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Automatic Image Enhancement by Noise Avoidance using Fuzzy and Histogram techniques

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Abstract— Automatic Image enhancement is one of the major concerns in the digital image processing. There are various methods to enhancement the image. Noise removal is one of the best followed approaches that results in better image. We are using fuzzy and histogram techniques to achieve it. In fuzzy based automatic image enhancement by noise avoidance using histogram technique, we have studied various fuzzy enhancement methods as wavelets that has different issues, and studied histogram hyperbolization. Fuzzy based noise avoidance technique makes use of noise cheating and correction and removal of grain noise. The results clearly show that, the proposed technique overcomes the existing limitations and removes the noise using encoder and decoder fuzzy mechanism thereby increasing automatically the image view using histograms.

Keywords— *Hyperbolization, Fuzzy, image enhancement, noise, histogram*

I. Introduction

Recently image enhancement technique has become desired research field. This gives a review quality of image and wholesome idea of digital enhancement technique. Histograms are used in image processing, brightness purposes, adjusting contrast and for thresholding which is used in computer vision for automatic image enhancement.

Now a days we require converting of image from one form to other such as digitalizing, scanning, transmission, storing etc. Hence the output image undergoes processing called Image Enhancement. It has several methods for improving Quality. Digital images are Enhanced by Histogram Equalization (HE) and Histogram Specification (HS). HE can be implemented in two ways 1. Spatial Domain (deals with Pixels) 2. Frequency Domain. HS method uses CDF (Cumulative Density Function) in this targeted image is matched with another targeted image. It gives better result than HE. We can also find MSE and PSNR of output image [1].

Image enhancement (IE) is such technique which makes the processing on image in order to increase its effectiveness for computer to process. Brightness Preserving Dynamic Histogram Equalization method is useful to providing brightness of an image and which gives the new range to intensities. The realistic image is provided by its look. A DWT is simply like other wavelet transform which uses wavelet coefficients. By using this technique, the content image of high frequency is produced [2]. The authors proposed a new framework CAM-SCTP in achieving fairness between optimal network resource utilization and end-to-end flow control in Multimedia communication [3].

The main purpose of image enhancement is to highlight certain features of that image which are required for some special purpose. By highlighting certain pixels of that image, we can achieve this. Here the image can be anything which is visible [4]. Using optimizing and clustering techniques authors proposed a technique to transfer the videos in networks [5]. To enhance picture quality image enhancement, we can specify improving and limiting some data present in the input pictures [6]. Table 1 shows the Different features in Image Enhancement that must be considered.

We introduce, Fuzzy based noise avoidance technique that makes use of noise cheating and correction and removal of grain noise. We present an automatic image enhancement algorithm that uses generative adversarial networks. This algorithm is data-driven: no heuristic rules or human interactions are required. The enhancement functions are directly learned from the training data. We design novel Domain Encoding. In this paper we are automatically improving the picture by removal of noise.

Table 1: Different features in Image Enhancement

	Concept Based Image Retrieval	Content Based Image Retrieval - Low Level Features					
		Color			Texture	Shape	
		Histogram	Color Layout	Region	Wavelet Transform and Gabor Transform	Contour-based shape descriptors	Region-based shape descriptors
Use	Metadata	RGB, HSV	Local color features	Segmentation	Texture statistic features & structure features	Shape boundary information	Regional pixel information
Disadvantages	– Every image do not have complete metadata – Time consuming manual labor to create the feature database	Doesn't consider the local color information	Computation and storage mechanism is expensive than region based method		Variances in textons can lead confusion for search.	Not been able to address accurately varieties of shape variations	
Advantages	Speed	– Speed – Low demand for memory space – Not sensitive for image transformations			Performance	Performance	

Section 2 describes the related work of the studies using fuzzy methods and histogram techniques and Section 3 gives the proposed technique. Section 4 discusses the results and section 5 gives the conclusion.

II. Related Work

Authors in [7] propose the extension of normal histogram equalization which has the drawbacks of changing the brightness of input image, deteriorate visual quality, unknown annoying artefacts. The BBHE words using minimum gray level maximum gray level and mean values. Input images are divided into sub-images using mean values of the input image. It enhances the contrast. It has the applications in the various fields of electronics, TV, VTR, Camcorder by using quantized probability density functions.

