The correlation study of parallel feature extractor and noise reduction approaches

Deshinta Arrova Dewi, Elankovan Sundararajan, and Anton Satria Prabuwono

Citation: AIP Conference Proceedings **1660**, 090001 (2015); doi: 10.1063/1.4915845
View online: http://dx.doi.org/10.1063/1.4915845
View Table of Contents: http://scitation.aip.org/content/aip/proceeding/aipcp/1660?ver=pdfcov
Published by the AIP Publishing

The Correlation Study of Parallel Feature Extractor and Noise Reduction Approaches

Deshinta Arrova Dewi, Elankovan Sundararajan and Anton Satria Prabuwono

Industrial Computing Research Group, Centre for Artificial Intelligence Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Malaysia

Abstract: This paper presents literature reviews that show variety of techniques to develop parallel feature extractor and finding its correlation with noise reduction approaches for low light intensity images. Low light intensity images are normally displayed as darker images and low contrast. Without proper handling techniques, those images regularly become evidences of misperception of objects and textures, the incapability to section them. The visual illusions regularly clues to disorientation, user fatigue, poor detection and classification performance of humans and computer algorithms. Noise reduction approaches (NR) therefore is an essential step for other image processing steps such as edge detection, image segmentation, image compression, etc. Parallel Feature Extractor (PFE) meant to capture visual contents of images involves partitioning images into segments, detecting image overlaps if any, and controlling distributed and redistributed segments to extract the features. Working on low light intensity images make the PFE face challenges and closely depend on the quality of its pre-processing steps. Some papers have suggested many well established NR as well as PFE strategies however only few resources have suggested or mentioned the correlation between them. This paper reviews best approaches of the NR and the PFE with detailed explanation on the suggested correlation. This finding may suggest relevant strategies of the PFE development. With the help of knowledge based reasoning, computational approaches and algorithms, we present the correlation study between the NR and the PFE that can be useful for the development and enhancement of other existing PFE.

Keywords: Image processing system; parallel feature extraction; image noise reduction; knowledge based reasoning.
PACS: 87.57.C-

INTRODUCTION

The low light intensity images require definite attention due to image noises that avoid quality of inspection. The difficulties occur while doing image processing such as segmentation, object identification, feature extraction and classification [1-3]. The difficulties may various from lower gray degree of certain image section, noise ratio and poor signal [2-6]. The contrast enhancement technique is one of the proposed developments to improve the quality of images and resolve image noise reductions respectively. By having better quality of images may increase the accuracy of feature extraction processes.
Working with noise reduction (NR) processes reveals working with numerous errors. Since images with noises do not capture the real scene hence noise reduction is a prime step to do. Determining type of noises that corrupting the images may submit the type of filters to be used, for example linier filters are unable to eliminate impulse noise due to blurring process on the edge of images. As such, it is better to use nonlinear filters to handle impulse noises [6-7].

The source of noises may be generated from devices such as scanners towards scanned images and other processes that involve image transmission either via satellite or wireless connection and conversion to digital images. Those errors may occur as a result of poor image signal [7-8].

The performance of NR techniques may influence the feature extraction (FE) processes and give significant impact in the overall efficiency and accuracy of the application. Enhanced images may reduce processing time towards series of image processes. The capability of NR techniques to eliminate various noises such as repetitive noise, or non-uniform lightning and blurred images due to camera motion may ease the job of image analysis. Image analysis attempts to perform background enhancement of segmented images to identify and describe objects in term of its size, shape, color and texture [8-9].

The idea of increasing speed upon image processing systems has been suggested by many previous researches. With the aids of current computer architecture such as multicore processors and GPGPU

International Conference on Mathematics, Engineering and Industrial Applications 2014 (ICoMEIA 2014)
AIP Conf. Proc. 1660, 090001-1–090001-11; doi: 10.1063/1.4915845

machines, image processing system can be accomplished in parallel environment in which the images will be divided into smaller sub-images and process them concurrently. With this acceleration, the huge data images such as satellite images, medical images, agriculture images and others can be conducted in timely manner, more reliable and effective [10-11].

