RESEARCH ARTICLE

SAMRIDDHI Volume 12, Special Issue 3, 2020 Print ISSN : 2229-7111 Online ISSN : 2454-5767

An Approach for Image Enhancement using Soft Computing (IESC): A State-of-the-Art Review

Rajni*[1], Gitanjali Pandove[2], Pawan Kumar Dahiya[3]

[1,2,3] ECE Department, DCRUST, Murthal, India; e-mail : rajni.dcrust12@gmail.com, gitanjalipandav.ece@dcrustm.org, pawan.dahiya@gmail.com

Abstract

Nowadays image enhancement plays is a most dominant and laborious technique in research of image processing. The principal of enhancement is to boost the visualization or vision application of an image. Image Enhancement (IE) is the extraction a better quality of an image or a video. The enhanced image can be used in many application such as biomedical, medical and defense. Image enhancement uses either as color, black and white. The image enhancement is used for upgrade the superior class of an image f a specific application. Freshly much work is fulfilled in this field. This paper is presenting a workflow for image enhancement using soft computing using optimization techniques. In this paper, we present an overview of image enhancement techniques, histogram techniques, optimization techniques and soft computing techniques with the help of their existing techniques with their scope and develop a new approach for future research with the help of image enhancement framework.

Keywords: Image enhancement, Soft Computing, Optimization, Histogram equalization.

SAMRIDDHI : A Journal of Physical Sciences, Engineering and Technology, (2020); DOI : 10.18090/samriddhi.v12iS3.32

Introduction

Image enhancement plays a foundational role in image processing, where the researcher or specialist makes a resolution with respect to the image information. Enhanced picture handling is dependably a fascinating zone, and it gives better pictorial or picture data. Advanced picture preparing is extending in all the field of our life. In various fields of interest such as medical imaging systems, digital photography, satellite imaging, underwater visibility imaging, vision and face recognition, video surveillance systems, radar image processing, digital photography and sonar image processing and so on. Nowadays, mobile phones for capturing pictures is mostly seen, but due to hardware limitation observed in mobile phones for digital photography, the image quality can vary based on its resolution, focus, light intensity, a sudden bright light change or a shadow effect *etc.*, leading to poor image contrast with distortions and high noise levels. It might be remote detecting, safeguard, aviation, bio-restorative field, and therapeutic field [1-3]. Today picture quality preparing is becoming very quick. Picture preparing is the strategy to improve pictures got from the camera/sensor. Image enhancement including the terms as edge detection, noise trimming, edge improvement, and contrast enhancement. Enhancement may be the technique of raising the superiority of an image. To create a picture appearance i.e. lighter or darker or

Corresponding Author : Rajni, ECE Department, DCRUST, Murthal, India; e-mail : rajni.dcrust12@gmail.com

How to cite this article : Rajni, Pandove, Dahiya, P., K., (2020). An Approach for Image Enhancement using Soft Computing (IESC): A State-of-the-Art Review.

SAMRIDDHI : A Journal of Physical Sciences, Engineering and Technology, Volume 12, Special Issue (3), 168-174.

Source of support : Nil

Conflict of interest : None

to increase or decrease contrast so on. The Enhancement is used to increase the contrast of information, for human visualization in an image, or to feed the enhanced input for other regular image processing methods. In this procedure, more than one quality of the image is customized. The possibility of quality and the direction they are customized are specific to a certain task [4]. So image enhancement is very important. Fig.1. (a) is showing an original image and (b) is showing an enhanced image. The purpose of this review paper is to supply the researcher with a systematic survey of existing IESC research by categorizing existing method according to the feature they used.

(a) (b)

Figure 1: Effects are showing of image enhancement (a) Original input image (b) Enhanced output image

The process of image enhancement using soft computing is shown in fig.2. This flow graph is showing an image enhancement process. At first, we acquire an image then apply an enhancement technique which is better for enhancement. After selecting a proper image enhancement technique we can apply a histogram that is used for adjusting the intensities level. At last for getting a good result we apply soft computing technique using an optimization algorithm on it. This figure is shown below which is categorized into four sections, they are summarizing as follows:

a) Image Acquisition: In image acquisition, we acquire an image at input point.

b) Image enhancement: To get better visualization apply suitable enhancement technique on acquired image.

c) Image histogram: Image graphical representation.

d) Soft Computing: To solve complex problems.

