A Neural Network based Approach for Image Enhancement using Histogram Equalization

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Abstract

Histogram equalization (HE) is one of the common methods used for improving contrast in digital images. Image enhancement improves an image appearance by increasing dominance of some features or by decreasing ambiguity between different regions of the image. The basic idea of Histogram Equalization method is to re-map the gray levels of an image. Histogram equalization (HE) is a simple and effective contrast enhancement technique which distributes pixel values uniformly such that enhanced image have linear cumulative histogram. The HE technique is a global operation hence it does not preserve the image brightness. An artificial neural network involves a network of simple processing elements (artificial neurons) which can exhibit complex global behavior, determined by the connections between the processing elements and element parameters. The utility of artificial neural network models lies in the fact that they can be used to infer a function from observations and also to use it. This paper is an attempt to improve the quality of digital images using Histogram Equalization and Spatial Filters with the help of neural networks.

Keywords: Histogram, Pixel, Neural Network, Spatial filter, processing element.

I. INTRODUCTION

Digital image processing is a popular and challenging area with direct connection to our daily life. The primary constituents of image processing basically include study, modification, storage, and display of graphical images from sources such as photographs, drawings, and so on. Important information may be lost due to improper or uneven lighting conditions during sensing. Image enhancement is the process of image to enhance certain features of an image. 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. Image enhancement is used in the following cases: Removal of noise from image, enhancement of the dark image and highlight the edges of the objects in an image etc. The result is more suitable than the original image for certain specific applications. The image enhancement techniques are very much problem oriented. For example, best techniques for enhancement of X-ray image may not be the best for enhancement for microscopic images. There exist many techniques that can enhance a digital image without spoiling it. The enhancement methods can broadly be divided into the following two categories: Spatial Domain Methods and Frequency Domain Methods. Spatial domain methods are operated directly on pixels whereas frequency domain methods operate on the frequency domain of an image.

To enhance the degraded image many techniques are used such as amplitude scaling, contrast modification through histogram equalization etc. Histogram is one of the fundamental techniques of Spatial Domain. Histogram processing is the act of altering an image by modifying its histogram. Common uses of histogram processing include normalization by which one makes the histogram of an image as flat as possible.

Histogram Equalization is a technique that generates a gray map which changes the histogram of an image and redistributes all pixels values through mathematical models. Histogram equalization allows for areas of lower local contrast to gain a higher contrast. This paper explains a novel approach for image enhancement which includes a statistical approach along with a back propagation neural network to equalize the histogram.

II. BACKGROUND STUDY

Similar types of work are being carried out in this area by different researchers.

Some works are listed below:


discusses various enhancement schemes used for enhancing an image which includes gray scale manipulation, filtering and Histogram Equalization (HE).


Though histogram equalization is a useful technique for improving image contrast, but sometimes its effect is too severe for many purposes.

III. PROPOSED WORK

In this work the image is enhanced by using a combined approach (statistical and neural network) to uniformly distribute the pixel intensities. The image enhancement process can be done by using any of the statistical approach. But the statistical approach sometimes gets affected by different parameters such as the round off error, image resolution, and accuracy of statistical approach. The proposed work may act as a solution to the above said problems. Here an efficient approach is used to enhance the image in terms of brightness, PSNR ratio, and resolution.

A. Histogram Equalization:

This application describes a method of imaging processing that allows images to have better contrast. This is attained via the histogram of the picture using a method that allows the areas with low contrast to gain higher contrast by spreading out the most frequent intensity values.

In general, a histogram is the estimation of the probability distribution of a particular type of data. An image histogram is a type of histogram which offers a graphical representation of the tonal distribution of the gray values in a digital image. By viewing the image’s histogram, we can analyze the frequency of appearance of the different gray levels contained in the image. A good histogram is that which covers all the possible values in the gray scale used. This type of histogram suggests that the image has good contrast and that details in the image may be observed more easily.

