SELECTIVE IMAGE ENHANCEMENT AND RESTORATION FOR SKIN CANCER IDENTIFICATION

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Abstract: Nowadays the skin cancer has become a more dangerous and an unpredictable disease among the humans. Nearly one million of people all over the world every year are been affected by the skin cancer and left with no treatment due to the lack of early diagnosis. Besides the usual types of cancer such as the melanoma, basal cell carcinoma and squamous cell carcinoma that could be identified easily there are certain types of unusual skin cancer such as the Merkel cell skin cancer that are rare and difficult to diagnose. As the identification of the Merkel cell skin cancer at the early stage would be very useful in deciding the necessary treatment for its cure, the paper has put forward preprocessing techniques to improve the image quality to make the further image processing procedure easy in the identification of the skin cancer. The proposed method applies the combined image enhancement and the restoration (CIEIR) on the input skin lesion images and makes it more presentable with the improved quality for the further image processing steps in the identification of the normal skin and the skin affected by the Merkel cell tumor. The CIEIR is implemented in the MATLAB and the parameters such as the PSNR, SSIM and the MSE are measured.

Keywords: Skin Cancer, Merkel cell skin cancer**,** Image Enhancement (IE), Image Restoration (IR), Fuzzy-Set Theory (FST), and Integrated Wiener Filter (WF+GF (gradient filter) +MF (median filter)).

1. INTRODUCTION

The image enhancement and the restoration are more prominent in computer graphics and are the sub areas of the image processing. The fundamental objective behind the image enhancements is to process the image to present it in a more suitable form compared to the original image [1]. In same way the primary objective behind the restoration is to restore the images that are been degraded [2] so the two process goes hand in hand with the aim of enhancing the image quality , so the image enhancement and the restoration (IR) are coined as "subjective and objective process" respectively. The image enhancement (IE) is referred as heuristic process designed to compute an image to provide a pleasing aspect to its observer with taking into consideration the degradation in it. Unlike IE the IR ensures the recovery of the original images from its degraded state by structuring the degradation with its prior knowledge and applying the inverse process of it. So the above two methods help in improving the quality of the

images that are to be subjected for the further processing such as the diagnosis of the disease, finger print identification, surface and the physical feature mapping of celestial bodies etc. Some of the techniques utilized in the IE are the contrast enhancement, histogram equalization, denoising, edge sharpening, red eye removal and the transformation from the grayscale to the pseudo-color and the techniques in aid of IR are, inverse filtering, wiener filtering, constrained least square filter, nonlinear filtering and the advanced restoration technique.

The proposed method aims in utilizing the image enhancement and the restoration in identifying the disease related to the skin especially the skin related cancer that are very rare and hard to diagnose. Despite the availability of the advanced methods in capturing of the images, still they are subjected to noise and the blemishes, making it hard to diagnose the actual information it is to reveal [10]. This is the case that exists in the most of the medical images, especially in the case of the images acquired from the Dermoscopy, the low contrast images with the indistinct borders and the skin lesion close to border makes it difficult to identify the type of the disease on the skin [11]. In particular skin cancers like Merkell cell skin cancer that is rare and tends grow quickly if not treated at the early stage, it becomes very hard to distinguish between the healthy and the affected area.

So the paper put-forwards the combined image enhancement and the image restoration (CIEIR) for the Merkell cell skin cancer identification at the early stage.

The paper organization is followed with 2 representing the related works on the image enhancement and the image restoration, 3 the proposed work, of image enhancement using the FST and the image restoration using the inverse filter, 4 the result and discussion, 5 conclusion.

2. RELATED WORKS

Sezn et al [3] the technique for the "automatic anatomically selective image enhancement in the digital chest radiography is proposed by the author for the automatic enumeration of the gray –level threshold between the lung field and the mediastinum". The anatomically selective gray –scale alteration or the un-sharp masking for the sharp edges are facilitated by the gray level threshold.

