ISSN 2047-3338

Improved Morphological Image Segmentation Techniques for Identifying Edge and Background Detection in Poor Lighting

Akshay P. Vartak and V.R. Mankar
HVPM's College of Engineering and Technology, Deputy Secretary RBTE, Pune, India

***Abstract*– Image enhancement is a technique that increases the visual contrast in a designated intensity range. Contrast is an act of distinguishing by comparing differences. Morphological transformation and block analysis are used to detect the background of various social and medical images. Opening by reconstruction method of contrast image transformation can be defined by two operators- opening and closing. The first operator makes use of the information from block analysis, while the second transformation utilizes the opening by reconstruction. The later is used to define the multi background notion. The complete image processing is done using JAVA simulation model. Quality of image enhancement is assessed by different techniques. In this paper, high performance computational techniques involving contrast enhancement and noise filtering on various medical, social images are developed using Weber's law. Image quality assessment is compared by different techniques. The values of all the quality assessment parameters are found to be in the standard ranges thereby confirming the enhancement of quality of images.**

***Index Terms*– Morphological Transformation, Morphological Reconstruction, Contrast Enhancement, Weber's Law and Quality Assessment**

I. INTRODUCTION

IN image acquisition, background detection is necessary in many applications to get clear and useful information from an image which may have been picturized in different conditions like poor and low lighting.

It is necessary to enhance the contrast of images before further processing or analysis. Contrast is the opposition or dissimilarity of things that are compared, extent to which adjacent areas on the image differ in brightness. Contrast is act of distinguishing by comparing differences. Contrast refers to how bright the highlights are while brightness refers to how bright the shadows are.

It appears from the review of literature that, in spite of a large number of works in the field of morphological image segmentation, studies on some specific aspects requires further attention. The present work is designed on the principle of engineering problem solving which is defined as three step method and comprises of step I, to establish, step II, to evaluate and step-III, to estimate. Based on the discussed method, the present work is divided into three parts viz.

In part I, morphological theories have been studied and a problem of Image enhancement in poor lighting for gray scale images is identified for application. In part II, these theories have been evaluated and applied to a problem of image enhancement in poor lighting for gray scale and color images. In part III, the results are analyzed and compared for evaluation of image quality assessment metrics using standard techniques, with respect to the present theme of the work.

Finally, this paper is organized as follows: section II, study and analysis of existing morphological background detection and enhancement of images with poor lighting for gray scale images. Section III, improved morphological image segmentation techniques for background detection. Section IV, comparative evaluation of image quality assessment metrics used in image segmentation and background detection. Finally, conclusions are presented in section V.

II. STUDY AND ANALYSIS OF EXISTING MORPHOLOGICAL BACKGROUND DETECTION AND ENHANCEMENT OF IMAGES WITH POOR LIGHTING FOR GRAY SCALE IMAGES

In this section, some morphological transformations are used to detect the background in images characterized by poor lighting. Lately, contrast image enhancement has been carried out by the application of two operators based on the Weber's law notion. The first operator employs information from block analysis, while the second transformation utilizes the opening by reconstruction, which is employed to define the multi-background notion. The objective of contrast operators consists in normalizing the grey level of the input image with the purpose of avoiding abrupt changes in intensity among the different regions. Finally, the performance of the proposed operators is illustrated through the processing of images with different backgrounds, the majority of them with poor lighting conditions.

III. IMPROVED MORPHOLOGICAL IMAGE SEGMENTATION TECHNIQUES FOR BACKGROUND DETECTION

In this section, once the contrast enhancement is implemented and established in gray scale images, it is extend for color images. It is to be noted that the objective of image enhancement lies not only in enhancing the quality of the image but also in revealing the objects which are not visible in the original image. Firstly spatial domain techniques are considered, and then transform domain. All the above implemented methods in gray scale are also extended to color images by following a standard procedure.

