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Noise Removal in Thermal Image for Skin Disease Detection

Jay Prakash[1]
[1]*Department of EDT, NIELIT, Aurangabad, Maharastra-431004, India*

Abstract: A new approach is proposed to distinguish the disease of skin from thermal camera imaging. The thermal camera captures the temperature distribution of skin and is employed in various medical applications. The method is based on the disease detection with self- organized neural network and features of the disease image. As the thermal images are more affecting with noise, so in this paper we present an algorithm to remove the noise present in the image. In thermal camera imaging, the selection of filter depends on the purpose of the processing, e.g. edge detection or detection of objects in complex images. Noise filter processes are proceeding in two steps. First detect the noise of the thermal image and second detecting only the noise affected point of the image and use noise removal technique for noise separation from thermal image. In this paper we are using Fast Median Base Filter to detect noisy pixels. This process is fast as compare to normal filter. The performance of filter was evaluated using peak signal to noise ratio and mean absolute error. The experimental results are shown from the similar types of skin disease database.

Keywords: Thermal Image, Skin Diseases, Kurtosis, Skewness, Entropy, ANN

I. Introduction

Thermal camera imaging is used now a day in many fields of life where new applications are developing. The application of Thermal camera imaging is in military, industry automotive and medicine. One of the most useful industrial applications of infrared (IR) imaging is NDT (Non Destructive Testing) of materials [1] and recent automotive is night vision system based on human detection and tracking. Another example of IR images is medicine, e.g. the measurement of the human body temperature [2].

In many research works it is observed [3, 4, 5], the main factor which influences the quality of images is the presence of noise. It is desired for the thermal images that the signal-to noise ratio and the contrast are low. The excess of these two things make the processing of images are difficult. So, the main aim of our work is to remove the noise from the acquired thermal image and remove the noise from the image, which gives more accurate result. In this paper, IR images are used in medicine dieses recovery process and classified types of skin infection also. Artificial neural networks (ANN), designed much like biological neural networks, have been used widely for pattern recognition problems. Properly trained ANN can be used to generate accurate output for new sets of inputs reliably.

II. Methodology

The method follows the steps of Pre-processing (noise detect and remove), segmentation feature extraction, classification and then evaluation. First of all load the input thermal image in Matlab workspace. The Channel does not recognize boisterous pixels from normal pixels and procedures each pixel. The Primary aim is to reduce computational load. One of the approaches to accomplish registering over-burden is to identify the clamor pixels before playing out any noise removal. The key indicate is the means by which recognize noise pixels wisely. To distinguish noise pixels in IR pictures, one must consider the imaging component of IR pictures. The imaging mechanism is derived based on the heat radiation law and heat conduction law. The heat radiation implies dim level of pixels has a positive association with the temperature of the protest surface. The heat conduction implies that the temperature of the protest changes monotonically on a surface. The pivotal property of the IR imaging system is that the dark level of flag pixel of a protest changes monotonically in IR pictures.

Fast Median Base Filter is developed based on this significant property of the IR imaging mechanism to detect noisy pixels. In the proposed approach, the method to discover median gray level is performed by the sort calculation with a low calculation many-sided quality. In the segmentation, we make utilization of the way that warm imaging grabs the skin temperature and consequently utilize a skin recognition strategy on the visual picture. The shades of human skin possess just a little locale in shading space. In the feature extraction, the co-occurrence grid is built in view of the introduction and separation between picture pixels. Using this co-occurrence matrix, the texture features Metrics are computed in terms of mean Entropy contrast, Skewness and kurtosis. After it we used a feed forward feed-forward back propagation Neural Network (NN)) with adaptable learning rate. When the neural training is preceded, simultaneously measure the PSNR. The sensitivity, specificity, and accuracy are calculated for ANN classification for training and testing set. Observe the testing result, Compare it with the training (reference) result and evaluate any type of skin disease is present or not. The below fig shows the block diagram of the system