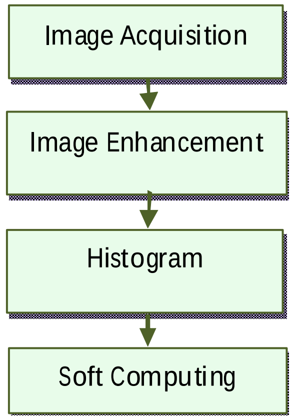


Figure 2: Stages of an IESC system

Purpose of this paper is to supply researchers with a well-ordered survey of existing IESC research by classifying existing methods according to their scope. The proposed work is focused on different enhancement evaluation parameters using optimization algorithm and for future scope, a framework for image enhancement is also shown.

The remainder of this research is ordered as follow: section II is showing Image enhancement are classified with detail reviewed section. Section III demonstrates the histogram method and section IV discuss the soft computing techniques. At the beginning of each section, we define and review about all the sections. In section V we summarize this paper and explore the area for future research.

IMAGE ENHANCEMENT

Enhancement is the method of increasing the appearance of a digitally stored image in computer vision. This can be done by utilizing the image with the help of software. For example, adjust the appearance or contrast of an image lighter or darker. Advanced image enhancement software bears many filters, which are used to improve the image in various ways. Image enhancement is used for improving the quality of an image. It is the process of adjusting the digital image by this we get more fit result. In image enhancement, there is a various method used such as edge, border, sharpening, etc. Fig.3. shows an image enhancement operation.

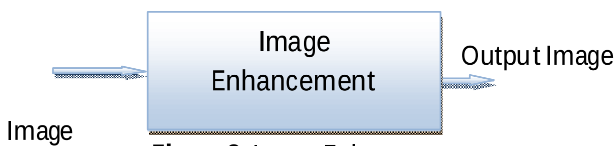


Figure 3: Image Enhancement

Digital image processing has two components:

(a) Image enhancement

(b) Information extraction.

Two class of enhancement are as follows:

(i) Spatial domain (ii) Frequency domain

Spatial domain straightly concerns with image pixels. The pixel value is utilized to achieve the desired enhancement. In frequency domain image firstly move into frequency i.e. Fourier transforms of image computed first [1-2]. Fig.3 is showing a flow chart of an image enhancement algorithm.

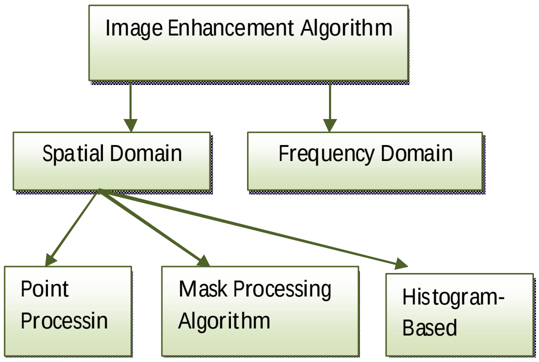


Figure 4 : Classification of the image enhancement algorithm

Histogram

A histogram is a very effective technique used for image enhancement. The histogram is a category that presents a diagrammatic presentation of the tonal issues in a digital image. Image enhancement can be done by histogram equalization. It is a graphical representation of pixels. This is used for balancing the intensities to enhance contrast. The histogram provides a straight path to to frequency of sample data information. Common shapes for the histogram are given below [5]:

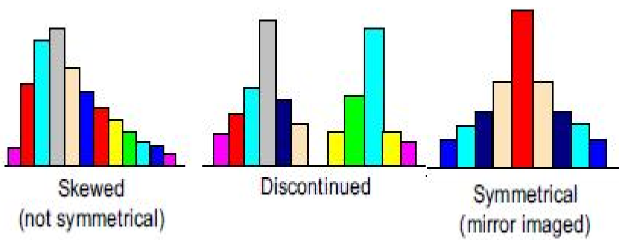


Figure 5: Common shapes of the Histograms

For histogram equalization, the following techniques are used.

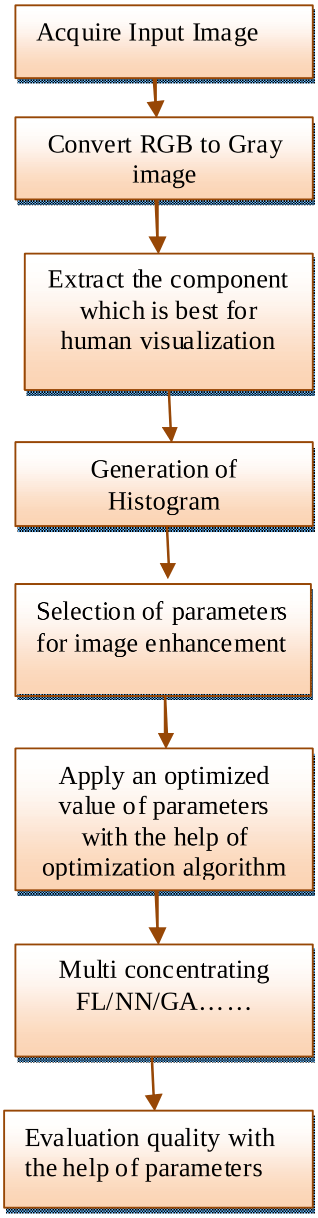
- Histogram equalization
- Adaptive histogram equalization
- Global histogram equalization
- Contrast Limited Adaptive Histogram Equalization
- Local histogram equalization
- Classical histogram equalization
- Bi- histogram equalization