Firstly partition the original image into R, G and B components. Consider a separate component at first (say R), perform the algorithm for the corresponding method i.e., if block analysis is to be implemented for color images, follow the previously mentioned algorithm for block analysis for the R component. Then repeat the same procedure for G and B component. To obtain the enhanced version of the color image as a whole, the R, G and B components are concatenated. This will produce the desired enhanced version of the original image. This procedure can also be successfully applied for Erosion-Dilation method and opening by reconstruction.

A standard segmentation algorithm is used for contrast enhancement which is as follows:

1) Read image data into image array
2) Read each pixel in image array
3) Find minintensity & maxintensity from its surrounding pixels
4) Calculate background intensity i.e. mean of max intensity & min intensity
5) For each surrounding pixels
   if pixel intensity less then background intensity
   k=(255-maxintensity)/log(256);
   set pixel intensity=k*log(pixel intensity+1)+max intensity
   else
   k=(255-min intensity)/Math.log(256);
   set pixel intensity=k*log(pixel intensity+1)+min intensity
   endif
   endfor
   endfor
6) stop

IV. COMPARATIVE EVALUATION OF IMAGE QUALITY ASSESSMENT METRICS USED IN IMAGE SEGMENTATION AND BACKGROUND DETECTION

In this section, a comparative evaluation of image quality assessment on enhanced images is done. The quality enhancement was assessed by two methods i.e., subjective method and objective method. In the subjective method, the result in the enhanced image is observed visually, while with the objective methods the quality parameters such as Means Square Error (MSE), Signal to Noise Ration (SNR), Pick Signal to Noise Ration (PSNR), Color Enhancement Factor (CEF), shannon entropy, wang bovic quality metric, values were calculated within the prescribed range and hence satisfactory.

The enhanced output image is compared with the original image. Both the images are given in Fig. 5, Fig. 6 and Fig. 7. For various sets of input and output images, the values for MSE, SNR, PSNR, CEF, and total time are calculated. They are given in the Table 1.

A) Results and Discussion

The enhanced output image is compared with the original image. Both the images are given in Fig. 5, for various sets of input and output images, the values for MSE, SNR, PSNR, CEF and total time are calculated. They are given in the Table 1.

