PHYS-GA 2000 Computational Physics PS5

Kaixuan Zhou

November 28, 2023

1 Problem 1

In problem 1, we imported two frequency sets of two instruments: Piano and Trumpet. Following is the plot of the original waveform of the two instruments:

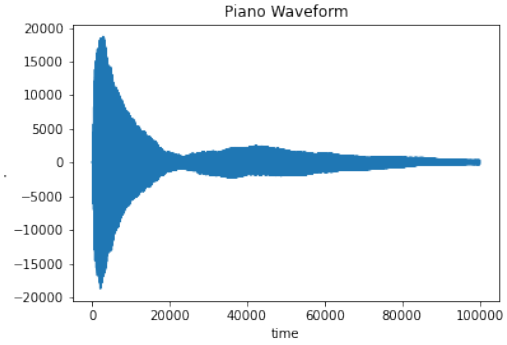

Figure 1: It is the waveform of the piano of time and frequency.

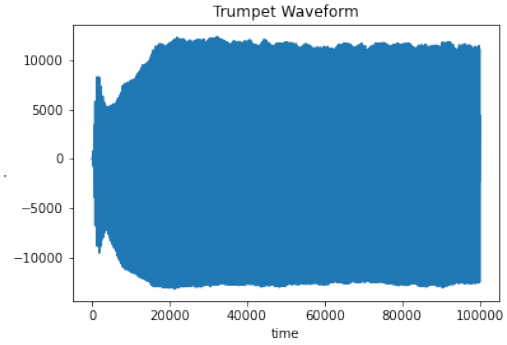

Figure 2: It is the waveform of the trumpet of time and frequency.

Then we apply the Fourier transform from the scipy package to transform the original waveform into signal form:

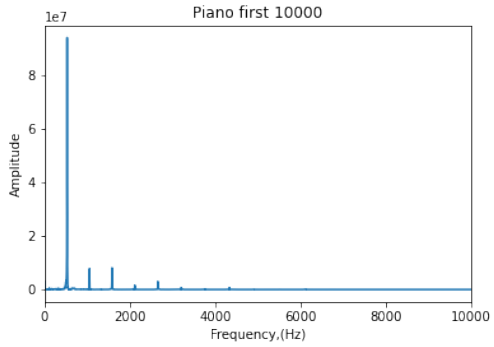

Figure 3: It is the FFT result of the piano with the first 10000 coefficients.

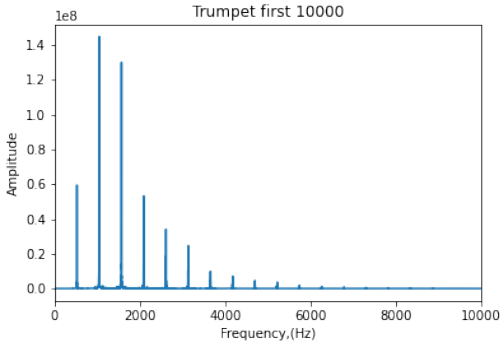

Figure 4: It is the FFT result of the trumpet with the first 10000 coefficients.

With this two plot we checked the validity of the FFT technique here. And now we can use the FFT data to find out what note they are playing by finding the peak of the signal:

```
Most frequency piano is [525.231] Hz
Most frequency of trumpet is [1043.847] Hz
```

Figure 5: It is the most frequency of the two instruments.

We are given the middle C is 261 Hz. By the pitch interval build, basically we have frequency of piano is 2 times of middle C, trumpet is 4 times of middle C. Which means they are middle D and middle E correspondingly.

2 Problem 2

We want to solve the Lorentz equations in this problem:

$$\frac{dx}{dt} = \sigma y - x \tag{1}$$

$$\frac{dy}{dt} = rx - y - xz \tag{2}$$

$$\frac{dz}{dt} = xy - bz \tag{3}$$

With given $\sigma = 10, r = 28, b = \frac{8}{3}$ with t range from 0 to 50, initial condition $(x, y, z) = (0, 1, 0)$. We used 4th Runge-Kutta to solve this equation:

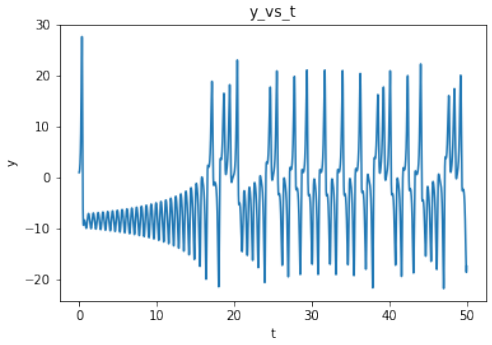

Figure 6: It is the plot of y versus time solution by our methods.

And now we plotted z versus x, which is so called "strange attractor":

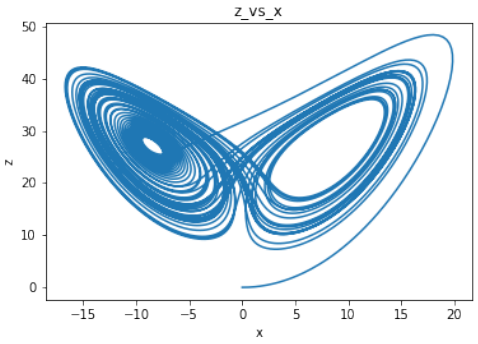

Figure 7: It is the plot of z versus x, also known as "strange attractor".

GitHub account:luminousxuan