, (2) LH, (3) HL and (4) HH [10].

L stands for low-pass filtering, and H stands for high-pass filtering. The LL band relates about to a down-sampled by a factor of two version of the original image. The LH band a reservation localized horizontal features, while the HL band tends to preserve localized vertical features in the original image. Finally, the HH band tends to separate localized high-frequency point features in the image. The one-level, two-dimensional DWT extracts only the highest frequencies in the image. Additional levels of rottenness can remove lower frequency features in the image these extra levels applied only to the LL band of the transformed image at the previous level [11].

The difference between the low resolution input image and the LL sub band image are in their high-frequency components, in the intermediate stage this difference image used to correct the estimated high frequency components.

The variance image correlated with all the interpolated high frequency sub bands getting an estimated LH, HL and HH images. Then all estimated sub band images and input image interposed by interpolation factor α/2 in to get required size for IDWT process. Applying inverse discrete wavelet transform to get high-resolution image, which is final output of this technique.

2.2 Signal–to–Noise ratio SNR

The noise can be characterized by standard deviation s_n were characterization of the signal that could be differ. If the signal known to lie between two boundaries, a_{min} and a_{max} then SNR defined as [12]:

$$SNR = 20\log_{10}\left(\frac{a_{max}-a_{min}}{s_n}\right) \ldots\ldots.(1)$$

If the Signal has been process, noise added to original image. Signal to noise ratio is a parameter used to know the amount by which the signal corrupted by the noise defined as the ratio of the signal power to the noise power.

$$SNR = 20\log_{10}\left(\frac{\sum_{n=1}^{N} s^2}{\sum_{n=1}^{N}(s-\hat{s})^2}\right.\quad \ldots.(2)$$

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Where, s is the original image $\hat{s}$ is the processing image, and *N* is the total number of pixels.

2.3 PSNR Algorithm Description

The ratio of the peak signal energy to the mean standard deviation MSE observed between the processed image and the original image defined as PSNR. The peak signal energy supposed to be $(255)^2$, and the MSE summation made over the selected input and output of the processed sequence.

The mean square error is the squared of the difference between the data and the approximation divided by the number of elements. PSNR can define the peak signal-to-noise ratio in decibels (dB). It is only meaningful for data encoded in terms of bits per sample, or bits per pixel, an image with 8 bits per pixel contains integers from zero to 255.The algorithm performs a linear fit of the processed image pixels to the corresponding original image pixels for each shift that examined before computing the MSE.

Peak Signal to Noise Ratio (PSNR in dB) is:

$$\mathrm{PSNR} = 20\log 10\left(\frac{2^{\mathrm{Bps}-1}}{\sqrt{\mathrm{MSE}}}\right) \ldots \ldots (3)$$

The default for BPS is 8, so the maximum possible pixel value of an image is 255. Maximum absolute squared deviation of the data X from the approximation XAPP, returned as a positive real number. Where XAPP is the same size as X. [13, 14]

$$\mathrm{MAXERR} = \sum_{i=1}^{m}\sum_{j=1}^{n}\mathrm{Max}\ (|D(i,j)|) \ldots . (4)$$

$$|D(i,j)| = X(i,j) - \mathrm{XAPP}(i,j) \ldots . (5)$$

Other calculations like, the ratio of the squared of signal or image approximation to the input signal or image X, denoted as the energy ratio between X and XAPP (L2RAT) [13, 14].

$$\mathrm{L2RAT} = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n} \quad B(i,j)}{\sum_{i=1}^{m}\sum_{j=1}^{n} \quad A(i,j)} \ldots \ldots (6)$$

$$A = X^2(i,j) \ldots . (7)$$

$$B = XAPP^2(i, j) \ldots . (8)$$

Energy ratio between the approximation XAPP and input data X, returned as a positive real number

2.4 Image Resolution Enhancement

The low-resolution image in wavelet domain obtained by low pass filtering of the high- resolution image while instead of using low-resolution sub bands using input image for the interpolation of low frequency sub band image, this increases the quality of image. Then inverse discrete wavelet transform (IDWT) applied to all the interpolated sub bands. The IDWT output is final output image, which is high-resolution image.

