A Robust Algorithm for Image Contrast Enhancement by Logarithmic Approach

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Abstract— With large increase in the number internet users different type of work get easy day by day such transfer of data in form of text, voice, image, video from one place to another. So enhancement of images of different users for various resources is selected for research in this paper. As this improve the visualization of the image for showing some of the dull information which is obtain by making some transformation. Proposed work uses Logarithmic function for image enhancement transformation. Experiment is done on standard as well as artificial image sets. Results shows that proposed work better on different evaluation parameters as compare to previous algorithms.

Keywords- Contrast Enhancement, Feature extraction, Logarithmic transformation.

I. INTRODUCTION

At present era peoples used to create, store and distribute data in digital multimedia format by using pen drives, memory cards, CDs/DVDs and hard drives. Multimedia is beneficial for the society in many ways. For example, easy transfer of good quality of images, data, voice and documents has changed the traditional methods of transfer of data and communication which helps society to overcome the difficulties of fast changing digital world. However, this revolution need more work by improving image quality for different analysis. With this aim of improving the image visual quality of an image enhancement technique is develop for human analyzing the in viewing, blurring and noise, increasing contrast, while the details of the image or information remain maintain in the image enhancement operation.

In image enhancement contrast adjustment if digital images is the method for showing much better results. So image quality is more often controlling the contrast as well as brightness of the image for increasing the visibility of an image by adjusting the high frequency or low frequency pixel values of an image.

It also help to find the objects from the dark background in the image by finding it in the region of low contrast area of image. Because of low contrast human eye cannot detect the object clearly in the image, many color dependent methods are not fruitful for this as the object or background methods may be same.

There are many different area for the use of the image enhancement technique one of them is the Synthetic Aperture Radar (SAR) images which are taken from the satellite many time it need to many steps like removing of the noise changing the brightness level where contrast level is adjust. Although sensors are so strong that it can penetrate alkind of atmospheric condition. Now in order to study this kind of image information some preserving steps need to be taken so that information may not get lose and most of the noise or unwanted data can be remove. Some of the common methods of de-noising the images are use of filters like spatial filter, Gaussian filter and Wiener.

The survey is done on techniques that classifies it into two broad categories: Spatial based domain image enhancement and Frequency based domain image enhancement. Spatial based domain image enhancement operates directly on picture elements. The main advantage of spatial based domain technique is that they are relatively simple to implement and have lower complexity. On the other hand, Frequency based domain image enhancement is a term used to describe the analysis of mathematical functions or signals with respect to frequency and operate directly on the transform coefficients of the image, such as Fourier transform, Discrete wavelet transform (DWT), and Discrete cosine transform (DCT). This techniques works on the principle of manipulating the transform coefficients.

II. RELATED WORK

Histogram equalization [3] has one of the best method that is very effective method to process the digital contrast enhancement but has not been suitable for every image. Sometimes it shows not good outcomes. To overcome this problem it provides a new method to improve the image result. In this interact with histogram that reflects improved outcomes as compare to conservative one. On the basis of Absolute mean brightness error and peak Signal to Noise Ratio values. It has an appropriate for real time applications.

The major limitation of contrast enhancement algorithm [4] has Over-Enhancement which could stimulate the loss of edges, alter the main texture, damage the fine details, and create the image appearance unnatural. It has no efficient reason for Over-enhancement until now. The outcomes have shown that the projected technique can establish the Over-enhancement areas perfectly and efficiently and give a quantitative method to assess the Over-enhancement levels fine.

In [2] they have use the DWT in there work where whole work is focus on the LL band of the image the different steps follow in the work are the dominant Brightness, decompose
image into low middle and high intensity values. Then transfer the coefficient values so that contrast values each part such as low, middle, high are adjust finally the inverse DWT is applied. After this Gaussian filter is applied for boundary smoothing. In this work changes are done in the pixel position of the LL band then merge it back that contain the low intensity values but it miss all the vertical, horizontal and diagonal intensity values which are not remain same so most of the information remain same in the image which it need to be cover.

