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# An Enhancement of Classical Unsharp Mask filter for Contrast and Edge Preservation

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## Abstract

Various images are low quality, difficult to detect and extract information. Therefore, enhancement of contrast and Sharpness of an image is required in many applications. Unsharp masking is a good tool for sharpness enhancement: it is an anti-blurring filter. By using Unsharp masking algorithm for sharpness enhancement, the resultant image suffering with two problems, first one is halo appears around the image and second one is rescaling process is needed for the resultant image. The aim of this paper is to enhance the contrast and sharpness of an image simultaneously and to solve the problems. Medical images are one of the fundamental images, because they are used in more sensitive field. In order to improve the visual quality of medical images, the proposed algorithm working on the medical images for their improved diagnostic with enhanced classical Unsharp mask filter which will not only preserve the edge but also the contrast is maintain i.e. suitable for body part. Experimental results, which comparable to recent published results, shows that proposed algorithm is significantly improve the sharpness and contrast of an image. This makes the proposed algorithm practically useful.

**Keywords**: Exploratory data model, Image enhancement, Log gabor filter, PSNR, Standard deviation, Unsharp masking.

## Introduction

Medical image enhancement processing can provide more rich clinically diagnostic information for doctors which can help clinicians to exam disease, especially find early lesion very significantly[l]. Even though the classic linear unsharp masking (UM) technique (Fig. 1) [2] is simple and works well in many applications, it suffers from drawbacks. i) The presence of the linear high pass filter makes the system extremely sensitive to noise. ii) It enhances high-contrast areas much more than areas that do not exhibit high image dynamics.

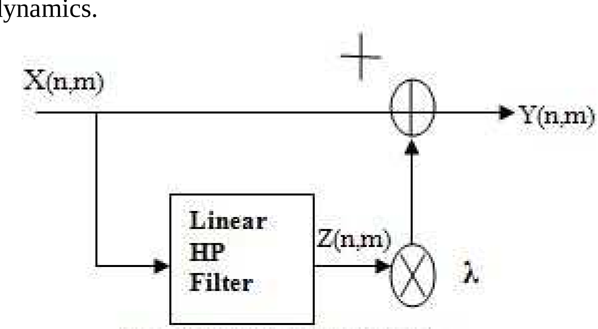


Fig.1. Linear Unsharp Masking

Various approaches in digital image processing allows the use of much more complex algorithms for image processing and hence can offer more sophisticated performance at simple tasks.

An image is defined as a two dimensional light intensity function, f(x ,y), where x and y are spatial coordinates, and the value f at any pair of coordinates (x ,y) is called intensity or grey level value of the image at that point[2]. So simultaneous enhancement of sharpness and contrast is required in many applications. To meet this requirement a continuous research is going on to develop new algorithms. There are different types of sharpness enhancement techniques, among these unsharp masking will gives enhanced sharpness with original image as background. We find some unwanted details in the resultant image. To avoid these we used new algorithms.

### Sharpness Enhancement

#### *High pass filter*

The principal objective of sharpening is to highlight fine detail in an image or to enhance detail that has been blurred, either in error or as a natural effect of a particular method of image acquisition. Uses of image sharpening vary and include applications ranging from

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electronic printing and medical imaging to industrial inspection and autonomous guidance in military systems.

| | | |
|---|---|---|
| -1/9 | -1/9 | -1/9 |
| -1/9 | 8/9 | -1/9 |
| -1/9 | -1/9 | -1/9 |

| | | |
|---|---|---|
| $Z_1$ | $Z_1$ | $Z_1$ |
| $Z_1$ | $Z_1$ | $Z_1$ |
| $Z_1$ | $Z_1$ | $Z_1$ |

(a) High pass filter
(b) Image gray level values

**Fig-2: 3×3 High pass Filter mask and image gray level values.**

***High boost filtering***

High pass filtering in terms of subtracting a low pass image from the original image, that is,

High pass = Original - Low pass.

However, in many cases where a high pass image is required, also want to retain some of the low frequency components to aid in the interpretation of the image. Thus, if multiply the original image by an amplification factor A before subtracting the low pass image, will get a high boost or high frequency emphasis filter. Thus,

High boost = A. Original – Low pass
= (A-1). (Original) + Original – Low pass
= (A-1). (Original) + High pass

Now, if A = 1 we have a simple high pass filter. When A > 1 part of the original image is retained in the output. A simple filter for high boost filtering is given by

| | | |
|---|---|---|
| -1/9 | -1/9 | -1/9 |
| -1/9 | ω/9 | -1/9 |
| -1/9 | -1/9 | -1/9 |

**Fig.3: High boost filtering**

Where ω = 9A-1.

