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Analysis of Various Image Preprocessing Techniques for Denoising of Flower Images

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Abstract— Identification, and classification of flower images is a crucial issue faced by academicians and researchers. The manual process to distinguish different flower images is a complex task and found difficult for novice persons. A process of extraction, analysis, and understanding of useful information from images is accomplished by an automated process using Computer vision. It basically aims to model, replicate and exceed human vision using computer hardware and software. Image processing techniques may help to recognize a flower image for further identification and classification of them in different species. The fundamental step in image processing is image preprocessing that is applied to improve the quality of images and removing the irrelevant noises existed in images. This paper represents a comparative analysis of different image preprocessing techniques implemented on flower images. The performance evaluation of these techniques is based on their potential to remove noise in flower images. For performance evaluation, Peak Signal to Noise Ratio (PSNR) and Root Mean Square Error (RMSE) methods are used.

Keywords—Image processing, Image preprocessing techniques, PSNR, RMSE

I. INTRODUCTION

In agriculture applications, image processing is having its significant importance. Moreover, one of the growing fields of image processing is floricultural image processing. There are various kinds of flower species available in the world. Each of them has its own characteristics and importance [1]. However, societies who know these flowers are not experts. Therefore, it is very hard for them to recall and differentiate the different flowers. Even an expert who has habituated himself with flowers for a long time sometimes cannot identify the flower correctly [2]. While applying image processing techniques on flower images, the first application is to identify the flower and to classify them an inappropriate way [3]. This classification can be done to identify the individual flower as well as flower category [4] [5]. The common approaches for flower detection comprise with various steps includes preprocessing, segmentation, feature extraction, and classification. Meanwhile, the outcome of each and every phase is the input of next phase, all phases have an essential role [6] [7].

Preprocessing is the essential phase for flower identification and classification. In this paper is divided into three section, section II is about the literature survey, section III is information of image preprocessing and their two phases: image enhancement and image restoration. Each phase includes different techniques elaborated in this paper. And section IV, a proportional analysis is available on various filters applied on flower images.

II. RELATED WORK

This section covers different image pre-processing techniques used and discussed by various researchers and authors in their papers. KIM (1997) [8] has discussed that the intensity of scene can be altered following the histogram equalization. The essence of the proposed algorithm is to conserve the mean intensity of an image while the contrast is enhanced.

An image enhancement algorithm under non-uniform lighting conditions for digital images is proposed by Saibabu et al. (2006) [9]. The proposed algorithm constitutes three problems, adaptive intensity enhancement, contrast improvement and color restoration. Cheng et al. (2012) [10] has worked upon detection of over- enhancement. The over enhanced areas located accurately and effectively as per shown in an experimental result. To optimize the parameter settings of the contrast improvement algorithms, the given method will be useful.

The contrast enhancement algorithm proposes by Chen et al. (2013) [11] combines two types of methods: histogram equalization based methods (HEBM) and a multi-scales un-sharp masking based methods (UMBM). To attain global contrast enhancement, the algorithm uses HEBM and to attain local multi-scales contrast enhancement, the algorithms use UMBM. Sundaram et al. (2014) [12] proposed technique for Histogram based contrast enhancement for mammogram images that provides better contrast enhancement with preserving the neighborhood information of the mammogram images.

Jaiswal et.al. [13] Worked with denoising of salt–pepper and Gaussian noise. Results of PSNR (peak signal to noise ratio) and MSE (mean square error) are calculated for analysis. Chandrika Saxena et.al [14] has presented a survey on Noises and Image Denoising Techniques. Different types of noises and filters for denoising images are covered in the paper. For an image having salt and pepper noise, the filtering approach has been proved to be the best. Images that are corrupted with Gaussian noise, the wavelet-based approach found the optimum. Meenal et al. [15] survey and analyzed different traditional image denoising method and suggested a new approach which provides a heterogeneous way for the challenging issue. Parmar J.M et. al. [16] proposed an image denoising method using partial differential equation. They proposed three different approaches for blur, noise and blur & noise. This paper discusses different types of noises and result of filters applied to denoise the images.

III. IMAGE PRE-PROCESSING TECHNIQUES

Image pre-processing is a fundamental step for noise removal and for enhancing the quality of an original image. The quality of raw flower image can be improved by removing unusual parts from the background of an image. The accuracy of this process can greatly improve by good selection of preprocessing methods. The available techniques considered in this paper for preprocessing stage for flower, which are shown in Fig. 1.