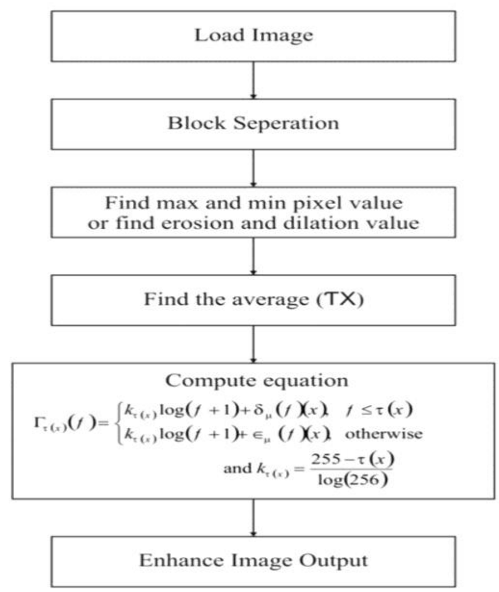


Fig. 1: The architecture of the implemented system

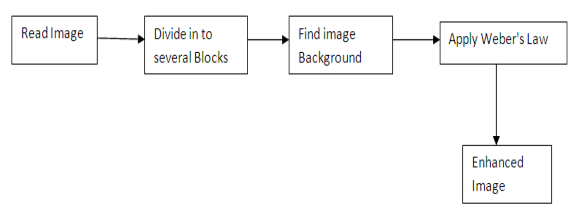


Fig. 2: Block Diagram of Background Detection by Block Analysis

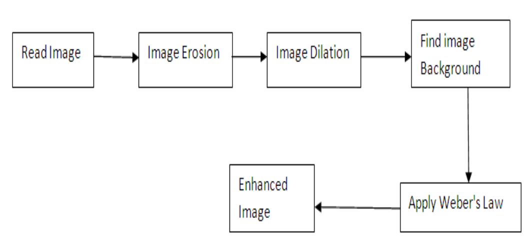


Fig. 3: Block diagram of Background Detection by Erosion & Dilation

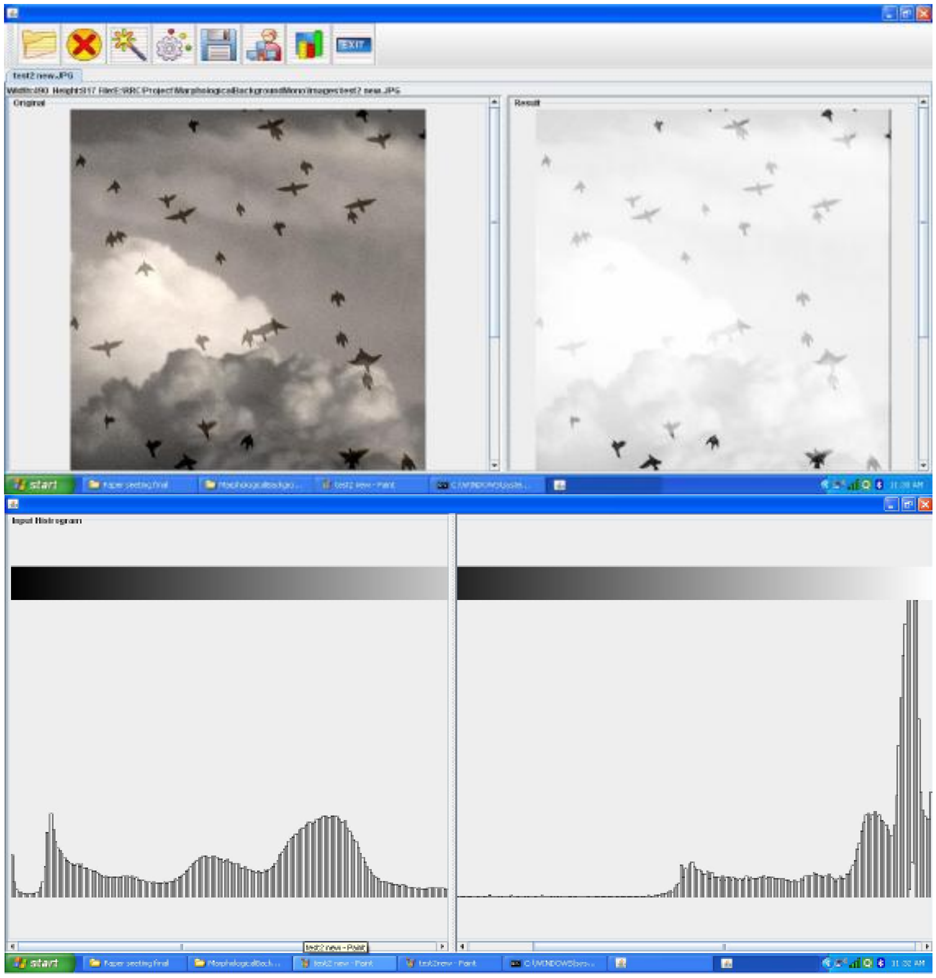


Fig. 4: Result obtained after applying existing algorithm for grey scale image

Table 1: Values obtained from MSE, SNR, PSNR and CEF

Input Image	MSE	SNR	PSNR	CEF	Total Time (ms)
a1	0.50	11.36	10.67	0.283	67672
b1	0.88	8.06	10.01	0.399	4500
c1	0.46	18.92	17.53	NAN (B/W)	22329

Table 2: Values obtained from Shannon entropy

Input Image	R	G	B
a1	1.00	0.999	1.00
b1	1.00	1.00	1.00
c1	1.00	1.00	1.00

Table 3: Values obtained from SSIM

Input Image	R	G	B
a1	0.360	0.934	0.131
b1	0.353	0.354	0.238
c1	0.383	0.383	0.383

Table 4: Values obtained from WBQM

Input Image	R	G	B
a1	0.221	0.938	0.0028
b1	0.125	0.185	0.075
c1	0.074	0.074	0.074