***Unsharp masking***

The unsharp filter is a simple sharpening operator which derives its name from the fact that it enhances edges (and other high frequency components in an image) via a procedure which subtracts an unsharp, or smoothed, version of an image from the original image [3]. The unsharp filtering technique is commonly used in the photographic and printing industries for crispening edges. The above two techniques resultant images are having their back ground intensity levels are near to black, but sometimes we require sharpness enhancement in the image itself, for this case unsharp masking algorithm is use full.

The classical unsharp masking algorithm can be described by the equation: $v = y + \gamma ( x - y )$ where x is the input image, y is the result of a linear low-pass filter, and the gain $\gamma(\gamma>0)$ is a real scaling factor. The signal $d = x - y$ is usually amplified ( $\gamma > 1$ ) to increase the sharpness. However, the signal d contains 1) details of the image, 2) noise, and 3) over-shoots and under-shoots in areas of sharp edges due to the smoothing of edges. While the enhancement of noise is clearly undesirable, the enhancement of the under-shoot and over-shoot creates the visually unpleasant halo effect. Ideally, the algorithm should only enhance the details of an image . Due to this reason, a filter is required that is not sensitive to noise and does not smooth sharp edges. These issues have been studied by many researchers. The cubic filter [4] and the edge-preserving filters [5]–[7] have been used to replace the linear low-pass filter. The former is less sensitive to noise and the latter does not smooth sharp edges. To reduce the halo effect, edge-preserving filters such as: adaptive Gaussian filter [8], weighted least-squares based filters [9] and bilateral filters [10], [11] are used. An important issue associated with the unsharp masking and retinex type of algorithm is that the result is usually out of the range of the image [8], [12]–[14]. For example, for an 8-bit image, the range is [0, 255]. A careful rescaling process is usually needed for each image.

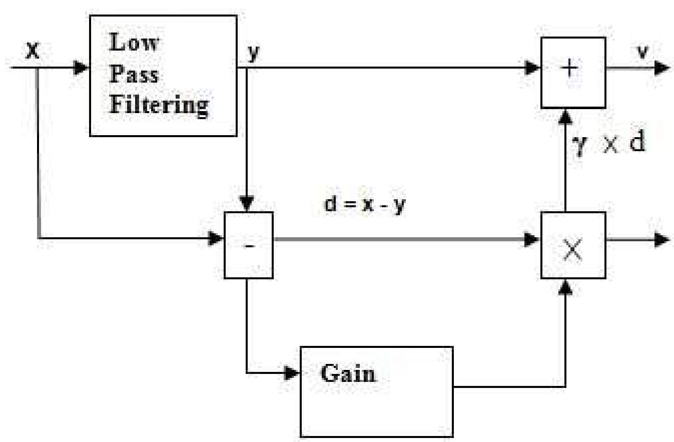


**Fig-4:.Block Diagram of Classical Unsharp Masking**

**Contrast Enhancement**

Contrast is a basic perceptual feature of an image [15] .It is Difficult to see the details in a low contrast image. To improve the contrast or to enhance the contrast the adaptive histogram equalization [16],[17] is frequently used. To enhance the contrast recently some new advanced algorithms are developed, which is retinex based algorithms.

***Generalized Linear System***

Before going to develop an effective computer vision technique one must consider [18] 1) Why the particular operations are used, 2) How the signal can be represented and, 3) What implementation structure can be used. And there is no reason to continue with usual addition and multiplication. For digital signal processing, via abstract analysis we can create more easily implemented and more generalized or abstract versions of mathematical operations. Due to the result of this creation, abstract analysis may show new ways to creating systems with desirable properties. Following these ideas, the generalized linear system, shown in Fig. 5, is developed.

The generalized addition and scalar multiplication operations denoted by $\oplus$and $\otimes$ are defined as follows:

$$x \oplus y = \emptyset^{-1}[\emptyset\ x + \emptyset(y)] \qquad (1)$$

And

$$\alpha \otimes x = \emptyset^{-1}[\alpha \emptyset(x)] \qquad (2)$$

Where $x$ and $y$ are signal samples is usually a real scalar, and Ø is a nonlinear function.

