De-noising of Skin Cancer Images Using Wavelet Thresholding and Analysis of Statistical Performance Metrics

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Abstract - Current research is going on to detect the skin cancer from skin lesions using image processing methods. The skin cancer detection involves two basic steps namely, image de-noising and image segmentation. In any image, de-noising is important because image quality is degraded by noise. The process of filtering the noise is de-noising. This paper proposes a novel approach for de-noising of skin cancer images, which is performed using Bi-orthogonal wavelet, transform at different levels of decomposition. Adaptive thresholding method is implemented on noisy image, by adding Salt & Pepper noise to the actual image. The performance of the proposed method is evaluated using statistical performance metrics, like arithmetic mean, median, standard deviation, L1norm, L2norm and maxi norm.

Key words- De-noising, wavelet transform, Adaptive thresholding, statistical performance metrics, standard deviation.

I.INTRODUCTION

Skin cancer is also called skin neoplasm is unwanted growth of skin with different causes and varying degrees of malignancies. It can spread very fast to all organs /parts of the human body through lymphatic system or blood. Five common modules of skin lesions are Actinic Keratosis (AK), BasalCell Carcinoma (BCC), Melanocytic Nevus or malignant melanoma, Squamous Cell Carcinoma (SCC), Seborrhoeic Keratosis (SK)[1], in this paper we analyzed Basal Cell Carcinoma (BCC), Melanocytic Nevus or malignant melanoma and Squamous Cell Carcinoma(SCC). Medical image segmentation is a challenging task since poor image contrast, noise and missing boundaries. Basal cell carcinoma, squamous cell carcinoma and malignant melanoma are the three types of skin cancers. Malignant melanoma is the most dangerous form of skin cancer among the three. It develops when unpaired DNA damage to skin cells most often caused by ultraviolet radiation from sun or tanning beds triggers mutations that lead to the skin cells to multiply rapidly and form malignant tumors. The cancerous cells are located in epidermis, the top layer of the skin. In the early stages of melanoma, it seems harmless and no discomfort. Most of the people didn‘t found that a small mark on their skin could be a major sign. Melanomas often develop from moles, but may also arise from normal skin. The majority of melanoma marks are black or brown but they can also be colored like pink, red, purple, blue or white. Melanoma can occur in any organ, most commonly cutaneous melanoma arises from melanocytes that are found in basal layer of the epidermis, sebaceous glands and other structure[8].Melanoma can be found by learning about moles , which are common pigmented skin lesions that may be flat or raised. The two types of moles are ordinary moles and dysplastic nevi (atypical moles) and atypical mole can be examined thoroughly. It has an irregular shape grows horizontally with the epidermis and it appears in two or more shades in brown or pink color. Dysplastic nevi appears with flat edges with a 0.25 inches in diameter. In melanoma lesions melanocytes reproduce melanin at a high, abnormal rate. If melanoma is found at any early stage it can be easily removed. The main challenge is identifying the abnormal skin lesions which cause skin cancer. Basal cell carcinoma (BCC)[]is one of the malignant non-melanoma skin cancer. BCCs are abnormal, uncontrollable growth arise in the basal kernocytes which lies in the deepest layer of the epidermis. BCC is the most common type of skin cancer. BCCs look like pink growths, open sores, red patches shiny bums or scars and are usually caused by a combination of cumulative and chronic sun exposure and ionizing radiation. BCC can be seen on the face, particularly on the nose. Only in rare cases it spread to other parts of the body. By using proper lighting BCC can be detected in diagnosing the skin image. Squamous cell carcinoma (SCC)[]is an uncontrolled growth of abnormal cells arising in the squamous cells in the upper layer of the epidermis.SCC often look like open sores and red patches they may crust or bleed. Sometimes it increases rapidly and increased risk of organ transplant recipients. SCC mainly caused by cumulative ultra violet exposure in the summer months. Ultraviolet rays produced in the summer damage skin that leads to SCC.

This paper is organised as follows: In Section II Wavelet Transforms are discussed. Section III describes about the overview of Image Restoration methods of the effective filters and noises. Section IV is the results and conclusion of the paper.