A robust FE may be supported by robust NR technique [12-13]. This impression comes from previous works that indicates pre-processing jobs of FE i.e. NR or noise removal has direct influences for a robust image enhancement that support feature extraction. The purpose of this research is to study and conduct systematic review towards several image processing system literatures to indicate correlation between parallel feature extractions (PFE) and noise reductions (NR). The review made based on previous image processing applications as stated in TABLE 1.

The main contributions of this research are:

- Conduct systematic review on image processing system applications in various different fields.
- Finding correlation between PFE and NR approach to be implemented towards low light intensity images.

The result of this work is expected to be one of the references for the development of PFE towards low light intensity images.

TABLE (1) Previous work examples of image processing in several application fields.

No	Author	Year	Field of Application	Research Scope
1	Csaba Finta, et al.	2013	Chemical Images	Acceleration of parallel algorithm and GPU for chemical images.
2	Preeti Kaur	2013	Computer Science (General Images)	Calculating various parameters in parallel algorithm that are implemented by using MATLAB.
3	Sanjay Saxena, et al.	2013	Medical Images	Exploration of multi-core architecture to accelerate image processing for medical images.
4	A.Fakhri A Nasir, et al.	2012	Agriculture Images	Image Analysis focusing on agriculture application using parallel and distributed image processing.
5	Eric Olmedo, et al.	2012	Computer Science (General Images)	Parallel computing with point to point approach to deal with grayscale, brightening, darkening, thresholding and contrast change.
6	G. Bueno, et al.	2012	Histological Images	Parallel image processing for high resolution images
7	Tadhg Brosnan and Da Wen Sun	2004	Food Engineering	Improving quality inspection of food products by using computer vision and image processing and analysis.

LITERATURE SURVEY

According to Nixon and Aguardo [9] basic features on images classified as low level and high level features. Low level features considered as basic features that are extracted without any shape information while high level features are extracted with shape information. The examples of low level feature extraction are line detection and corner detection that has been popular in image interpretation because it is unresponsive to the overall illumination level. High level features extraction to find shapes of images generally use reliable and robust technique either in light or dark. As long as the contrast between shapes and background are clear, the shapes are always able to be detected. Based on this literature, both low level and high level feature extraction is eligible to be tested on low light intensity images.

Mythilli and Kavitha [6] proposed several of filtering technique to remove noises that adaptable towards color image noises. While a person captures images the possibility of image noise occurs is rather high. Image noise is obvious especially when the light entering a digital camera misalign with the sensors. Other image noises such as impulse noise may occur during transmission as result of noisy channels used. These typical noises are noticeable to human eyes. As impulse noise appears as positive and negative point, the positive point obtain larger value that the background while negative point obtain smaller value. The filters therefore are crucial to do as part of NR. Some filters have been suggested such as linear smoothing filter, median filter, wiener filter and fuzzy filter. Specifically, this paper focuses on separate action upon three primaries color i.e. Red, Green and Blue before then combines to form the colored image. FIGURE 1 indicates how the approach is being done.

Kaur [22] described the evaluation towards image processing algorithms implemented on parallel platform with the help of MATLAB software. This work presents the result of calculation upon various parameters for example the overhead, timing of serial and parallel algorithms, fork-join time, etc. The research concludes that parallel computing is able to support the idea of accelerating image processing algorithms in acceptable period. This paper have also made some review about suggested parallelization techniques for example CAP (Computer Aided Parallelization) that proposed by Gennart et al., SIMD/MIMD architecture by Krishnakumar et al. that applicable for real time computer vision, data and task parallel image processing by Christine Nicolescu, pixel parallel processing for fingerprint by Namiko Ikeda et al., APIPM (Abstract Parallel Image Processing Machine) by Seinstra and double parallel scheme proposed by Yao et al.

