Identifying suitable enhancement technique for thermal and non thermal diabetic foot images

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ABSTRACT : Image processing plays a vital role in disease diagnosis, treatment planning and monitoring. The Images acquired by various modalities like MRI(Magnetic resonance imaging), ultrasound , x-ray, PET(Positron emission tomography) are all to be processed to extract information that are crucial for diagnosis and treatment. The noise removal and contrast enhancement are the key steps in preprocessing of an image which make the image suitable for further processing. This paper probes the suitability of contrast stretching and histogram equalization methods of image enhancement techniques for thermal and non thermal diabetic foot images. Thermal and non thermal Images of diabetic and normal foot are taken filtered and enhanced. The SNR(signal to noise ratio) is then calculated to find the suitable method of image enhancement for thermographic, non thermographic diabetic foot images. The results obtained show that contrast stretching is giving better SNR(signal to noise ratio) for thermographic diabetic foot image where as histogram equalization is superior in performance in case of non thermo graphic diabetic foot image enhancement.

Key words: Diabetic foot-,Thermographic,Non thermographic ,Contrast Limited Adaptive Histogram Equalization (CLAHE), Contrast stretching ,Signal to noise ratio(SNR).

I. INTRODUCTION

The difference in visual properties that makes an object (or its representation in an image) distinguishable from other object is known as contrast. In the visual perception of real world, contrast is determined by the difference in the colour and brightness of the object. The principal objective of enhancement is to process an image to achieve reliable results. Histogram is defined as the graphical distribution of pixels over the luminous intensity. In statistics, a histogram is a graphical representation of the distribution of data. It is the estimatation of the probability distribution of a continuous variable. The histogram equalization is an approach to enhance a given image. Contrast stretching increases the dynamic range of the gray levels in the image.Thermography is a procees of printing or imaging method that uses heat to create an image. The imaging method thermographic imaging captures infrared energy emitted by the subject. Medical Thermography (digital infrared thermal imaging - DITI) is the method for early pre-clinical diagnosis and control during treatment of homeostatic imbalances.

Active thermography is an effective tool for non-destructive evaluation. It includes modulated (lock-in) or pulsed thermography, Thermography is a non-invasive, non-contact tool that uses the heat from our body to aid in making diagnosis of a subject under investigation and is completely safe and uses no radiation.

II Literature survey

M.Aarthy.etal[1],described three different techniques of expansion namely dynamic range expansion, linear contrast expansion and symmetric range expansion.Each of these has their specific strength and weakness. For colored images linear contrast expansion is used. These all methods help in easy study of histograms and helps in image enhancement. Salem Saleh Al-amri.etal[2], attempted to undertake the two types of the contrast enhancement techniques, linear contrast techniques and non-linear contrast techniques. In linear contrast techniques applied three methods, Max-Min contrast method, Percentage contrast method and Piecewise contrast technique. Non-linear contrast techniques applied four contrast methods, Histogram equalization method, Adaptive histogram equalization method,Homomorphic Filter method and Unsharpe Mask. Raman Maini.etal[3], provided an overview of underlying concepts, along with algorithms commonly used for image enhancement. They focused on spatial domain techniques for image enhancement, with particular reference to point processing methods and histogram processing. Almar Klein[4],addressed the problem of aligning the images of feet taken at different instances in time. They proposed to use keypoints to find the geometric deformation between two photo‘, then have a set of landmarks for each image.By finding the corresponding landmarks (i.e. matching the keypoints),They know the deformation in a sparse set of points.Using these points, calculated a B-spline deformation model, which allows us to describe the deformation in every point in the image. Sanjeev Kumar.etal[5], proposed with contrast enhancement of X-

Ray images and presents here a new approach for contrast enhancement. Comparative analysis of proposed technique against the existing major contrast enhancement techniques has been performed. Here, the results of each technique were illustrated for various backgrounds, majority of them in poor lighting condition. . S. Srinivasan[6], described a real time contrast enhancement technique for digital video applications.This method called ACE is based on a modified histogram equalization procedure that adapts to the input video statistics. The method decides whether to increase dynamic range or to light up dark regions of the image. Mrs. Pallavi Mahajan.etal[7],proposed the state of the art of image processing techniques to detect the thyroid gland disease non- traumatically using Thermograph. Thermal Imaging is a technology that creates analyzes images by detecting the heat radiating from an object. They have proposed a system to detect the thyroid gland disease using thermograph.C.Ibarra-Castanedo.etal [8],proposed raw images are not often appropriate since most will be missed. In some other cases, what is needed is a quantitative analysis such as for defect detection and characterization. Presented was made of various methods of data analysis required either at preprocessing and/or processing of thermo graphhic images.

In this work tells about the novel method of identifying the enhanced methods for thermal and non thermal diabetic foot images.

III Methodology

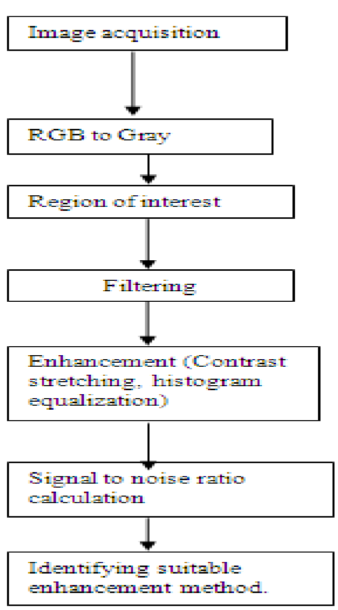


Fig1: Flow diagram

Thermal and non thermal diabetic foot images are taken for analysis. The color images are converted to gray. The region of interest (ROI) is then selected. The ROI must have at least 600 to 1200 pixels to get reliable results. Different enhancement techniques like contrast stretching, histogram equalization are applied for both thermo graphic and non thermo graphic foot images. The ROI of these images are taken and the signals to noise ratio values are then calculated. The calculated signal to noise ratio values of the filtered images by different enhancement techniques have been compared to analyze the performance of the contrast stretching and histogram equalization for thermographic and non thermo graphic diabetic foot images.

