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A REVIEW OF IMAGE ENHANCEMENT TECHNIQUE BASED ON WAVELET THRESHOLD AND NEURAL NETWORK

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Abstract: Image enhancement plays an important role in computer vision. The degraded image, blurred image and noised image effect the medical diagnosis of image data, satellite image for information retrieval. Various authors and researcher propose a method of image enhancement such as histogram equalization, multi-point histogram equalisation and some method based on neural network and wavelet threshold. Wavelet is very important transform function for image enhancement. Wavelet transform function decomposed layer wise one layer is called details layer and another layer is called approximation layer. The details layer acts as threshold function and approximate layer is processing of image enhancement. For the processing of neural network used approximate layer data. The use of neural network in image enhancement gives a better performance in compression of all conventional enhancement technique. In this paper we discuss the image en enhancement based on neural network and wavelet transform function processing.

Keywords: - image enhancement, Wavelet, neural network

I. INTRODUCTION

Image enhancement is basically improving the interpretability or perception of information in images for human viewers and providing better input for other automated image processing techniques. The main objective of image enhancement is to modify attributes of an image to make it more suitable for a given task and a specific spectator. For the duration of this process, one or more characteristic of the image are customized. The alternative of attributes and the way they are customized are specific to a given problem. Moreover, observer-specific factor, such as the person visual system and the observer's experience, will bring in a great deal of subjectivity into the choice of image enhancement methods [2]. There exist many methods that can enhance a digital image without spoiling it. Image enhancement improves the quality (clarity) of images for human presentation. Eliminating blurring and noise, increasing contrast, and enlightening details are examples of enhancement operations. For example, an image might be chosen of an endothelial cell, which may be of low contrast and little blurred. Decrementing the noise and blurring and incrementing the contrast range could enhance the image. The real image might have areas of very high and very near to the ground intensity, which facade details [4]. An adaptive enhancement algorithm unhides these details. Adaptive algorithms correct their operation based on the image information (pixels) which is processed. In this scenario the mean intensity, contrast, and sharpness (amount of blur removal) could be adjusted based on the pixel intensity statistics in various areas of the image. Contrast enhancement is essential to improve substandard images that are captured in extreme lighting conditions, such as excessively bright or dark environments that produce low contrast images, or are backlit, which produce normal global-contrast images with a low dynamic range in shadowed areas the solution of this problem is a very popular technique for contrast enhancement of images is Histogram Equalization (HE) Fig 1, In HE, the cumulative density function (cdf) of the histogram is used as the intensity transfer function; this method enhances the contrast by distributing the cdf across the entire dynamic range. However, this even distribution creates artifacts in the smooth regions of the image. Moreover, it does not consider the boundaries, which degrades the sharpness of the resulting image.,HE which is simple and has good performance compared to nearly all types of images. disadvantage of HE is the wash-out effect that occurs when the original histogram does not occupy the entire dynamic range of the image. Consequently, the equal redistribution of HE can leave gaps in the final histogram. Thus, several methods based on HE have been proposed in order to eliminate the shortcomings of the original technique. For example, the bi-histogram equalization (BHE) method splits the histogram into two parts based on where the mean lies. Each part is then enhanced independently using HE. BHE maintains the intensity mean of the original image, which suppresses the overenhancement problem.