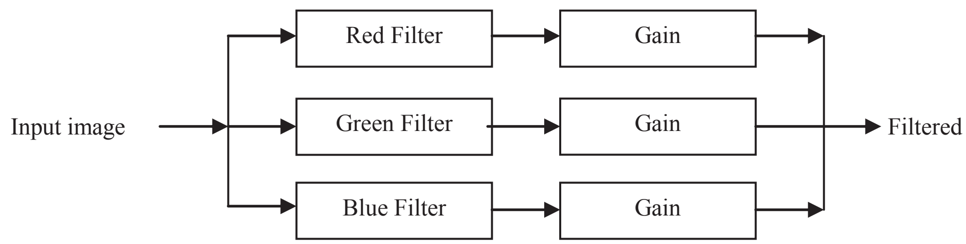

FIGURE 1. Action upon R,G,B by Mythilli and Kavitha (2011).

The image processing applications have been applied in food industry years ago. Cheng-Jin Du and Da-Wen Sun [23] have mentioned about food quality inspection which involving image processing system i.e. image acquisition, image pre-processing, image segmentation, object measurement and image classification. Firstly, food products are selected for quality inspection. Using certain technique (Electrical Tomography (ET) is most popular), image acquisition is executed relatively fast since this technique feat differences in the electrical properties of different materials. Secondly, capturing food images is subject to several types of noises which requires NR technique such as pixel and local pre-processing, Thirdly, image partition or segmentation is performed with four philosophical methodologies i.e. thresholding based, region-based, gradient-based and classification based. The result of segmentation is presented in FIGURE 2. Fourthly, features are extracted and object is measured. Many extracted features may describe only for one object. For example a mushroom can be identified by having extracted features measure for its length, width and certain shape descriptor. Lastly, the classification of identified object is determined after comparison with database that consists of known objects. Fuzzy and Neural Network had been proposed as more advanced classification technique in comparison with traditional classification. This article has strengthen the idea of the NR performance do determine the FE action.

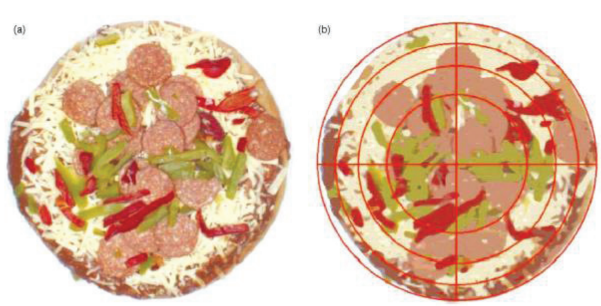

FIGURE 2. Image segmentation on a pizza by Du and Sun (2004).

Saxena et al. [10] suggested interesting technique to parallelize image processing tasks in multicore architecture applied in medical imaging. Not only acceleration achieved for image segmentation but also for NR tasks. The idea of parallel NR is to generate copies of image on client processor before kernels activation and four types of filters are adopted i.e. Median filter, Wiener filter, Order statistical filter and Min-Max filter. The values of PSNR and MSE will be sent back to the client before deactivation of kernels. By doing so, the performance of NR is improved as well as image segmentation and histogram processes. The work recorded acceleration by 2.5 times faster. This is a great finding to identify correlation between NR and PFE.

Another parallelization strategy was introduced by Bueno et al. [24]. The applied methodology was focusing on executing high resolution data images and bigger than 800MB. Three main tasks was employed in this research i.e. contrast analysis, region of interest (ROI) detection and classification. The ROI detection and classification is basically functioning as feature extractor upon digital images. However parallelization is rather difficult for ROI classification because many data acquires strong dependencies. While it is feasible to be applied on ROI detection and contrast analysis, the main solution is to involve master processor in handling sub-images sent by clients. The process was ended while master processor successfully compiled its partial result and store overall result into local database. Figure 3 depicts the main solution proposed by this paper.