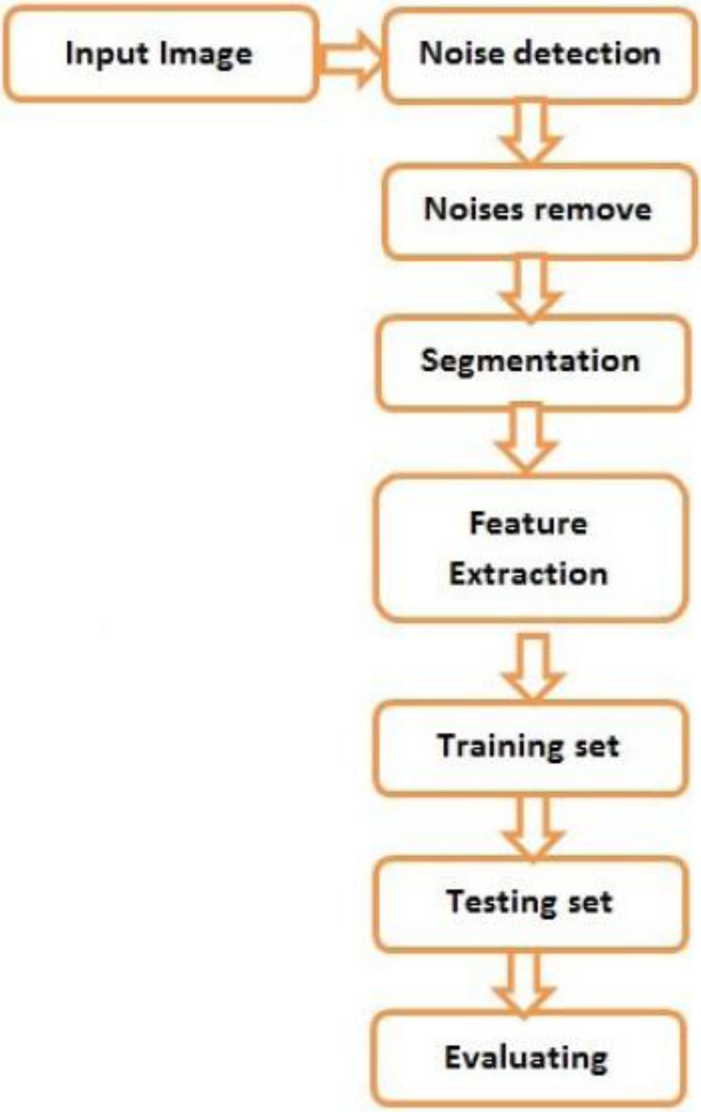

Figure 1 Block Diagram of the system

A. Noise Detection

As per the law of imaging mechanism law of Infrared image, the change in the gray level of the image monotonically, result in an properties: if the gray-level value equal to maximum or minimum gray level value, inside the filter, the central position pixel will be noise pixel otherwise it considered as noiseless pixel. The noise detection algorithm to find noisy pixels in images, based on two steps. First, the noise detection method is used to find the maximum and minimum gray-level inside the filter window. Next, the algorithm checks, the gray-level g(x,y) with minimum(gmin) and maximum(gmax) value of gray-level, to consider whether the pixel p(x,y) is noise or signal. This noise detection can be performed in the following steps.

Step 1. Evaluate the maximum and minimum gray-level inside the filter window.
gmax = Argument(max{g(x,y)})

gmin = Argument(min{g(x,y)})

Step2. Check gray-level g(x,y) with gray-level gmin and gmax to determine whether the pixel p(x,y) is noise or signal.

{
If g(x,y) = gmin or gmax
p(x,y) is a noise
Otherwise
Signal pixel
}

B. Noise Removal

As indicated by the property of IR imaging mechanism, the pixel with median gray level inside the window is received replacing the noise pixels. In the proposed approach, the method to discover median gray level is performed by the sort calculation with a low calculation many-sided quality. Furthermore, it just procedures the noisy pixels, yet not the flag pixels. Sorting is the fundamental calculation of the noise removal, so with a specific end goal to accelerate the noise removal, diminishing the computational load is basic. This study adopts a sort algorithm with low computational load. The complexity described as

Complexity = O (m log p(R))

Where m is the number of data, p is the number of digits; R is the range of the digit. Thus in the proposed approach, a Radix sort algorithm with suitable p and R is selected to sort the pixel gray-level.

C. Segmentation

As the overlay is accomplished through utilization of a power based picture enlistment calculation, foundation of warm pictures taken in a temperature controlled lab is conspicuous difference an unmistakable difference to the patient's body warm a similar complexity must be accomplished for the visual picture. That is, the foundation should be isolated from the closer view (i.e. the patient). In our approach we make utilization of the way that warm imaging grabs the skin temperature and consequently utilize a skin recognition strategy on the visual picture. The shades of human skin possess just a little locale in shading space.