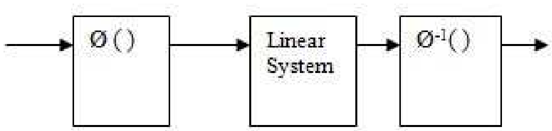


**Fig.5. Block Diagram of genearlized linear system**

**Motivation and Contributions**

This work is motivated by unsharp masking algorithm, an outstanding analysis of the halo effect, and the requirement of the rescaling process. In this paper, a simple and efficient algorithm is proposed based on the Log Gabor filter and predefined contrast level for body part selected. It will enhance the functionality of unsharp Mask filter. Using Adaptive gain control (ADC), the process is combined for the unsharp mask filter. The major contribution and the organization of this paper are as follows. In Section II, we first present a frame work for the generalized unsharp masking and we described about the proposed algorithm.

## Frame Work for the Proposed Algorithm

**Exploratory data Model and Generalized Unsharp Masking**

The idea behind the exploratory data analysis is to decompose a signal into two parts. One part fits a particular model, while the other part is residual. In simple way the data model is: "fit PLUS residuals" ([19] pp.208). From this definition, the output of the filtering process, denoted as f(x), can be regards as the part of the image that fits the model. Thus we can represent an image using the generalized operations as follows:

$$x = y \oplus d \qquad (3)$$

Where d is called the detail signal (the residual).
The detail signal is defined as
$d = x \ominus y$,
where $\ominus$ is the generalized subtraction operation. A generalized form of the unsharp masking algorithm can be written as

$$v = h(y) \oplus g(d) \qquad (4)$$

Where v is the output of the algorithm and both h( y) and g(d) could be linear or nonlinear functions. This model explicitly states that the part of the image being sharpened is the model residual. In addition, this method allows the contrast enhancement by means of a suitable processing function such as adaptive histogram equalization algorithm. In this way, the generalized algorithm can enhance the overall contrast and sharpness of the image.

**Outline of the Proposed algorithm**

The proposed algorithm is based upon the previous image model and generalizes the classical unsharp masking algorithm. Digital images have applications in medical images such as Digital Radiography and in areas of research and technology including GIS (Geo-graphical Information System). Datasets collected by image sensors are generally contaminated by noise and noise can be introduced by transmission errors and compression. The problem of image is to recover an image that is cleaner and more informative than its raw observation. Thus, Enhancement in the image is an important technology in image analysis and the first step to be taken before images are analyzed. Although unsharp mask filter have efficient enhancement ability, still have problems on an edge preservation and Contrast adjustment. In this approach, investigate the problem of image enhancement when the source image is formed with raw data which is a valid assumption for images obtained through transmitting, scanning or compression.

## Algorithm

1) Input medical image
2) Normalize the frequencies with Log Gabor filter
3) Prepare a look up table that that have Different contrast adjustment parameter according to body part selected
4) Using AGC (Adaptive gain control) to combines the steps and for unsharp mask filter.

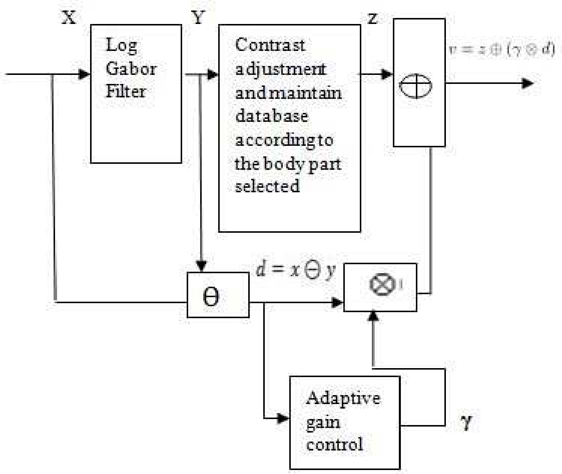


**Fig.6. Block Diagram of proposed unsharp mask filter**

### Log gabor filter

Gabor filters are commonly recognized as one of the best choices for obtaining localized frequency information. They offer the best simultaneous localization of spatial and frequency information. There are two important characteristics of log gabor filter. Firstly, Log-Gabor functions, always have no DC component, which contributes to improve the contrast ridges and edges of images. Secondly, the transfer function of the Log-Gabor function has an extended tail at the high frequency end, which enables to obtain wide spectral information with localized spatial extent and consequently helps to preserve true ridge structures of images.