3.1 Image Enhancement

Image Enhancement is a significant process to recover the visual look of an image. It is provided for the "better" transform representation for the next phases of image detection [17] [18]. Image enhancement is characterized in three types:

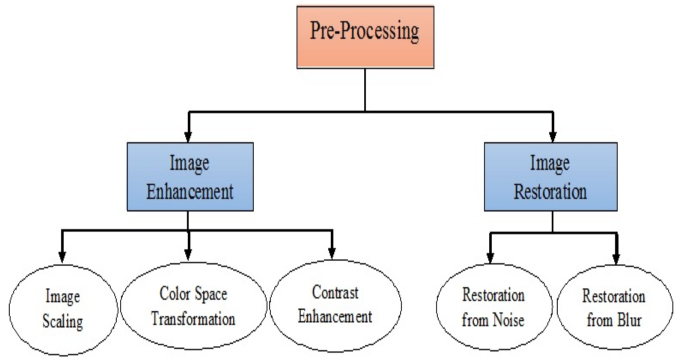


Figure 1. Techniques for preprocessing stage

3.1.1 Image Scaling

Due to the inconsistent size of images, scaling method is applied. Since the flower images are collected from various sources and sizes, so the initial phase is scaling the image and to fix pixel of height and width.

3.1.2 Color Space Transformation

The appropriate data of Color of an image plays an inevitable role in flower identification and classification, it is very much required to appropriate color of flower image for next processing. Commonly, RGB, HSV, HSI, LAB and YCbCr are the common color spaces available for transformation. The best frequent use of colors in image processing is RGB. It has been observed that, RGB color space has some restriction. Therefore, more color spaces have also been established. The purpose of applying Image processing on flower images is to gain the high level intensities to detect the edges of flower petals, it would convert the image into binary and gray-scale [19][20]. The Figure 2 shows the transformed image into gray-scale and binary using Matlab.

Figure2. (a) RGB image (b) Gray Scale image (c) Binary image

3.1.3 Contrast Enhancement

It is a crucial stage to improve the next processing steps. It can refine the boundary and increase the correctness by highlighting the clarity difference between the foreground and background of an image. In order to increase a quality of an image, it plays an essential role in flower image. The contrast enhancement techniques are further divided into two methods: Linear and Non-Linear contrast enhancement [21]. The following Fig. 3 display the linear contrast enhancement approaches.

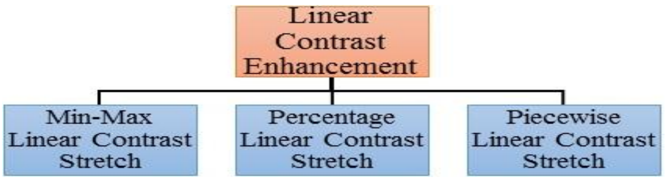


Figure 3. Linear Contrast Enhancement Methods

In Linear contrast enhancement method contrast stretching methods are used. The flower's image can be converted to higher contrast or stretching the gray-level values therefore the image of histogram is extended over the full range [21]. Fig. 4 shows the resulting images after applying linear techniques on flower image.

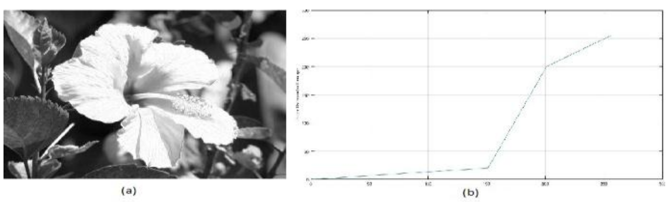


Figure 4. (a) Min-Max Linear Contrast Enhancement (b) Piecewise Linear Contrast Enhancement

On the other side, Non-Linear contrast enhancement method mostly deals with histogram equalizations and algorithms [22]. It avails the various values of outcome image against values of an input image, so, it is losing the brightness of a flower image. Another technique is Non-Linear enhancement illustrated in Fig. 5.