II Wavelet transforms:

Wavelet can be implemented as a filter bank that use high pass filter H and low pass filter L. One dimensional signal can be decomposed some chosen frequency sub bands along the rows of the signal and two dimensional images into along the rows and columns in image. Different wavelets ψ and ψ are used in the decomposition process and the reconstruction process of bi -orthogonal wavelet transform composition besides two scale functions φ and φ̃ respectively. There are four filters in Bi-orthogonal wavelet transform.[5]

LL	LH
HL	HH

Wavelets decompose an image into orthogonal sub bands with low–low (LL), low–high (LH), high–low (HL) and high–high (HH) components which resemble to approximation, horizontal, vertical and diagonal respectively. LL sub-band: It consists of the coefficients that corresponding to low pass filter of rows and columns. LH sub-band: It contains wavelet results from low pass filtering of rows and high pass filtering of columns respectively. HL sub-band: It results in high pass filtering of rows and low pass filtering of columns. HH sub-band: It gives the results of both rows and columns after high pass filtering, which gives the diagonal details of images [4]. The Haar wavelet is the only orthogonal wavelet with linear phase, Bi-orthogonal wavelets feature a pair of scaling functions and associated scaling filters — one for analysis and one for synthesis [9].

III Image De-noising: The main characteristics of the medical images are unknown noise, poor image contrast, weak boundaries and unrelated parts will affect the medical images. This problem rectified by pre-processing techniques [2]. De-noising is the foremost step in image pre-processing. Gabor filter used for de-noising of mammogram images [5].De-noising of skin cancer color images were processed directly by using wavelet transforms. First, the original image was added with _salt &pepper noise‘ and then de-noised using adaptive thresholding technique.

Block diagram:

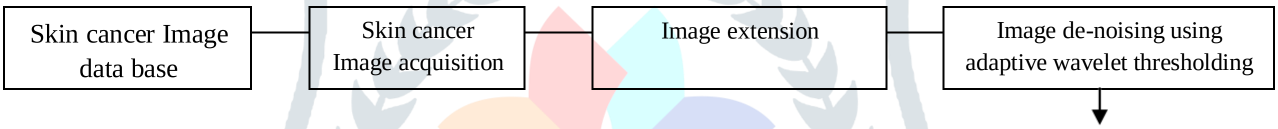

Fig. 1 Block diagram of proposed method

a) BCC image b) SCC image c) Malignant melanoma

Fig. 2 Examples of skin lesion images from the different classes used in this work

Methodology: Adaptive thresholding (dynamic thresholding) method contains image division into many overlapping sub images. The sub image histograms are constructed and then local thresholding values are obtained. Then the actual threshold value was obtained by interpolating the values of sub images. Actually this process takes lot of time to compute, but it was implemented using wavelet, gives better results.

Skin cancer detection involves different stages that include de-noising and segmentation..Image de-noising is the most important to remove noises and enrich the quality of the original image[6]. Skin lesion images were collected from skin cancer image data set. Basal cell carcinoma image was de-noised using bi-orthogonal wavelet with system generated threshold value. The original image was added with Salt & Pepper noise and then de-noised using Adaptive thresholding method.

Performance Metrics: In this paper statistical performance metrics were observed by using bi-orthogonal wavelet for system generated threshold values and adaptive threshold values.

The statistical performance metrics were mean, median, standard deviation, L1-Norm, L2-Norm, Maximum Norm. Mean is the average gray value

Mean $= \frac{\sum_{i=1}^{I}\sum_{j=1}^{J} x_{ij}}{I \times J}$ ----------------------------- (1)

Median $= \frac{x1+x2+ \ldots xi + y1+y2 \ldots yj}{I \times J}$ -------------- (2)

Standard deviation is a measure of contrast in the neighborhood.

Standard deviation $= \sqrt{\frac{\sum_{i=1}^{I}\sum_{j=1}^{J} (x_{ij} - M(n_i))^2}{I\ X\ J}}$ -- (3)

Maximum Norm $N(n_i)=\max(\sqrt{eig(xi\ X\ xi')}$ - (4)

Norm: Norm is a total size or length of all vectors in a vector space. The higher the norm is larger the vector. L1 norm is also called Least Absolute Difference (LAD)

L1 Norm $= \sum_{i=1}^{I} |y_i-x_i|$ --------------------------- (5)

L2 norm is minimizing the sum of absolute differences between the actual value and the estimated value. L2 norm is also called least squares. It is also named as mean squared error (MSE).

L2 Norm $= \sum_{i=1}^{I} (y_i-x_i)^2$ --------------------------- (6)

IV Results: In this paper bcc1 image was processed through Bi-orthogonal wavelet, with Adaptive Thresholding at 5 different levels of decomposition in presence of _Salt &Pepper' noise.

