LOW-CONTRAST IMAGE ENHANCEMENT USING SPATIAL SIMILARITY HISTOGRAM COMPUTATION

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ABSTRACT:

Image Enhancement plays an important role in image processing,where image processing refers to perform mathematical operations on an image to extract some information from it.In order to enhance an image contrast enhancement is required.Contrast Enhancement is used to adjust brightness and darkness of an image to improve its visibility. In this proposed system low contrast images are being enhanced.If background color is white and the foreground colour is a grey those images are refered to as low contrast images.In this system Spatial contextual similarity histogram computation is used.This step computes a similarity histogram that captures the spatial contextual information of input image,here the similarity between each pixel and its neighboring pixels is measured and recorded in the histogram.This method also introduces a gamma correction to enhance the contrast of an image. Overall, this method enhances the contrast of low-contrast images by capturing their spatial contextual information.
Keywords:Imageenhancement,contrastenhancement,lowcontrast image,similarity histogram computation.

1.INTRODUCTION:

Image Enhancement refers to the processing of image to make the visual information clear and improves the quality of original data before processing[1]. Histogram Equalization (HE) is most widely used Contrast Enhancement technique in image processing, which works based on global histogram information[3],[12]. While global histogram equalization improves the contrast of the complete image. Global Histogram Equalization (GHE) enhances the overall image without considering the spatial relation between the pixels, the results in producing artifacts[3],[12]. In order to produce visually pleasing image, we incorporate the spatial information in histogram equalization. Spatial information plays an important role in accurate matching of the neighbouring pixel weights, which helps in image retrieval applications. In this paper, we proposed to enhance the images with low-contrast using spatial information in Histogram Equalization.Low-Contrast Image Enhancement using Spatial Contextual Similarity Histogram Computationproposes a method to enhance the contrast of low-contrast images. Low-contrast images often suffer from poor visibility and lack of details, making them difficult to understand by the observer[3],[13]. This method aims to address this issue by capturing the spatial contextual information of the input image using a similarity histogram.andmethod can be evaluated on various low-contrast images.This project has potential applications in various fields such as medical imaging, remote sensing, and computer vision.

2.LITERATURE SURVEY :

Guided filter(GF) andbi-histogram equalization with plateau limit (BHEPL)are used to overcome the limitations like unnatural artifacts, brightness inconsistency, over-enhancement and unwanted noise amplification.[3],[4],[14]Hence to preserve the brightness and to calculate the PLs for sub-histogram,Junwonmun proposed histogram segmentation. By using PLs histogram modification has been done and these PLs are used for the prevention of over enhancement. To generate the edge-enhanced images, linear coefficients and cdfs are used while the noise amplification has been suppressed. Adaptive PL method is used to determine the edge enhancing HE transformation function is proposed using Guided Filter(GF)[2],[4].

To preserve mean brightness histogram segmentation is required. When more number of segmentation takes place then the image at the output will be in less contrast.By using PLs the sub-histograms are designed. More than one PLs are used for each sub-histogram. To prevent over-enhancement this is method is used, in the histogram segmentation because of morePLs are used it reduces the contrast.Overall, the project proposes an improved image enhancement method that can enhance the contrast of an image while preserving the edge information[4], which is important for many image processing applications.

