ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 5, May 2015

A Study on Image Enhancement Techniques

Pooja Rana[1], Vinay Chopra[2]

Research Scholar M.Tech., Department of CSE, DAVIET, Jalandhar, India [1]

Assistant Professor, Department of CSE, DAVIET, Jalandhar, India [2]

Abstract: The purpose of image enhancement is to make images better than the original so that they become clearer and they can be easily interpreted. The image enhancement techniques may have spatial domain or frequency domain. But the researchers have proved that frequency domain techniques are better than spatial domain techniques. Today optimization algorithms are used in the approach used for image enhancement. This paper reviews the various image enhancement techniques.

Keywords: DWT, SVD, CLAHE, DCT, Cuckoo Search Algorithm, Bacterial Foraging Optimization Algorithm

I. INTRODUCTION

Digital image processing is the under digital signal processing which is dealing with the manipulation of the digital images by the use of digital computers. Digital image processing is better than analog image processing. It is done so that the images are interpreted easily by human eyes. It consists of many steps. The steps of image enhancement are: Image Acquisition, Image Enhancement, Image Restoration, Color Image Processing, Wavelets & Multi resolution Processing, Compression, Morphological Processing, Segmentation, Representation & Description, Object Recognition. Image Enhancement is important step. It is used to enhance the digital images. It is done for highlighting specific features of images. It is done to change low contrast images into high contrast images. Image enhancement differentiates the objects from the background.

Digital images are consisting of pixels. Each pixel has its own color. Digital images are useful for conveying information. But usually these images are low contrast or contain noise. This makes the images less interpretable. So image enhancement is needed for better interpretation. There are various types of noises. Some are: Gaussian Noise, Speckle noise, Salt-Pepper Noise and Poisson Noise. Gaussian is also known as additive noise. In image in which Salt-Pepper Noise is present, dark pixels are present in bright regions and bright pixels are present in dark regions. Poisson Noise is also known as short noise. It is a type of electronic noise. Speckle Noise is known as multiplicative noise.

The image enhancement techniques are basically divided into two domains. They are: Spatial Domain and Frequency Domain. In spatial domain, the pixel values are manipulated for image enhancement. The spatial domain techniques are usually used to achieve contrast enhancement. In frequency domain, the Fourier Transform concept is used. The basic idea for the frequency domain techniques is to manipulate the transform coefficients for image enhancement. The principle in the frequency domain techniques is consisting computation of a 2-D discrete unitary transform of the image, for instance the 2-D DFT, manipulating the transform coefficients by an operator M, and then finally performing the inverse transform [1]. The spatial domain techniques are easy to understand and their complexities are low so they are easy to implement. The main advantage of frequency domain techniques is low complexity of computation.

There are three important image enhancement techniques for enhancement of underwater images. They are: Contrast Stretching, Contrast Limited Adaptive Histogram Equalization (CLAHE) and Histogram Equalization [2]. The histogram equalization is very common technique for image enhancement. Image enhancement is improving the visual quality of the images [3]. Image enhancement is shown in the following figure [4]:

Fig. 1 Showing image before enhancement and after enhancement

A. Discrete Wavelet Transform (DWT):

DWT decomposes the input signal into four parts with the use of the translation and dilation property. An appropriate wavelet function is chosen for decomposing the image. The 2-D DWT decomposition can be achieved by employing 1-D wavelet transform first along the rows and then along the columns on the resultant. The image is decomposed into four frequency bands and they are LL, LH, HL and HH.

B. Singular Value Decomposition (SVD):

Every real matrix can be decomposed into the product of three matrices [5]. Let A be any matrix then

$$A = U\Sigma V^T$$

where U and V are orthogonal matrices. Diagonal component of Σ are singular values of A, columns of U as left singular values of A and columns of V as right

DOI 10.17148/IJARCCE.2015.45130

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Vol. 4, Issue 5, May 2015

singular vectors of A [5].The singular value matrix is representing intensity information of the image and changes made on these values can change the intensity of the images.

II. LITERATURE REVIEW

Contrast Stretching Recursively Separated Histogram Equalization (CSRSHE) has been presented for preserving brightness and contrast image enhancement and it is a new technique [6]. Histogram Equalization has been widely used for grey-level images. It becomes difficult for color images to be enhanced by histogram equalization. Therefore, a new technique for enhancing the color images by using Histogram Equalization has been presented in which there are two hierarchical levels used: local and global [7]. The main drawback of histogram equalization is that the brightness of the image gets changed after applying histogram equalization. This is because of flattening property of histogram equalization. Moreover, histogram equalization is a global operation so the brightness is not preserved. Brightness Bi-Histogram Equalization (BBHE) has been introduced to overcome the shortcomings of histogram equalization [8]. In [9], a generalization of BBHE has been proposed which is known as recursive mean-separate histogram equalization (RMSHE). This provides better and scalable brightness preservation. A novel technique for color image enhancement is introduced in the compressed domain [10]. A new image enhancement technique for enhancing the satellite images has been proposed in [11]. In this approach, Discrete Wavelet Transform (DWT) and Singular Value Decomposition (SVD) have been used. The experimental results show that this technique is better than the conventional and state-of-the-art techniques for image enhancement. Image enhancement technique based on DWT SVD and DCT has been presented in [12]. In [13], satellite images are firstly enhanced by using DWT-SVD technique and then segmentation is applied on the enhanced using MRR–MRF Model. 3-level DWT technique for image enhancement has been implemented in [14]. In [5], a novel technique for image enhancement has been presented which is based on Cuckoo Search Algorithm and DWT-SVD. DWT is used to decompose the image into four sub-band images (LL, HL, LH and HH). Cuckoo Search Algorithm is applied for optimizing each sub- band and then singular value matrix of LL thresholded sub band image is obtained and finally image is reconstructed by using inverse discrete wavelet transform (IDWT). The experimental results show that this approach is better than conventional techniques and state-of-the-art techniques. An image resolution enhancement technique has been proposed in which discrete wavelet transform and stationary wavelet transform have been used [15].

III. PROPOSED WORK

In [5], Cuckoo Search Algorithm is used with DWT-SVD technique for image enhancement. This technique shows better results than conventional and state-of-the-art techniques. But there are some limitations of Cuckoo Search Algorithm. This technique shows low convergence rate [16, 17].

In the proposed work, I will use Bacterial Foraging Optimization Algorithm with DWT-SVD technique for enhancing the images. Bacterial Foraging Optimization Algorithm is proposed because it converges faster and it is a global optimization algorithm [18].

IV. APPLICATIONS OF IMAGE ENHANCEMENT TECHNIQUES

The image enhancement techniques are useful for many fields. The various fields in which image enhancement concept is used are agriculture, geology, weather forecast, education, forestry, remote sensing, fingerprint matching, etc. The application of image enhancement in remote sensing is very common and important. The different image enhancement techniques are used for converting low contrast satellite images into high contrast satellite images. Image enhancement techniques are useful in the fingerprint matching.

The frequency domain techniques are mostly used in remote sensing where low contrast remote images are enhanced. These techniques are widely used for fingerprint images enhancement.

V. CONCLUSION

Image enhancement is very vital for making images better and interpretable. Usually images contain noise or have low contrast. So they are difficult to understand and interpret. The image enhancement techniques are divided into spatial domain and frequency domain. But frequency domain techniques are better than spatial domain techniques. Now, more researches have been made in the frequency domain techniques. In the proposed work, Bacterial Foraging Optimization Algorithm is used with DWT-SVD for enhancing the images.

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ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
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