Fuzzy based Image Enhancement using Attribute Preserving and Filtering Techniques

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ABSTRACT

In this paper a general framework for image improvement is proposed based on fuzzy logic with histogram modification for image improvement is bestowed. During this framework, image enhancement is posed as an improvement downside that minimizes a cost function. Histogram equalization is a good technique for image enhancement. However, a traditional histogram equalization (HE) typically leads to excessive contrast enhancement. By applying the fuzzy membership function the extent of various image attributes will be adjusted; noise lustiness, white/black stretching and mean-brightness preservation could simply be incorporated into the optimization. Conjointly a median filter of 5x5 is additionally incorporated with the fuzzy image enhancement system. The performance of the entire projected system is evaluated by applying it on different test images and therefore the results obtained are conferred. The aim of this paper is to reinforce the color images using the fuzzy filtering techniques. Image enhancement is employed to enhance the standard of a picture. The experiment is applied on varied pictures that prove that proposed image enhancement algorithms enhance poor quality pictures terribly effectively.

Keywords

Fuzzy Logic, Image Processing, Image Enhancement.

1. INTRODUCTION

The objective of image enhancement is to boost the standard image as perceived by a human beings through an image processing algorithm. Image enhancement is performed both in the spatial domain in addition, as in the time domain. In spatial domain technique median filter is employed that works on pixel values of the image. The high-pass filter can work on high-frequency parts of images.

An image enhancement program is one that yields a much better quality image for the aim of some specific application which may done by either suppressing the noise or increasing the image distinction. Image enhancement algorithms are utilized to emphasize, sharpen or smoothen the image details for display and analysis. Enhancement ways are application specific and are often developed through empirical observation. Image enhancement techniques emphasize specific image features to enhance the perception of an image.

2. RELATED WORK

In [16] the authors present a fuzzy gray scale based improvement technique for low contrast image. The degradation of the low contrast image is especially caused by the inadequate lighting throughout image capturing and therefore eventually resulted in non-uniform illumination within the image. Most of the developed contrast improvement techniques improved image quality while not

considering the non-uniform lighting within the image. The fuzzy gray scale image enhancement technique is projected by increasing fuzzy measures contained within the image. The membership function is then changed to reinforce the image by using power-law transformation and saturation operator. The qualitative and quantitative performances of the proposed technique are compared with the different strategies. The proposed technique created higher quality, enhanced image and take minimum processing time than the other strategies.

Image enhancement may be a common operation in image processing. It is a helpful technique for process scientific images like X-Ray images or satellite images. And it's additionally helpful to boost detail in the pictures that are over or under-exposed. Contrast improvement techniques are wide used for image/video processing to attain a wider dynamic range.

Histogram equalization (HE) is widely used for contrast enhancement in different kind of applications because of its easy operation and effectiveness. Examples embrace medical image processing and microwave radar signal processing. One downside of the histogram equalization is found in the fact that the brightness of a picture are modified after the histogram equalization, that is especially because of the flattening property of the histogram equalization. Thus, it is rarely used in consumer electronic products such as TV where protective original input brightness may necessary so as to not introduce unessential visual deterioration. Kim projected the algorithmic rule [15] that preserves the mean brightness of a given image considerably well compared to typical histogram equalization whereas enhancing the contrast and, thus, provides a lot of natural enhancement that may be used in consumer electronic products.

Histogram equalization could be a common technique for enhancing the quality of images. Suppose we've got a picture that is preponderantly dark. Then its histogram would be inclined towards the lower end of the gray scale and all the image detail is compressed into the dark end of the histogram. If we tend to might stretch out' the gray levels at the dark end to supply a lot of uniformly distributed histogram then the image would become much clearer.

Figure 1: Original image and its Histogram, and the equalized versions.

Image Enhancement based on Spatial Domain

In image processing, airspace consists of pixels of space. The spatial improvement refers to an immediate impact on the pixels of the improvement strategies. It is expressed as:

$$G(x, y) = EH[f(x, y)]$$

The $f(x, y)$ and $g(x, y)$ means that before and after pictures were improved. If the EH is outlined in every (x, y) , then it get the purpose of operation EH; if EH is outlined within the (x, y) of a part, then EH is termed the model operation. EH will either act as an image $f(x, y)$, it can even act on a series of images. Supported the spatial domain approach will build histogram equalization much better. This is often a big enhancement approach in statistics. However, within the image processing field, it'll be underexposed or overexposed. An image histogram is the corresponding image pixel gray level of every approximation of the distribution of the likelihood density function. Histogram equalization could be a classical image improvement technology. [13]

The histogram equalization method relies on a distribution function of transformation. It's just like the basis of the histogram correction technique. The essential plan is to use the additive distribution function as a metamorphosis function to remodel the initial image histogram form for the uniform distribution, therefore increasing the dynamic range of pixel gray values to attain the result of enhancing the image contrast. [13]

In fact, the histogram is that the approximate probability and density function. With separate gray levels for the transformation is uttered. This is often the inevitable result of the pixel gray. For these reasons, the digital image will solely be approximate histogram equalization [13].

