Digital Image Watermarking In Frequency Domain

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Abstract: *Notwithstanding the high availability of image contents, multimedia products propose very low quality pictures, primarily due to the fact that effective systems for the copyright protection of multimedia works are unavailable. A digital image can, in fact, be easily reproduced obtaining as many identical copies of it as we want, without any possibility to prevent it. To get around the problem, further than scrambling the data to be protected by means of cryptographic techniques, code carrying information about IPR could be invisibly embedded into them, in such a way to provide a mean to control their distribution. This is the aim of image watermarking techniques. In this paper general issue related to copyright protection of digital data as well as some items referring to the embedding of a watermark in the frequency domain, are discussed.*

Key Words:

Frequency domain image filtering, high pass filter, low pass filter

I. INTRODUCTION

Signals are converted from time or space domain to the frequency domain usually through use of the Fourier transform. The Fourier transform converts the time or space information to a magnitude and phase component of each frequency. With some applications, how the phase varies with frequency can be a significant consideration. Where phase is unimportant, often the Fourier transform is converted to the power spectrum, which is the magnitude of each frequency component squared. Filtering, particularly in non-real-time work can also be achieved in the frequency domain, applying the filter and then converting back to the time domain. This can be an efficient implementation and can give essentially any filter response including excellent approximations to brick wall filters. There are some commonly-used frequency domain transformations.

II. What is the need of frequency domain analysis?

Often the Fourier transform is converted to the power spectrum, which is the magnitude of each frequency component squared. The most common purpose for analysis of signals in the frequency domain is analysis of signal properties. It is remarkably useful to analyze the frequency spectrum of a signal

III. Frequency domain Filtering

Frequency domain is basically a space defined by Fourier transform. Fourier transforms has wide applications in image processing, such as image analysis, image filtering, image reconstruction and image compression. In frequency domain analysis, it indicates that how signal energy is distributed over a range of frequencies. The basic principle of the frequency domain image filtering consists of computing a 2-D discrete Fourier transform of the image, for instance the 2-D DFT, manipulating the transform coefficients by an operator i.e. filter function and then performing the inverse discrete Fourier transform.

IV. Frequency Domain

We first transform the image to its frequency distribution. Then our black box system performs whatever processing it has to performed, and the output of the black box in this case is not an image, but a transformation. After performing inverse transformation, it is converted into an image which is then viewed in spatial domain.

V. Frequency Domain Analysis

Till now, all the domains in which we have analyzed a signal, we analyze it with respect to time. But in frequency domain we don't analyze signal with respect to time, but with respect of frequency.

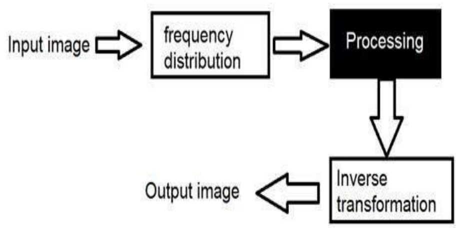

Figure 1. Frequency domain processing

VI. Spatial Domain

In spatial domain, we deal with images as it is. The value of the pixels of the image change with respect to scene. Whereas in frequency domain, we deal with the rate at which the pixel values are changing in spatial domain

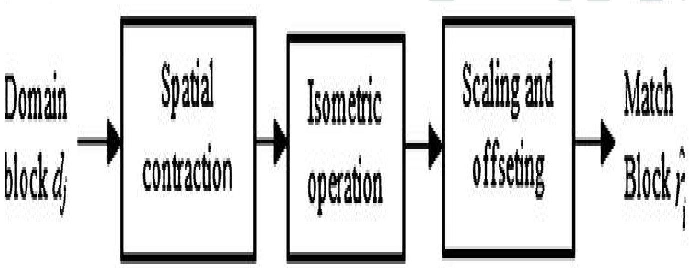

Figure 2. Spatial Domain Processing

VII. Transformation

A signal can be converted from time domain into frequency domain using mathematical operators called transforms. There are many kind of transformation that does this. Some of them are given below.