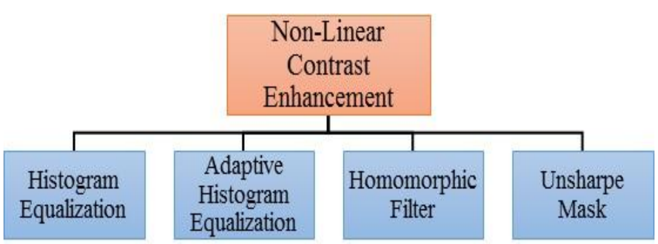


Figure 5. Non-Linear contrast Enhancement Methods

In flower identification using image processing, details of flowers are more important than global, therefore, three familiar enhancement approaches which are more appropriate are Adaptive Histogram Equalization (AHE), Unsharp Masking and Histogram Equalization (HE) [21][22][23][24]. The following Fig. 6 shows the resulting images after applying non-linear techniques on flower image.

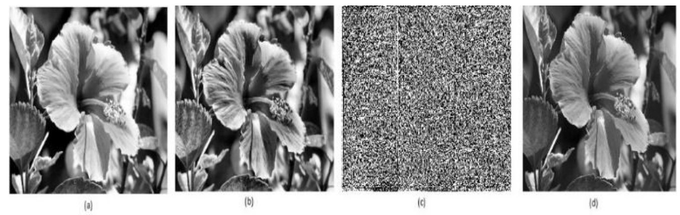


Figure 6. (a) Histogram Equalization (b) Adaptive Histogram Equalization (c) Homomorphic Filter (d) Unsharp Masking

3.2 Image Restoration

It is defined as the process to improve the degraded flower image from a noise and blur [25]. The flower image degradation can occur such as bad focusing, motion, imaging system, etc. [26]. These defects make an image usually blur or noisy [27]. To identify the presented noise in an image is necessary to select the most suitable denoising algorithm.

3.2.1 Image Restoration from Noise

It is a most important phase in preprocessing of a flower image. It is very challenging to apply for various kinds of noisy images. The important property of image denoising technique is to destroy the noise as well as maintaining the edges [28] [29]. The noises can be classified into four types Speckle, Salt and Pepper, Poisson and Gaussian [28] [29] [30] [31] [32].

During image acquisition, sometimes, a noise is added that is denoted as Amplifier noise or Gaussian noise. The example of such noise is a sensor noise occur by low light, high temperature, and transmission noise. Another type of noise is Salt & Pepper noise, often called as Spike noise, and it is always independent and uncorrelated to image pixels. It appears in form of sports, colored as black and white, on the images. Poisson noise corrupts the signal at different proportions and called as Photon noise. The effect of randomly ups and downs in the signal coming back from an object that is denoted by Speckle noise.

The different noises have been simulated in MATLAB 2017 – an image processing toolkit and the resulting images are shown in Fig. 7.

For removal of noise, many methods are available. The main techniques can be categorized into two such as Spatial Filtering and Transform Domain Filtering [36]. There are different filters are available like, Mean, Median, Wiener filter, Total variation filter. The explanation of more common Spatial filters are following [28] [29] [33] [34] [35] [36].

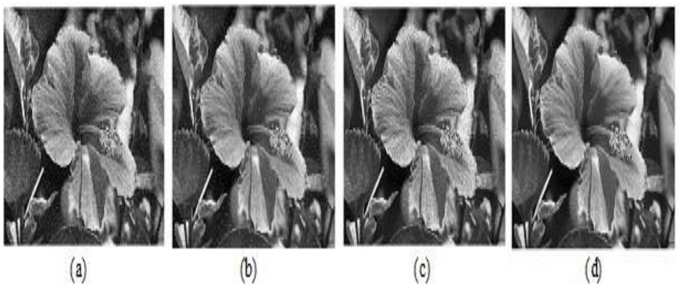


Figure 7. (a) Gaussian noise (b) Salt and Pepper noise (c) Speckle noise (d) Poison noise

• Mean filter: It perform fine with salt and pepper noise and Gaussian noise. While this filter decreases the noise, blur and sharp edges of the flower image. There are various types of mean filters which are describe as follow:

First is Arithmetic mean, it is the simplest of mean filter. It can uniform the noise and well with Gaussian noise. Second is Geometric mean, it can preserve the detail information of an image and enhanced then the arithmetic mean. Third is Harmonic mean, it works well with salt and Gaussian noise, but doesn't work fine with pepper noise.

• Adaptive filters: It use when the noise is white additive like Speckle and Gaussian noise. It can be divided in to two parts, First is Adaptive local noise reduction filter can be used for random noises. And second is Adaptive median filter which can preserve the details as smoothing non-impulse noise.

