

A Survey on Image Enhancement Techniques

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ABSTRACT: Image Enhancement is the preprocessing technique widely used in Digital Image Processing. This paper presents techniques that are developed to enhance the visual appearance of images. This survey includes Image Enhancement using traditional methods along with fuzzy logic, genetic-based, and machine learning algorithms. The role of machine learning in the field of digital image enhancement is a new frontier. Machine learning is an application of artificial Intelligence that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.

KEYWORDS: Enhancement, Filter, Noise, Convolution Neural Network, Machine learning

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I. INTRODUCTION

Today, there is almost no area of technical endeavor that is not impacted in some way by Digital Image Processing. It involves the modification of digital data for improving the image qualities with the aid of computer. Image enhancement and information extraction are two important components of digital image processing. Image enhancement techniques improve the visibility of any portion or feature of the image suppressing the information in other portions or features. Image enhancement is among the simplest and most appealing areas of digital image processing. Basically, the idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image [1]. Over the past several years computer vision and analysis are attracting several researchers' attention and it motivated us to write this survey paper dealing with contemporary studies on image enhancement. In this paper, Section II deals with various image enhancement techniques. Section III presents an illustration of Image enhancement for both gray scale and color images. Section IV deals with results analysis of image enhancement methods implemented by various researchers. Finally, in Section V, conclusions are drawn obtained from this analysis.

II. IMAGE ENHANCEMENT METHODS

The main aim of enhancement is to process an image so that results are more suitable than the original image for a specific application. Processing of an image can be either to remove noise, sharpen the image or brighten an image. Image enhancement approach can be dealt in spatial domain or in frequency domain and/or in both. Simplest image enhancement techniques include histogram equalization. The histogram is a preprocessing technique to enhance contrast in natural images, used to show how many times a particular grey level (intensity) appears in an image. Histogram Equalization transforms the intensity values so that the histogram of the output image approximately matches the flat (uniform) histogram. This method is useful in object tracking but resulting images are either oversaturated or under saturated and thus have poor quality hence adaptive histogram equalization techniques were developed which produced higher quality images. The contrast stretching technique is the simplest algorithm for image enhancement. It stretches the pixel values of a low contrast or high contrast by extending the dynamic range across the whole image spectrum whereas thresholding transformations are particularly useful in image segmentation. These techniques are often referred to as point processing whereas masks also referred to as filters, kernels, templates, or windows deals with larger neighborhood. Various filters are in development from linear filters such as Gaussian filter, Laplacian filter, Laplacian- of-Gaussian filter and non-linear filters such as gradient filter combined with Gaussian filter and thinned using canny's method, using non sub sampling contour let transform, random sampling, Max filter, Min filter, Mean filter, Wiener filter, Non-local means for image de noising, Bilateral-filtering, and trilateral filtering, Adaptive vector median filter, Homomorphic filtering, Guided image filter, and Diffusion processes [2-7].

Evolutionary algorithms were also applied to image enhancement which include Genetic Algorithm (GA), Particle Swarm Optimization(PSO), Artificial Bee Colony (ABC), Fuzzy logic, Genetic based fuzzy, Differential Evolution(DE), Fuzzy differential evolution algorithms. DE algorithms were developed to overcome the GAs limitation of convergence. The main difference between DE and GA is the mutation that makes DE algorithm self-adaptive.

Machine Learning is now playing a major role. According to Liu, Yan, Yang Convolution Neural Network (CNN) can be used for image denoising. The advantage of CNN model is that it continuously optimizes the weights of convolution kernel during network training [9]. In [11], image denoising and enhancement from graph-based viewpoint was proposed. The color image denoising and enhancement is done by graph-based dictionary learning obtained from nonlocal similar patches in each color channel and image is enhanced by graph-based sharpening filter [12]. In [10], image contrast enhancement based on learning ensemble based histogram equalization was proposed. Both Fully sampled and undersampled K-space data is used for reconstructing the image. The undersampled image is deteriorated by noise and is enhanced by random sampling and learning ensemble strategy. Even patch dictionary based learning was proposed in [12]. Resolution enhancement can also be done through patch-based learning [13]. Image enhancement of high resolution image can be denoised by auto-encoders. Auto-encoders in neural networks conduct unsupervised learning [14].

III. ILLUSTRATION OF ENHANCED IMAGES

A low contrast input image is shown in Fig. 1 (a), and when histogram equalization is applied on this input image, it results in enhanced image. Fig. 1(b) shows the result of performing histogram equalization which is given below. Some more illustrations of Image Enhance are shown in Fig. 2 and Fig. 3.