2.5 Algorithm for IR image transforms using DWT

The steps of work listed in algorithm (1). Figure (1) shows the block diagram of the DWT-based Resolution Enhancement in Algorithm (1). The information of IR image using here illustrated in table (1).

Algorithm (1) : Enhancement Resolution IR-Image

Input: IR Low-resolution image

Output: Four image (LL, LH, HH, LH) which will be added to original IR image, and the enhance image after preform inverse discrete wavelet transform IDWT

- **image (IR+LL), image (IR+LH), image (IR+HH) , image (IR+HL) and image (IDWT)**

Began:

Step1: Reade the original IR image

Step2: Perform a transform (DWT) for the array that contains image data.

[LL , LH ,HH ,Hl] $\longleftarrow$ **Preform DWT (IR image)**

Step3: Resize the arrays (LL, LH, HH, and Hl) to dimension equal to the size of original IR image.

(SLL , SLH ,SHH ,SHL) $\longleftarrow$ **RE-Sizing**

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Step4: Create four enhance images as follow:

Enhance image (LL + IR), Enhance image (LH + IR), Enhance image (HH+ IR), Enhance image (HL + IR)

Step5: Find the calculation of measures (MSE, PSNR, MAXERR, and L2RAT) and draw histogram for each one of the previous images.

Step6: Preform the inverse transformation to get the fifth enhance image and calculate its measures.

[LL + LH ,HH , Hl] ⟵ Inverse transform (I DWT)

End algorithm

3. Result and Discussion

A modeling program made using MATLABR2014 program in order to verify work then to get result. Table (1) illustrates the function used with output data. Figure (1) blocks Diagram of DWT-based Enhancement Resolution Algorithm. Figure (2) demonstration the original or input IR image with the four enhanced images using DWT function put it in figure (3). Figure (4) shows histogram for the input image.

Table 1. IR image information

TYPE OF IMAGE	emissivity	Temperature	Transmission	Image Range	Camera Model	Lens description
Secondary power station	0.95	T_{min}=301.1k T_{max}=361.5k	1.00	-9.4°C-87.9°C	Ti55FT Fluke	20mm/F0.8

Table (2): function and output data

Input IR-Image	LL + OrgImg	LH + OrgImg	HH + OrgImg	HL + OrgImg
PSNR	9.3355	28.3312	28.2550	37.5196
MSE	0.007577	95.4895	97.1807	11.5112
MAXERR	255	233	224	156
L2RAT	1.7695	1.0197	1.0226	1.0058