Grey-Level Grouping (GLG) is proposed in [8]. The contract switching is used to increase the dynamic range of the Gray level, and GLG is applicable to broad variety of images. In [9], GLG can't fulfill the certain special application purpose. To overcome this, authors introduced the extension of basic GLG known as Selective Grey Level Grouping. [10] Infrared Images (IR) used a lot of Domains, and these has the low contrast and signal –to- noise ratio. This is the main problem to IR images because of effect of atmosphere. CLAHE results have higher Peak-To-Peak Signal-To-Noise Ratio (PSNR) than the Histogram Equalization (HE).

The technique mentioned in [11] reduces noise present in the images. In [12] there are different types of enhancement techniques used based on required output, for example Power-law transformations are useful for general purpose contrast manipulation. In [13], authors deal about contrast image in the medical field. To avoid this low contrast image in medical field by using some techniques. The images are known as mammogram images. Authors try to enhance contrast images by using CT images in affected region. The low contrast images are reduced by using one method modification histogram-based contrast enhancement using high-pass filtering. This method has two steps one is global contrast of image and another one is high filtering. By using these two techniques it increases the sharpness of contrast image. The image will be clearly analyzed by the people easily. Also, histogram equalization and high pass filtering are used.

In [14] global contrast images are improved without over-enhancing the local image contrast by using Gaussian mixture. In this the contrast images are divided into two sub–intervals color and depth image histograms. The contrast images are not understood by the people. So, the global contrast images are analyzing by the peoples to improve the images. The images are split into color and depth. After splitting global contrast image into sub-intervals. The depth histograms are black and white images. It is only used to improve global image without over enhancing the local image contrast.

In [15] the low contrast images are enhanced by using gaussian mixture model. Tin is model the images are easily decomposed into the small images and the individual small images are stretched and group to setup into gaussian mixture model. By using this method, we can increase the quality of low contrast images into high. The natural images in homogeneous areas acts as a gaussian shaped histogram. The individual histograms are stretched by increasing their variance parameters that are optimized to set up a gaussian mixture model. It is also a low complexity method to enhance the low contrast image. But this method has low complexity to solve this problem.

In [16] HSV color space is showing better performance than LAB color space. It brings better image segmentation if the task is performed HSV color space. In [17] the quality of the image will be decreased and visibility of the image will become low. Experiments are performed on synthetic and real-world images, which indicate the strong and effective performance. It contains ten convolutional layers and 16 feature maps at each convolutional layer, which provides fast and efficient training and testing on GPU platforms. In [18], users have a tendency to propose a generalized levelling model for image improvement. This have a tendency to then derive associate degree best image improvement formula that in theory achieves the most effective joint distinction improvement.

In [19] Image enhancement techniques work in frequency and spatial domains. The results reflect that their high quality after applying LHE and DSIHE techniques followed by median filtering. In [20], users apply HE method for contrast enhancement on modified histogram. Authors use two wiener filter parameters that are, wiener1 filter and wiener2 filter which produces better results than other linear filtering. Gamma correction technique is used to transfer the image into a suitable dynamic range. In order to overcome this problem, idea of histogram equalization technique for image enhancement using wiener filter is proposed. This provides optimum contrast enhancement while preserving the brightness of given image and suitable for images enhancement.

In [21] the research quotes the direction of the improvement of image processing techniques and methods which has undergone few years back. Reflection of the light varies greatly depending on the structure of the sea. The result of this research is to enhance underwater images two models are used such as RGB colour model and HIS colour model to equalize the colour contrast in the images and also addresses the problem of lighting by slide stretching algorithm

In [22] image enhancement in treated as most important part of digital image processing. The proposed technique can be performed as some stages such as practical swarm optimization [POS] and detection and Gamma correction. There are two types of images used in this experiment such as black and white. Colour images can be enhanced by separating the colour and intensity components. This enhancement can be performed using how techniques or software algorithms. In order to applying changes in images for enhancing contrast has been used. To apply PSO algorithm for multi objective this problem is considered each of the objective's optimization using an absorptive point for particle in search space.

In [23] Research has been done on picture improvement and quality. So, there are numerous outcomes which are results of these researches present it is essential to categorize these results. Create a picture with great perceptual quality by featuring certain highlights. These techniques can be used to highlight the picture edges. Picture with good visual quality. Graphic display and analysis are involved in the picture improvement process. The Field Programmable Gate Array (FPGA) picture improvement technique is explained in detail here. It is an open area investigation.so more powerful picture improvement is achieved. In [24] image enhancement is done improving the picture quality. This method is used to solve some drawbacks such as poor optics, absence of flashgun etc. It is used to improve the quality of resulting picture. Main problem affecting image quality comes from improper exposure light.