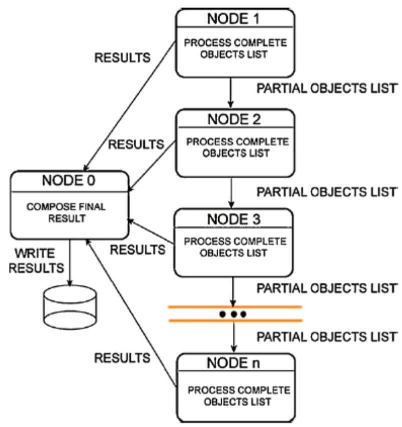

FIGURE 3. Solving data dependencies in parallel environment by Bueno (2012).

In July 2013, Philip and Omotosho [25] introduced a very focus research about image processing techniques for reducing noises that helpful for object identification and feature extraction applied on underwater images that suffer from Speckle noise, impulse noise and Gaussian noise. This research proposed two stages of noise reduction by name LPG – PCA techniques. LPG stands for Local Pixel Group and PCA stands for Principle Component Analysis. Generally, there were two stages of noise removal in this technique which noisy images was sent out to LPG and PCA at first. The technique then transform a set of correlated values to linearly uncorrelated variables and these variables will be passed to PCA again. The output of less noisy image is produced and ready for object identification or/and feature extraction. FIGURE 4 below is the comparison of noisy and less noisy images after LPG-PCA implementation.

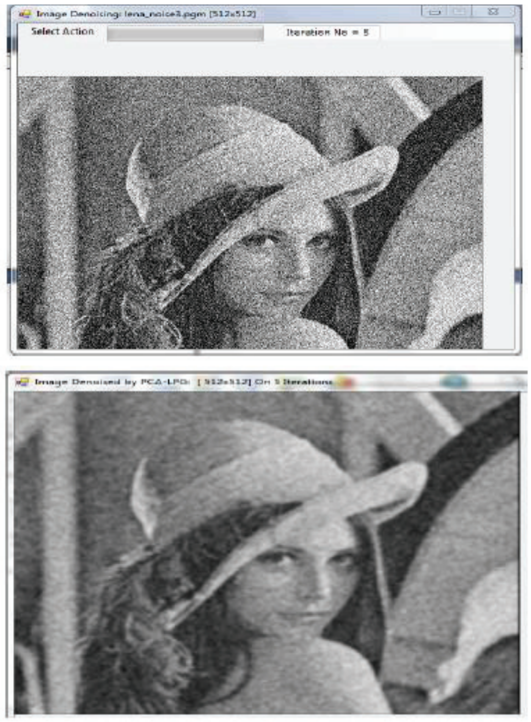

FIGURE 4. Noisy image (above) and less noisy image (bottom) after LPG-PCA technique by Philip and Omotosho (2013).

FINDING CORRELATION BETWEEN FE/PFE AND NR APPROACHES

The association between FE/PFE and NR approaches have been clearly identified, stated, experimented and proofed by previous researches. Since the NR approaches are executed earlier that FE/PFE in image processing system, the filter plays important roles in NR approaches to ensure the enhanced images are sufficiently readable by FE/PFE before it goes to image classifier. Some researches have mentioned the best filtering techniques that successfully reduce image noises in which four of them are presented in TABLE (2).

On the other hand, some researchers have exposed their study and implementation of Feature Extractor applied in many different fields. The development of feature extractor definitely involves noise reduction techniques to enhance the quality of object identification and classification. The summary of this information is presented in TABLE (3). By combining data inside TABLE (2) and TABLE (3), a framework to find correlation between FE/PFE and NR approaches is satisfied and can be carried out to the next implementation stage. This framework is captured at FIGURE (4).

The best output of the combined two tables is the proposed combination of FE/PFE with NR approaches that promises positive feature extraction towards low light intensity images. The proposed combination is presented at TABLE (5). In this paper, the Knowledge Based Reasoning (KBR) is also reviewed and used as tool to evaluate the statements carried out by the literatures to strengthen the positive correlation of FE/PFE and NR approaches. The result of KBR is shown at TABLE (4). The KBR has employed some of the proportional logic theories to proof the correctness of correlation between FE/PFE and NR approaches by evaluating the researcher's statements in the literature.