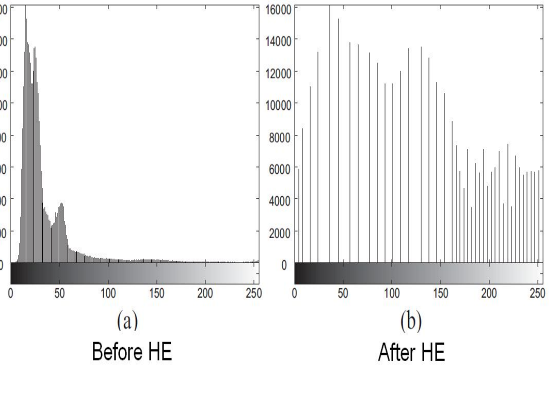

Figure 1, Histogram Equalization

Histogram Equalization performs its operation by remapping the intensity levels of the image based on the probability distribution of the input intensities. Various researches have been performed on Histogram Equalization, and many methods have already been proposed [7]. Usually, these techniques are classified into two principle categories; global and local Histogram Equalization. Global Histogram Equalization (GHE) uses the histogram information of the entire input image for its transformation. Though this worldwide approach is appropriate for overall enhancement, it fails to adapt the local brightness features of the input image and shifts the mean intensity to the middle intensity level, apart from the input mean intensity[9]. Thus it appears to be unsuitable for consumer electronic goods. Local HE (LHE) can remove the local brightness problem; however the overlapping sliding mask mechanism makes the LHE computationally expensive. With the technical advancements in processing power, the speed is not a problem. The Local Histogram Equalization still faces trouble with amplified noise and an unnatural output due to over-enhancement. Other approach is to apply a partially- overlapped or non-overlapped block based Histogram Equalization. Wavelet transform decomposed image in to different layers, the decomposed layer differentiate by horizontal, vertical and diagonal. The soft thresholding decide the parameter of enhanced of noised image quality. One of these methods is wavelet thresholding developed first by Donoho and Johnstone .This method removes the noise in an image by removing the wavelet coefficients that are too noisy and preserving or shrinking the coefficients that contain important image signals Fig 2. The success of the method depends heavily on the choice of the threshold parameters. As a result, various wavelet thresholding methods have been evolved, which use different approaches to determine the threshold parameters, have been reported Wavelet transforms are multiresolution representations of signals and images. Artificial neural network play important role in image enhancement and for preserving brightness and contrast of digital image. The nature of neural network is adaptive and variant; this nature sustained a pervious value of image pixel and set the desired target for enhancement of image. Some enhancement approaches utilize single layer and some other are used multilayer of artificial neural networks. Such as ART network for binary image enhancement [15]. A general approach for implementation of morphological image operations by a modi1ed feed-forward ANN using shunting mechanisms, i.e., neurons acting as switches. Self organized map network (SOM) artificial neural network used for the process of image enhancement in frequency domain of digital image. The rest of paper is organized as follows. In Section II discuss related work of image enhancement. The Section III wavelet threshold. The section IV neural network followed by a conclusion in Section V.

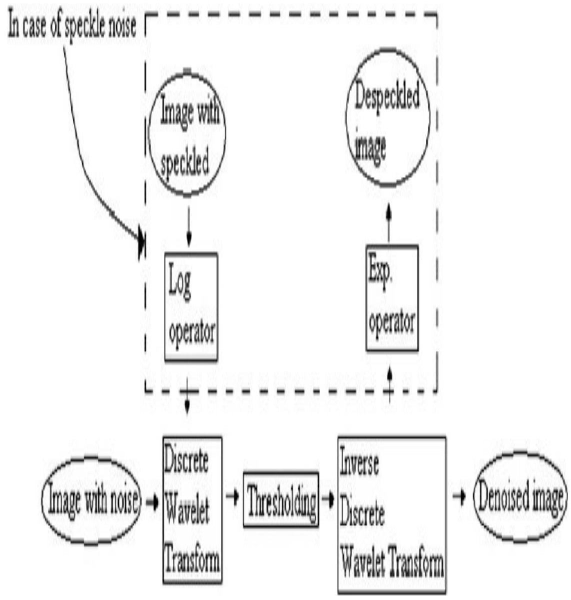

Figure 2.Noice Reduction in wavelet domain

II. RELATED WORK FOR IMAGE ENHANCEMENT

- Mdtyh Brendel and Tantcis Roska entilted "Adaptive image sensing and enhancement using the Adaptive Cellular Neural Network Universal Machine" a method for image enhance using pixel equalization and neural network[11]. The method can be used for the adaptive control of image sensing and for subsequent image enhancement. The algorithm uses intensity and contrast content as well. The method is completely executable on the Adaptive Cellular Neural Network Universal Machine (ACNN-UM) architecture. Both methods use basically the same technique for equalization as they apply the intensity and contrast information of the basic image. The equalization masks are computed by using the diffusion template via the CNN-UM. The algorithm is ideal for the ACNN-UM the most time consuming task is the diffusion. Accordingly, the use of the currently available CNN-UM chip speeds up the process significantly. On the other hand, the presented methods are of acceptable quality as this is shown by the sample images. In the algorithms the radius of the adaptation can be controlled by the time or gain of diffusion, thus all intermediate cases between full global and local equalization are dynamically available.