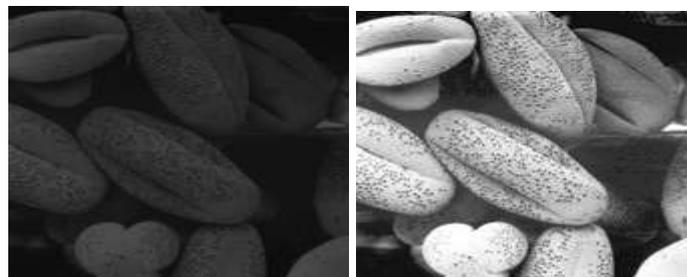


Fig 1: Histogram-Based Technique of Contrast Enhancement



Original Input Image Enhanced Image
Fig 2 Enhanced Output Image after Salt-and-pepper Noise removal

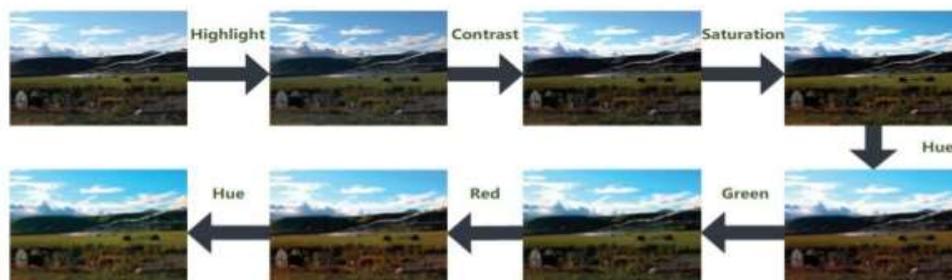


Fig3: Machine Learning based Image Enhancement

Illustrations indicate that the advancement of techniques from filters to the usage of CNN a radical improvement in the image enhancement especially in color images in terms of HSI.

IV. RESULTS ANALYSIS

In this paper, we have studied, analyzed various image enhancement techniques and presented various parameters which indicate quality of enhanced images by peak signal noise ratio (PSNR), Multi-Scale Retinex (MSR), Structural Similarity Index Measurement (SSIM), contrast and noise density obtained by various techniques of image enhancement when compared to original image and we can say that multilayering of neural network and along with learning technique of machine learning outperforms the traditional ways of image processing hence it is a new frontier in the field of image processing techniques

Technique/Method	Author, year	Advantages	Experimental Results
Image Enhancement via bilateral Filtering	N.H.Kaplan I.Erer N.Gulmus 2017	Preserves the color information while increasing the contrast. Enhances the edges better	<u>Contrast</u> Original Proposed 0.0085 0.0273 <u>Enhancement</u> Original Proposed 0.0895 0.7116
Image enhancement via trilateral filtering	Chengtao Cai, Haiyang Meng & Qidan Zhu,2018	Suppress the noise and enhance the edge information	PSNR SSIM 32.65 0.91
Image enhancement via Homomorphic filtering & Local entropy guided image filtering	Sisi Han, Weibin Liu, Weiwei Xing 2017	Color Image illumination enhancement	Original Proposed MSR MSR 4.7225 3.7563
Image enhancement via weighted guided image filtering	Sangu Aruna Kumari Rajasekhar Karumuri,2017	WGIF has ability to provide the local & global smoothing filters advantage and avoids the halo artifacts. Provide better Visual Quality	Original Proposed MSR MSR 0.0119 0.0078
Image enhancement via improved guided filtering	Jiafei Wu, Chang Wang, Yongze Xu,2018	Incorporates adaptive structure aware constrain, preserves the edges & smooth details. Provides better visual quality than WGIF.	<u>Lightness order error(LOE)</u> GIF WGIF BLF IGIF 4.12 3.84 4.01 3.65
Structure Adaptive vector median filter(SAVMF) for impulse noise removal in color images	Lianghai Jin, Min Jin, Xiangyang Xu, Enmin Song,2017	Suppresses impulse noise of color image	<u>PSNR</u> VMF SAVMF 29.63 34.61
Image enhancement via a novel optimal fuzzy system	Madasu Hanmandu, Om Prakash Verma .et al,2009	A visually pleasing image is obtained with appropriate contrast factors using fuzzy entropy optimization.	V_f V_f of of approach entropy Proposed 1.0894 1.5224
Image enhancement via Genetic-based fuzzy image filtering	Chang- ShingLee, Shu-Mei Guo, & Chin- Yuan Hsu,2005	Removes noise without degrading the image structure and preserves the quality of fine details & texture	<u>Noise Density (p=0.1)</u> FIF GFIF 0.89 1.41
Data-adaptive color image denoising and enhancement using graph-based filtering	H.sadrezami A. Asif A.Mohammadi 2017	Visual quality of the denoised image is enhanced iteratively. It provides higher value of PSNR	Original proposed SSIM 0.43 0.92 Enhanced Image 1 iteration SSIM 0.94 3 iteration SSIM 0.97
Image denoising based on a linear CNN model	Zhe Liu, Wei Qi Yan & Mee Loong Yang,2018	Best performance for removing Gaussian noise and salt &pepper noise than traditional image filters	Traditional Proposed Guassian 0.0007 0.0004 filter Salt-&-pepper noise 0.0005 0.0001
Image enhancement Via learning ensemble	Xiaoyan Wang Zhenzhou An Haifeng Wang Yuchou Chang,2018	It outperforms traditional equalization, exact histogram equalization, CLAHE method	HE MSE 6.12×10^{-5} Exact HE MSE 1.8×10^{-6} CLAHE MSE 1.12×10^{-5} Proposed 3.76×10^{-7}