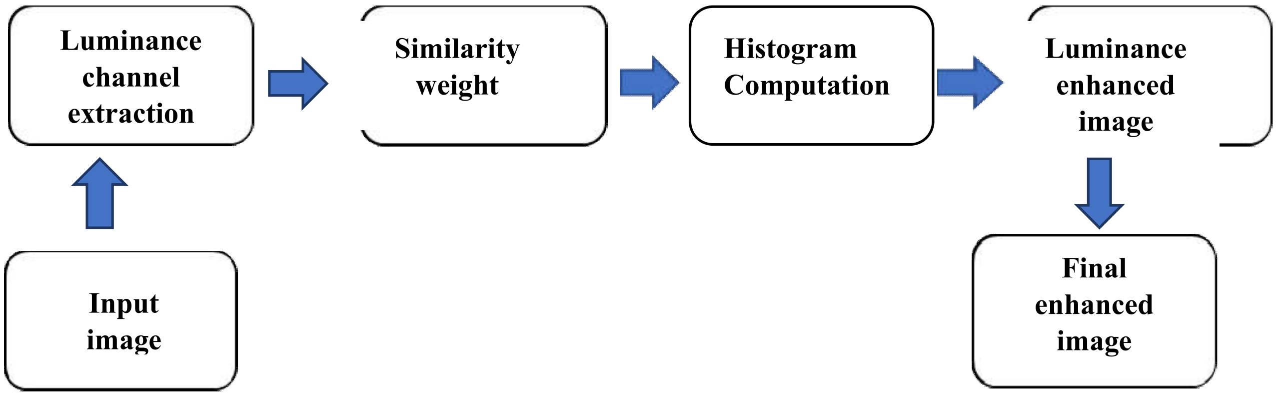
Later Jing Rui Tang and Nor Ashidi Mat Isa aimed to improve the quality of digital images by enhancing their contrast and brightness[6]. This method uses a technique called bi-histogram equalization, which divides the histogram of the image into two regions based on their intensities and performs equalization separately on each region[4].In addition, a clipping limit q is introduced to limit the contrast enhancement and prevent over-amplification of noise in the image. The clipping limit q determines the maximum amount of enhancement that can be applied to a particular pixel, and pixels that exceed this limit are clipped or truncated.This method also analyzes the contrast distribution of the image and adjusts the clipping limit q accordingly to provide optimal enhancement. The performance of the method is evaluated on a set of benchmark images and compared with other existing image enhancement methods. The results demonstrate that the proposed method achieves superior image quality in terms of contrast improvement, preservation of image details, and suppression of noise.

To improve the image contrast enhancementWang, X., & Chen, L proposed BHE [7].It is a popular technique used to enhance the contrast of an image by redistributing the intensity values. However, it can result in over-enhancement and loss of details, which limits its practical applications.Toovercome the issue,wang proposed a feature-preserving BHE method that preserves the important features of the image while enhancing the contrast. This method first extracts the salient features of the image using a feature detector, and then applies BHE only to the non-salient regions. The salient regions are preserved to avoid over-enhancement and loss of details.The proposed method also introduces a clipping limit to limit the maximum difference between the pixel intensity values before and after enhancement. This method can be evaluated on various types of images, including medical images and natural images and also adaptive to different image types and can be applied in various image processing applications.

Celik.Taimed at improving the contrast enhancement techniques for images[8]. Image contrast enhancement is a technique used to improve the visual quality of an image by enhancing the differences between the pixel intensities[1],[3],[4]. It is an essential step in various image processing applications.In this paper two methods are proposed for image contrast enhancement and measurement. The first method is residual spatial entropy-based contrast enhancement, which uses the residual entropy of the image after applying a contrast enhancement technique as a measure of the effectiveness of the technique[8]. The method aims to enhance the contrast while preserving the image details and avoiding over-enhancement.The second method is gradient-based relative contrast measurement, which measures the relative contrast of an image using its gradient. The method calculates the gradient magnitudes of the image and computes the ratio of the maximum gradient magnitude to the average gradient magnitude. The method provides a quantitative measure of the relative contrast of an image.Theabove mentioned methods are evaluated on various types of images, including medical images and natural images[1], and the results of contrast enhancement and measurement methods. The methods are also adaptive to different image types and can be applied in various image processing applications.Finally [8] improved methods for image contrast enhancement and measurement that can enhance the contrast while preserving the image details and provide a quantitative measure of the relative contrast of an image.