Soft Computing

Soft computing is depend on problem-solving algorithm such as fuzzy logic, artificial neural networks, neural nets, probabilistic reasoning. Soft computing is a set of or a collection of an algorithm that is employed to solve the complex problem. The objective of soft computing is obtaining a robust solution at a reasonable cost. When we talk about cost it is how much time and space consume to run the algorithm. When we talk about the advantages of soft computing, it is used for solving the nonlinear problem in which mathematical model is not possible or available. It introduces mortal knowledge such as recognition, cognition, learning, etc. Depend upon solid binary logic, crisp system, numerical analysis is called hard computing. This computing signifies tolerant of partial truth, imprecision, approximation, and uncertainty [2, 6-7]. Soft Computing Techniques:

- Intelligent system
- Neural Network
- Fuzzy Logic
- Evolutionary algorithm: Genetic algorithm

Fig.6 shows the proposed work-flow of image enhancement. In this flow, we are taking some input images these images are such as medical, general, satellite. After taking the input we put a converter block which is used to convert an RGB image into gray image because RGB has high intensity and gray has low intensity. Now select the component which is suitable for human visualization i.e. Y component is best for human visualization. When we found a better component for visualization system then go on the histogram. The histogram is a pictorial representation of various issues in a digital image (lightness i.e. light and dark of color called tonal).



For each variation of value, it plots the number of pixels. The histogram is used to balance the intensities to enhance an image. There are different histogram method which are used for image enhancement such as histogram equalization, local histogram, classical histogram equalization, adaptive histogram equalization, etc [1-5]. We need conversion i.e. RGB to gray. After this step, we explained about the image components which are best for visualization. Then we are talking about equalization histogram that is used to adjusting an image intensity. There are different types of histogram equalization according to a literature survey such as HE, AHE, GHE, CLAHE, etc. Now we discuss about enhancement technique with suitable parameters for the histogram. We also explain different optimization techniques and soft computing techniques for better enhancement ***(Annexure-1)***.

Conclusion and Future Scope

This review presents a comprehensive literature on existing IESC technique with their scope. It also provides an overview on various techniques of image enhancement, histogram techniques, soft computing techniques and optimization techniques with different image formats and color conversions. It has also been discussed about various kind of literatures and work related to image enhancement techniques using soft computing. The proposed work is focused on different enhancement evaluation parameters using optimization algorithm and for future scope, a frame-work for image enhancement is also shown in this paper.

References

[1] Senthilkumaran, N., and J. Thimmiaraja, "Histogram equalization for image enhancement using MRI brain images" *Computing and Communication Technologies (WCCCT), World Congress on*, pp. 80-83. IEEE (2014).

[2] Yuvarani, P, "Image denoising and enhancement for lung cancer detection using soft computing technique" *Sustainable Energy and Intelligent Systems, IET Chennai 3rd International on*, pp. 1-4. IET (2012).

[3] Goel, Neelam, and Manvjeet Kaur "A review of soft computing techniques in biometrics" *Recent Advances in Engineering & Computational Sciences (RAECS), 2nd International Conference on*, pp. 1-4. IEEE (2015).

[4] Aarthi, T., E. Sowmiya, and N. Sairam "Enhancement of visual quality of an image using fuzzy logic" *Intelligent Systems and Control (ISCO), IEEE 8th International Conference on*, pp. 240-242. IEEE (2014).

[5] Bhai, Govind, and Shweta Agrawal "A Novel Low Complexity Histogram Algorithm for High Performance Image Processing Applications" (2017).

[6] Guo, Susu, Zijing Zhou, Jianming Li, Qiao Xiang, and Zhonghua Li, "Applications of soft computing in RFID system: A review" *Control and Decision Conference (CCDC), 27th Chinese*, pp. 1237-1242. IEEE (2015).

[7] Narnaware, Shweta, and Roshni Khedgaonkar "Image enhancement using artificial neural network and fuzzy logic" *Innovations in Information, Embedded and Communication Systems (ICIIECS), International Conference on*, pp. 1-5. IEEE (2015).