V. CONCLUSION

In this paper we have brought forth the developments of various techniques of image enhancements including machine learning-a recent development. The machine learning mechanisms revolutionized the way images are processed especially medical images and in future it will transform radiology field of medical imaging. Machine learning based Image Enhancement provides better results. Image enhancement techniques can be applied to gray scale images and color images. It can also be applied to videos which is called video enhancement. From the results analysis, it can be inferred that the image enhancement techniques provide a way for image analysis and pattern recognition applications.

REFERENCES

- [1]. Gonzalez & Woods , Digital Image Processing (Pearson Education ,2002)
- [2]. N.H.Kaplan, I.Erer, and N. Gulmus Remote Sensing Image Enhancement Via Bilateral Filtering in Intern. Conf. On RAST, 2017.
- [3]. Chengtao Cai, Haiyang Meng, and Qidan Zhu Blind Deconvolution for Image Deblurring based on Edge Enhancement and Noise Suppression IEEE Access 2018.
- [4]. Sangu Aruna Kumari and Rajasekhar Karumuri Weighted Guided Image Filtering For Image Enhancement in proc. ICCES 2017.
- [5]. Lianghai Jin , Min Jin, Xangyang and Enmin Song Structure-Adaptive Vector Median Filter For Impuls Noise Removal in Color Images IEEE Inter.conf. on ICIP 2017
- [6]. SisHan, Weibin Liu and Weiwei Xing Image Enhancement Based on Spatial MultiScale Homomorphic Filtering and Local Entropy Guided Image Filtering in Inter. Conf., on DASC/PiCom/DataCom/CyberSci Tech 2017
- [7]. Jaifei Wu, Chang Wang ,and Yongze Xu An Improved Guided Filtering Algorithms for image Enhancement in IEEE Intern. Conf. On ICME 2018.
- [8]. Maasu Hanmandlu, Omprakash Verma, Nukala Krishna Kumar , Muralidhar Kulkarni A Novel Optimal Fuzzy System for Color Image Enhancement Using Bacterial Foraging IEEE Trans.on Instrumentation & Measurement, vol 58. No.8, Aug 2009.
- [9]. Chang-Shing Lee, Shu_Mei Guo, and Chin-Yuan Hsu Genetic-Based Fuzzy Image Filter & its Application to Image Processing IEEE Trans. On Systems Man and Cybernetics-Part B Cybernetics Vol 35 No.4.Aug 2005
- [10]. Zhe Liu, Wei Qi Yan, and Mee Loong Yang Image Denoising Based on a CNN Model in Intern. Conf. on Control, Automation and Robotics 2018.
- [11]. Xiaoyan Wang, Zhenzhou An, Haifeng Wang, and Yuchou chang MR Brain Image Enhancement Via Learning Ensemble proc.IEEE Intern. Conf. on Intellegence & safety for Robotics,2018
- [12]. H.Sadrezami, A. Asif, A. Mohammadi Data-adaptive color Image Denoising and Enhancement Using Graph-based Filtering IEEE 2017
- [13]. Bangzhong Gu, Bin Chou, Limin Luo Retinal Vessel Enhancement Via Sparse Coding and Dictionary Learning Intern. Conf. on MVA 2017
- [14]. Saurabh B. Lakade and Dr. S.K Shah Single Image Resolution Enhancement by Patch based Learning IEEE 2017
- [15]. Juhwan Kim, Seokyoung Song and Son-Cheol Yu Denoising Auto-Encoder Based Image Enhancement for High Resolution Sonar Image IEEE 2017

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