Shi,et al [4] the author puts forward a novel strategy of "character image enhancement using the neighborhood operator" the procedure of the "character image enhancement by selective region growing " is applied to both the images that are hand written as well as machine printed. The method insists on both the filling the gap checking the

overfilling and are implemented with the binary tree structure.

. Lagendijk et al [5] the author presents the closer view of the two algorithms for restoration the LSI restoration procedure followed by the adaptive restoration procedure that comprises of two strides in reducing the ringing (degrades the quality of the restores images in terms of the visual and the measurement) in the restored images by the prior constraint usage and the balancing between the noise amplification and the regularization error.

Figueiredo et al 6] the author proposes an "expectation maximization algorithm for the wavelet based image restoration.

Katsaggelos et al [7] the issues concentrate on the performance of the different restoration strategies available such as the restoration based on the ANN, non-stationary mathematical image models. , Restoration algorithm for the continuous blur parameter identification and the restoring of scanned photographic images

Irmak et al [8] the author presents the discussion of the image enhancement algorithms and the analysis of the same by subjecting them to the noisy images. The evaluation of the methods based on the comparison of the image quality based on the measure of the performance metrics PSNR and the MSE are also discussed in the paper.

Zhao, et al [9] the significance of the motivated losses when the images are to be evaluated by the human observers are projected in the paper and the alternative methods for the image restoration are brought into attention in the paper, further the author proposes the neural network based image restoration and highlights the enhancement in the loss function.

Joshi et al [10] the paper presents the diffusion based filtering strategies in identifying the spot and the noise in the medical pictures, the proffered procedure employs a SRD filter that is followed by latest filtering determination and utilizes the machine learning assistance and identifies the variation and the abnormalities.

Hu et al [11] the paper proposes the segmentation that combine the "enhanced fusion saliency with the adaptive threshold based on the wavelet transform is used to obtain the more accurate lesion regions.

Singh et al [12] the author explains the importance of the preprocessing technique that is to be applied to the images

before they are been subjected to the image processing tools through the "comparative study on the different genres of the image restoration techniques".

Kumar et al [13] the" image restoration based on wiener filtering for the noisy and the blur images of the real time application" is proposed in the paper.

Ali, et al [14] the author proposes the integration of the median filters into the inverse filters for the purpose of the noise removal and the blurring in that are found in the images, due to the conditions existing in the environment and the difference found in the atmosphere.

Sun, et al [15] the author explores the fuzzy set theory and the manifold algorithm for the appropriate identification of the green apples.

3. PROPOSED WORK

The Image enhancement and the Image restoration the subjective and the objective process respectively are utilized to enhance the quality of the image in a more presentable way by removing the noise and restoring the original image from its degraded state. So the proposed method utilizes the FST image enhancement algorithm [15] and the WF integrated with the gradient, median [12] filter image restoration algorithm in the prep-processing stage of the image processing of the skin lesion to improve the quality of the image and make it easier for the identification of the normal and the skin affected by the cancer cells. The fig.1 below shows the steps in the identification of the skin cancer using the image processing.

Fig .1 Steps in the Processing of the Image

The input image of the skin lesion has to be preprocessed for the removal of the noise and the blurriness in it before it's subjected to the next stage of the image processing. The paper concentrates only on the

preprocessing stage of the image processing procedures in the identification of the skin cancer cells. As the pre-processing stage is the very essential and the foremost step in the process of classifying the skin cancer, and as most of the paper concentrates mostly only in the enhanced type of the classifier used. The paper pays attention to the pre-processing stage to reduce the noise and the degradation in the image and improve the image appearance when subjecting to the further analysis to make the detection through the image processing easier. The fig.2 below shows preprocessing steps for the image quality improvement.
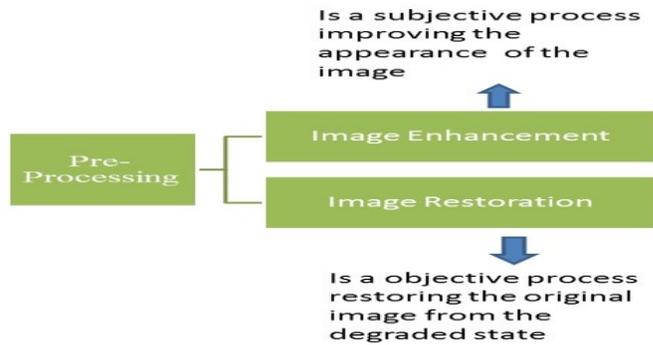

Fig.2. The stages in the Preprocessing

The paper puts forward the algorithm based on the FST for the image enhancement and the wiener filter algorithm for the image restoration to improve the quality and the appearance of the original image.