[8] Kaur, Gagandeep, Nishant Bhardwaj, and Pradeep Kumar Singh "An Analytic Review on Image Enhancement Techniques Based on Soft Computing Approach" *Sensors and Image Processing*, pp. 255-265. Springer (2018).

[9] Saxena, Kumud, Avinash Pokhriyal, and Sushma Lehri "SCIENCE: Soft Computing Based Image Enhancement for Contrast Enhancement" *International Journal of Advanced Computing, ISSN*: 2051-0845.

[10] Alsuwailem, Abduallah M., and Saleh A. Alshebeili. "A new approach for real-time histogram equalization using FPGA." *Intelligent Signal Processing and Communication Systems, 2005. ISPACS 2005. Proceedings of 2005 International Symposium on*, pp. 397-400. IEEE, 2005.

[11] Bilal, Muhammad "Algorithmic optimisation of histogram intersection kernel support vector machine-based pedestrian detection using low complexity features" *IET Computer Vision* 11, no. 5, 350-357 (2017).

[12] Pandey, Pratibha, Kranti Kumar Dewangan, and Deepak Kumar Dewangan "Enhancing the quality of satellite images using fuzzy inference syste." *International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS)*, pp. 3087-3092. IEEE (2017).

[13] Tania, Marzia Hoque, K. T. Lwin, and M. A. Hossain "Computational complexity of image processing algorithms for an intelligent mobile enabled tongue diagnosis scheme" *Software, Knowledge, Information Management & Applications (SKIMA), 10th International Conference*, pp. 29-36. IEEE (2016).

[14] Narnaware, Shweta K., and Roshni Khedgaonkar "A Review on Image Enhancement using Artificial Neural Network and Fuzzy Logic" (*IJCSIT) International Journal of Computer Science and Information Technologies* 6, no. 1 (2015).

[15] Aarthi, T., E. Sowmiya, and N. Sairam "Enhancement of visual quality of an image using fuzzy logic" *Intelligent Systems and Control (ISCO), IEEE 8th International Conference*, pp. 240-242. IEEE (2014).

[16] Oloyede, Muhtahir O., Gerhard P. Hancke, and Herman C. Myburgh "Improving Face Recognition Systems Using a New Image Enhancement Technique, Hybrid Features and the Convolutional Neural Networ." *IEEE Access* 6, 75181-75191 (2018).

[17] Gorai, Apurba, and Ashish Ghosh "Gray-level image enhancement by particle swarm optimization" *Nature & Biologically Inspired Computing, World Congress*, pp. 72-77. IEEE (2009).

[18] Braik, Malik, Alaa F. Sheta, and Aladdin Ayesh, "Image Enhancement Using Particle Swarm Optimization" *World congress on engineering*, vol. 1, pp. 978-988 (2007).

[19] Saravanan, G., and G. Yamuna, "Real Time Implementation of Image Enhancement Based on 2D-DWT." *Procedia Computer Science* 87, 105-110 (2016).

[20] Saini, Priyanka, Adesh Kumar, and Neha Singh, "FPGA implementation of 2D and 3D image enhancement chip in HDL environment" *International Journal of Computer Applications* 62, no. 21 (2013).

[21] Yang, Hung-Yu, Pei-Yin Chen, Chien-Chuan Huang, Ya-Zhu Zhuang, and Yeu-Horng Shiau, "Low complexity underwater image enhancement based on dark channel prior" *Innovations in Bio-inspired Computing and Applications (IBICA), 2011 Second International Conference*, pp. 17-20. IEEE (2011).

(Annexure-1)

Table- 1: Work-Flow for Image Enhancement [8-21]

WORK FLOW	EXISTING TECHNIQUES FOR WORK-FLOW	SCOPE OF WORK-FLOW
Image Formats	• Tag Image File Format • Joint Photography Expert Group • Portable Network Graphics • Graphics Interchange Format	• TIFF: TIFF Create a large file. These are uncompressed and a lot of detailed images. • JPEG: JPEG is mostly used in camera to storage image. These are usually used for photography on the web. These are bad for line drawing, logos, and graphics. These are lossy. • PNG: It is a raster graphics file format. These are used for lossless data. • GIF: GIF is used as a bit-map image formation animation.
Input	• Audio Signal • Video • Image	• Audio: When we take an audio signal at the input for example: speech signal • Video: At the input we will take motion or moving data for example: video clip, animation. • Image: When we take any image at the input for example: image.
Conversion [9]	• RGB to Gray • Gray to RGB	• RGB to Gray: These are used to convert a colour image into gray image. • .Gray to RGB: These are used for convert a gray image into colour image.