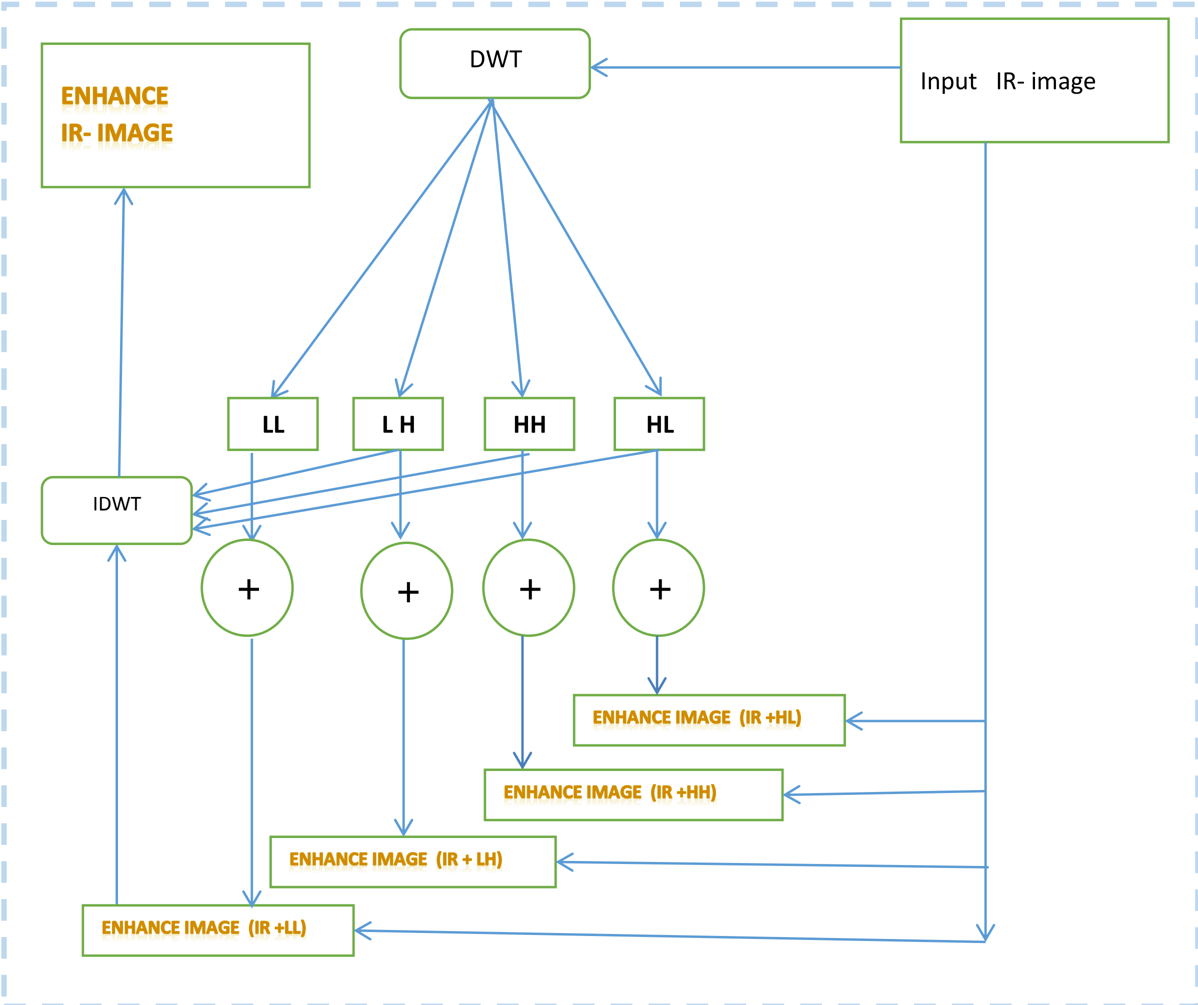

Figure (1): Block Diagram of DWT-based Enhancement Resolution Algorithm

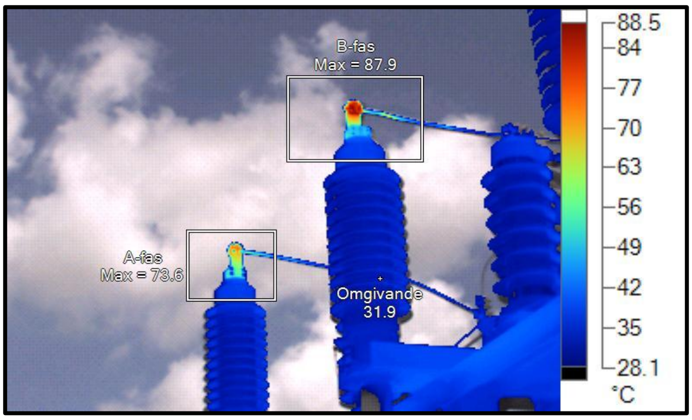