TABLE (2). Best filtering techniques from the previous researches.

No	Filtering Techniques	Types of Noises	Applied Algorithms	References
1	Perona-Malik Filter Gabor Filter	n/a	Noise Reduction and Contrast Algorithm	Flores et al. [26]
2	Non Linear Filter	Speckle noise impulse noise and Gaussian noise	Median filter Algorithm, Component Median Filter (CMF), The Vector Median Filter (VMF), Spatial Median Filter (SMF), Modified Spatial Median Filter (MSMF).	Philip and Omotosho [25]
3	Linear Filter Non Linear Filter Fuzzy Filter	Impulse / Gaussian Noise Amplifier Noise Shot Noise Uniform Noise Non-Isotropic Noise Speckle Noise Periodic Noise	Linear Filter: Linear smoothing filter, Adaptive filter Non Linear Filter: Median Filter, Fuzzy Filter (for edge preservation and smoothing)	Mythili and Kavitha [6]
4	Median Filter Wiener Filter Gabor Filter	Salt-Paper Noise Marginal Noise	n/a	Farahmand et al. [27]

TABLE (3). The proposed PFE by previous researches.

No	FE/PFE	Library Or Tools	Field Of Application	References
1	Gaussian distributed model and contrast analysis	C with OpenCV image processing library using MPICH2 on Linux platform	Change Detection on video	Mubasher et al. [28]
2	Feature Extraction	Massage Passing Interface	Histological images	Bueno et al. [24]
3	Parallel Processing	OpenMP, POSIX Threads, MATLAB’s PCT with MDCS, MPJ Express	Agriculture Application	Fakhri et al. [29]
4	Parallel Vector Operator	C++, OpenGL, Thrust 1.3, and CUDA 3.2. Feature	Sphere and Shock-Channel data set	Pagot et al. [31]
5	General Feature Extraction	Open Multiprocessing (OpenMP) or Open Computing Language (OpenCL), using a general purpose GPU and Compute Unified Device Architecture (CUDA) or OpenCL	Chemical imaging	Finta [30]
6	Parallel Image Segmentation	MATLAB R2011a and JAVA JDK 1.6.0_21, 64 bit operating system	Medical imaging	Saxena et al. [10]
7	Contrast algorithm	MATLAB simulator	General images	Kaur [22]
8	Contrast Image transformation	OpenCV and CUDA	General images	Olmedo et al. [32]

TABLE (4). KBR with proportional logic applied to some literatures as examples.

No	References	Deduction Rules [18-21]	Literature Interpretation	Result
1	Angadi and Kodabagi [16]	1) Modus Ponen 2)Hypothetical Syllogism	Noise exists. (N) Noises lead to significant degradation of images. (N→ SG) The significant degradation affects the feature extraction of images. (SG→FE)	1) N N →SG =SG *The significant degradation is obvious when noise exists.* 2) N → SG SG → FE =N → FE *If noises exist then it affects the feature extraction tasks*
2	Bir et al. [14]	1) Modus Ponen 2) Absorption Law	Noise exist (N) The FE algorithm exist (FE) The FE algorithm is robust towards noise. (N→ FE) If poor quality of image exist, then false minutiae occur (Pq→Fm) If false minutiae occur then post-processing is required (Fm→Pp)	1) N N → FE =FE *Feature Extraction in this research is robust towards noises* 2) FE ∨ (FE ∧ Pp) =FE *Feature Extraction must exist regardless any condition and its existence has no dependencies with post-processing task*
3	Noé et al. [12]	1) Disjunctive Syllogism 2) Conjunction	Noise robust feature extraction exists. (Fn) Standard MFCC feature extraction algorithm exists. (Mf) Blind Equalization exists. (Be) Feature Vector selection exists. (Ve)	1) Fn ∨ Mf = ~Mf *Noise robust feature extraction is preferable than standard MFCC feature extraction algorithm* 2) Be ∧ Ve *Blind Equalization and Feature Vector techniques which introduced by this paper is more preferable than others*