The formulae of Contrast stretching Histogram equalization and SNR are as follows:

Histogram: $\sum_{i=1}^{k} m_i$…………………..(1)

n be the total number of observations and k be the total number of bins, the histogram m_i

Contrast stretching:

New_value=[(Old_value-Min_value)/(Max_value-Min_value)]*255………………………..(2)

Signal to noise ratio:

SNR= $\frac{P_{signal}}{P_{noise}}$ …………………………………..(3)

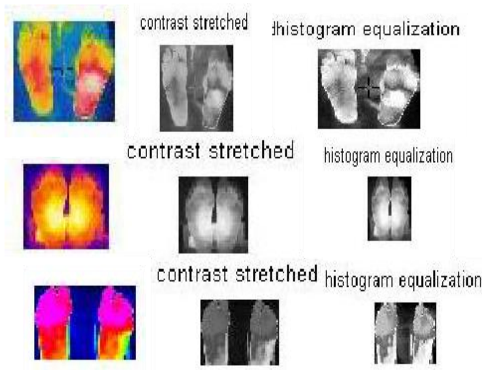
where P is average power. Both signal and noise power must be measured at the same or equivalent points in a system, and within the same system bandwidth.

IV Results

S.NO	Images	SNR(signal to noise ratio)	
		Contrast stretching	Histogram equalization
1	Thermo graphic diabetic foot1	14.0772	10.6510
2	Thermo graphic diabetic foot2	13.45	9.34
3	Thermo graphic diabetic foot3	15.56	11.78
4	Non thermal diabetic foot1	10.56	15.654
5	Non thermal diabetic foot2	9.80	13.67
6	Non thermal diabetic foot3	11.78	14.56

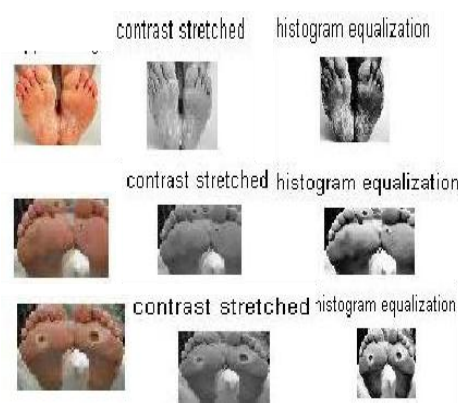
Table1:Signal to noise ratio of contrast stretching and histogram equalization

Fig2(i): Thermal diabetic foot (ii) contrast stretched diabetic foot image (iii)histogram equalization of diabetic foot image



2 (i) 2(ii) 2(iii)

Fig3(i): Non thermal diabetic foot image (ii) contrast stretched diabetic foot image (iii) histogram equalization of diabetic foot image



3(i) 3(ii) 3(iii)

Figure 2(i) shows the thermal diabetic foot image,Fig2(ii) shows the contrast stretched thermographic diabetic foot image and fig 2(iii) shows the histogram equalization of thermal diabetic image . Figure 3(i) shows the non thermal diabetic foot image,Fig3(ii) shows the contrast stretched non thermo graphic diabetic foot image and fig 3(iii) shows the histogram equalization of non thermal diabetic image.

Table1 shows the Signal to noise ratio values of the thermal and non thermal diabetic foot images using different enhancement techniques.

V. Discussion

Three set of thermal and non thermo graphic diabetic foot images are taken for experimentation. A region of interest is identified in each sample and various enhancement methods are used to enhance this region of interest. Signal to noise ratio values are found for the enhanced images.

The results tabulated in Table-1 show that the contrast stretching method of thermo graphic diabetic foot is having better signal to noise ratio value compare to other enhancement method i.e: histogram equalization is having lower signal to noise ratio value. For the non thermo graphic diabetic foot the signal to noise ratio for two enhancement methods are following reverse pattern i.e: contrast stretching is less and for histogram equalization it is higher. From the tabulated signal to noise ratio results it is seen that of two enhanced methods considered here the contrast stretching results in higher signal to noise ratio while enhancing the thermo graphic diabetic foot image and for non thermo graphic images histogram equalisation gives higher SNR. Hence contrast stretching is superior to histogram equalisation enhancement method in case of thermo graphic foot image processing where as histogram equalisation enhancement method performs better than contrast stretching in the case of non thermo graphic diabetic foot images.

VI. Conclusion

The proposed method is tested on three sets of thermo graphic and non thermo graphic diabetic foot images. The results obtained show that the thermo graphic diabetic foot is having higher signal to noise ratio for contrast stretched enhancement method compared to the histogram equalization method. It is found that the contrast stretched enhancement method for thermo graphic diabetic foot image properly enhanced. Whereas histogram equalization method is having signal to noise ratio is lesser compared to contrast stretched method. In non thermo graphic diabetic foot image the signal to noise ratio values for both the enhancement methods are following reverse pattern compared to thermo graphic diabetic foot image i.e., histogram equalisation enhancement method performs better than contrast stretching in the case of non thermo graphic diabetic foot images. Hence contrast stretching is superior to histogram equalization enhancement method in the case of thermo graphic foot image processing where as histogram equalization enhancement method performs better than contrast stretching in the case of non thermo graphic diabetic foot images.

However more samples of thermo graphic and non thermo graphic diabetic foot images are to be tested to know about the accuracy of the proposed method.

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