In [25] authors preserve the brightness of the input picture with significant contrast method to remove the non-existing things in the output picture. In HE method, the gray level is remapped as some annoying things and unnatural improvement are introduced. Brightness preserving methods are used to preserve the brightness from these drawbacks such as CLAHE, DSIHE, and DHE. In [26], the image techniques and its modification methods and exact Histogram Equalization with different techniques are used to increase the efficiency. It results over contrast enhancement and another method are also specified to overcome from over contrast enhancement as Contrast Limited AHE.

In [27], the new contrast enhancement method during this method is established. It can avoid unnatural artifacts such as saturation and wash out. It shows that the shape preserving method of GMMCE enhances the contrast of image and the computational complexity analyses that shows the greedy parameter estimation algorithms. In the categorization, it shows the method of GMMCE is a low complexity method and make it suitable for real time applications. In [28], a dynamic approach for contrast enhancement of low contrast images without making any loss in image details, is proposed. This method is simple and computationally effective which makes it easy to implement and also it is used in real time systems. To overcome this issue, a new enhancement method has been introduced Called Dynamic Range Separate Histogram Equalization. It involves, Enhancing the contrast of images that is one of the major issues in image processing. DRSHE preserves naturalness of images and improves overall contrast. The major issue of this method is to prevent the color distortion because of excessive enhancement. Computation complexity might be significantly reduced in software/hardware implementation. Therefore, DRSHE could be utilized in the consumer electronics, such as LCD & PDP TV's.

In [29], Histogram equalization is made very simple, Only the global histogram equalization can be done completely automatically. Few drawbacks are identified. Such as, the most of the images are less contrast such that some objects of the image are not clearly visible and may not be used for the identification purpose. Most of the captured images are low in contrast due to low illumination source that results the poor visual effect. Authors proposed an algorithm to adjust the image contrast for a better visual effect. It explains the algorithm that can improve the contrast of the images and preserve the details of the image.

Section 3 presents the Proposed work for automatic image enhancement.

III. NOISE AVOIDANCE USING FUZZY AND HISTOGRAM TECHNIQUES

Image enhancement is one of the noise cleaning methods. Typical noise effects are sensor noise, film grain noise etc., and may be reduced by classical statistical filtering techniques. Most of these methods are better classified as restoration methods, since they use information about the degradation process itself. Another approach is the application of spatial ad hoc methods. Most of these methods operate in local neighborhoods around each pixel, and the grey level value is examined against the average value of its neighbors. Methods with different weighting of the center pixel and the neighboring pixels are reported. The problem, however, is that the edges are degraded or blurred in these smoothing processes.

One of the more interesting filters for ad hoc noise removal is the median filter, first proposed for image processing. The main effect of the median filter, is that noise is removed, but edges are not blurred or smoothed out. Another, but unwanted effect in this regard, is that small objects, thin lines and sharp corners may be deleted. The median and other similar statistical property operators, belongs to the so called robust methods in mathematical statistics for the two-dimensional images the median filter. The result of applying a median filter with a window of size mxm is the matrix (y_{ij}), where each pixels Y_{ij} is equal to the media of the median of the grey levels of the pixels in the mxm window centered at position (i,j).

a^2 n=1/(4f^2(m).n) - (1)

The autocovariance function, giving information about the interrelations between output variable generated by the filter, for filter size 3x3 is given by

r(x)=cov(y1,y1+k)=a.c(k) - (2)

For the input image of noise error less than 20%, a median filter of size 3x3 will reduce the portion of errors to less than 2%, while for error rate at 30% the same filter will reduce the amount of error to 10%. for the both impulses noise and salt-and pepper-noise, the actual experiment presented in the report, are in good argument with the estimated values. Implementation uses the fact that the median filter algorithm in our system. This implementation uses the fact that neighboring pixel window because most of the pixels are unchanged. only m pixel values are changed each time, for description of image processing program system.

Image Enhancement Noise Cheating Technique

It is interesting noise cleaning method, also giving unblurred edges, called noise cheating, is described. This method has shown to be reasonably good to combat the effects of photographic film-grain noise in low contract images, where the edges often are blurred during the image formation process itself. This method starts with a high spatial resolution digital image with each pixel finely quantized, call this image I1. Then, another image with lower resolution is produced by combining non-over-lapping two-by-two pixels. call this image I2. The variance of the noise per pixel in image I2 is approximately one fourth of the noise variance in the resolution image, I1. for white noise the noise reduction is exactly 1/4. However, I1 contains much better edge information than the blurred image, I2. Image I2 is requested at a lower resolution, the quantization levels are spaced by four noise standard deviation units over a uniform scale. The lower resolution image is then operated upon by a 3x3 neighborhood operator. For image enhancement, it is very difficult to collect a large set of such pairs of images. Processing one image for better visual quality could take a professional user several minutes, if not more, with an image editing software such as Photoshop. Therefore, it is very time-consuming and expensive to build thousands of such pairs.