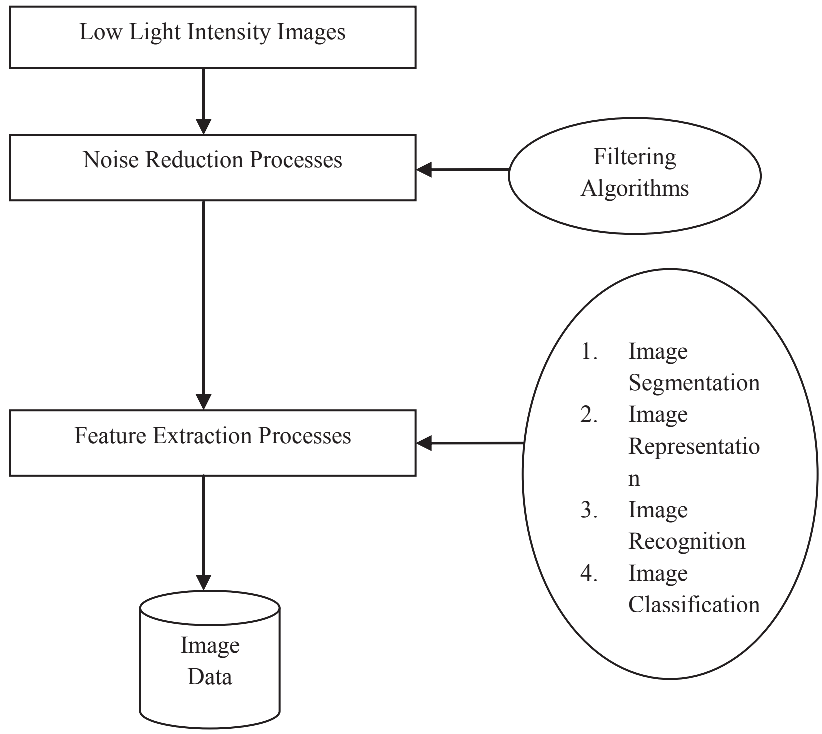

FIGURE 5. The proposed framework of image processing for low light intensity images.

The proposed framework in FIGURE 5 is showing the steps that need to be carried out to process low light intensity images. The required filtering algorithms should be capable to reduce noises found on the images before it goes to feature extraction processes. During feature extraction processes there are four main steps i.e. image segmentation that basically to segment the images, image representation is the options either for boundary or regional representation, image recognition is to assign a label on the identified object on images and image classification is to distinguish overall image from others. The image recognition process requires descriptors. The descriptors from the image data stored in database are to compare with the descriptor from the query. For example a plant species will be comparable with other species based on data obtained from the features selection. The closer gap within those descriptors is then selected to appoint the query image to be in which class.

For parallelization, generally the concept involves a master processor and worker processors [24]. Each processor loads its image block, carries on several processing tasks and solves independencies by using libraries. One of the libraries is MPI. The framework of parallelization can be seen in FIGURE 6 below.