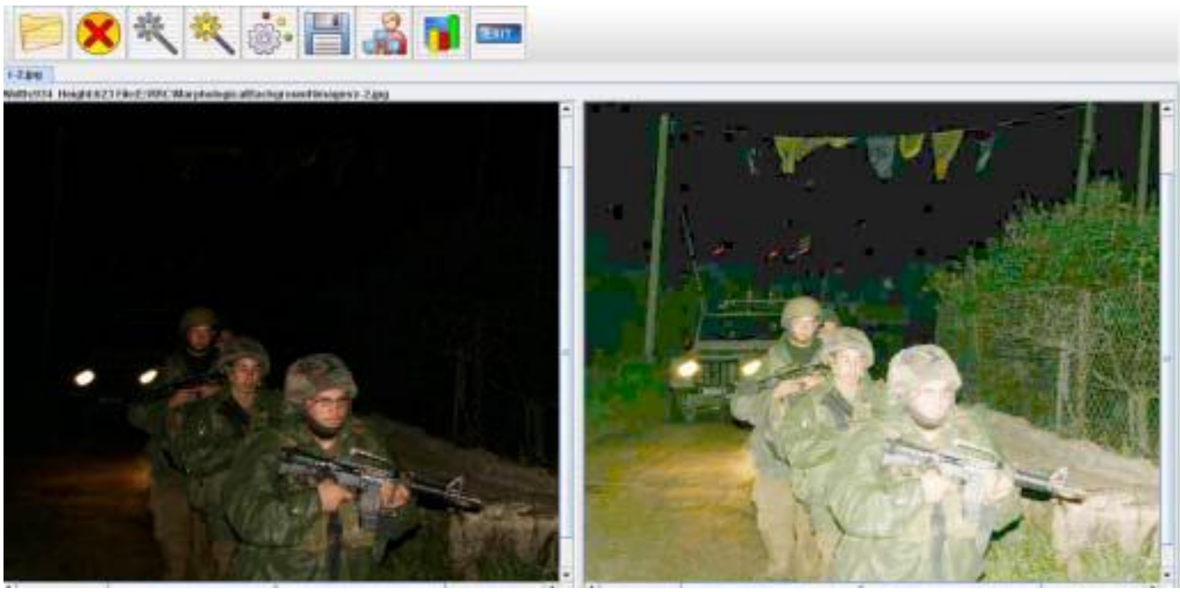
For the same images values of Shannon entropy, SSIM, WBQM are calculated. The values of parameter are given in the Table 2, Table 3 and Table 4.

Discussion: The objective of this research was to detect background and to enhance the quality of grayscale and color images with poor lighting with the help of a standard segmentation algorithm method. The quality enhancement was assessed by two methods i.e., subjective method and objective method. In the subjective method, the result in the enhanced image is observed visually, while with the objective methods the quality parameters such as MSE, SNR, PSNR, CEF, shannon entropy, wang bovic quality metric, values were calculated within the prescribed range and hence satisfactory.

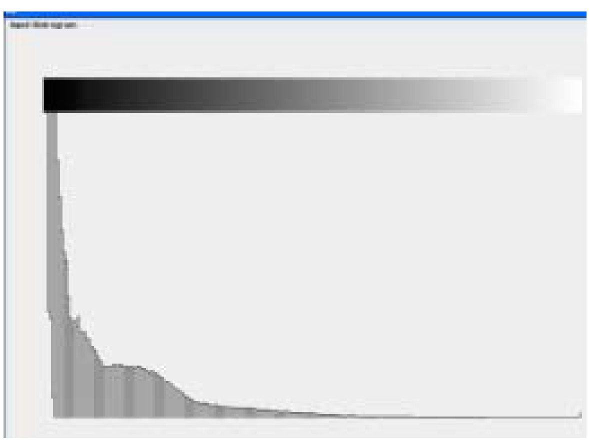
V. CONCLUSION

This paper presents the method to detect the image background and to enhance the contrast in grey scale and color images with poor lighting. First, block analysis methodology was used to compute an approximation to the background. This proposal was subsequently extended using mathematical morphology operators as well; another methodology based on the use of morphological connected transformations was propounded to detect the image background.