3. PROPOSED METHODOLOGY

Fuzzy image improvement is completed by mapping image gray level intensities into a fuzzy plane using membership functions, the membership functions are changed for contrast improvement, and also the fuzzy plane is mapped back to image gray level intensities. The aim is to get a picture of upper contrast than the initial image by giving the larger weight to the gray levels that are nearer to the mean gray level

of the image than to those who are farther from the mean. In recent years, several researchers have applied fuzzy set theory to develop new techniques for image improvement. Fuzzy set theory offers a mathematical framework for a replacement image understanding. An image of size $M \times N$ pixels and L gray levels is being used as an array of fuzzy singletons, everyone is having a worth of membership denoting its degree of brightness relative to some brightness levels.

Fuzzy image processing methodology consists of 3 stages:

- Fuzzification (Image coding),
- Operations within the membership plan, and
- Defuzzification (Decoding of results).

Fuzzification will mean that we tend to assign an image with one or a lot of membership value relating to attention-grabbing properties (e.g. Brightness, edginess, and homogeneity). When the transformation of image in the membership plan (Fuzzification), an acceptable fuzzy approach modifies the membership values is projected. To realize changed gray levels, the output of membership plan ought to be decoded (defuzzification).

It means the membership values are transformed into the gray-level plane. As an example, to manage the gray ambiguity, the gray levels should be fuzzified in reference to the placement of an image histogram. It means every gray level is allotted to a degree of membership reckoning on its location within the histogram. Generally, dark pixels are allotted as low membership values, and bright pixels are allotted as high membership values.

Fuzzy Membership Function:

$$\mu_F(m, n) = \begin{cases} 1.5 \times (\mu_{mn})^2 & 0 \leq \mu_{mn} \leq 0.5 \\ 1 - (1.5 \times (\mu_{mn} - 1)^2) & 0.5 < \mu_{mn} \leq 1 \end{cases}$$

The improved median filter selects the median from the window by initial sorting the pixels in ascending order or degressive order. This method of selecting the median type each window and using it as a sturdy value and honest illustration of the pixels within the window may be a greedy technique that's utilized.

The greedy algorithmic program is an optimization problem solving technique that produces the selection that appears best at the instant. That is, it makes a regionally optimum selection within the hope that this selection can result in a globally optimum answer. The greedy technique is applied within the selecting of the norm within the window.

When the median value is capable the minimum value of identical window, then the change median technique is applied within the computation of the effective median. The method selects consequent higher stratified worth from the sorted list. A check is carried on the worth elite to verify if it's an impulse or not. During this means the effective norm is computed.

Figure 2: Proposed Algorithm for Image Enhancement

4. IMPLEMENTATION AND RESULTS

A programming tool referred to as MATLAB is employed to develop the improved algorithmic program in order that its operation might be verified and tested. MATLAB could be a superior language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where issues and solutions are expressed in acquainted notational system. The MATLAB programming language was used because it handles terribly giant dimensions of matrices and speed up mathematical operations on matrices.

The implementation of the improved median filtering algorithmic program is employed to scale back noise within the image, just like the adaptive median filter and also the normal median filter. The plan is easy to look at the element values within the designated window of the signal and replace the noisy and distorted or blurred pixels with the median/effective median. The program works by employing a moving mounted 5×5 window of element neighborhoods. For each movement the operation of the improved algorithmic program is applied. The 5x5 mounted window was wont to scale back the complexness of the method and conjointly to scale back the time needed to kind the pixels values in ascending order. The planned algorithmic program achieves excellent results even with noisy and boring pictures.

Table 1: PSNR of Input and Output Image

Input Image	Input PSNR	Output PSNR
a.png	26.4	25.6
b.png	26.7	28.8
c.png	19.8	21.3

d.png	21.2	22.9
e.png	22.2	23.8
f.png	24.2	26.1
g.png	21.4	22.4

Table 2: MSE of Input and Output Image

Input Image	Input Image MSE	Output Image MSE
a.png	145.6	177.0
b.png	137.4	85.3
c.png	667.2	478.6
d.png	484.6	333.3
e.png	385.1	268.2
f.png	246.0	156.2
g.png	467.2	368.8

Figure 3: Results taken from proposed method

Input Image – a.png

Output Image

Figure 4: Simulation results of test image 'a.png'

Figure 4, 5, 6, seven shows the resulting images obtained by the proposed technique for the color based mostly images. it's simply recognized that resultant image has sharp color as compare to the initial image that is inputted by the user. it's simply seen that the distinction of the image is improved while not having any visual artifacts that decrease the visual quality of the input image and cause it to possess an unnatural look.

Input Image – b.png

Output Image

Figure 5: Simulation results of test image 'b.png'

Input Image – c.png

Output Image

Figure 6: Simulation results of test image 'c.png'

Input Image – g.png

Output Image

Figure 7: Simulation results of test image 'b.png'

5. CONCLUSION

The proposed enhancement technique using fuzzy set theory has been developed for all images includes color as well as gray-scale non-uniform illumination images. The findings signified that the proposed method produced better image quality and compete with other methods in terms of image contrast and measure of fuzziness without enhancing existing noise in the image.

In this paper a technique is proposed with fuzzy logic enhancement based median filter technique for image enhancement, The outputs of the projected techniques are complied in Matlab 7.0.1 surroundings. it's concluded that median filter is effective tool to get rid of the random whereas incidence of image noise and unsharp masking can perform the image enhancement. Though the planned methodology outperforms the prevailing denoising techniques at higher price of noise variances, however scope of improvement still exists. As this methodology involves a 2 stage method, the quantity of computations is extremely high and thence the simulation time will increase with increase within the size of the corrupted image. Therefore as a future work, modifications is also incorporated to scale back the computation time and create the algorithm quicker.

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