• Other filters:

Min and max filters can be used for the finding of darkest points contains by an image. In Median filter evaluation with mean filter is less sensitive to the maximum values. Without reducing the sharpness, it can remove the outlier of an image. It can be useful for salt and pepper noise. Another is Mid-point filter which is the finest for random distributed noises which speckle noise.

The next part of de-noising technique is Transform Domain Filtering, which is depended on wavelet transforms [38]. It is the prolonged form of Fourier transform [37]. Wavelets are well-defined as mathematical functions which analyze data based on resolution. There are various kinds of techniques available in Transform Domain Filtering such as VisuShrink, SureShrink, BayesShrink, Neighshrink, OracleShrink, Smoothshrink and LAWML [37].

3.2.2 Image Restoration from Blur

Blur is a type of image degradation that befalls by bad focusing or motion among camera and original image [39] [40] [42]. Wiener filter, Inverse filter, Neural Network Approach and Lucy-Richardson algorithm are the different techniques for de-blurring of an image [39] [40] [41] [42] [43]. In agriculture applications, Neural Network has been useful as one of the most great and mutual method which also remove the noise [40] [42] [43]. The Wiener filter has been performed in MATLAB 2017 – an image processing toolkit and the outcome is shown in Fig. 8.

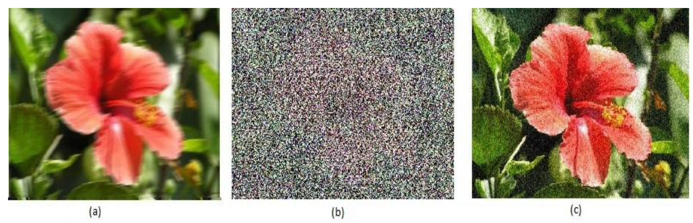


Figure 8. (a) Blur image (b) Restoration of Blurred image (c) Restoration of Blurred using Wiener filter

IV. RESULTS AND DISCUSSION

The implementation work is carried out using image processing toolkit - MATLAB R2017a. Performance analysis of four different filters, which process input image with four types of noises, is performed using PSNR and RMSE. These methods are the frequently used methods for performance evaluation of different filters applied on image [44] [45] [46].

There are two error metrics namely Mean Square Error and Peak Signal to Noise Ratio are used to compare image compression quality. The cumulative squared error between the compressed and the original image is represented through MSE. The other is PSNR, represents a measure of the peak error. The lower value of MSE presents the low error. The high value of the PSNR is the better the quality of the reconstructed image. The root-mean-square error is used a measure the differences between values predicted by a model [47] [48].

• MSE (Mean square Error): It is defined as some sort of average or the sum of the square of the error between two images.

$$MSE=1/(N*M)*sum\_\{I,J\}(X\_\{I,J\}-Y\_\{I,J\})^2$$

Where: (I, J) is the original image, Y (I, J) is the decompressed image, M, N is the dimensions of the image.

• PSNR (Peak Signal to Noise Ratio): It is defined as the ratio between signal variance and reconstruction error variance

$$PSNR = 20.\log_{10}(\max_1) - 10.\log_{10}(MSE)$$

Where: MSE - mean squared error, max1 is the maximum possible pixel value of the image.

• RMSE (Root Mean Square Error): It is defined as the square root of MSE.

$$RMSE = \sqrt{MSE}$$

Where: MSE - Mean square Error

For experimental purpose, the input images are corrupted by simulated Gaussian noise, Salt & Pepper noise, Speckle noise, Poisson noise. For denoising process, average (5x5), median (5x5), min (5x5) and max (5x5) filters have been used. For performance evaluation of above-mentioned filters, we calculate the values of PSNR and RMSE.

Table 1. PSNR

Types of Noise	Noise Variance	Types of Filters			
		Average Filter	Max Filter	Median Filter	Min Filter
Gaussian	10.592005	**12.064118**	11.860393	11.773188	10.196320
Salt & Pepper	10.662052	11.912949	11.729367	**11.925946**	10.304306
Poisson	10.312440	**12.189660**	12.162839	12.120395	11.479873
Speckle	10.582578	12.101204	**12.172813**	11.971927	11.469388

