Application of FFT with Badminton

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1 Introduction

After playing badminton for 10 years, a tribute was much needed. The best way to combine my passion of badminton and mathematical computation led me to explore the use of Fourier Analysis in Image Processing. I have taken an image of the badminton racket I am currently using and have used Matlab to return the fourier transform of it. The following pages will contain a quick explanation of the maths, code and the result.

2 Fourier Transform

The Fourier tranform extends the fourier series so that it can be applied to non-periodic functions, which helps us view any function in terms of sum of sinusoids.
The Fourier tranform of a function $f(x)$ is given by:

$$\int_{\infty}^{-\infty} F(k)e^{2\pi ikx}dk \tag{1}$$

We can use this defintion and then further extend it to be used in a 2-D Fourier Transform. The formula below defines the discrete the Fourier Tranform Y of an m by n matrix X:

$$Y_{p+1,q+1} = \sum_{j=0}^{m-1}\sum_{k=0}^{n-1}\omega_m^{jp}\omega_n^{kq}X_{j+1,k+1}$$

(2)

ω_m and ω_n are the complex roots of unity. These can be defined as:
$\omega_m = e^{-2\pi i/m}$
$\omega_n = e^{-2\pi i/n}$
i is the imaginary number. The formula above shifts the indicies for X and Y by 1 to reflect the matrix indicies in Matlab.

The program written has 6 main components:
Loading the image
Converting the image into greyscale
Getting the Fourier Coefficients
Shifting the zero frequency component
Applying the log function to bring out any patterns in the image
Reconstructing the image