Table1: Performance metrics of original image with fixed threshold values.

Performance metric/Level	Level 1	Level 2	Level 3	Level 4	Level 5
Mean	**$9.83e^{-06}$**	**$1.971\ e^{-05}$**	**$2.214\ e^{-05}$**	**$2.468\ e^{-06}$**	**$2.168e^{-05}$**
Median	**$1.526\ e^{-05}$**	**$3.0526\ e^{-05}$**	**$3.052\ e^{-05}$**	**$3.052\ e^{-05}$**	**-0.01045**
Standard Deviation	**2.237**	**2.617**	**2.706**	**2.708**	**2.836**
L1 –Norm	**$1.372\ e^{+06}$**	**$1.592\ e^{+06}$**	**$1.643\ e^{+06}$**	**$1.658e^{+06}$**	**5.664^{+05}**
L2-Norm	**2329**	**2730**	**2828**	**2852**	**1441**
Maxi-Norm	**7.503**	**11.04**	**12.51**	**12.73**	**12**

Table2: performance metrics of de-noised image using Adaptive thresholding method in presence of noise.

Performance metric/Level	Level 1	Level 2	Level 3	Level 4	Level 5
Mean	**$9.952e^{-06}$**	**$1.9993\ e^{-05}$**	**$2.227e^{-05}$**	**$2.468\ e^{-06}$**	**0.2017**
Median	**$1.526\ e^{-05}$**	**$3.0526\ e^{-05}$**	**$3.052\ e^{-05}$**	**$3.052\ e^{-05}$**	**0**
Standard Deviation	**1.99**	**2.349**	**2.44**	**2.463**	**2.637**
L1 –Norm	**$1.24\ e^{+06}$**	**$1.446\ e^{+06}$**	**$1.496\ e^{+06}$**	**$1.511e^{+06}$**	**1.632^{+06}**
L2-Norm	**2095**	**2474**	**2570**	**2593**	**2801**
Maxi-Norm	**6.669**	**9.96**	**11.39**	**11.7**	**12.69**

Table3: Comparison of Standard Deviation with fixed and adaptive threshold values:

Level	Fixed threshold value	Standard Deviation	Adaptive threshold value	Standard Deviation
1	5.002	2.237	4.706	**1.99**
2	4.725	2.617	4.402	**2.349**
3	4.422	2.706	4.075	**2.44**
4	4.097	2.708	3.719	**2.508**
5	3.743	2.836	3.325	**2.637**