D. Features Extraction

The texture is the fascinating picture feature that has been utilized for the characterization of image, a noteworthy normal for the texture is the redundancy of an example or examples over a locale in a picture. The components of examples are once in a while called sextons. The size, shape, shading and introduction of the Textron's can change over the district. The distinction between two surfaces can be in the level of variety of the sexton's. It can likewise be because of spatial measurable dispersion of the Textron's in the picture. The surface is a natural property of essentially all surfaces, for example, blocks, textures, woods, papers, floor coverings, mists, trees, terrains, and skin. It contains essential data with respect to hidden auxiliary course of action of the surfaces in a picture. The surface investigation has been a dynamic territory of research in example acknowledgment. An assortment of procedures has been utilized for measuring textural closeness. The Proposed co-event lattice portrayal of surface elements is used to scientifically speak to the dim level spatial reliance of surface in a picture. In this strategy, the co-occurrence grid is built in view of the introduction and separation between picture pixels. Using this co-occurrence matrix, the texture features Metrics are computed as follows: mean Entropy, Skewness and kurtosis.

a. Mean

The mean of a set of data is equivalent to the arithmetic average of all the values present in the data set,

$$\text{Mean}=\frac{\sum_{i=1}^{N} Xi}{N}$$

b. Entropy

It is the amount of information which must be coded for by a compression

$$E= -\text{sum}\ (x_i.*\log2\ (x_i))$$

c. Skewness

Skewness is the measure of the degree of asymmetry exhibited by the data.

$$\text{Skewness} = \frac{3(\text{mean} - \text{median})}{\text{Standard Deviation}}$$

The Skewness value can be either positive, negative or even it can be undefined. In digital image processing, darker and glossier surfaces are positively skewed than lighter and matte surfaces. [6]

d. Kurtosis

In digital image processing kurtosis values are interpreted in combination with noise and resolution measurement. Kurtosis is given as follows: [6]

$$\text{Kurtosis}=\frac{\sum_{i=1}^{N}(Yi-\bar{Y})^4/N}{S^4}$$

Kurtosis characterizes the relative peak or flatness of a distribution compared to the normal distribution.

e. PSNR

It is known as Peak signal-to-noise ratio. PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation.

PSNR=$10\log_{10}$ (R^2/MSE), Where MSE is the mean square error.

E. Artificial Neural Network

We used a feed forward feed-forward back propagation Neural Network (NN)) with adaptable learning rate. The Neural Network (NN) has three layers: an input layer (6 neuron), a hidden layer and output (1 neuron) layer. The activation function used is the tan sigmoid function, for both the hidden and the output layer. The input to the neural network is the feature vector component of image; the NN has only one output.

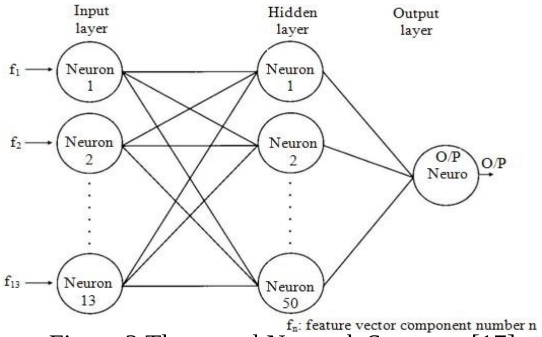

Figure 2 The neural Network Structure [17]

F. Training

When the neural training is preceded, simultaneously measure the PSNR and MSE, which is a well-known metric for quantitatively evaluating image restoration quality and the perceptual quality to check the progress of learned reconstruction results. Even though, the PSNR measurement is a very suitable metric toward what we aim to learn, it is not easy to be used as the objective function, because of differentiable matters. According to these terms the clinical performance of a classification is described where sensitivity, specificity, and accuracy are calculated for ANN classification through the following equations. Fig 3 shows software simulation box in Matlab.

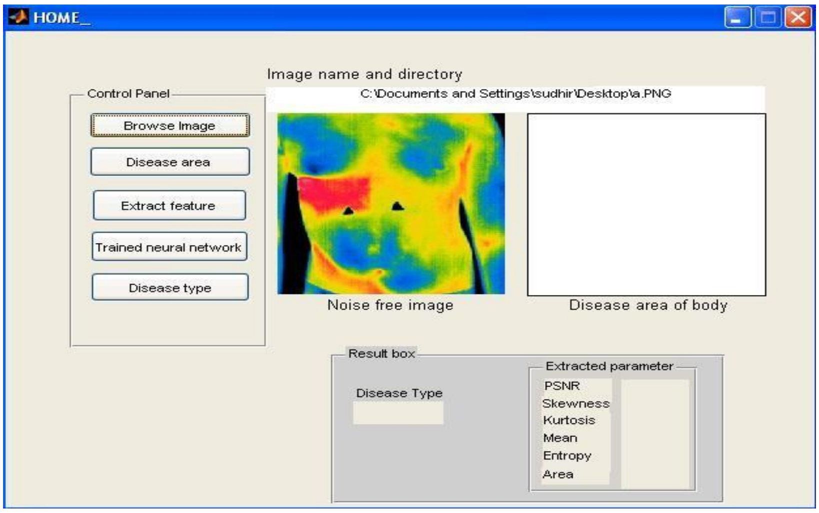

Figure 3 Software Simulation Box

$$\text{Sensitivity} = \frac{TP}{TP+FN} * 100\%$$

$$\text{Specificity} = \frac{TN}{TN+FP} * 100\%$$

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FN+FP} * 100\%$$

Where, TP- true positive, TN-true negative, FP-false positive.