3.1. IMAGE ENHANCEMENT ALGORITHM USING THE FOURIER-SET THEORY

The image enhancement for the identification of the cancer cells initiates with the input images gathered from the Dermoscopy , the histogram of the images are manipulated , and further the computed image is transformed to the fuzzy layer using the equation given below in the equation (1)

$$\mu_{(g)} = \frac{g - gmin}{gmax - gmin} \tag{1}$$

Where $gmin$ is the minimum intensity and $gmax$ is the maximum intensity, the values of $gmin\ is\ set\ to$ 0 and

$gmax$ is set to 1 , the in-between values of $gmin$ and $gmax$ are acquired using the equation (1). Further alterations to the member ship functions are applied utilizing the equation (2) shown below

$$X(Y; i, j, k) = \begin{cases} 0 & Y < i \\ 2\left[\frac{Y-i}{k-i}\right]^2 & i \leq Y \leq j \\ 1 - 2\left[\frac{Y-k}{k-i}\right]^2 & j \leq Y \leq k \\ 1 & Y > k \end{cases} \tag{2}$$

And the boosted image is presented. The algorithm of the FST for the IE is presented below in the fig.3
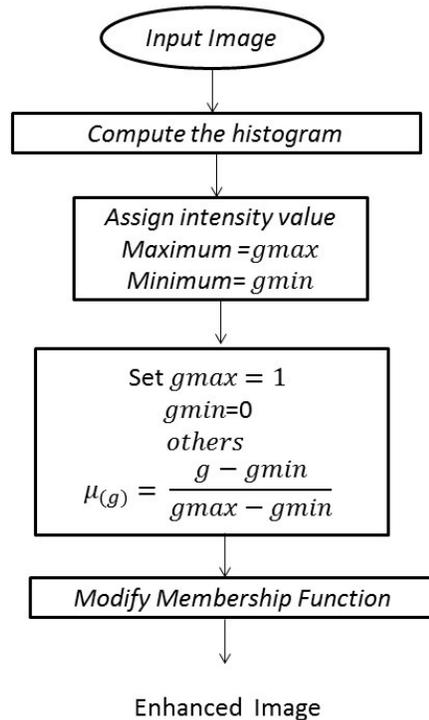

Fig .3 IE using FST

The boosted image with the enhanced image quality is received at the output whenever the next image is added to the input. The image enhancement just boosts the appearance of the original images, to further restores the images

from the degraded state and enhance the quality of the images the image restoration algorithm are used.

3.2. IMAGE RESTORATION ALGORITHM USING THE WIENER-FILTER

The image restoration for the purpose of the construction back of the degraded images is to improve the quality of the images utilizes the wiener filter integrated with the gradient , median filter (WGM-F), the algorithm below show the steps in the image restoration.

Step1: The output of the IE is fed into the WF for the removal of the degradation in the image due to the noise and the blurriness.