Figure (2) input image

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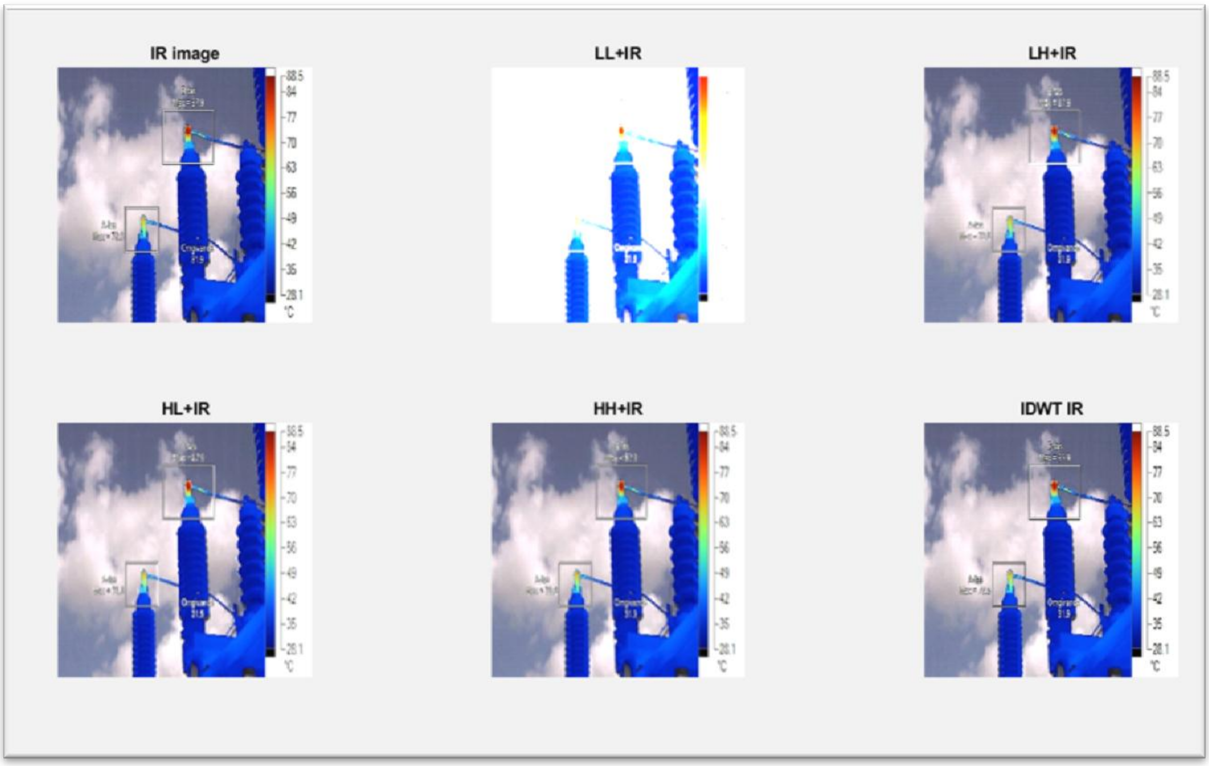