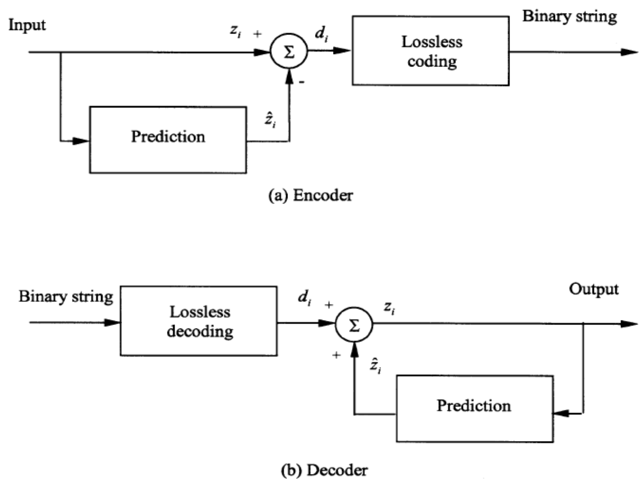


Fig. 1: Framework to prevent image enhancement on encoding and decoding

Additionally, as better visual quality is a subjective concept, there can be a large number of possible operations to enhance a low quality image. Building a complete set of ground truth images is thus very difficult, if not impossible. To overcome such limitations on the training data, we propose a novel framework. As mentioned before, input images are normally in a PCM coded format with a bit rate of eight bits per pixel for monochrome pictures. The difference signal is therefore integer-valued. Having no quantization and using an efficient lossless coder, the coding system depicted in, therefore, is an information-preserving differential coding technique. If the 8-adjacent neighboring pixels are all quantized to the same level, but different from the center pixel, the center pixel is set to the value of its neighbours. a border point is a pixel with neighbours belongs to two different segments.

If the center pixel is a border point, it is subdivided into its four high resolution pixels, from the original image 1, and assigned values according to the values of the 4-adjacent neighbours in the low-resolution image closest to the value of the corresponding high-resolution pixels. The overall effect of the operation, is to reduce the noise in homogenous areas, but to maintain the detailed edge information in areas where there is abrupt change in average grey level. We have implemented a similar algorithm in our system and tested it on images of welded joints. Our results were rather poor giving rise to false contour lines in the image. The reason for this was probably the low number of different grey levels in the resulting image. The number of grey levels in the input image was only about 90 out of a maximum potential of 256.

After the requantization, the number of different grey level was in the order of 10-20. By using a context sensitive algorithm similar to the one we used for extending the number of grey levels, as described above, it is probably possible to get much better results. If the 8-adjacenet neighboring pixels are all quantized to the same level, but different from the center pixel, the center pixel is set to the value of its neighbours. A border point is a pixel with neighbours belongs to two different segments. If the center pixel is a border point, it is subdivided into its four high resolution pixels, and assigned values according to the values of the 4-adjacent neighbours in the low-resolution image closest to the value of the corresponding high-resolution pixels.

Grain noise Correction and removal

Due to imaging geometry, radiation energy decreases with square of distance from source, the film density varies throughout the image. Ideally, when all data of imaging geometry is known, correction is possible. For most images exact data of the geometry is unknown, and any correction should be based on calibration. Correction of image degradation, due to geometrical effects, is of great importance when images are used mainly for object thickness measures.

Due to the fine digitization of 20 lines per mm, the digital images are degraded by film grin noise. film grain noise is usually modelled by a gaussian distribution. several models for film grain noise restoration have been published, most of which are based in wiener filtering, for instance. The result of applying such a method, is an image with lower noise-variance, but the edges are usually blurred. We have experimented with a noise-cheating method. The results of applying this algorithm to image 1 in order to get useful results, the input image has to be more finely quantized.

We developed a median filter algorithm useful for removing noise without destroying edge information. The use of the median filter is discussed. Algorithm shows how to compute an estimate of Pl (P ,Z) from a single image under the assumption that it is independent of P. The result is known as the histogram H (Z) of the image. If f (P) denotes the brightness level at pixel P, then Algorithm can be used to evaluate H(Z).

Algorithm 1: Fuzzy Histogram Evaluation

Notation: *f(P)* is value of pixel *p* with range *[O,L]*. *H* is histogram array

Step 1. Begin

Step 2. Initialize the array *H(Z) (O<z<L)* to zero

Step 2. For all pixels *P* of the image do:

Step 4. Increment *H(f(P))* by *1*.