- Her-Chang Pu, Chin-Teng Lin, Sheng-Fu Liang and Nimit Kumar entitled[14] "A Novel Neural-Network-Based Image Resolution Enhancement" a novel HVS-directed neural network-based adaptive interpolation scheme for natural image is proposed. A fuzzy decision system built from the characteristics of the human visual system (HVS) is proposed to classify pixels of the input image into human perception nonsensitive class and sensitive class. High-resolution digital images along with supervised learning algorithms are used to automatically train the proposed neural network. Simulation results demonstrate that the proposed new resolution enhancement algorithm can produce higher visual quality of the interpolated image than the conventional interpolation methods. The fuzzy decision rules inspired by human visual system (HVS) are proposed to analyze the sensitivity of human eyes to the image for interpolation. According to the experiment results, the proposed HVS-directed neural-network-based interpolation is superior to conventional methods such as the bilinear and bicubic interpolations in some aspects of visual quality such as the clarity and the smoothness in edge regions as well as the visual quality of the interpolated images. In addition, the proposed fuzzy decision rules combined with the neural network can balance the trade-off between speed and quality for different applications by just adjusting a threshold parameter.

- S. Chitwong, T. Boonmee, and F. Cheevasuvit entitled [15]"Local area histogram equalization based multispectral image enhancement from clustering using competitive hop-field neural network" problem of clustering or segmenting in image enhancement is discussed . One of important issues for enhancing image based on local area histogram equalization (HE) is a clustering or segmenting technique. That is, the more the accuracy of separating image into specified classes is needed, the better the performance of enhancement is. As mentioned objective, in this paper, the competitive Hopfield neural network (CHhW) is then proposed for clustering 10 the LHE based image enhancement. By using simulated image, standard image and multi-spectral image from Landsat 7 satellite, experimental results are shown in both accuracy of clustering and variance of the enhanced image. The criteria for a good enhancement algorithm are that if can give high variance in detail area, low variance in smooth and edge areas. Also comparing the variance of the enhanced image by both LHE and global area histogram equalization (GHE) methods shows that one from LHE outperforms. In addirion, the enlarged image fiam small area is shown clearly by visualization. Equalizing histogram from the local area classified by such the clustering methods, CHNN show that not only the accuracy of clustering is clearly better exact in the simulated image but also the performance enhancement outperforms when comparing with FCM in all clusters for standard image. For TM image, not only in detail area the variance of FCM is more than that of CHNN, but also in the smooth and edge areas it is still higher. Thus, CHNN bas better trended as mentioned reasons.

- Adin Ramirez Rivera, Byungyong Ryu," Content-Aware Dark Image Enhancement Through Channel Division"[1], The current contrast enhancement algorithms occasionally result in artifacts, overenhancement, and unnatural effects in the processed images. These drawbacks increase for images taken under poor illumination conditions. They propose a content-aware algorithm that enhances dark images, sharpens edges, reveals details in textured regions, and preserves the smoothness of flat regions. The algorithm produces an ad hoc transformation for each image, adapting the mapping functions to each image's characteristics to produce the maximum enhancement. We analyze the contrast of the image in the boundary and textured regions, and group the information with common characteristics. These groups model the relations within the image, from which we extract the transformation functions. The results are then adaptively mixed, by considering the human vision system characteristics, to boost the details in the image. Results show that the algorithm can automatically process a wide range of images—e.g., mixed shadow and bright areas, outdoor and indoor lighting, and face images—without introducing artifacts, which is an improvement over many existing methods.
- G.G. Bhutada,R.S. Anand,S.C. Saxena," Image enhancement by wavelet-based thresholding neural network with adaptive learning rate"[3], A new approach has been proposed to improve the computational performance of denoising in which adaptively defined learning step size has been used for tuning the parameter of the thresholding function of wavelet transform-based thresholding neural network (WT-TNN) methodology. In this approach, steepest gradient-based learning step size of WT-TNN methodology are changed to the proposed adaptively defined learning step size for tuning the parameters of thresholding function. The generalised simple way of denoising in the wavelet domain is presented as follows: at first, the noisy image is decomposed in the wavelet domain and then coefficients are modified by suitable thresholding function. Finally, by applying the inverse wavelet transform on these modified coefficients, the reconstructed image is obtained. In addition to above steps, homomorphic approach is used in case of multiplicative noise The results of the image enhanced by such adaptive learning step size exhibit the increase in the speed of learning and improved edge preservation feature. Further, the learning time has also become independent of noise level and initial values of learning parameters.