Figure (3) input and output images

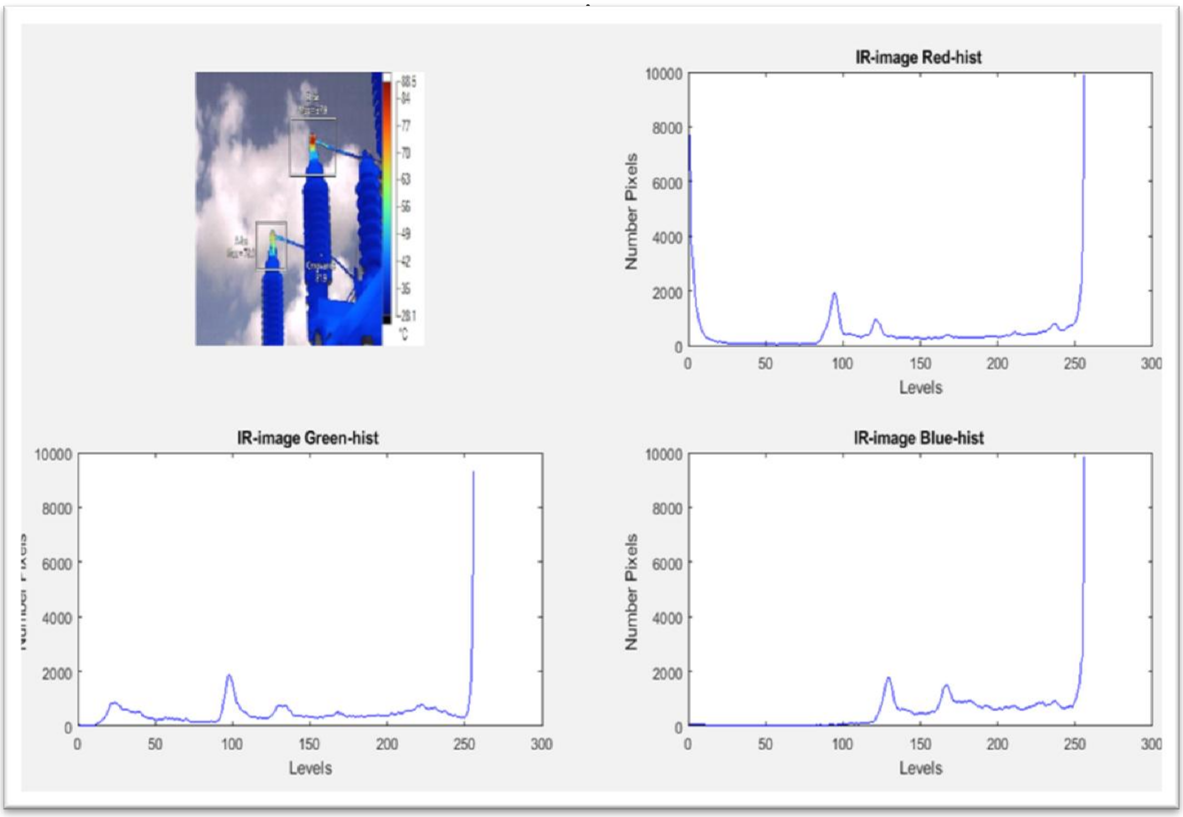

Figure (4) the histogram of input image

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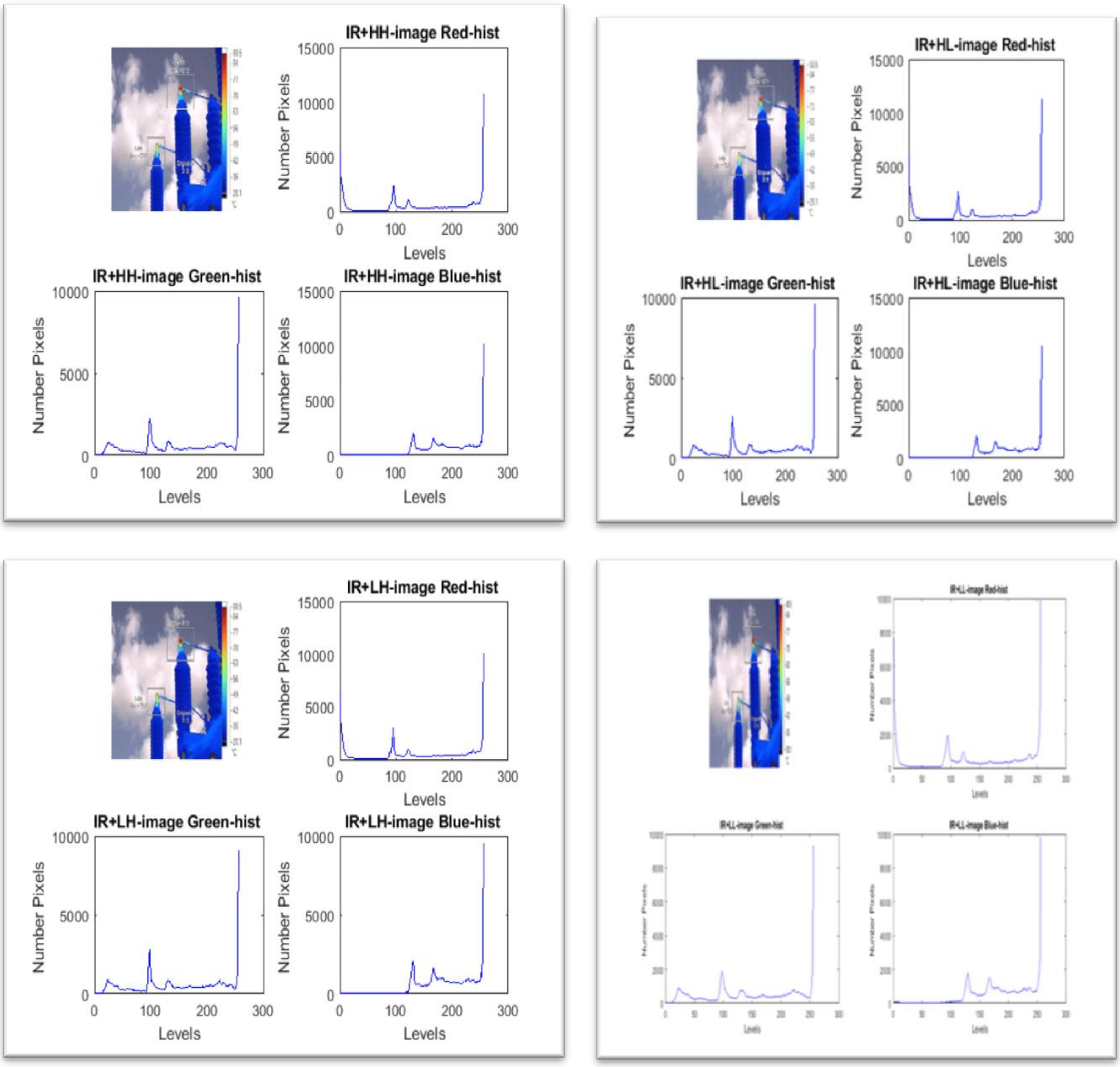