The Gabor filter bank is a well-known technique to determine a feature domain for the representation of an image. A Gabor filter bank can be designed by varying the spatial frequency and orientation of a Gabor filter which mimics a band-pass filter. However, a Gabor filter can be designed for a bandwidth of 1 octave maximum with a small DC component in the filter. To overcome this limitation, field proposes the Log-Gabor filter. A Log-Gabor filter has no DC component and can be constructed with any arbitrary bandwidth. There are two important characteristics in the Log-Gabor filter. Firstly the Log-Gabor filter function always has zero DC components which contribute to improve the contrast ridges and edges of images. Secondly, the Log-Gabor function has an extended tail at the high frequency end which allows it to encode images more efficiently than the ordinary Gabor function [20] .To obtain the phase information log Gabor wavelet is used for feature extraction. It has been observed that the log filters (which use Gaussian transfer functions viewed on a logarithmic scale) can code natural images better than Gabor filters. Statistics of natural images indicate the presence of high-frequency components. Since the ordinary Gabor filters under-represent high frequency components, the log filters is a better choice [21]. Log-Gabor filters, consist of a complex-filtering arrangement in p orientations and k scales, whose expression in the log-polar Fourier domain is as follows

$$G(\rho,\theta,p,k) = \exp\left(-\frac{1}{2}\left(\frac{\rho-\rho_k}{\sigma_\rho}\right)^2\right)\exp\left(-\frac{1}{2}\left(\frac{\theta-\theta_{k,p}}{\sigma_\theta}\right)^2\right)$$

in which ( $\rho$ , $\theta$) are the log-polar coordinates and $\sigma_p$ and $\sigma_\Theta$ are the angular and radial bandwidths (common for all the filters). The pair ($\rho_k$ and $\theta_{k,n}$ ) corresponds to the frequency center of the filters, where the variables p and k represent the orientation and scale selection, respectively. In addition, the scheme is completed by a Gaussian low-pass filter G ( p ,θ, 1 ,k).

### Implementation of the proposed algorithm for color Images

In color image processing we use RGB color space images to processing. For this algorithm firstly we have to convert the color image from the RGB color space to the HSI or LAB color space. The chrominance components, such as the H and S components are not processed the luminance component I only processed. After the luminance component is processed, the inverse conversion is performed. An enhanced color image in its RGB color space is obtained. To avoid a possible problem of varying the white balance of the image when the RGB components are processed individually, we process luminance component I only [22].

### Adaptive Gain Control

In the enhancement of the detail signal we require gain factor to yield good results, it be must be greater than one. Using a same gain for the entire image does not lead to good results, because to enhance the small details a relatively large gain is required. This large gain can lead to the saturation of the detailed signal whose values are larger than a certain threshold. Saturation is undesirable because different amplitudes of the detail signal are mapped to the same amplitude of either -1 or 1. This leads to loss of information. Therefore, the gain must be controlled adaptively.

**Quality Metric**

To evaluate the performance of an image fusion technique in terms of retaining important details, edges and quality of image, several quantitative measures have been developed.

**(a) Peak Signal-to-Noise Ratio**

PSNR is considered to be the least complex metric, as it defines the image quality degradation as a plain pixel by pixel error power estimate. The Peak Signal-to-Noise Ratio (PSNR) is most commonly used as a measure of quality of reconstruction in image compression, image denoising and image fusion etc. It is measured in decibels (db). It is measured as given by Eq.

$$PSNR = 10 log_{10} [\frac{255 * 255}{MSE}]$$

**(b) Standard Deviation** Standard deviation is usually used to represent the deviation degree of the estimation and the average of the random variable, the activity level is estimated by standard deviation. The standard deviation mainly reflects the discrete degree between the pixel gray and the mean value. The bigger the standard deviation is, the more discrete the distribution of gray level.

**(c) Visual Quality** is the subjective method for the performance evaluation for the techniques of image enhancement. By looking at the enhanced image one can easily determine the difference between the original image and enhanced image.

## Results and Comparison

The proposed method have applied on different parts of the body and also on color images. Some results are illustrated below:

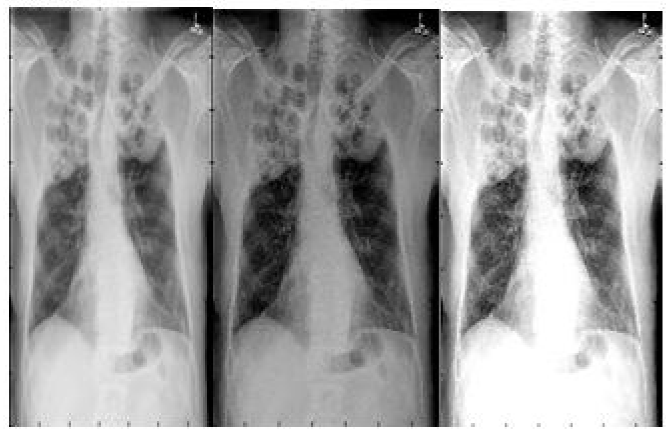

**Fig7. (a) Original image (b) classical unsharp masking algo (c) proposed algorithm**

**Fig5. (a) Original image (b) classical unsharp masking algo (c) proposed algorithm**


**Fig5. (a) Original image (b) classical unsharp masking algo (c) proposed algorithm**

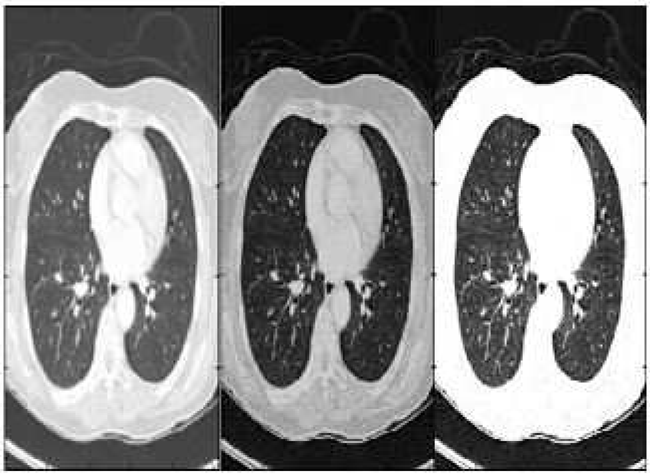

**Fig5. (a) Original image (b) classical unsharp masking algo (c) proposed algorithm**

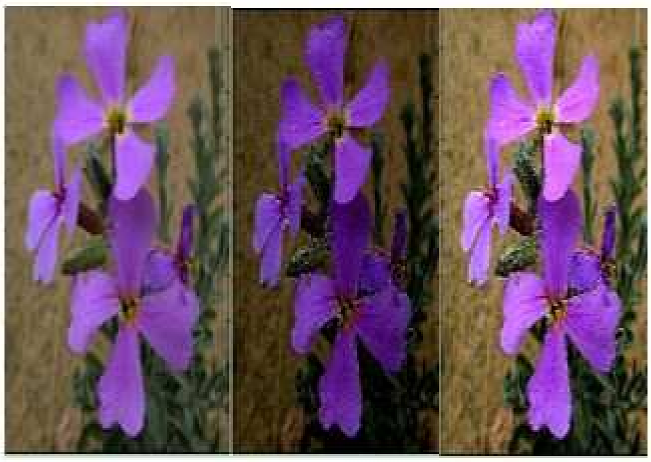

**Fig5. (a) Original image (b) classical unsharp masking algo (c) proposed algorithm**

**Table1. Comparative results of various medical images**

| Image Name | Quality metric | Classical unsharp mask filter | Proposed unsharp mask filter |
|---|---|---|---|
| Chest | PSNR | 43.762 | 51.1612 |
| | Standard deviation | 48.9033 | 67.7602 |
| Hand | PSNR | 57.5856 | 69.8627 |
| | Standard deviation | 57.4159 | 78.508 |
| Knee | PSNR | 49.5753 | 68.8826 |
| | Standard deviation | 43.9141 | 66.7744 |
| Lung | PSNR | 43.0075 | 50.2782 |
| | Standard deviation | 76.9095 | 104.8395 |
| Color image | PSNR | 43.9078 | 60.8177 |
| | Standard deviation | 46.8905 | 60.5901 |

From the above Table1. It is clearly shown that PSNR and Standard deviation value of various medical images become low to high. It means the proposed method gives much more better results than earlier. It is significantly improve the contrast and sharpness of the image.

## Conclusion

In this research, a very simple and expert image enhancement system has been implemented for the medical images using enhanced classical unsharp mask filter with the help of log gabor filtering approach. The first objective of this paper is to improve the visual quality of medical images, the proposed algorithm working on the medical images for their improved diagnostic with enhanced classical unsharp mask filter which will not only preserve the edge but also the contrast is maintain i.e. suitable for body part. The second objective of this paper is to compare the proposed method with existing state-of-art techniques. In this paper, results of proposed algorithm is compared with classical unsharp masking technique. PSNR and Standard deviation quality metric have been used for calculating results to compare quantitatively this technique. Experimental results show that proposed

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method performs well than the classical unsharp masking in terms of quality of images. The proposed method increases the quality significantly, while preserving the important details or features. This also gives the better results in terms of visual quality. In future, we need to implement the hybrid scheme that may give much better results. Then results can be tested.