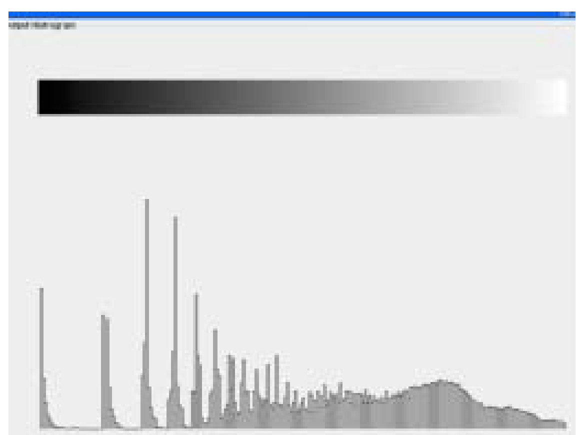
The performances of the proposals provided in this work were illustrated by means of several examples throughout the paper. Also, Image quality assessment can be performed with different methods such as MSE, SNR, PSNR, SSIM, CEF, total processing time, Shannon entropy, Wang–Bovic-Quality-Metric (WBQM). The visual inspection of the output image and the calculated values of quality parameters were compared with the standard values of parameters. The subjective as well as the objective methods of assessment of quality enhancement confirm the quality enhancement of original image.



(a1) (a2)



(h1)

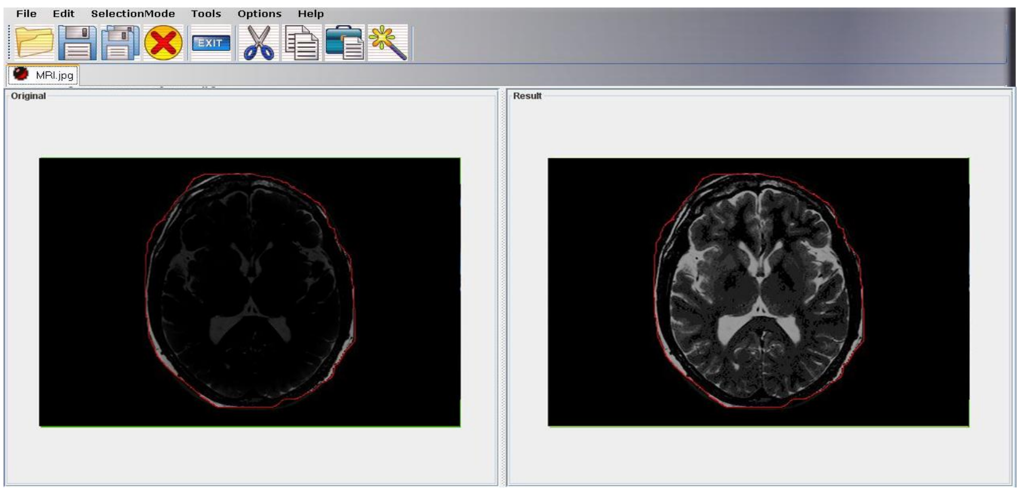


(h2)

Fig. 5: Result obtained by proposed segmentation algorithm using JAVA tool
(a1) Original Color image, (h1) Histogram of Original Image
(a2) Enhanced Color image, (h2) Histogram of enhanced image

(b1) (b2)

Fig. 6: (b1) Original Color image, (b2) Enhanced Color image



(c1) (c2)

Fig. 7: Result obtained by proposed segmentation algorithm using C Sharp tool
(c1) Original Color image, (c2) Enhanced Color image

REFERENCES

[1]. Angélica R, "Morphological Background Detection and Enhancement of Images With Poor Lighting", IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 18, No. 3, Mar 2009.

[2]. I.R. Terol-Villalobos, "Morphological image enhancement and segmentation with analysis", P. W. Hawkes, Ed. New York: Academic, 2005, pp. 207–273.

[3]. V. Murino, C. S. Regazzoni, and G. L. Foresti, "Grouping as a searching process for minimum-energy configurations of labeled random fields," in Computer Vision Image Understanding. New York: Academic, 2006, pp. 157–174.