III. WAVELET THRESHOLDING

Wavelets play a major role in image compression and image enhancement. Since our topic of interest is image enhancement, the latter application is discussed in detail. Wavelet coefficients calculated by a wavelet transform represent change in the time series at a particular resolution. By considering the time series at various resolutions, it is then possible to filter out noise. The term wavelet thresholding is explained as decomposition of the data or the image into wavelet coefficients, comparing the detail coefficients with a given threshold value, and shrinking these coefficients close to zero to take away the effect of noise in the data. The image is reconstructed from the modified coefficients [8]. This process is also known as the inverse discrete wavelet transform. During thresholding, a wavelet coefficient is compared with a given threshold and is set to zero if its magnitude is less than the threshold; otherwise, it is retained or modified depending on the threshold rule. Thresholding distinguishes between the coefficients due to noise and the ones consisting of important signal information. The choice of a threshold is an important point of interest. It plays a major role in the removal of noise in images because enhancement most frequently produces smoothed images, reducing the sharpness of the image. Care should be taken so as to preserve the edges of the denoised image. There exist various methods for wavelet thresholding, which rely on the choice of a threshold value. Some typically used methods for image noise removal include. Prior to the discussion of these methods, it is necessary to know about the two general categories of thresholding. They are hard- thresholding and soft-thresholding types. The hard-thresholding TH can be defined as [8]

$$T_H = \begin{cases} x & \text{for} \mid x \geq t \\ 0 & \text{in all other regions.} \end{cases}$$

Here t is the threshold value. A plot of *TH* is shown in Figure 3.

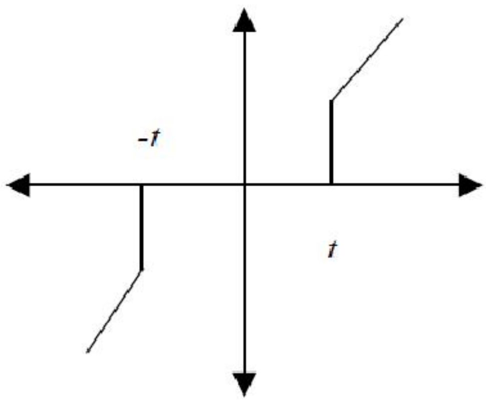

Figure 3: Hard thresholding

Thus, all coefficients whose magnitude is greater than the selected threshold value t remain as they are and the others with magnitudes smaller than t are set to zero. It creates a region around zero where the coefficients are considered negligible. Soft thresholding is where the coefficients with greater than the threshold are shrunk towards zero after comparing them to a threshold value. It is defined as follows [5].

$$T_s = \begin{cases} \text{sign}(x)(\mid x \mid - t) & \text{for } \mid x \mid > t \\ 0 & \text{in all other regions.} \end{cases}$$

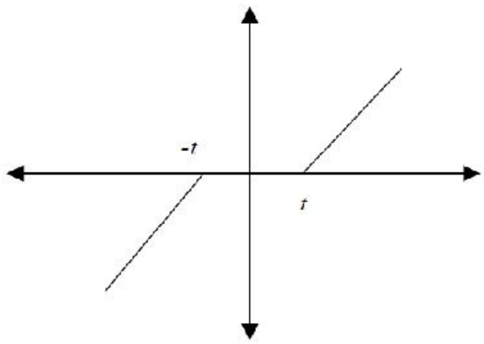

Figure 4: Soft thresholding

In practice, it can be seen that the soft method is much better and yields more visually pleasant images. This is because the hard method is discontinuous and yields abrupt artifacts in the recovered images. Also, the soft method yields a smaller minimum mean squared error compared to hard form of thresholding. Now let us focus on the three methods of thresholding mentioned earlier. For all these methods the image is first subjected to a discrete wavelet transform, which decomposes the image into various sub-bands. Graphically it can be represented as shown in Figure 5[10].