As stated earlier, basically the histogram equalization spreads out intensity values along the total range of values in order to achieve higher contrast. This method is especially useful when an image is represented by close contrast values, such as images in which both the background and foreground are bright at the same time, or else both are dark at the same time.

The algorithm of proposed work

1. Take an unenhanced image
2. Apply the unenhanced image to statistical approach that is the enhanced image.
3. Store the output of statistical approach that is the enhanced image
4. Apply the median filter against the enhanced image
5. Convert the filtered image (enhanced) and original image (unenhanced) in to binary image.
6. Take right most and second right most bits of each pixel of original image as input to the neural network
7. Take right most and second right most bits of each pixel of enhanced image as target to the neural network
8. Train the neural network to get the output.
9. Then substitute output of the neural network to the enhanced image
10. Apply the median filter
11. Find out the output, an enhanced image with uniform histogram and Low PSNR.

IV. RESULT AND OBSERVATION

The proposed work was implemented in matlab7 environment which is an efficient tool for image processing. Here the neural network tool box is used to map the two LSB bits of the original image to enhanced image. The neural network used consists of 2 layers. The hidden layer contain 4 neuron and output layer consists of 2 neuron. Here Train SCG is used as the training function and LERNGDM is used as the learning function. Transfer function for both the layers is Log sigmoidal function and the error is calculated by applying the MSE formula.

In implementation phase 8 images are taken and both the statistical and the proposed approaches were applied on them. In the figures below, the original image, the enhanced image by statistical approach, and the enhanced image by proposed approach are shown along with their histogram and PSNR values.

The PSNR between 2 images is calculated by the formula

\[
PSNR = 10 \cdot \log_{10} \left( \frac{MAX^2}{MSE} \right) \\
= 20 \cdot \log_{10} \left( \frac{MAX_1}{\sqrt{MSE}} \right) \\
= 20 \cdot \log_{10} (MAX_1) - 10 \cdot \log_{10} (MSE)
\]

Fig-1
A Neural Network based Approach for Image Enhancement using Histogram Equalization

Fig-8

Table-1

<table>
<thead>
<tr>
<th>Fig-No.</th>
<th>Size</th>
<th>PSNR For Approaches</th>
<th>Different</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Statistical</td>
<td>Proposed</td>
</tr>
<tr>
<td>1</td>
<td>240x320</td>
<td>-9.0335</td>
<td>-9.6382</td>
</tr>
<tr>
<td>2</td>
<td>1024x768</td>
<td>-8.0448</td>
<td>-8.1731</td>
</tr>
<tr>
<td>3</td>
<td>130x130</td>
<td>-2.9346</td>
<td>-3.2802</td>
</tr>
<tr>
<td>4</td>
<td>134x122</td>
<td>-0.0035</td>
<td>-0.1325</td>
</tr>
<tr>
<td>5</td>
<td>139x139</td>
<td>-17.3960</td>
<td>-17.4611</td>
</tr>
<tr>
<td>6</td>
<td>266x189</td>
<td>-11.7016</td>
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<td>7</td>
<td>116x77</td>
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<tr>
<td>8</td>
<td>124x93</td>
<td>-12.1211</td>
<td>-12.1801</td>
</tr>
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</table>

Analyzing the above figures and table1, it can be inferred that the proposed approach enhances the images more efficiently with lower resolution. From the above results it can be observed that PSNR is showing a reverse effect. That means the PSNR for the proposed approach is less than the PSNR for the statistical approach. This is due to the fact that PSNR is calculated with respect to the original image which is poor in quality. Hence as the PSNR decreases the dissimilarity between the output image and the original image increases thereby improving the quality of the output image.

V. CONCLUSION AND FUTURE SCOPE

From the results and observations it can be inferred that the proposed algorithm works better than the statistical approach. The PSNR is found to be better which shows improvement in quality of the enhanced images. Another characteristic of the proposed work is that it works efficiently for images having lower resolution. The future scope of this algorithm is to put effort towards enhancing the images having higher resolutions. Introduction of hybrid neural networks may give a new direction to this work.

REFERENCES