[4]. SIKORA, T.: "The MPEG-4 Video Standard verification model." IEEE Trans. Circuits Syst. Video Technol., vol. 1, July, 1997, pp. 19-31.

[5]. Z. Liu, C. Zhang, and Z. Zhang, "Learning-based perceptual image quality improvement for video conferencing," presented at the IEEE Int. Conf. Multimedia and Expo (ICME), Beijing, China, Jul 2007.

[6]. V. Murino, C. S. Regazzoni, and G. L. Foresti, "Grouping as a searching process for minimum-energy configurations of labeled random fields," in Computer Vision Image Understanding. New York: Academic, 1996, pp. 157–174.

[7]. T. Kanungo, B. Dom, W. Niblac, and D. Steele, "A fast algorithm for MDL-based multi-band image segmentation," in Proc. IEEE Computer Vision Pattern Recognition, Seattle, WA, June 1994, pp. 609–616.

[8]. J. Shi and J. Malik, "Normalized cuts and image segmentation," in Proc. 1997 IEEE Computer Soc. Conf. Computer Vision Pattern Recognition, San Juan, Puerto Rico, June 1997, pp. 731–737.

[9]. B. Moghaddam and A. Pentland, “Probabilistic visual learning for object representation,” IEEE Trans. Pattern Anal. Machine Intell., vol. 19, pp. 696–710, July 1997.

[10]. Y.-L. Chang and X. Li, “Adaptive image region-growing,” IEEE Trans. Image Processing, vol. 3, pp. 868–872, 1994.

[11]. F. Meyer and J. Serra, “Contrast and Activity Lattice,” Signal Process. vol. 16, pp. 303–317, 1989.

[12]. I. R. Terol-Villalobos, “Morphological image enhancement and segmentation,” in Advances in Imaging and Electron Physics, P. W. Hawkes, Ed. New York: Academic, 2001, pp. 207–273.

[13]. I. R. Terol-Villalobos, “Morphological connected contrast mappings based on top-hat criteria: A multiscale contrast approach,” Opt. Eng., vol. 43, no. 7, pp. 1577–1595, 2004.

[14]. J. D. Mendiola-Santibañez and I. R. Terol-Villalobos, “Morphological contrast mappings based on the flat zone notion,” Computación y Sistemas, vol. 6, pp. 25–37, 2002.

[15]. A. Toet, “Multiscale contrast enhancement with applications to image fusion,” Opt. Eng., vol. 31, no. 5, 1992.

[16]. S. Mukhopadhyay and B. Chanda, “A multiscale morphological approach to local contrast enhancement,” Signal Process. vol. 80, no. 4, pp. 685–696, 2000.

[17]. J. Kasperek, “Real time morphological image contrast enhancement in virtex FPGA,” in Lecture Notes in Computer Science. New York: Springer, 2004.

[18]. A. K. Jain, Fundamentals of Digital Images Processing. Englewood Cliffs, NJ: Prentice-Hall, 1989.

[19]. J. Short, J. Kittler, and K. Messer, “A comparison of photometric normalization algorithms for face verification,” presented at the IEEE Int. Conf. Automatic Face and Gesture Recognition, 2004.

[20]. C. R. González and E.Woods, Digital Image Processing. Englewood Cliffs, NJ: Prentice Hall, 1992.

[21]. [21] R. H. Sherrier and G. A. Johnson, “Regionally adaptive histogram equalization of the chest,” IEEE Trans. Med. Imag., vol. MI-6, pp.1–7, 1987.

[22]. A. Majumder and S. Irani, “Perception-based contrast enhancement of images,” ACM Trans. Appl. Percpt., vol. 4, no. 3, 2007, Article 17.

[23]. Z. Liu, C. Zhang, and Z. Zhang, “Learning-based perceptual image quality improvement for video conferencing,” presented at the IEEE Int. Conf. Multimedia and Expo (ICME), Beijing, China, Jul. 2007.