Eswar Reddy and Ramachandra Reddy proposed a new method for improving the contrast and visual quality of low contrast images[5].This method uses a combination of histogram equalization and clipping to enhance the contrast of the image[3],[4],[7].This method works by first computing the histogram of the input image and then clipping the histogram to a predefined range of intensities.The clipped histogram is then equalized using a modified histogram equalization technique that takes into account the clipped pixels.Italso incorporates a dynamic approach where the clipping range is adaptively adjusted based on the local image contrast. This ensures that the image is enhanced in a way that preserves the details and reduces noise.The performance of the method is evaluated on a set of benchmark images and compared with other existing contrast enhancement techniques[5].The results demonstrate that the proposed method achieves significant improvement in contrast enhancement and visual quality, especially for low contrast images.

3.PROPOSED METHOD:



3.1: Block Diagram

Luminance channel extraction: It is the process of extracting the brightness information from an image by separating. Luminance channel is the representation of grayscale information. In digital image processing, with the colour channels red, green and blue the image is constructed.By Converting the RGB image to different colour as Yuv (or) YCbCr, the luminance Channel is extracted.In image compression, image enhancement and Colour Correction applications we use luminance channel extraction.

Histogram Computation: Histograms are used in data analysis and statistics to visualize the distribution of data.Creating a graphical representation of distribution of numerical data is the process of the Histogram Computation.

Similarity weight: The measurement of neighbouring and adjacent pixels weights and check how similar they are to each other. Similarity weight is usually represented in matrix format, where each element represent similarity weight between two pixels.It is used in tasks like image segmentation, Object recognition, and image retrieval. It helps to quantify the similarity between different parts of an image.

This project "Low-Contrast Image Enhancement using Spatial Contextual Similarity Histogram Computation" proposes a method to enhance the contrast of low-contrast images. Low-contrast images often suffer from poor visibility and lack of details, making them difficult to analyze and interpret. This method aims to address the issue by capturing the spatial contextual information of the input image using a similarity histogram. Here histogram is used to enhancecontrast and improvevisual quality. The proposed method can be evaluated on various low-contrast images.This project has potential applications in various fields such as medical imaging, remote sensing, and computer vision.

Spatial contextual similarity histogram computation: This step computes a similarity histogram that captures the spatial contextual information of the input image. The histogram is computed using a sliding window approach, where the similarity between each pixel and its neighboring pixels is measured and recorded in the histogram.The proposed method also introduces a gamma correction step to further enhance the contrast of the image. Overall, the method enhances the contrast of low-contrast images by capturing their spatial contextual information.

$\mathbf{l \in [0, L-1]}$,Initially, the mean intensity image is computed by considering 3×3

the neighborhood. It can be given as:

$$I_m(u,v) = \frac{1}{9}\sum_{x=-1}^{1}\sum_{y=-1}^{1} I_{in}(u+x, v+y) \quad (1)$$

Now the similarity strength map can be derived as:

$$\hat{S}(u,v) = 1 - max\{1 - |(I_{in}(u,v) - I_m(u,v)/\sigma_{in}|, 0\} \quad (2)$$

The similarity map obtained from (2) computes the simple similarity and also gives weight to intensity values.

$$\tilde{S}(u,v) = \begin{cases} \hat{s}(u,v), & if\ I_{in}(u,v) = l\ and \\ & I_{in}(u,v) - I_{in}(u,v-2) > th \\ 0 & otherwise \end{cases}$$

(3)

The computation ofSpatial contextual similarity histogram from similarity map is done using

$$H(\tilde{S_r}) = \sum_{m=1}^{M}\sum_{n=1}^{N}\tilde{S}(u,v) \quad for\ 0 < l < L-1$$

(3).Hereth represents threshold value.

(4)

(4) represents Spatial contextual similarity histogram and now PDF is calculated using (5).

