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Fast Fourier Transformation on Image Enhancement Process in Digital Image Processing

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Abstract: *Digital image processing is the use of a digital computer using an algorithm to process digital images. The method of image enhancement has a very important role in image processing and resolution. It is the method of modifying and adding various changes to an input digital images so that the effects are more suitable for display or further image analysis. This type of current method suggests that the colour sensations have a clear association with reflectance, depending on the reflectance and illumination product, and the amount of visible light reaching observers. The Retinex technique is generally used to boost the accuracy of the photographs that are processed. Histogram equalisation is the most common image enhancement algorithm that is used to improve image contrast. In this paper, we suggested fast and optimal image based on Retinex method enhancement algorithm for Quality enhancement, such as sharpening, smoothing, Reduction in computational time and image details by using Fast Fourier Transport with Retinex and histogram equalisation.*

Key words: *Image processing, image enhancement, fast fourier transform, Retinex algorithm, single scale Retinex, multi scale Retinex, histogram equalisation*.

1. INTRODUCTION:

Digital Image Processing is the process of a digital images by use of digital computers through an algorithm. In digital image processing, variety of algorithms can be processed to an input image and the output image can be rendered more attractive to viewers by using the methods of image processing. Image enhancement is one of the key and most promising areas of digital image processing. It allows techniques to upgrade the image quality to make the resulting image more effective than the original image. The basis of this process is to enhance the low image contrast and focus the hidden image description. While converting an image from one form to another, such as digitising an image, may cause some form to occur. Image processing is defined as the process of analysing and manipulating images on a computer. The most famous image enhancement techniques algorithms are equalisation of histograms, filtering of low passes, and High-pass filtering applicable to a certain particular region having certain disadvantages. Low-pass filtering and high-pass filtering, respectively, can only sharpen and smooth the image. Histogram equalisation is used for image enhancement by evenly distributing the value of image intensity and is useful for maintaining an image's contrast and brightness.

To enhance the consistency of the processed images, the Retinex method is commonly used. A non-linear spectral algorithm that mimics the Retinex algorithm is framework of human vision which offers simultaneous complex dynamics compression of range and constancy of colour. The algorithm for Retinex for centred on recursive bilateral filtering, image enhancement is proposed to solve the problems of the previous algorithm, almost solved problems, but particularly in computational time, still requires improvement. Notably, almost all the algorithms for enhancement have their own cons and prons.

2. FAST FOURIER TRANSFORM:

The first step in the proposed method is to compute the Fast Fourier Transform (FFT) of the spatial domain input image. The effect of FFT is a frequency domain that does not include all image-forming frequencies, but only a collection of samples that are sufficiently large to completely characterise the image of the spatial domain. Filters may be added to the image by convolution until the image is converted into the frequency domain. FFT transforms the complex operations of convolution into straightforward multiplications. To obtain the product of convolution, an inverse transform is then performed in the frequency domain. All the significant details are contained in the resulting image. It is computationally easier to apply philtres in the frequency domain to the image than to do the same in the image domain. This will speed up and have better outcomes for the process.

The Fast Fourier transport of image S(u,v) is denoted by F(x,y) is given by the equation:

$$f(x,y) = \sum_{u=0}^{M-1} \sum_{v=0}^{N-1} s(x,y) e^{-j2\pi\left(\frac{xu}{M}+\frac{yv}{N}\right)}$$

where u= 0,1,2,…,M-1 and v=0,1,2,…,N-1

denoted a digital image of size M x N pixels. And x= 0,1,2,…,M-1 and y=0,1,2,….,N-1 which determine the frequencies of u and v. S(u,v) is the image in spatial domain and F(x,y) is the exponential term corresponding to each point f(x,y) is the fourier space. The f(x,y) is obtained by multiplying the image with the corresponding function in the spatial domain and summing up the result. This showed that the number of frequencies in the domain of frequency is equal to the number of pixels in the domain of space, i.e. the image in the domain of space and the domain of frequency are of the same size. The outcome of FFT is a complex number that has a wide range in the spatial domain than the image. In addition, the complex range of Fourier coefficients is too large to be shown on the computer, so these values must be scaled to within the range of values that can be displayed.

3. RETINEX THEORY:

Edwin Land first formulated this theory in 1977, and later Jobson.et al suggested two of the most famous retinex algorithms are Single Scale Retinex (SSR) algorithms and Retinex Multiple Scale (MSR). A human lightness and color perception model that defines an image enhancement approach that aims to bridge the difference between digital images and those images perceived by the human eyes. Provides a means of sharpening an image, improving its color quality regardless of illumination variations, and the means of achieving compression of dynamic range.

The general method of retinex algorithm is

S(u,v): log(S(u,v)) = s log(R(u,v)) = r log(L(u,v)) =l
S(u,v) = R(u,v)* L(u,v)

Where, S(u,v) = original image
R(u,v) = reflectance and
L(u,v) = illumination

3.1 SINGLE SCALE RETINEX:

Single Scale Retinex is an image enhancement algorithm where the difference between the value of the input image and its neighborhood average is calculated by the output image.