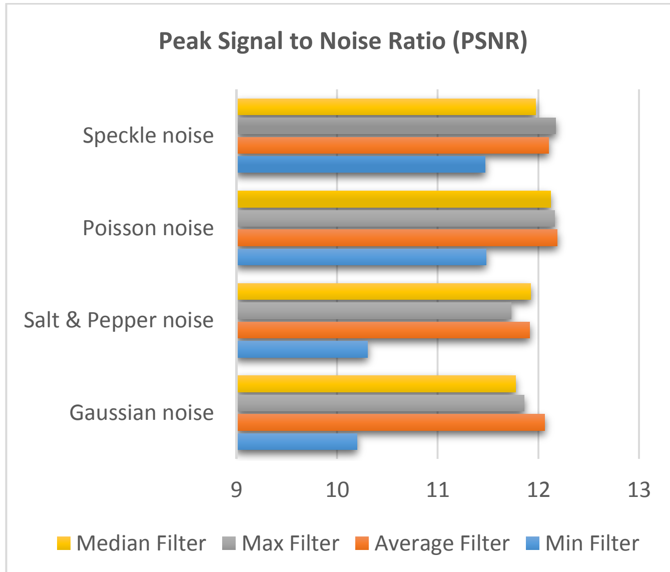
For the results represented in Table 1, as a parameter for performance evaluation of various denoising techniques, PSNR is used. In PSNR, the highest value is considered as best [47]. The high PSNR value is considered the selection of optimum filter for an image. The image with this value will be considered as an input for image segmentation stage.

Table 2. RMSE

Types of Noise	Noise Variance	Types of Filters			
		Average Filter	Max Filter	Median Filter	Min Filter
Gaussian	75.325139	**63.582012**	65.090940	65.747735	78.835930
Salt & Pepper	74.720127	64.698282	66.080271	**64.601544**	77.861882
Poisson	77.788994	**62.669640**	62.863450	63.171390	68.005891
Speckle	75.406932	63.311116	**62.791310**	64.260461	68.088035

For the results presented in Table 2, as a parameter for performance evaluation of various denoising techniques, RMSE is used. In RMSE, the lowest value is considered as best [48]. The low RMSE value is considered for the selection of optimum filter for an image. The image with this value will be considered as an input for image segmentation stage.

From the obtained results are shown using Histogram in Figure 9. It shows that the salt and pepper noise affected image is effectively denoised with a median filter so the outcome is low in PSNR and high in RMSE value. But, when compared to other noise like Poisson and speckle produces high PSNR value and low RMSE value. So it is observed that Median filter is not appropriate for Gaussian and salt and pepper noise. But it is appropriate for Poisson and speckle noise.



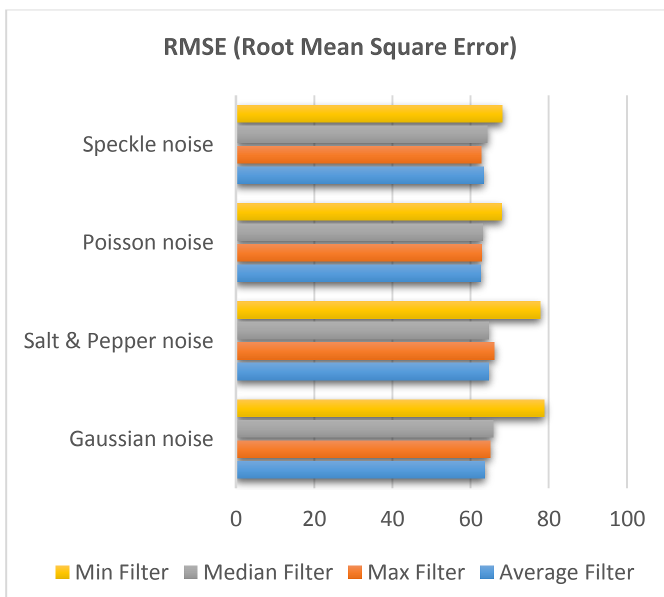


Figure 9. Histogram of PSNR and RMSE

So, it is clear from the above table 1 and table 2, that PSNR and RMSE values for the proposed approach are analyze the ratio of noise removal filter for the flower images. So, it also shows that which filter is better performed on noise [49]. Image preprocessing allows a various method to be applied on the flower image and can avoid problems such as the collection of noise and blur during processing [50].

V. CONCLUSION

This paper discusses the implementation details of different pre-processing techniques required for flower image processing. It has categorized the entire procedure into two divisions of Image Enhancement and Image Restoration. In both these methods, the techniques are used to improve the flower images and the different filters to eliminate the noise, blur and smoothing the images have been described. Moreover, performance evaluation is also discussed using PSNR and RMSE methods. This paper is beneficial for researchers who are working in the area of image processing.

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