## References

[1] Xu Yanli, "DR image enhancement Based on nonlinear unsharp mask [J]", *Chinese Journal of Medical Physics* 2010, 27 (4) : 2013-2015.

[2] RafaelC.Gonzalez and Richard E.Woods ,digital image processing ,publishing house of electronics industry 2010

[3] Hanan Saleh S.Ahmed and Md Jan Nordin, "Improving Diagnostic Viewing of Medical Images using Enhancement Algorithms" *Journal of Computer Science*, vol. 12, pp. 1831-1838,2011.

[4] G. Ramponi, "A cubic unsharp masking technique for contrast enhancement," *Signal Process*., pp. 211–222, 1998.

[5] S. J. Ko and Y. H. Lee, "Center weighted median filters and their applications to image enhancement," *IEEE Trans. Circuits Syst*., vol. 38,no. 9, pp. 984–993, Sep. 1991.

[6] M. Fischer, J. L. Paredes, and G. R. Arce, "Weighted median image sharpeners for the world wide web," *IEEE Trans. Image Process*., vol. 11, no. 7, pp. 717–727, Jul. 2002.

[7] R. Lukac, B. Smolka, and K. N. Plataniotis, "Sharpening vector median filters," *Signal Process*., vol. 87, pp. 2085–2099, 2007

[8] J. Zhang and S. Kamata, "Adaptive local contrast enhancement for the visualization of high dynamic range images," in *Proc. Int. Conf. Pattern Recognit*., 2008, pp. 1–4.

[9] Z. Farbman, R. Fattal, D. Lischinski, and R. Szeliski, "Edge-preserving decompositions for multi-scale tone and detail manipulation," *ACM Trans. Graph*., vol. 27, no. 3, pp. 1–10, Aug. 2008.

[10] M. Elad, "Retinex by two bilateral filters," in *Proc. Scale Space*, 2005, pp. 217–229.

[11] F. Durand and J. Dorsey, "Fast bilateral filtering for the display of high dynamic-range images," in *Proc. 29th Annu. Conf. Comput. Graph. Interactive Tech*., 2002, pp. 257–266.

[12] H. Shvaytser and S. Peleg, "Inversion of picture operators," *Pattern Recognit. Lett*., vol. 5, no. 1, pp. 49–61, 1987.

[13] G. Deng, L. W. Cahill, and G. R. Tobin, "The study of logarithmic image processing model and its application to image enhancement," *IEEE Trans. Image Process*., vol. 4, no. 4, pp. 506–512, Apr. 1995.

[14] L. Meylan and S. Süsstrunk, "High dynamic range image rendering using a retinex-based adaptive filter," *IEEE Trans. Image Process.*, vol. 15, no. 9, pp. 2820–2830, Sep. 2006.

[15] E. Peli, "Contrast in complex images," *J. Opt. Soc. Amer*., vol. 7, no. 10, pp. 2032–2040, 1990.

[16] S. Pizer, E. Amburn, J. Austin, R. Cromartie, A. Geselowitz, T. Greer,B. Romeny, J. Zimmerman, and K. Zuiderveld, "Adaptive histogram equalization and its variations," *Comput. Vis. Graph. Image Process*., vol. 39, no. 3, pp. 355–368, Sep. 1987.

[17] J. Stark, "Adaptive image contrast enhancement using generalizations of histogram equalization," *IEEE Trans. Image Process.*, vol. 9, no. 5, pp. 889–896, May 2000.

[18] D. Marr, Vision,"A Computational Investigation into the Human Representation and Processing of Visual Information", San Francisco, CA:Freeman, 1982.

[19] J. W. Tukey, Exploratory Data Analysis. Reading, MA: Addison-Wesley, 1977.

[20] Mara, N.S.S . and Fookesb , "Automatic Solder Joint Defect Classification using the Log-Gabor Filter" *Advanced Materials Research*, vol. 97-101. pp. 2940-2943, 2010.

[21] Mehrotra, H . Majhi , B and Gupta , "Multi-algorithmic Iris Authentication System", *International Journal of Electrical and Computer Engineering*,pp 78—82, 2009.

[22] Guang Deng ,"A Generalized Unsharp Masking Algorithm" *IEEE transactions on Image Processing*, vol. 20, no. 5, May 2011.