IMPACT: International Journal of Research in Engineering and Technology
ISSN (P): 2347–4599; ISSN (E): 2321–8843
Vol. 11, Issue 9, Sep 2023, 41–48

IMAGE COMPRESSION USING GENERALIZATION OF FOURIER SERIES AND FILTERING TECHNIQUE

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Received: 15 Sep 2023 **Accepted:** 15 Sep 2023 **Published:** 27 Sep 2023

ABSTRACT

The Discrete Fourier Transform (DFT) improves image quality without affecting image quality and information. The Fourier transform approach for picture processing and compression is discussed in this paper. We analyzed the performance of an image compression implementation strategy based on the Fourier transform method. We are also monitoring the results of the picture alteration with quantization procedure. After performing the de-quantization approach, the quality of the reconstructed compressed image is also evaluated. Director filter is applied on the filter coefficients.

KEYWORDS: *Robotic Welding System, Sensors, Arc*

INTRODUCTION

Image compression has applications for massive data storage, video conferencing, and medical imaging. Nowadays, the usage of telecommunications, multimedia sources such as cameras, mobile phones, and data transport is rapidly rising. Uncompressed photos always take up more space and bandwidth. The primary goal is to compress images in order to free up memory space for other uses. Reduced memory spaces will be highly valuable in various applications such as hospitals, shops, museums, security cameras, and so on. As data storage prices reduce, so will transmission costs. When the data is no longer needed, it can be removed and then reinserted when we need it.

Images or data are coded in bits in image compression. The multimedia information will be in video, audio, and web formats. When we get photographs from the internet that time will be reduced. So, time performance is also good. We can cut storage costs by using compression methods, while increasing speed and performance. Image compression is used to reduce file size without affecting image quality or condition. Assume an image is 100 kb in size and we compress it to 70 kb in size, saving 30 kb memory for other multimedia tasks. As a result, these compression techniques will be very useful in future telecommunication systems.

The Compression Systems Have Two Types

- **Lossy compression techniques**: In this the unnecessary content is discarded. When we have to save little more storage then some data we may discard.
- **Lossless compression**: In Lossless compression we are computing the data without losing any information. Here; we get the exact same image of our original image.

We get the same image in the same format with a lossless compression technique without losing any information. After compressing the photos, every single bit of info will remain the same. All the data and information will be restored. It does not have a high compression ratio and is highly effective in situations where words are lost or financial concerns arise. It is commonly used in medical reports, x-rays, and legal documents.

Lossless picture compression methods include entropy coding and Huffman coding.

Lossy image compression minimizes the file size by permanently removing some information, particularly redundant data. In video signal compression, lossy compression is performed or audio transmission, where removing certain data also prevents most users from detecting it. Encryption, on the other hand, increases overhead in both the time and space domains. A system that relies extensively on encryption should use the most efficient algorithms possible in order to be scalable.

2. FOURIER TRANSFORM

The Fourier transform is a traditional method for converting images from one format to another. It is also the cornerstone of image processing and is referred to as the second language for picture description. It adds another dimension to picture observation and image to frequency distribution features. Among other things, the Fourier transform allows for alternate to linear spatial filtering. The Fourier transform is more efficient than a spatial filter. For a large filter, the Fourier transform allows us to precisely extract and process specific picture frequencies as well as low-pass and high-pass filters. Image processing frequently performs comparable transformations.

Fourier's description of function as a superposition of sins and cosines has become widely used for analytic and numerical solutions of differential equations, as well as the analysis and management of communication signals. The Fourier transform is useful in that it can analyse a signal's frequency content in the time domain. Because the Fourier coefficients of the converted function represent the contribution of each sine and cosine function at each frequency, the signal may then be analysed for its frequency content. An inverse Fourier transform accomplishes exactly what it sounds like: it transforms data from the frequency domain to the time domain.

The Discrete Fourier Transform (DFT) is extremely appealing for image processing. DFT is a transform that takes a discrete signal in the time domain and that signal in its discrete frequency domain is transformed.

Representation this property of DFT signifies the importance of DFT in the area of spectrum analysis. There are number of extremely fast and efficient algorithms for computing a DFT. One of the algorithms is called as fast Fourier transform or FFT. It is fast and efficient way of calculating DFT, which reduces number of arithmetical computations from. The key of the algorithm is data reorganization and further operations on it. The fast Fourier transform (FFT) also known’s as frequency analysis or spectral involved in the implementation of many digital technique for processing signals and images. FFT being the high speed and discrete nature equivalent of DFT is suitable for the signal’s spectrum analysis in MATLAB.