Figure (5) the histogram of output images.

Table (3) output data after conversion image to gray in band (3-5) µm

Gray Image	LL + OrgImg	LH + OrgImg	HH + OrgImg	HL + OrgImg	IDWT-Image
PSNR	9.3702	28.6163	27.1063	34.6976	9.2234
MSE	7.5173e+03	89.4242	126.6044	22.0458	7.7757e+03
MAXERR	174	156	155	118	130
L2RAT	1.8191	1.0250	1.0341	1.0100	1.2520

Table (4) output data after conversion image to gray in band (8-12)

Gray Image	LL + OrgImg	LH + OrgImg	HH + OrgImg	HL + OrgImg	IDWT image
PSNR	14.4425	32.7400	32.2377	38.7576	6.5840
MSE	2.3379e+03	34.6006	38.8429	8.6560	1.4278e+04
MAXERR	175	141	168	99	130
L2RAT	1.1277	1.0057	1.0065	1.0022	1.2520

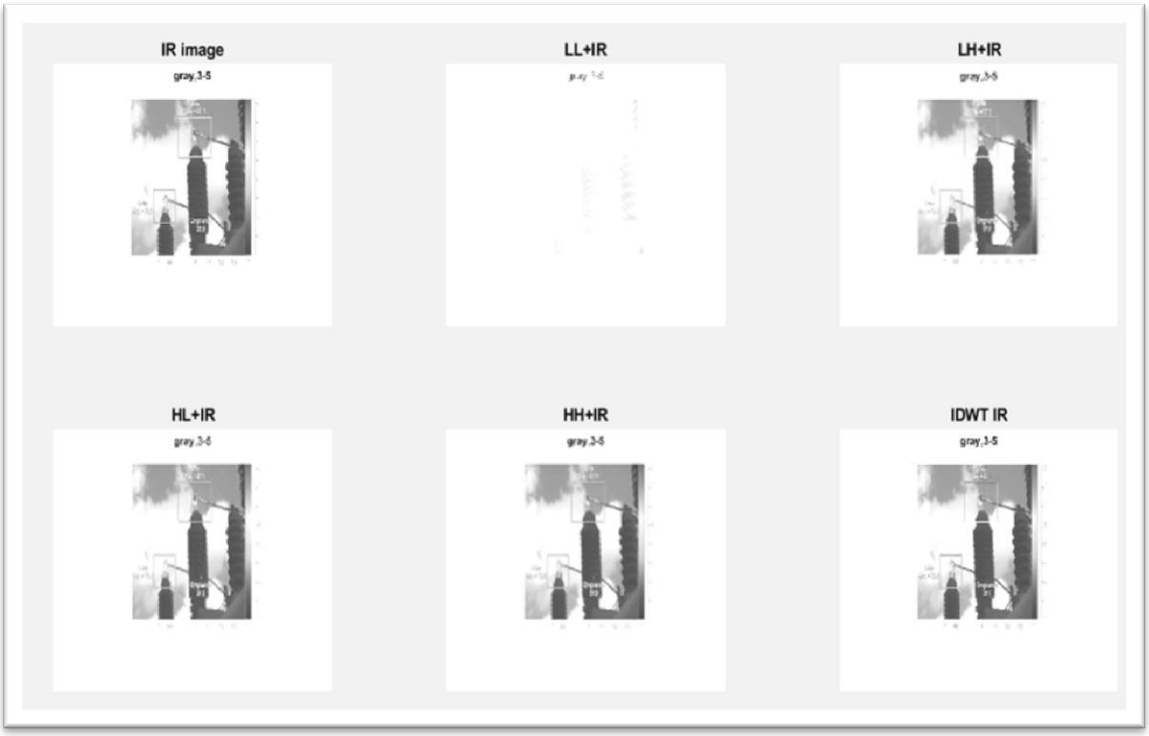

Figure (6) input and output gray images after using DWT in band (3-5) µm

When analyzing the results and output images notice that a high PSNR and good agreement for IR image and gray image after converging to another wavelength or frequency which equivalent to eliminating contrast and level brightness correction errors.