- Fourier Series
- Fourier transformation
- Laplace transform
- Z transform

VIII. Image Enhancement

Image Enhancement improves the perception of information in images for human viewers. The deteriorated image due to optics, electronics or environment may be enhanced to restore certain features of an image. The image maybe corrupted by different types of noise such as additive noise, Gaussian noise, impulse noise and Poisson noise etc. To remove these types of noises there are various filters are available. The basic operations performed with noisy image is smoothing and sharpening just as low pass filtering and high pass filtering. Smoothing or blurring of noisy images is analogous to the low pass filtering while sharpening of images represent high pass filtering. The term frequency in images has very interesting definition. It is just representing the changes or transition in pixel intensities. Low intensity transition from pixel to pixel shows low frequency however high frequency indicates high intensity transition from pixel to pixel. The term cutoff frequency in image filter represented by the pixel distance from center pixel of the image, usually it is denoted by D0.

Figure: Examples of image enhancement

IX. FRQUENCY DOMAIN FILTERS

Low Pass Filters

Low pass filter Low pass filter perform smoothing or blurring of images. It is achieved in frequency domain by attenuation of high frequency or high intensity transition. The output of low pass filter contains small or less intensity transition in to a particular group of pixels. We implement Ideal low pass filter (ILPF), Butterworth low pass filter (BLPF) and Gaussian low pass filter (GLPF) on MATLAB platform and analyze it. Ideal low pass filter (ILPF) ILPF gives ideal response for image filtering. It passes all the frequency within a circle of radius D0 which is cutoff frequency of ILPF.

High pass filter

High pass filter performs sharpening of images. It is achieved in frequency domain by attenuation of low frequency or low intensity transition. The output of high pass filter contains high intensity transition in to a particular group of pixels. We implement Ideal high pass filter (IHPF), Butterworth high pass filter (BHPF) and Gaussian high pass filter (GHPF) on MATLAB platform and analyze it. Ideal high pass filter (IHPF) The filter function of IHPF is given by equation 3.5

H (u, v) = 0 if D (u, v) ≤ D0 1 if D u, v > $D0$ …………. Equation .3.5

X. Steps for filtering in the frequency domain

1. Let original image f(x, y) of size M X N that is discrete image.

2. Apply zero padding to f (u, v) to get image fp (x, y) of size P X Q. such that P= 2M and Q= 2N. Padding means appending necessary number of zeros to original image f (u, v).

3. Multiply the padded image fp (u, v) by $-1^{(x+y)}$ to center the transform to u=$\frac{p}{2}$ and v=$\frac{q}{2}$. Where u and v are center coordinate of padded image.

4. Compute the 2D- DFT of centered image f (u, v).

5. Define filter function h(x, y) of size P X Q get H (u,v) that is FFT of h(x, y)

6. Centralize the coordinate of H (u, v) at ($\frac{p}{2}$), $\frac{q}{2}$.

7. Multiply F (u, v) by a filter function H (u,v).

8. Compute the inverse DFT of the result.

9. Crop the result in 6.

10. Obtain the real part of the result in 6.

11. Multiply the result in (6) by $-1^{(x+y)}$ to reverse centering of the output image as input image.

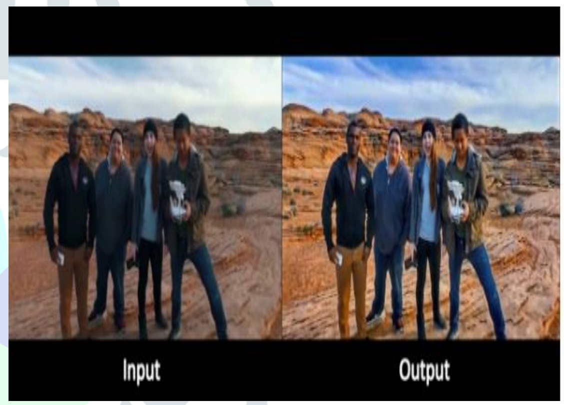

Fig: - Block diagram representing steps for filtering in the frequency domain.

XI. CONCLUSION

Image enhancement is the prime aspect of digital image processing. Image filtering is a very important step in image enhancement. In our paper we implement low pass and high pass filter for same cutoff frequency. We analyze the various results as shown, after successful simulation of all these filters. Their performance depends on selection of cutoff frequency. Other than it, Ideal filter is the desire filter for both the image smoothing and sharpening. This can be achieved using higher order Butterworth filter. Especially for large images frequency domain filtering is much faster. High pass filter preserves the edges by image sharpening and shows only sharp transition of pixel intensity. While low pass filter de-noises the image by smoothing the image and preserves image detail. Selection of cutoff frequency and filter order for Butterworth filter gives variable performance. Gaussian filter gives normal generalized performance exponentially.

XII. REFERENCES

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