A 2D signal can be decomposed into its corresponding frequencies using 2D DFT with Fourier Coefficients

$$\cdot\ \hat{f}_{j,k} = \langle f, \omega^{(j,k)} \rangle = \frac{1}{mn} \sum_{u=0}^{m-1} \sum_{v=0}^{n-1} f_{u,v} \overline{\omega}_{u,v}^{(j,k)} = \frac{1}{mn} \sum_{u=0}^{m-1} \sum_{v=0}^{n-1} f_{u,v} e^{-2\pi i\left(\frac{ju}{m}+\frac{kv}{n}\right)}$$

A combination of 2D DFT coefficients can be applied with inverse DFT to get the original signal as

$$f_{j,k} = \left(\sum_{u,v} \hat{f}_{u,v} \omega^{(u,v)}\right)_{j,k} = \sum_{u=0}^{m-1} \sum_{v=0}^{n-1} \hat{f}_{u,v} \omega^{(u,v)} = \sum_{u=0}^{m-1} \sum_{v=0}^{n-1} \hat{f}_{u,v} e^{2\pi i\left(\frac{ju}{m}+\frac{kv}{n}\right)}$$

The above equations denote the discrete Fourier transform (DFT) and the inverse discrete Fourier transform (IDFT), respectively. Using an FFT drastically reduces the time required to compute a DFT. The FFT method recursively divides the original vector into two halves, computes the FFT of each half, and then combines the results. As a result, the FFT is most efficient when the vector length is a power of two.

Steps Followed

- Imported image using *imread*()
- Plotted the image using □□□□□□□() for color image
- Obtained the Fourier coefficients vector using Fast Fourier Transform, B= □□□2()
- Plotted the gray image Fourier Coefficients (as log (□□□ (□)+ 1)
- Created an index matrix to eliminate or scale the chosen Fourier Coefficients and multiplied it to □t
- Applied inverse DFT using □□□□2() and converted the resulting matrix to 8-bit integer for plots using □□□□8()
- Plotted the final image alongside its gray image Fourier Coefficients to show applied modifications using using imagesc()

The Following Figures Represent the Progress of Image Compression Using Fourier Transform

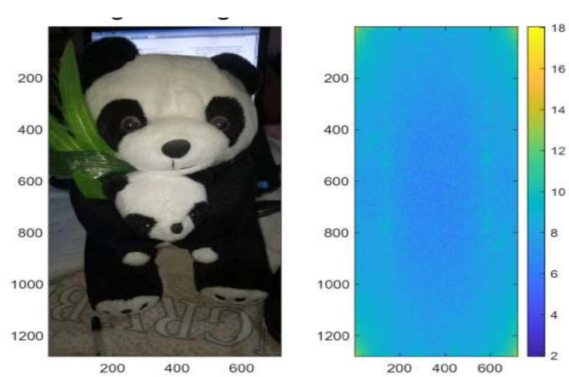

Figure 1: Input Image and Fourier Coefficients.

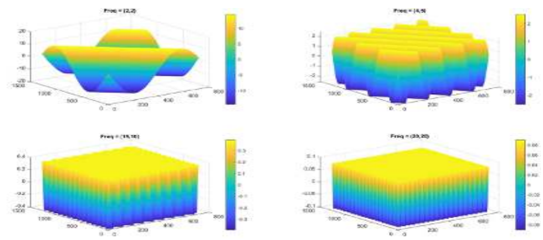

Figure 2: Vector Diagram.

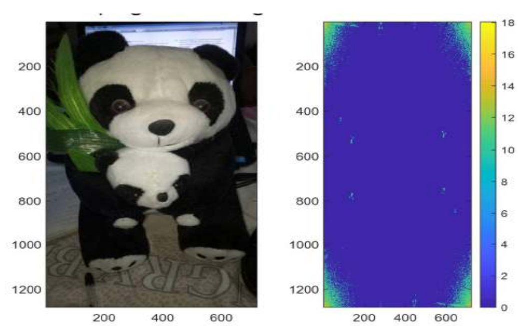

Figure 3: High Pass Filter (Sharp).

