Comparative Analysis of Image Enhancement Techniques

[1]Nisha Singh [2]Anugrah Srivastava

[1]M.Tech Scholar [2]Assistant Professor
Computer Science and Engineering Department
Rama University, Kanpur, Uttar Pradesh, INDIA-208014

Abstract: **In the field of image processing, image enhancement is one of the central tasks. On applying conversion of an image from one form to another form using operations for example compressing, scanning, storing, digitizing, and transmitting and so on, some loss of image details occurs in the output. Therefore, the image has to undertake a process of adjusting contrast called image enhancement. Image enhancement incorporates different classes of spatial operations to escalate the contrast, smoothen the areas of image, and sharpen the edges and structures. Hence, it gives a clear, a more visible and a distinct image as its output. There exists numerous techniques for improving the image quality, including: histogram techniques, gray-level modification, filters based on order statistics, filters which use Fourier/ Wavelet transform, adaptive and morphological filters, fuzzy logic. Because of its non-linear and knowledge based nature, fuzzy technique provides an appropriate framework for the implementation of various methods. In this paper, existing techniques for image enhancement have been compared and analyzed based upon different key descriptors.**

Index Terms : **fuzzy logic, membership function, fuzzification, HE.**

I.INTRODUCTION

Image enhancement techniques have wide application in the fieldof medical scienceimaging, art studies, forensic science and atmospheric science. Image enhancement improves the quality of the image so as to prevail over the limitations of the human visual system. The incentive of image enhancement techniques includes higher visual quality, extracting the hidden details in the image, increases the contrast of low contrast image, enhances image features for further processing. In image enhancement, the low quality image is transformed into high quality with the intent of improving the look of the image (Yaman *et al,* 2016). Instead of increasing the inherent information of the data, enhancement upsurges the range of features.

II.IMAGE ENHANCEMENT

In image enhancement process, the visual look of image is perked up or is converted in a form that it can be easily understandable to human eyes or machines. There are three main categories in image enhancement technique:

i. Method operating directly on pixels is spatial domain method.
ii. Method operating on the Fourier transformation of the image is Frequency domain method.
iii. Fuzzy domain method which involves knowledgebase systems.

III.FUZZY IMAGE ENHANCEMENT

A nonlinear knowledge-based fuzzy logic can process imperfect data, if this imperfection originates from vagueness and ambiguity rather than randomness (Tizhoosh et al, 2000). These are categorized as automated control or decision making support (Patil *et al*, 2016).

I. IF… THEN ELSE Rules
II. Rule-Based Smoothening

IV.PERFORMANCE EVALUATION

The analysis of performance of various techniques is done using different parameters that is "MSE (Mean Square Error)", "PSNR (Peak signal To Noise Ratio)"and "CII (Contrast Improvement Index)". The average of values of each parameterof the tested images was calculated of conventional and new techniques wereto compare the performance of the proposed techniques.

MSE

Mean Square Error is the measure of average squares of errors.

MSE$=\frac{1}{RC}\sum_{i=1}^{R}\sum_{j=1}^{C}(f(y,z) - f'(y,z))^2$ ………………………………………..(4.1)

Where, R is rows in original image and C columns in original image at index y and z. f(y, z) is the original image and f´(y, z) is the degraded image.

CII

Contrast improvement index is the division of $C_{enhanced}$ to $C_{original}$ (Reshmalakshmi et al, 2013).

Where, $C_{enhanced}$ is average contrast of new image and is the average contrast of input image. A higher value of CII is always favored.