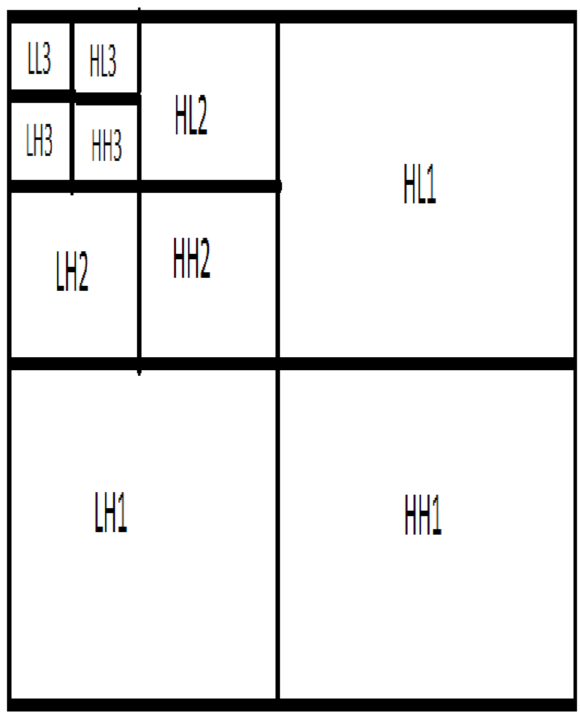

Figure 5 (a): DWT on 2-dimensional data

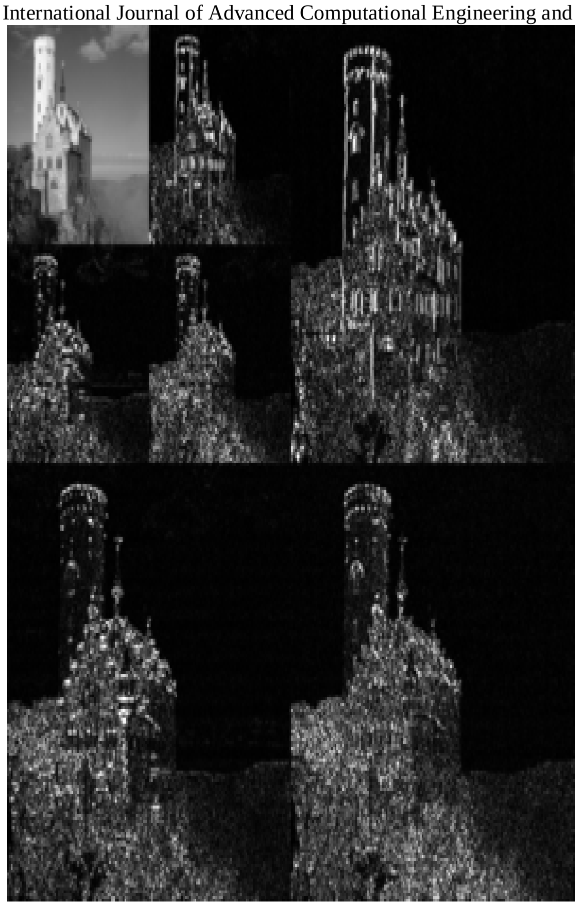

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Figure 5 (b): DWT

The sub-bands HH*k*, HL*k*, LH*k*, k = 1, 2…... j are called the details, where k is the scale and j denotes the largest or coarsest scale in decomposition. Note, LL*k* is the low-resolution component. Thresholding is now applied to the detail components of these sub bands to remove the unwanted coefficients, which contribute to noise. And as a final step in the enhancement algorithm, the inverse discrete wavelet transform is applied to build back the modified image from its coefficients.

IV. NEURAL NETWORK

Artificial neural networks (ANNs) proved to be capable of finding internal representations of interdependencies within raw data not explicitly given or even known by human system. Its special characteristic together with the simplicity of building and training ANNs and their very short response time encouraged their application to the task of image enhancement. Because of their inherent nonlinearity, ANNs are able to deal with the complex interactions between variables that affect image pixels[1]. There is no need for complex functional models to describe the relationships between the input variables and the input image. Recently the ANNs technology has been proposed as a substitute for statistical approaches for classification and image denoising problems [3]. The advantages of ANNs over statistical methods include robustness to probability distribution assumptions, the ability to classify in the presence of nonlinear relationships, and the ability to perform reasonably well using incomplete data bases[6]. Comparison results between ANNs and statistical techniques indicated that neural nets offer an accurate alternative to other classical methods such as histogram equalization or autoregressive models In this dissertation cascaded ANNs are used for image enhancement and bright contrast preserving. The ANNs are trained with the back-propagation algorithm, which is a gradient-decent technique that is easily applied to networks whose neurons have smooth, monotonic differentiable transfer functions such as sigmoid and hyperbolic tangent. The first small-dimensional ANNs are used to predict the peak intensity of input image IM the minimum pixel value P, and absolute mean error rate is AMBR [15].

CONCLUSION AND FUTURE WORK

In this paper we review the image enhancement technique based on wavelet thresholding and neural network application. In study we found that wavelet decomposition is important for neural network input processing. in wavelet decomposition data are not lost. Neural network also play important role in image enhancement. For the thresholding of wavelet and processing of neural network is great combination of image enhancement. For the combination of multiple networks is also improved method for image enhancement. In this paper we not discuss computational cost of wavelet transform and neural network enhancement algorithms. In future we used cascaded model of neural network for image enhancement.

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