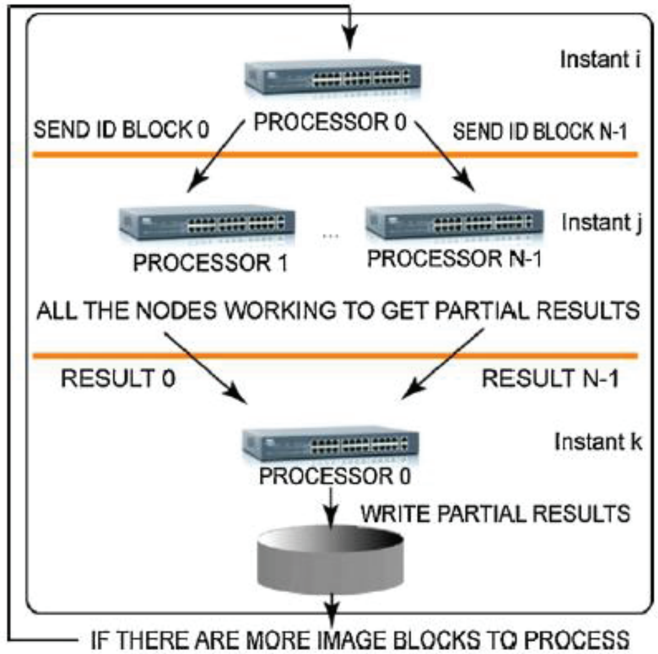

FIGURE 6. The proposed framework of parallelization adopted from [24].

TABLE (5). The proposed combination of NR and PFE to be carried out for low light intensity images based on previous works.

No	NR Approaces	PFE	Proposed By Previous Researches?	Applied to Low Light Intensity Images?
1	Perona-Malik filtering + Gabor filters	Contrast Enhancement Algorithm and Region Segmentation Algorithm	Yes	No
2	Scale-Invariant Feature Transform (Sift) + Speeded Up Robust Features (Surf)	Tresholding And Subtraction Feature Extraction Algorithm	Yes	No
3	PCA - LPG	Tresholding and Subtraction	Yes	Yes (Underwater images)
4	Median filter	Image segmentation	Yes	No

CONCLUSION

This paper reviews about NR approaches in its association with FE or PFE processes. This paper also attempted to find any correlation between FE/PFE and NR approaches for the purpose of handling noises in low light intensity images to support better feature extraction processes. Some previous works suggest combination of NR approaches with FE/PFE algorithms and have been tested towards images which have same noises found in low light intensity images. Hence, this combination appears to be suitable to carry out in the implementation stage. On the other hand, some previous works did not reveal the NR approaches on their FE/PFE applications and vice versa. This gives room for other researches to explore and experiment the new combination of NR and FE/PFE in finding best solution for low light intensity images.

ACKNOWLEDGMENTS

This work is part of PhD project in Industrial Computing Research Group, Centre for Artificial Intelligence Technology (CAIT), Universiti Kebangsaan Malaysia (UKM), Bangi, Malaysia. This project has been proposed to be funded by the Ministry of Science, Technology and Innovation (MOSTI) Malaysia in 2014.