Component [8]-[9]	• HSV (Hue Saturation value) • HIS (Hue Intensity Saturation) • YCbCr (luma component, blue and red component)	• HSV: Represent color space in term of three basic components Y Cb Cr. H: represents the variety of color RGB. S: Saturation of color added gray image look or dull appearance. Its color range starting from 0 to 100 %. V: value of intensity is 0 to 100 % for getting good enhancement. • HIS: H: represents the variety of colour RGB. I: intensity is the amount of light or numerical value of a pixel. S: Saturation of color added gray image look or dull appearance. Its color range starting from 0 to 100 %. • YCbCr: Y: luminance component i.e. brightness or intensity of color. Human eye is more sensitive for y component. Cb: Blue component respective to the green component. Cr: Red component respective to green component. Cb and Cr are less sensitive to human eyes.
Histogram Generation [1], [5],[10]	• Histogram Equalization • Automatic Histogram Equalization • Contrast Limited Adaptive Histogram Equalization • Local Histogram Equalization • Classical Histogram • Bi-Histogram • Global Histogram	• HE: It draw a gray map which replaces a graphical representation of an image and redistribution all the pixel value. These pixel value is very close to user-specific desired histogram. It automatically determines a transform function. • AHE: It is used to contrast the image but has disadvantages is that increase noise in some similar regions of an image. • CLAHE: To overcome the drawback of AHE an advance version of AHE introduced called CLAHE. • LHE: It can enhance many image details by taking the different transformation of the same gray level. • CHE: In this technique gray level images are considered. Output image of CHE with a smooth histogram means a uniform distribution. But this method has some drawbacks that it is not properly differentiate between the various pixels i.e. while increasing the contrast of its background, the signal gets distorted and always produce unclear and unlikely effects in photographs. • Bi-HE: This method introduced to overcome the disadvantages of CHE by the original input image is segmented two times. This has the same disadvantages as CHE by inputting unwanted signals. • GHE: It is used to enhance the brightness/disparity of the entire image.
Parameters for enhancement [8]	• Let X • n • k = 0,1,.....L-1 • Xk	• X is the input image • n is the total no of the sample in the input • k is showing the number of times that the level Xk appears in the image • Xk is a number of pixels that have a fix intensity Xk. For example, we can optimize the number of samples and level.
Soft Computing Techniques [3]-[4],[6]-[9],[12]-[16]	• Fuzzy Logic • Neural N/W • Neural Fuzzy • Artificial Neural Network • Genetic Algorithm	• FL: Used for unclear problems. It has a human-like reasoning capability. When we clarify the image characteristics as linguistic variables. The fuzzy rules i.e. if-then rules are used to split the image into many parts. • NN: Neural network is irregular numerical figures. They can be used to search the shapes in the information. It is also to make a complex relationship between inputs and outputs. • NF: In this the firstly system behaves as NN were learning only parameters and then behave as fuzzy which is used for evaluation. • ANN: These networks understand through the learning process. It determines the data noise and samples. ANN has learning a ability like a human. It is best for real-time applications. Widely used for speech, pattern, and vision recognition. • GA: It is used to solve optimization problems. This technique is best for low complexity.

Optimization [8],[17]-[18]	• Particle Swarm Optimization • Different Evolutionary • Artificial Bee Colony • Ant Colony Optimization	• PSO: Give high efficiency, fast coverage, and strong robustness. PSO takes less time of coverage. PSO has more fitness value and takes less execution time as compared to GA. • DE: It is best for real-time world applications. This technique has the capability of repeating cycling and optimizing with real value parameters. • ABC: In this AB are the agents, which solve the complex combinatorial optimization problem. In this, every AB computes one solution to the problem. • ACO: Used to solve computational pathfinding problems. In this artificial ants walk through a specific graph and find a good path. In ACO ants working in parallel.
Evolution Parameters [8],[13],[19]-[21]	• Complexity • Execution Time (ET) • Peak Signal to Noise Ratio (PSNR) • Contrast improvement Index (CII) • Mean Square Error (MSE)	• Complexity: If the algorithm takes more time to execute a problem called system is more complex. If the algorithm takes less time to execute a problem called low complexity. • ET: The time taken by algorithm to process the problem. • PSNR: Relation between maximum possible power signal and the power of noisy or disturbing signal that affect the quality of an image. High PSNR shows higher quality. • CII: Compare the result of contrast enhancement. **CII = C proposed/C original.** C is average the value of local contrast. High CII represent the better result. • MSE: By this we can measures the average of square error. A minimum value of MSE represents good quality.