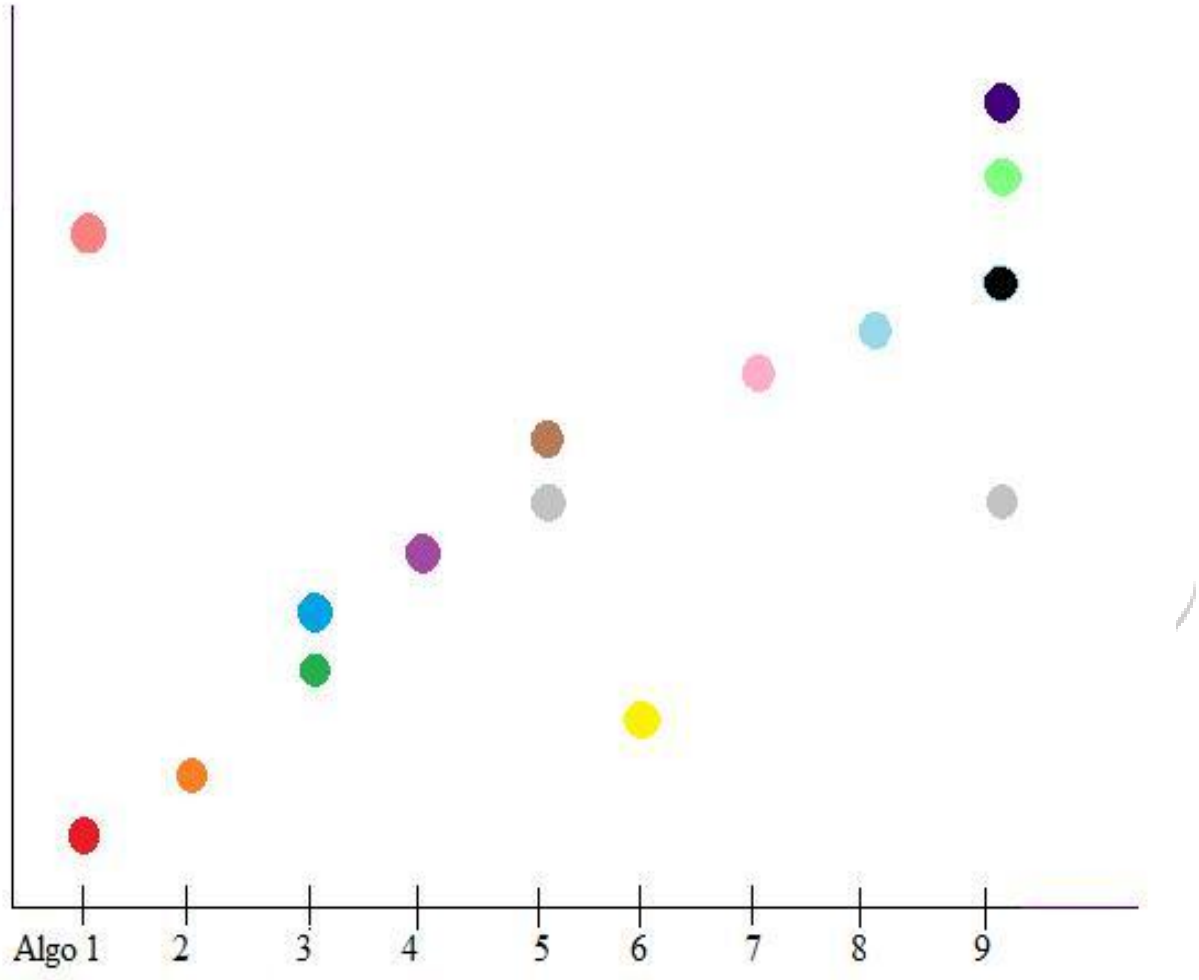
PSNR

"PSNR is the division of the maximum possible power of a signal to the power of corrupting noise affecting image quality". For reconstruction to be of higher quality, the value of PSNR should be high.

V.COMPARATIVE ANALYSIS

As per the constraints discussed in these papers, a comparative analysis has been compiled in the Table 3.

Figure 1 Comparative Analysis of Image Enhancement algorithms



Where, algorithm 1 proposed by Patil *et al* (2016), algorithm 2 by Shetty *et al* (2015), algorithm 3 by Mahashwari *et al* (2013), algorithm 4 by Asha *et al* (2016), algorithm 5 by Aarthi et al (2016), algorithm 6 by Suneetha *et al* (2011), algorithm 7 by Suple *et al* (2013), algorithm 8 by Garud *et al* (2011) and algorithm 9 by Reshmalakshmi *et al* (2013).

Feature Set Description of Algorithms
Table 5.1 Feature Set Selection

Features	Code
Adaptive and elective	
Reduction in amount of data to be processed	
Reduced execution time	
Minute details enhanced	
Suitable for dark unclear images	
Clarity and visibility destroyed, made images darker	
Produced high contrast	
Preserved natural look	
Successful in dealing limitations of "Frequency and spatial domain methods"	
Maintained mean brightness	
Enhancement of flat and sharp portions	
Removed problem of over or under enhancement	
Errors and artifacts not introduced	
Smoothens intensity of pixels and enhances edges of image	

CONCLUSION

The contrast enhancement techniques are classified as indirect methods and direct methods. The most common traditional indirect methods include Histogram specification and histogram equalization whereas, direct methods include fuzzy image enhancement. The direct approaches are better and are more useful than indirect contrast approaches because they consider both global and local details of the image.

In image processing one of the simplest methods is Histogram equalization (HE) that improves the contrast, but it has some limitations: Not maintaining the brightness and natural look of the image. To prevail over this limitation, Bi-histogram and "Multi-histogram methods" have been suggested as inferred from the literature survey. The Bi-Histogram Equalization method remarkably enhances the contrast as well as preserves the brightness, but somewhat didn't overcome the problem of destroying the natural appearance of the image. Multi-HE methods have been put forward to keep the natural look of the image, in which after dividing the histogram of the image into multiple segments, HE is again applied on each division independently.

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