REFERENCES

1. C. Zhang, H. Jiang, C. Jiang, C. Hu, W. Yang and C. Hou, *International Symposium on Computer Network and Multimedia Technology*, Wuhan, China, 2009, pp.1-4.
2. S. W. Lee, V. Maik, J. Jang, J. Shin and J. Paik, *IEEE Transactions on Consumer Electronics* **51**, 648-653 (2005).
3. E. Abreu, M. Lighstone, S.K. Mitra and K. Arakawa, *IEEE Transactions on Image Processing* **5**, 1012-1025 (1996).
4. L. F. Bai, Y. Zhang, C. Zhang, W. X. Qian and B. M. Zhang, *The 6th World Congress on Intelligent Control and Automation*, Dalian, China, 2006, pp. 10266-10269.
5. L. F. Bai, Q. Chen, G. H. Gu and B. M. Zhang, *International Conference on Signal Processing* **2**, 1052-1055, (1998).
6. C. Mythili and V. Kavitha, *The Research Bulletin of Jordan ACM* **2**, 41-44, (2011).
7. A. Mc Andrew, *Introduction to Digital Image Processing with MATLAB*, Course Technology, 2004, pp. 123-321.
8. T. M´elange, M. Nachtegael and E.E. Kerre, "International Processing and Management of Uncertainty", in *Knowledge Based System*, Malaga, Spain, 2008, pp. 1191-1198.
9. M. Nixon and A. Aguado, *Feature Extraction and Image processing*, 2nd ed., Elsevier Ltd, 2008, pp. 183-205.
10. S. Saxena, N, Sharma, S, Sharma, *International Journal of Advanced Research in Computer and Communication Engineering* **2**, 1896-1900 (2013).
11. P. Pacheco, *An Introduction to Parallel Programming*, Elsevier, 2011, pp. 183-235.
12. B. Noe, J. Sienel, D. Jouvet, L. Mauuary, J. Veth, L. Boves and F. Wet, *7th European Conference on Speech Communication and Technology*, Aalborg, Denmark, 2001, pp. 102-112.
13. A. Phinyomark, C.Limsakul and P. Phukpattaranont, *International Workshop and Symposium on Science and Technology*, Bangkok, Thailand, 2008.
14. B. Bir, M. Boshra and X. Tan, *Proceedings of 15th International Conference on Pattern Recognition* **2**, 2000, pp. 846-850.
15. A. Rao, *A Taxonomy for Texture Description and* Identification, Springer-Verlag, 1990, pp. 30-65.
16. S. A. Angadi and M. M Kodabagi, *International Journal of Image Processing* **3**, 121-128 (2010).
17. B. Noe, *7th European Conference on Speech Communication and Technology*, Aalborg, Denmark, 2001, pp. 102-112.
18. L. Sinavopa, "Proportional Logic : Overview", Simpson College, Indiana, USA, see http://faculty.simpson.edu/lydia.sinapova/www/cmsc180/LN180_Johnsonbaugh-07/Overview_logic.htm
19. D. Poole, A. Mackworth, "Artificial Intelligence Foundation for Computational Agent", Cambridge University, UK, see http://artint.info/html/ArtInt_8.html
20. D.F. Kibler, "Proportional Logic", University of California, USA, see http://www.ics.uci.edu/~kibler/ics171/RNLectures/PropLogic.pdf
21. K. C. Klement, "Proportional Logic", University of Massachusetts, Amherst, USA, see http://www.iep.utm.edu/prop-log/
22. P. Kaur, *International Journal of Computer Science & Engineering Technology* **4**, 696-706 (2013).
23. C.J. Du and D.W. Sun, *Trend in Food Science & Technology* **5**, 230-249 (2004).
24. G. Bueno, R. Gonzales, O. Deniz, M. Garcia-Rojo, J. Gonzales-Garcia, M.M. Fernandez-Carrobles and N. Vallez, *Computer Methods and Programs in Biomedicine* **1**, 388-401 (2012).
25. A. A. Philip and M. M. Omotosho, *Proceedings of World Congress on Engineering*, Vol. 3, London, 2013.
26. A. Flores, L. Miguel-Alvarez, Aleman, P. Fuentes and R. Santana, *International Conference on Applied Computing*, Rome, Italy, 2009, pp. 10-15.
27. A. Farahmand, A. Sarrafzadeh, and J. Shanbehzadeh, *Proceedings of the International Multi Conference of Engineers and Computer Scientists*, Vol. 1, Hong Kong, China, 2013.
28. M. M. Mubasher, M.S. Farid, A. Khaliq, M. M. Yousaf, *15th International Multitopic Conference, Islamabad, Pakistan*, 2012, pp.201-208.

29. A.F.A Nasir, M.N.A Rahman and A.R. Mamat, *International Journal of Computer Science and Telecommunication* **2**, 16-24 (2012).
30. C. Finta, P. Teppola, M. Juuti and P. Toivanen, *Chemometrics and Intelligent Laboratory Systems* **127**, 132-138 (2013).
31. C. Pagot, D. Osmari, F. Sadlo, D. Weiskopf, T. Ertl and J. Comba, *IEEE Symposium on Visualization* **3**, (2011).
32. E. Olmedo, J. Calleja, A. Benitez, and M.A. Medina, *International Journal of Computer Science Issues* **9**, 1-10 (2012).