A visual image analysis is always rich in terms of information. Image Enhancement is very simple and interesting area among all types of digital image processing techniques. So in [8] three contrast enhancement techniques namely Image Adjustment, Histogram Equalization (HE) and Adaptive histogram Equalization (AHE) are applied to each band of de-noised SAR image because the SAR image is an RGB image so it contains three planes [9]. The main goal of these techniques is to bring out detail that is hidden in the image or to improve the contrast of the SAR image [10]. So all the three techniques are applied one by one on de-noised SAR image and trying to enhance the visual quality of SAR image.

III. BASIC NOTATION

Image & Matrix: As image is a collection of pixels, which emit different color, based on the specified value. So collection of pixel is actually a matrix of n dimension, where n depends on different color format. Such as for RGB image of 100 x 100 pixel contain three matrix, one matrix for red, one for green and one for blue. While same image for gray format have single matrix of 100x100 dimension.

Spatial domain: This techniques directly deal with the image pixels. The pixel values are manipulated to achieve desired enhancement. Spatial domain techniques like the logarithmic transforms, power law transforms, histogram equalization are based on the direct manipulation of the pixels in the image. Spatial techniques are particularly useful for directly altering the gray level values of individual pixels and hence the overall contrast of the entire image.

Logarithmic transformation is the technique which maps a narrow range of low gray levels into a wider range of gray levels i.e. expand values of bright pixels and compress values of dark pixels. If C is the scaling factor, then log transformation can be achieved as

\[ S = C \log (1 + |r|) \]  

(1)

Logarithmic image of a cameraman reveal more detail as shown in Fig.4.

IV. PROPOSED WORK

Pre-Process:

Here image is read from the database and convert into required environment. As most of the image are of 3D matrix so conversion of this 3D matrix to 2D is done. Here RGB image is read from the database then convert it into gray scale. This can be understand by fig. 2.

Problem Identification: In [2] if the DWT is replace with the logarithmic function then two things get improve first is the image information or the quality of the image as it will handle whole intensities of the image by analyzing each one thing that some of the information which is present in the horizontal, vertical and diagonal part are improved as these are left in previous work. Second factor is the time complexity as DWT two major steps are remove that are division of image into four quadrant then inverse DWT.
**Logarithmic Transform:**

In this transformation of image pixel values is done. As this transformation can directly modify the pixel value so some precaution is taken during this process. Chance of new color of the pixel is totally depend on the previous value, so an average value of the surrounding pixels is taken for uniformity of the transformation. This is done by equation (1). This can be understand as let I image has pixel position (m, n) then its transformation is done by below steps.

\[
S = \sum \text{Surround} \left[ C \log \left(1 + \left| I(m, n) \right| \right) \right] \\
T(m, n) = \exp(S)
\]

Image De-Fusion

Here image is divide into three part base on the new transform values. As new pixel value is compare for three category first is low pixel value second is middle and third is high intensity value. Base on the two threshold value one can classify image or defused. Let low threshold value is \( L_t \) and high threshold value is \( H_t \).

\[
\text{Loop 1: i} \\
\text{Loop 1: j} \\
\text{If } I(i, j) < L_t \\
\quad \text{Sum}_L = \text{Sum}_L + I(i, j) \\
\quad \text{L_count} = \text{L_count} + 1 \\
\text{ElseIf } I(i, j) > H_t \\
\quad \text{Sum}_H = \text{Sum}_H + I(i, j) \\
\quad \text{H_count} = \text{H_count} + 1 \\
\text{Else} \\
\quad \text{Sum}_M = \text{Sum}_M + I(i, j) \\
\quad \text{M_count} = \text{M_count} + 1 \\
\text{EndIf} \\
\text{EndLoop} \\
\text{EndLoop}
\]

\[
\text{mL} = \frac{\text{Sum}_L}{\text{L_count}} \\
\text{mH} = \frac{\text{Sum}_H}{\text{H_count}}
\]