$$P(l) = H(l)/\sum_{l=0}^{l-1} H(l) \qquad for\ 0 \leq l < L-1 \tag{5}$$

CDF is calculated using

$$C(l) = \sum_{l=0}^{L-1} P(l);\ \ 0 \leq l \leq L-1 \tag{6}$$

Now mapping function is calculated ,

$$T(l) = (L-1) \times C(l) \tag{7}$$

The obtained mapping function in (9) is used to map intensity level in the input image and is given as

$$I_{e(u,v)} = T\big(I_{in}(u,v)\big) \tag{8}$$

To restore natural characteristics of an image, local contrast adjustment is needed. This can be achieved by the weighted adaptive fusion of the enhanced image with input image as:

$$\hat{I}_e(u,v) = \hat{w}(u,v) \times I_e(u,v) + \big(1 - \hat{w}(u,v)\big) \times I_{in}(u,v) \tag{9}$$

where the weighting component is computed using

$$\boldsymbol{\omega(u,v) = 1 - e\left(\frac{I_{in}(u,v)^2}{2\sigma_{in}^2}\right)}$$ (10)here σ parameter is adaptively selected as

(11) $$\hat{\sigma} = 1 - \sigma_{in}/\sigma_e$$

4.RESULTS AND DISCUSSION:

ABSOLUTE MEAN BRIGHTNESS ERROR (AMBE): It is used to preserve the brightness of the original image.It is defined as[4]:

AMBE=|*M(I)*-*M(J)*|,(12)

Here the parameters *M(I),M(J)* represents the mean values of low contrast and enhanced image[9].

Table 1 : Evaluation results of AMBE metric:

Test Images	HE	GC	EEBHE	PROPOSED
Man	16.26	35.33	7.80	23.29
House	37.44	32.73	9.60	14.93
Leena	6.35	32.89	6.87	7.04
Building	7.73	32.20	3.46	2.84
Food	22.73	37.55	2.05	3.66

STANDARD DEVIATION:It provides a measure of dispersion of image gray level intensities and can be understood as a measure of the power level of the alternating signal component.

$$\sigma = \sqrt{\frac{\sum(x_i - \mu)^2}{N}} \quad (13)$$

Table 2 : Evaluation results of Std metric:

Test Images	HE	GC	EEBHE	PROPOSED
Man	73.66	32.70	49.40	76.32
House	73.57	42.84	57.97	63.50
Leena	73.82	43.26	55.41	73.40
Building	75.35	50.15	56.91	77.40
Food	72.06	11.31	13.29	79.94

ENTROPY: It is used to measure histogram dispersion and average quantity of information to enhance the image values[11].

$$E(I) = -\sum_{l=1}^{P} p(i_l)\log_2 p(i_l) \quad (14)$$

Table 3:Evaluation results of Entropy metric**:**

Test Images	Input	HE	GC	EEBHE	PROPOSED
Man	6.93	6.78	6.79	7.21	6.77
House	6.89	6.68	6.60	7.07	6.80
LeenaBuilding	6.95	6.75	5.16	7.07	6.77
Food	6.49	6.24	6.40	6.65	6.31
	5.10	5.06	5.06	5.16	5.06