Step2: The WF concurrently inverts the blurriness, removes the random noise and restores the edges of the images. The designing of the WF is shown as in equation (3)

$$WF = \frac{d_f^* * snr}{Snr \, |d_f| + 1} \text{ , } d_f \text{ is the degradation function and the } d_f^* \text{ is its conjugate} \qquad (3)$$

Step3: The output of the WF is fed into the median (MF) for the removal of the salt and pepper noise and then into the gradient filter (GF) to identify the low frequency areas of the images and remove the noise in them, the magnitude of the GF is given as in the equation (4)

$$magnitude = \sqrt{gradient(X^2) + gradient(Y^2)} \qquad (4)$$

The images subjected to the triple filtering, is acquired in the output with the smooth images with the edges preserved and the diminished noise. The fig. 4 below shows the image appearance and the quality improvement of the skin lesion in the preprocessing stage applying the proposed method of Combined IE and the IR (CIEIR)
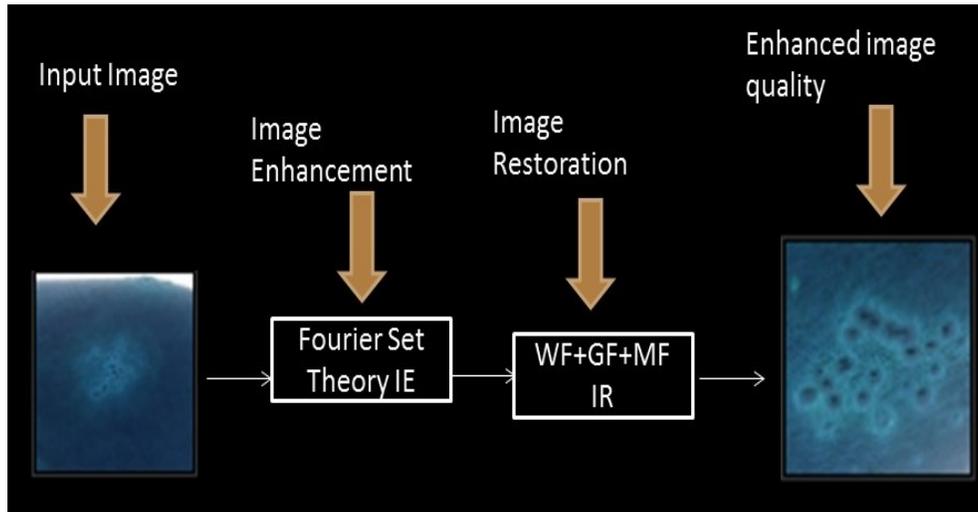
Fig .4 Enhanced Image Quality using the CIEIR

4. RESULTS AND DISCUSSION

The proposed method of combined IE and the IR (CIEIR) algorithm to enhance the appearance and the quality of the image in the preprocessing stage to make the disease diagnosis using the image processing easier is implemented using the MATLAB and the parameters such as the PSNR (peak signal to noise ratio), SSIM (Structure Similarity Index measurement) and the MSE (Mean square error) are measured and compared with the conventional methods of the IE (Conv-IE) and the conventional IR (Conv-IR). The table.1 below shows the comparison of the parameters for the different images set of the Merkel cell carcinoma skin cancer extracted from the public data bases dermis (http://www.dermis.net)and the dermQuest (http://www.dermquest.com).

Images	Conv-IE			Conv-IR			Proposed CIEIR		
	PSNR (db.)	MSE	SSIM	PSNR (db.)	MSE	SSIM	PSNR (db.)	MSE	SSIM
Image Set 1	25.12	108.45	.4654	27.26	101.14	.6544	29.19	79.14	.9658
Image Set 2	25.28	107.32	.4537	27.35	98.63	.6753	29.35	76.43	.9421
Image Set 3	26.34	106.21	.5431	28.45	85.21	.6185	29.04	78.26	.9901

Table.1 Comparison of Parameters

5. Conclusion

The preprocessing to improve the appearance and the quality of the images for the easy and the early identification of Merkel cell skin cancer is put forward in the paper. The paper concentrates mainly on the preprocessing stage and does the image enhancement utilizing the FST algorithm to enhance the appearance of the image followed by the Image restoration using the integrated wiener filter that includes the Wiener ,gradient, and the median filter to improve the quality of the images reducing the noise and the blurriness. This combined IE and the IR is implemented using the MATLAB and the parameter such the Peak signal-noise ratio, Structure Similarity Index Measurement and the Mean Square Error are measured to evince the competence of the CIEIR against the convention methods of the image enhancement and the restoration.

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