SSR for an image R_i(u,v) = log (P_i(u,v) – log[F(u,v) *P_i(u,v)]

$$R_i(u,v) = \log\left(\frac{P_i(u,v)}{F(u,v) * P_\iota(u,v)}\right)$$

$$= \log\left(\frac{P_i(u,v)}{P\text{^}-_\iota(u,v)}\right)$$

Where, P_i(u,v) : the image distribution in the i^{th} spectral band
R_i(u,v) : retinex output

By using Gaussian function to F(u,v), the normalized surrounded function is

$$F(u,v)=ke^{-(u2+y2)/C2}$$

Therefore, C is the gaussian surrounded space constant

K is determined by

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$$\iint F(u,v)dxdy = 1$$

Either dynamic range compression or colour rendition can be given by this algorithm.

3.2 MULTI SCALE RETINEX: (MSR)

An extension of the single-scale Retinex algorithm is the multi-scale Retinex (MSR) algorithm. The choice of the correct scale σ for the surround filter F (x, y) is crucial in SSR due to the trade-off between dynamic range compression and color rendition, and MSR seems to have an appropriate trade-off between a good local dynamic range and a good color rendition. A weighted sum of the outputs of several SSRs is known as the MSR output.

The multiscale retinex of the formula can be represented as,

$$R_{MSRi} = \sum_{n=1}^{N}(WnRni)$$

Where, $R_i(u,v) = \log[\, P_i(u,v)] - \log[\, F_n(u,v) * (P_i(u,v)]$

$$R_{MSRi} = \sum_{n-1}^{N} w_n\{\log[\, P_i(u,v)] - \log[\, F_n(u,v) * (P_i(u,v)]\},$$

i = 1,2,…,s,

n is the number of scales, Rni is the i^{th} component of the nth scale, R_{MSRi} is the ith spectral component of the MSR output, and $w_n$is the weight with nth scale. The MSR algorithm is better than SSR which can simultaneously achieve both dynamic range compression and color rendition, but has some problems with halation.

4. HISTOGRAM EQUALIZATION:

Histogram equalisation is a processing method for computer images used to increase image contrast. This is accomplished by distributing the most frequent intensity values efficiently, i.e. by expanding the intensity range of the image. Typically, this technique increases the global contrast of images when near contrast values reflect their accessible data. This enables greater contrast to be obtained in areas of lower local contrast.

5. EXPERIMENTAL EVALUATION:

We used MATLAB software to test the proposed framework. This software is used to evaluate fast fourier transformation techniques that apply to an image to improve image quality.

5.1 Subjective analysis:

The following figures are the testing results. These are original image, enhanced image by Multi Scale Retinex and enhanced image by histogram equalization.

5.1.1. Histogram equalization:

Figure:1(a)

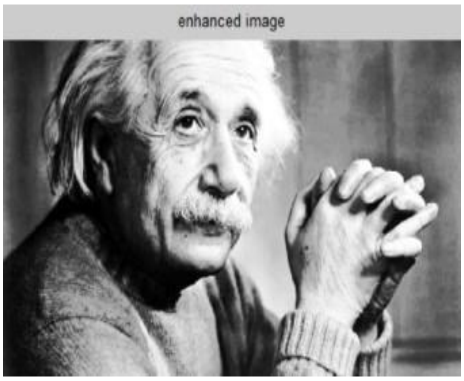

Figure:1(b)

5.1.2 Multi scale retinex:

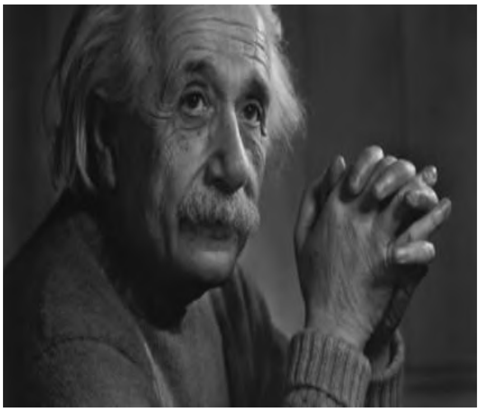

Figure:2(a)original image

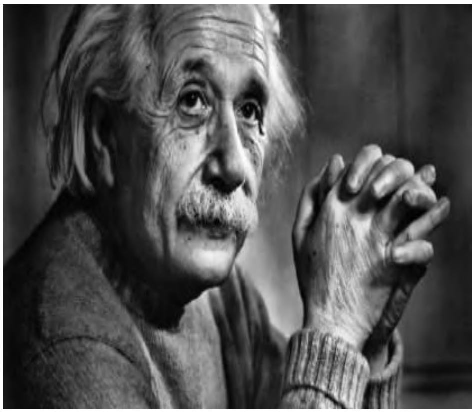

Figure:2(b) enhanced image

6. RESULT AND CONCLUSION:

In this paper, we suggested a fast and efficient image enhancement algorithm based on fast Fourier transforms with histogram equalisation instead of conventional application of gaussian filter to an image. In the frequency domain, we applied the filter and optimized the visual effect with histogram equalization. The result shows that the fast fourier transform with histogram equalisation provided better improvement compared with multi scale retinex.

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