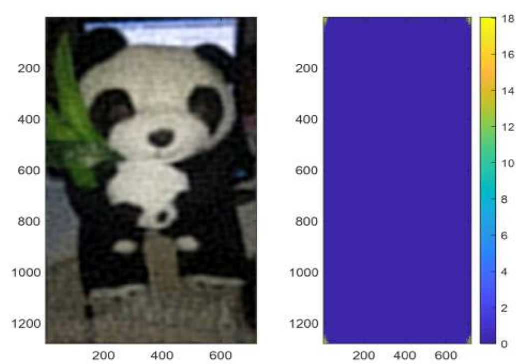

Figure 4: High Pass Filter (Blurred Image).

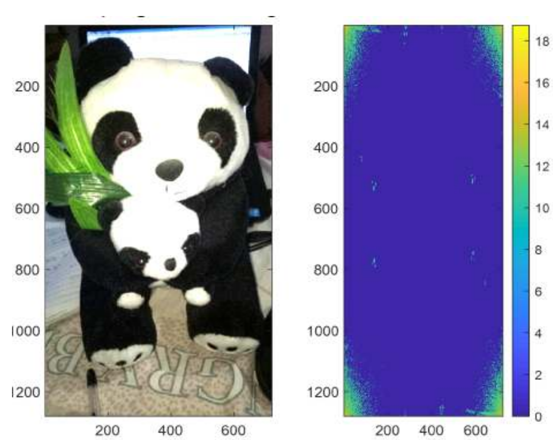

Figure 5: High Pass Filter (Scaled)

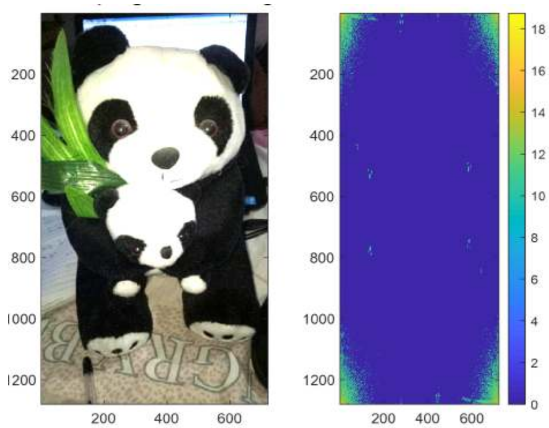

Figure 6: High Pass Filter (Scaled)

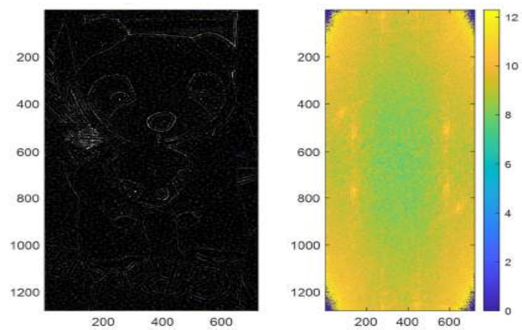

Figure 7: Low Pass Filter (Scaled)

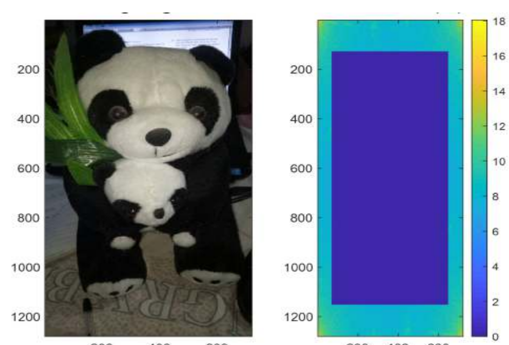

Figure 8: High Region Filter(Low Cutoff)

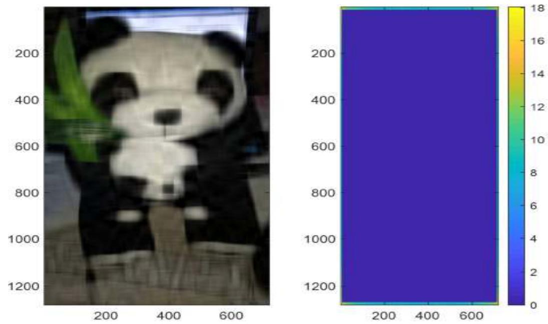

Figure 9: High Region Filter(High Cutoff)