From figure (5) all output images from the most important portion of functions are clear and best feature of the images except LL function. This LL sub band image has the low resolution than the original image, using original image as an input instead of LL sub band image though the interpolation process, which have high brightens getting best result to study for night vision.

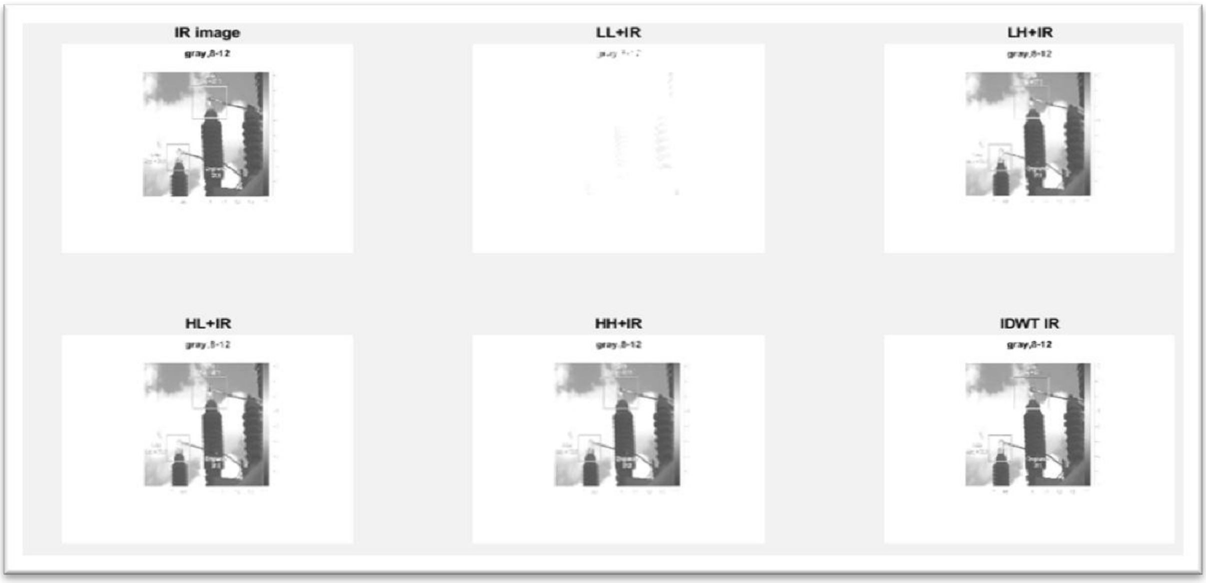

Figure (7) input and output gray images after using DWT in

A best quality or a good resolution for image process using DWT and IDWT that be used in day vision regarding that IDWT function return the same image.

Relating all output images with original one notice that there is no noise because it is the same one, four arrays getting four images like the original image. Comparing the histogram of each one of the components RGB for the original image with the other images produced by DWT and IDWT techniques, it is found that the clear approximation of the original image's histogram shown with the histogram of the other images, demonstrating that it is very similar to the original image. The values of MSE for RGB images is lower than values of MSE for gray images this lead to notice that DWT function is work with good enhancement for RGB images.

4. Conclusion

DWT and IDWT is a good performance analysis for IR image field because of the multi-resolution and good properties of time frequency for daily vision and night vision. A good achievement of the best feature of the images observing, that can use for target recognition system and remote sensing. IDWT technique having high-resolution image than image obtain from using DWT because it return the same image. DWT is a good presentation for IR image field their high-resolution images obtain from resolution enhancement using DWT technique and high-resolution image obtain from same procedure after transform to another wavelength or frequency.

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