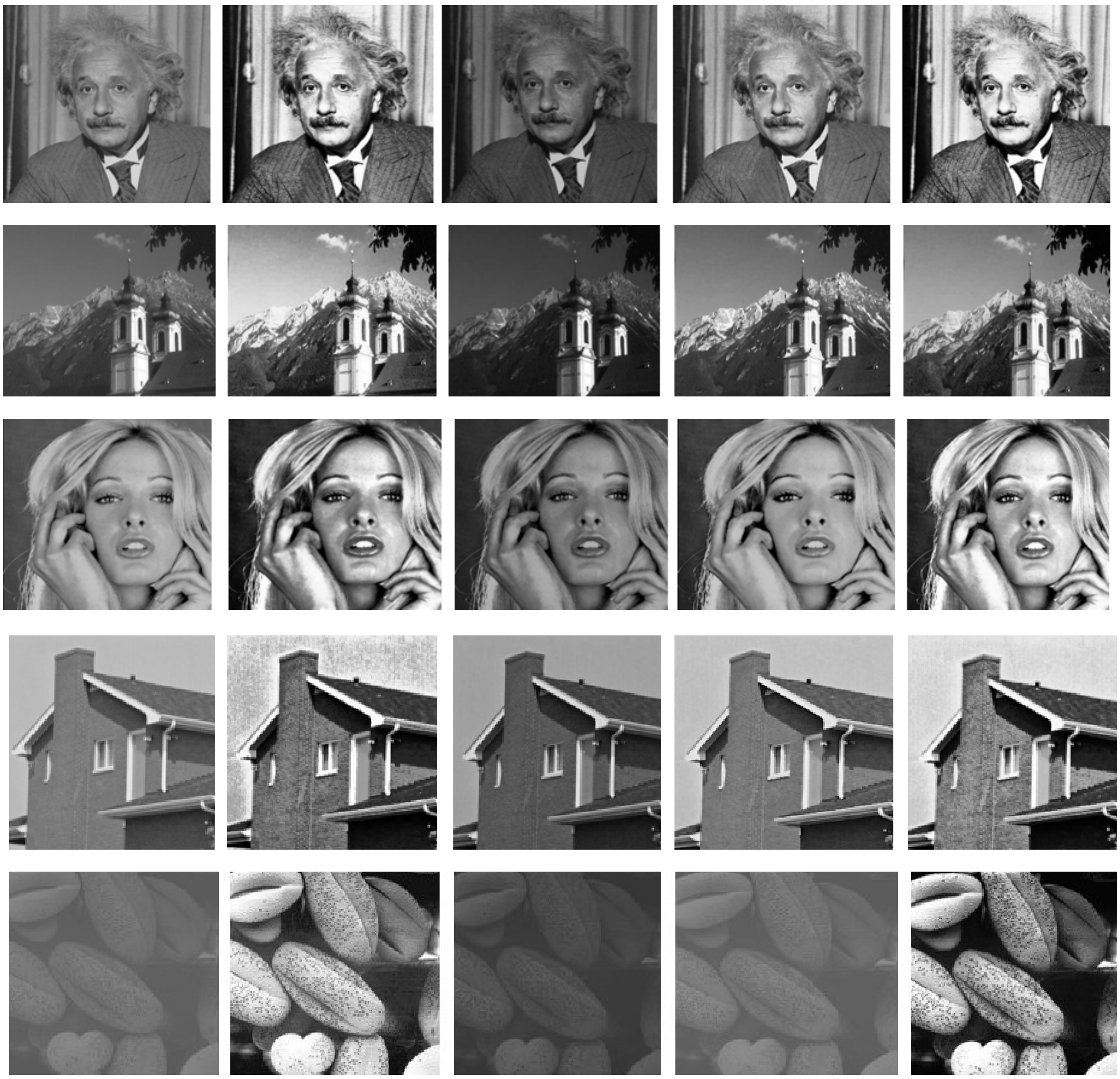
CONTRAST IMPROVEMENT INDEX (CII) :

It is used to compute local contrast between the input and output images[10].

$$CII = \frac{E(C_{loc}(J))}{E(C_{loc}(I))} \quad (15)$$

Table 4 : Evaluation results of CII metric:

Test Images	HE	GC	EEBHE	PROPOSED
Man	2.58	1.43	1.51	2.63
House	1.85	1.40	1.43	1.90
LeenaBuilding	1.98	1.33	1.65	1.73
Food	2.70	1.39	1.53	2.53
	5.04	1.38	1.10	7.06



a)INPUT **b)HE** **c)GC** **d)EEBHE** **e)PROPOSED**

Figure 4.1:Results and Discussion

5.CONCLUSION:

Finally we conclude that most recent techniques are used for various contrast enhancement.Each of the enhancement techniques used have their specific advantages and also suited for various applications based on the user requirements.In this paper low contrast images can be effectively enhanced through the use of spatial similarity histogram computation by analyzing the distribution of pixel values in the image and identifying regions of similar texture and intensity, this technique allows for targeted adjustments that preserve important features and details while enhancing overall contrast. The use of spatial similarity histograms can also help to minimize the introduction of artifacts or noise into the final image, resulting in a high-quality output. With its ability to enhance both grayscale and color images, this method has a wide range of applications in fields such as photography, medical imaging, and remote sensing.Hencespatial similarity histogram computation provides a powerful and flexible tool for improving the visibility and clarity of low contrast images.

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