**Adjust Contrast**

Now contrast of the image is adjust by equation no 2. For the global contrast enhancement, the knee transfer function stretches the low-intensity range by determining knee points.
according to the dominant brightness of each layer as shown in Fig. 3(a). More specifically, in the low-intensity layer, a single knee point is computed as

\[ Pl = bl + w_1^*(ml-bl) \]

Where

\[ \delta = \left[ \left( \frac{L}{M_k} \right)^{1/\lambda} - \left( 1 - \frac{L}{M_k} \right)^{1/\lambda} \right] + 1 \] – – – eq.2

Where \( M \rightarrow k = \begin{cases} Pl = Lt + C1^*(mL-Lt), \\ Ph = Ht - C2^*(Ht - mH) \end{cases} \)

\( mL, mL \) is mean of low intensity values and high intensity values. \( C1, C2 \) are constant. \( L \) is representing pixel value in the image.

**Fused Image**

In this step all pixel values of different region of intensity are reposition to its original position in the image matrix. This can be understand as if the pixel value \( p \) is of position \( m, n \) then place this updated value after adjusting the contrast value of the pixel is done in this step.

V. EXPERIMENT AND RESULT

**Experimental Setup:**

This section presents the experimental evaluation of the proposed Image contrast enhancement technique. All algorithms and utility measures were implemented using the MATLAB tool. The tests were performed on an 2.27 GHz Intel Core i3 machine, equipped with 4 GB of RAM, and running under Windows 7 Professional. Experiment done on the video that are of different environment.

**Dataset:**

Dataset: Here for the experiment different images are use at the initial level but as the standard images for watermarking are use such of lena.jpg 256X256, modrila 512X512, few of random images of Tajmahal.jpg 225X225 dimension.

**Evaluation Parameters:**

For performance evaluation, we used the measure of enhancement (EME) [15], which is computed

\[ EME = \frac{1}{k_1k_2} \sum_{k=1}^{k_1} \sum_{l=1}^{k_2} \frac{I_{max}(k, l) - I_{min}(k, l)}{I_{max}(k, l) + c} \]

where \( k_1k_2 \) represents the total number of blocks in an image, \( I_{max}(k, l) \) represents the maximum value of the block, \( I_{min}(k, l) \) represents the minimum value of the block, and \( c \) represents a small constant to avoid dividing by zero.

**Results:**

<table>
<thead>
<tr>
<th>Images</th>
<th>Proposed Work</th>
<th>Previous Work [2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lena</td>
<td>15.2022</td>
<td>11.9866</td>
</tr>
<tr>
<td>Mandarin</td>
<td>33.0501</td>
<td>12.9457</td>
</tr>
<tr>
<td>Taj Mahal</td>
<td>10.5979</td>
<td>7.07773</td>
</tr>
</tbody>
</table>

Table 1. Represent Measure of enhancement value of both propose and previous work.

Table 1 is the comparision results of the propose method and previous work in [2]. As it is found that propose method have all the values obtain from the evaluation parameters Measure of Enhancement is better then previous work in [2].

Figure 5 represent the average value of measure of enhancement for previous and propose workproposed work is much better as compare to previous [2].
VI. CONCLUSION

As the research in image processing field is improving day by day. This paper also contributing in this field by contrast enhancement of images. Here by the use of Logarithmic function with diffusion a new approach is develop for contrast enhancement. Experiment is done on standard as well as on artificial images of different category and environment. Results show that proposed work works better as compare to previous one. There is always work remain in every field for research, so work on color images is required for contrast enhancement.

REFERENCES

[5]. “CHAPTER 2. WAVELET TRANSFORMS ON IMAGES” sundoc.bibliothek.uni-halle.de/diss-online/02/03/H033/t4.pdf