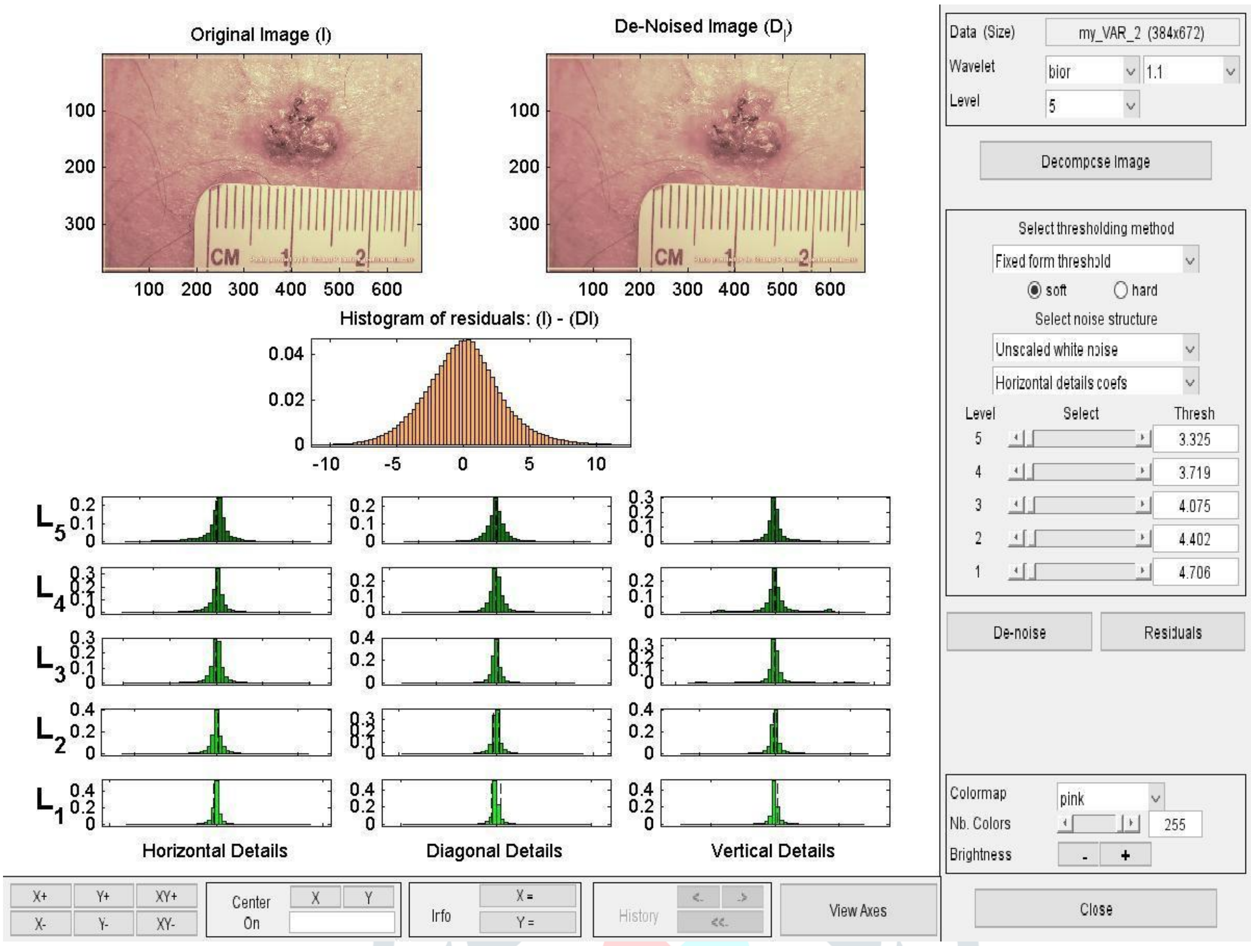

Fig. 3 Output of De-noised Image

Conclusion:

In this paper de-noising of skin cancer images was performed directly by using Bi-orthogonal wavelet transforms. If the image size was small, then image extension operation was performed. The original image was added with ‗salt & pepper noise' and then de-noised using two various techniques. For de-noising of skin cancer image bi-orthogonal wavelet was used with two type's thresholding methods. In first method fixed threshold values are directly applied where as in Adaptive thresholding method values were manually applied. ‗Standard Deviation' was compared for two methods, however proposed method performed well in performance metrics.

References:

1. Lucia Ballerini, Robert B. Fisher, Ben Aldridge, Jonathan Rees,‖ A color and texture based hierarchical K-NN approach to the classification of non-melanoma skin lesions‖ - 2013/01/01,VL - 6,DO - 10.1007/978-94-007-5389-1_4

2. R.Ramani,Dr.N.SuthanthiraVanitha,S.Valarmath,
―The Pre-Processing Techniques for Breast Cancer Detection in Mammography Images‖ International Journal of Image, Graphics and Signal Processing, 2013, 5, 47-54 Published Online April 2013 in MECS DOI: 10.5815/ijigsp.2013.05.06

3. http://www.mecs-press.org

4. Yogendra Kumar Jain, Indira Megha Jain,‖ Comparison between Different Classification Methods with Application to Skin Cancer‖. International Journal of Computer Applications (0975-8887) Volume 53-No.11,September2012.

5. Baochen Jiang1, 2, Aiping Yang1, Chengyou Wang2 and Zhengxin Hou1‖ Implementation of Bi- orthogonal Wavelet Transform Using Discrete Cosine Sequence Filter ― International Journal of Signal Processing, Image Processing and Pattern Recognition Vol. 6, No. 4, August, 2013. 6.MunibaAshfaq,NasruMinallahZahidUllah ,Arbab Masood Ahmad , Aamir Saeed and Abdul Hafeez by ― Performance Analysis of Low-Level and High-Level Intuitive Features for Melanoma Detection‖. Electronics 2019, 8, 672.

7. Lucia Ballerini, Robert B. Fisher, Ben Aldridge, Jonathan Rees, ―Non-melanoma skin lesions classification using colour image data in a hierarchical K-NN classifier‖, funding project(grant no: 083928/Z/07/Z

8. www.gannett.cornell.edu 9.https://in.mathworks.com/help/images/image- segmentation.html.