Step 5. End.

Step 6. End of Algorithm.

Algorithm 2: Histogram Noise Removal and Equalization

Require: An image, F(I,j) with n pixels in the gray level range $[X_0, X_{N-1}]$ and limitation parameters a,b,c,d.

Step 1. Consider the Otsu's threshold, the input image *F(i,j)* is segmented into lower sub-images $F_L(i,j)$ and upper sub-image $F_U(i,j)$

Step 2. Compute the PDF, $PL(r_k)$ and $PU(r_k)$ for the lower and upper sub-images respectively.

Step 3. Apply the constraints a,b to lower sub-image

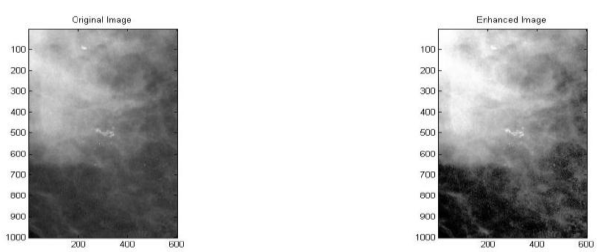
Step 4. Apply the constraints c,d to upper sub-image

Step 5. Independently equalize both the sub-images $(F`_L(i,j)$ *and* $F`_U(I,j))$.

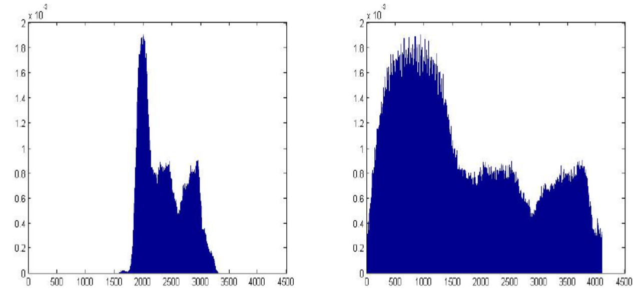
Step 6. Final image after contrast enhancement is given as: $F_0= F`_L(i,j) \cup F`_U(i,j)$

Algorithm implements histogram equalization for any of these rules. Step 0 prepares the histogram according to Algorithm Steps 1 to 6 do the equalization by mapping the old brightness levels onto the new levels.

IV. Results and Discussion



(a) Original Image (b) Enhanced Image



(c) Original Histogram (d) Enhanced Histogram

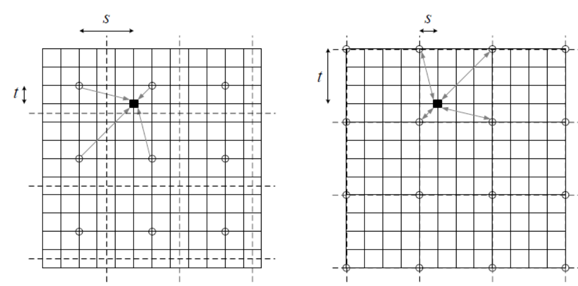
Figure 2 shows the obtained results by applying the proposed techniques varying the original image and the enhanced image

Fig.2: An example of histogram equalization

Figure 3 presents the fuzzy histogram and noise removal results applied on images. Figure 4 presents noise reduction based on corner and block histograms.

(a) (b) (c)

Fig.3: Fuzzy Histogram Technique: (a) original image; (b) fuzzy histogram equalization; (c) Noise Removal



(a) (b)

Fig.4: Histogram Noise Reduction (a) block-based histograms, (b) corner-based histograms.

Pixels are located on grid intersections. The black square pixel's transfer function is interpolated from the four adjacent lookup tables (gray arrows) using the computed (s; t) values. Block boundaries are shown as dashed lines. By these results, we can conclude that our proposed methods help in noise removal and ensures automatic image enhancement in the any type of pictures.

V. Conclusion

In fuzzy based automatic image enhancement by noise avoidance using histogram technique, we have studied various fuzzy enhancement methods as wavelets has different issues, and studied histogram hyperbolization. Fuzzy based noise avoidance technique is introduced that makes use of noise cheating and correction and removal of grain noise. We present an automatic image enhancement algorithm that uses generative adversarial networks. This algorithm is data-driven: no heuristic rules or human interactions are required. The enhancement functions are directly learned from the training data. We designed novel Domain Encoding. The results clearly show that, the proposed technique overcomes the exiting limitations and removes the noise using encoder and decoder fuzzy mechanism thereby increasing automatically the image view using histograms.

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