III. Results and Discussion

By utilizing Fast Median Base Filter noise detection and noise removal is performed by sorting with bit-plane decomposition, which effectively decreases the computational load for noise reduction. ANN compares the feature of thermal image and gives the more accurate disease result as compare to the normal camera image.

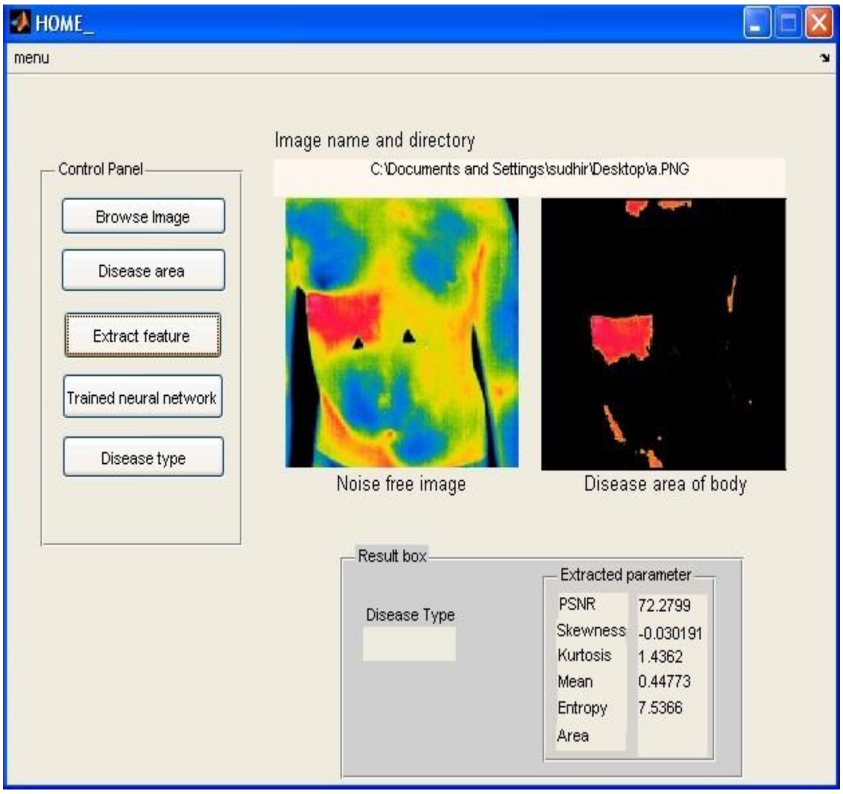

Figure 3 Output of the system

Table I is representing the extracted output parameter of the system and fig 3 shows the Matlab output of the system. Table II Shows the Sensitivity, Specificity and Accuracy of the classifier for tranied and tested signal.

TABLE I
EXTRACTED OUTPUT PARAMETER

Parameters	Values
PSNR	72.279
Mean	0.4473
Entropy	7.5366
Skewness	-0.0301
Kurtosis	1.4362

TABLE II
SENSITIVITY, SPECIFICITY AND ACCURACY OF THE CLASSIFIER FOR TRANIED AND TESTED SIGNAL

	T	T	F	F	Senc	Spec	Acc
Training Signal	97	95	97	0	50%	100%	67.6%
Test Signal	75	73	75	2	48.84%	95.6%	65.15%

IV. Conclusion

Hence, In this paper we used Fast Median Base Filter to detect noisy pixels. This process is fast as compare to normal filter. The performance of filter was evaluated using peak signal to noise ratio and mean absolute error. The experimental results or testing results we observed and compared with the training signal results and extract the different types of skin diseases. We made types of skin disease database. In conclusion, thermal imaging with artificial neural network provides an alternative method to existing technology for auto- detection of the skin diseases. The system implemented in this paper provides reliable results.

This technique can be further expanded for detection of some other diseases. Implementing such intelligent system on hardware can be presented as future work which provides a cheaper solution as compared to existing technologies i.e. MRI, X-rays and CT scan.

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