[24]. E. H. Weber, “De pulsu, resorptione, audita et tactu,” in Annotationes anatomicae et physiologicae. Leipzig, Germany: Koehler, 1834.

[25]. J. Serra and P. Salembier, “Connected operators and pyramids,” presented at the SPIE. Image Algebra and Mathematical Morphology, San Diego, CA, Jul. 1993.

[26]. P. Salembier and J. Serra, “Flat zones filtering, connected operators and filters by reconstruction,” IEEE Trans. Image Process., vol. 3, no. 8, pp. 1153–1160, Aug. 1995.

[27]. J. Serra, Mathematical Morphology Vol. I. London, U.K.: Academic, 1993.

[28]. P. Soille, Morphological Image Analysis: Principle and Applications. New York: Springer-Verlag, 2003.

[29]. H. Heijmans, Morphological Image Operators. New York: Academic, 1994.

[30]. L. Vincent and E. R. Dougherty, “Morphological segmentation for textures and particles,” in Digital Image Processing Methods, E. R. Dougherty, Ed. New York: Marcel Dekker, 1994, pp. 43–102.

[31]. E. Peli, “Contrast in complex images,” J. Opt. Soc. Amer., vol. 7, no.10, pp. 2032–2040, 1990.

[32]. A. Edgar, R. Araiza, J. D. Mendiola Santibañez, G. Herrera Ruiz , C. A.G. Gutiérrez, M. T. Perea, and G. J. R. Moreno, “Contrast Enhancementand Illumination Changes Compensation,” Computación y Sistemas, vol. 10, no. 4, pp. 357–371, 2007.

[33]. A. S. Georghiades, P. N. Belhumeur, and D. J. Kriegman, “Generative models for recognition under variable pose and illumination,” in Proc. IEEE Int. Conf. Automatic Face and Gesture Recognition, 2000, pp. 277–284.

[34]. R. H. Sherrier and G. A. Johnson, “Regionally adaptive histogram equalization of the chest,” IEEE Trans. Med. Imag., vol. MI-6, pp. 1–7, 1997

[35]. I. R. Terol-Villalobos, “A multiscale contrast approach on Morphological connected contrast mappings” Opt. Eng., vol. 43, no. 7, pp. 1577–1595, 2009.

[36]. J. Kasperek, “Real time morphological image contrast enhancement in FPGA,” in LNCS, New York: Springer, 2008.

[37]. A. Majumder and S. Irani, “Perception-based contrast enhancement of images,” ACM Trans. Appl. Percpt., vol. 4, no. 3, 2007, Article 17.

[38]. J. Huddleston and J. Ben-Arie, “Grouping edgels into structural entities using circular symmetry, the distributed Hough transform and probabilistic nonaccidentalness,” J. Comput. Vis., Graph. Image Process: Image Understand. vol. 57, o. 2, pp. 227–242, Mar. 1993.

[39]. Zhou Wang, Alan Bovik, Image quality assessment: From error visibility to structural similarity, IEEE transaction on image processing, Vol. 13. No. 4, April 2004.

[40]. Yusra A. Y. Al0Najjar, Dr. Der Chen Soong, Comparison of image quality assessment : PSNR, HVS, SSIM, UIQI, International journal of Scientific & Engineering research, Volume 3, Issue 8, August - 2012, ISSN 2229-5518.

Akshay P. Vartak received his B.E. degree in 1997 in Electronics and Telecommunication from College of Engineering Badnera, M.E. in Digital Electronics from Sipna's College of Engg. & Technology. Post graduate diploma from C-DAC Pune and MBA in Human Resources. He is pursuing PhD degree in Morphological Image Processing. He is working as an Assistant Professor in HVPM's College of Engg. & Technology. He has 12 years of experience in industrial field and 4 years of experience in teaching field as well. He is a member of IETE and ISTE.

Dr. Vijay R. Mankar received his PhD degree in 2010 from Amravati University. He has more than 25 years of Experience in the field of Engineering & Technology. He worked as a Head of the Department, Govt. Polytechnic Amravati. He is currently working as a Deputy Secretary RBTE Pune. His research interest includes digital image processing.