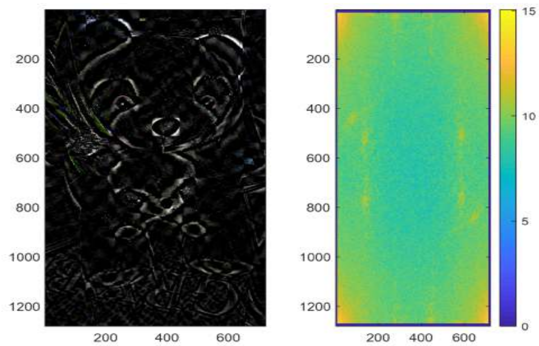

Figure 10: Low Region Filter(scaled)

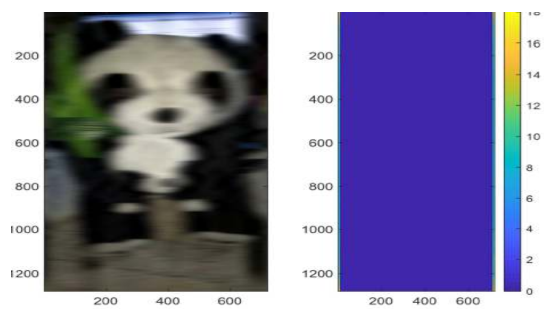

Figure 11: Left\Right Region Filter

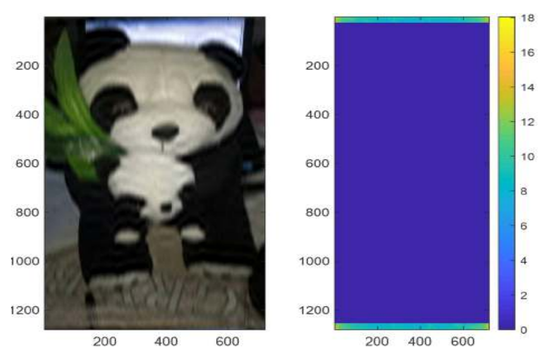

Figure 12: Top\Down Region Filter

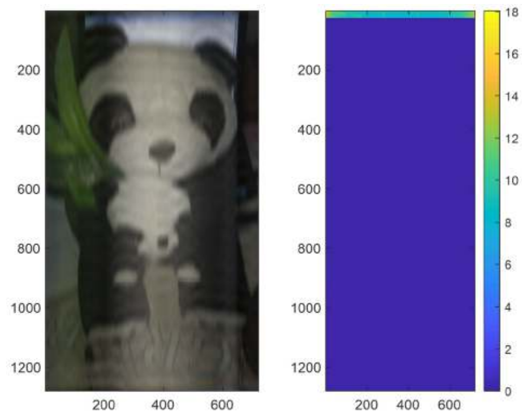

Figure 13: Top Region Filter

The FFT of an image of size m X n is obtained in MATLAB by the function fft2. It Compute its Fourier transform and display the spectrum. This function returns a Fourier transform that is also of size m X n, with the data arranged in the form, origin of the data at the top left and with four quarter periods meeting at the centre of the frequency rectangle.

The Fourier spectrum is obtained by using function abs i.e. S= abs(C). This computes the magnitude of each element of the array. Visual analysis of the spectrum is obtained by displaying it as n image. It is an important aspect of working in the frequency domain. Fft2 puts the zero frequency components at the top left corner. Another function fft shift can be used to make the origin of the transform to the centre of the frequency.

In our experiment, we employed panda image with varying resolution pixels (256x256, 512x512, and 1024x1024). In this research, we present an implementation and simulation approach for image transformation using the Fourier transform and subdividing the picture block size by 4x4. We raised the number of picture blocks to 8x8, 16x16, and 32x32, respectively. After that, we use the fft2 function to transform the entire image block with the Fourier transform, and then we apply the quantization approach to the transformed images.

For each block, the two-dimensional Fourier transform (fft2) is computed. After the de-quantized fft coefficients are computed, the fft coefficients are quantized and communicated. The two-dimensional inverse, ifft2, of each block is computed, and the blocks are subsequently rebuilt into images.

From the Above Analysis, We Can Conclude That

- Filtering out some Fourier coefficients reduces the quality of image
- Quality of image remains intact if high frequency coefficients are kept for compression
- Compression with low frequency coefficients reduces quality significantly
- Scaling of Fourier coefficients causes sharpening/brightening of image
- Unidirectional filter disfigures the image in corresponding direction

CONCLUSIONS

In this paper, image compression using generalization of fourier series with multiple filters in various coefficients. The filters used are low pass filter, high pass filter and directional filter and the performance is plotted.

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