3 Results

Code can be accessed here:
https://github.com/Soham-Deshpande/FFTBadminton

Figure 1: Original image

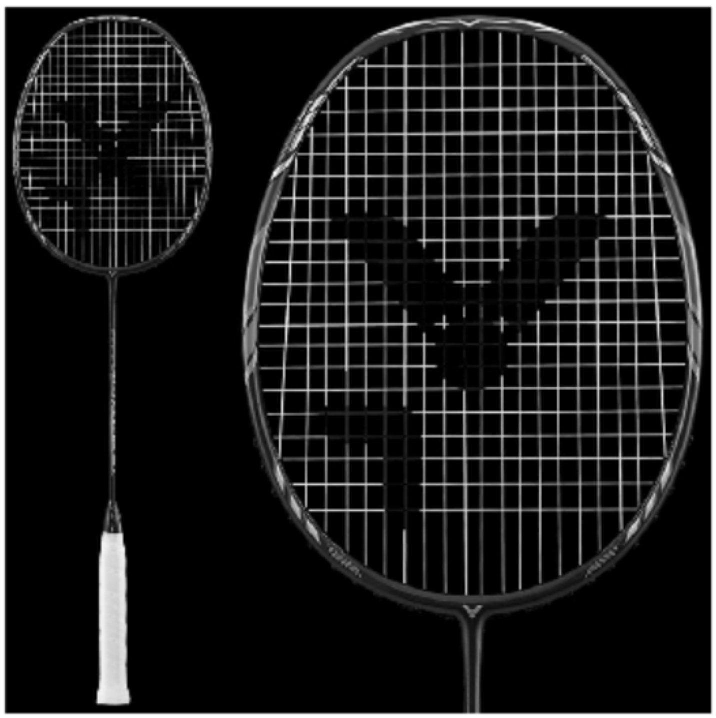

Figure 2: Grey scale image

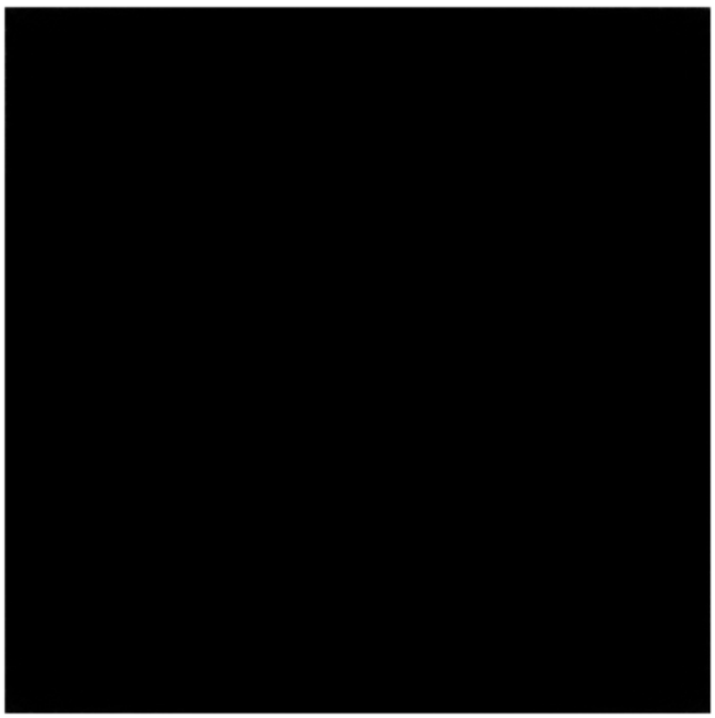

Figure 3: Fourier transform of image

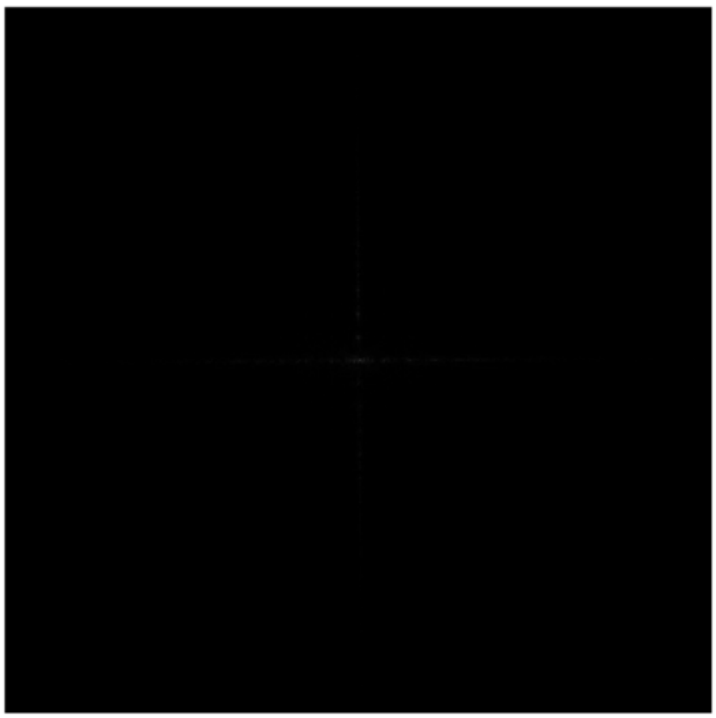

Figure 4: Centered fourier transform of image

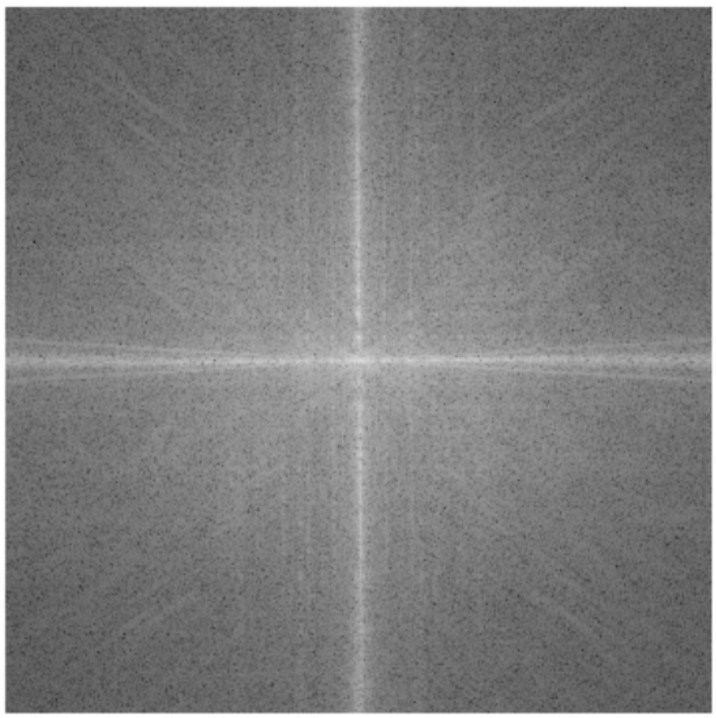

Figure 5: Log fourier transform of image

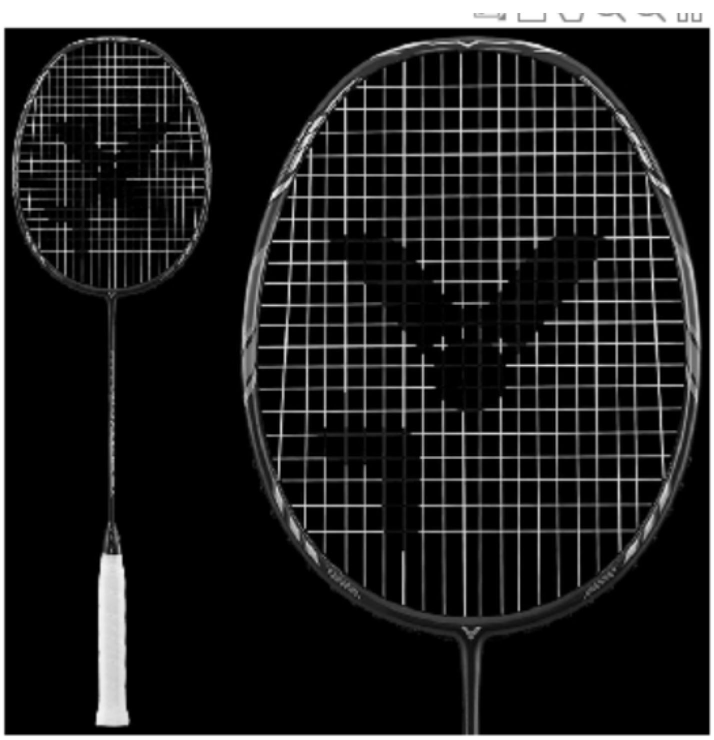

Figure 6: Reconstructed image

4 Conclusion

Beyond image processing, the fourier transform has a multitude of uses. An Application is in modelling time series data which is very relevant to the stock market. I aim to further my knowledge about this powerful tool and look to implement it in my own tools