25|May|2020 Digital Signal Processing

Introduction to fourier Transform:-

FFT: Fast fourier transform is used to process as audio signals, video etc by compressing & representing efficiently by using FFT.

- All the modern & digital communication is build on FFT

Fourier Series:-

$$f(t) = \frac{1}{2}a_0 + \sum_{k=1}^{\infty} (a_k \cos 2\pi k t + b_k \sin 2\pi k t)$$

where k → frequency

$a_k, b_k$ → coefficient

Fourier transform:-

$$X_a(F) = \int_{-\infty}^{\infty} x(t) \cos 2\pi F t \, dt,$$

$$X_b(F) = \int_{-\infty}^{\infty} x(t) \sin 2\pi F t \, dt,$$

} Result 2 Real coefficient per frequency.

$$X(F) = \int_{-\infty}^{\infty} \overbrace{x(t)}^{f(t)} \underbrace{e^{j2\pi Ft}}_{\text{analyzing fun sinusoid}} dt$$

Result: One complex coefficient per frequency.

continues FT: $X(F) = \int_{-\infty}^{\infty} x(t) e^{j2\pi Ft} dt$

discrete FT: $X_K = \sum_{n=0}^{N-1} x_n \cdot e^{\frac{j2\pi kn}{N}}$

By Euler's ~~funtion~~ formula:

$$e^{jx} = \cos x + j \sin x$$

$$X_k = x_0[\cos(-bo) + j \sin(-bo)] + \cdots\cdots$$

at end

$$X_K = A_K + B_K j$$

By plotting the $X_K$ on complex plain

Vector magnitude : $mag = \sqrt{A_k^2 + B_k^2}$

$$\text{phase} = \theta = \tan^{-1}(B_k/A_k)$$

- Inner products in Hilbert space.

Inner product of vectors

$$\langle f(x), g(x) \rangle = \int_a^b f(x)\, g(x)\, dx$$

- complex fourier series

$$f(x) = \sum_{k=-\infty}^{\infty} c_k e^{jkx}$$

where $e^{jkx} = \cos(kx) + j\sin(kx) = \psi_k$

$$\langle \psi_j, \psi_k \rangle = \int_{-\pi}^{\pi} e^{ijx}\, e^{jx}\, dx = \int_{-\pi}^{\pi} e^{i(j-k)x}\, dx$$

(4) fourier series using matlab

```
clear all, close all, cle
figure
set[gcf, position', [1500 200 2000 1200])
L = Pi;
N = 1024;
dx = 2*L/(N-1);
x = -L : dx : L;
f = 0*x;
f(N/4 : N/2) = pulse(1 : N/4+1)/N;
f(N/2+1 : 3*N/4) = 1 - 4*(0 : N/4-1)/N;
plot(x, f, '-k', 'linewidth', 3.5). hold on
cc = jet(20);
for k = 1:20
    A(k) = sum(f.* cos(pi*k*x/L)*dx/Pi;
    B(k) = sum(f.*sin(pi*k*x/L)*dx/Pi;
fFS = fFS + A(k)*cos(k*pi*x/L) + B(k)*sin(k*pi*x/L)
```

```
plot(x, fs, '-', 'color', cclk, i), 'linewidth', 2)
pause(.1)
end
```

(9) fourier series using python

⇒ In[ ]: import numpy as np
import matplotlib.pyplot as plt
from matplotlib.cm import get_cmap
plt.rcparams['figure.figsize'] = [8, 8]
plt.rcParams.update({'font.size': 18})
dx = 0.0001
L = np.pi
X = L* np.arange(-1+dx, 1+dx, dx)
n = len(x)
nquart = int(np.floor(n/4))
f = np.zeros_like(x)
f[nquart:2*nquart] = (4/n)*np.arange(', nqurt+1)
f[2*nqurt:3*nquart] = np.ones[nquart) - (4/n)*np,
arange(0, nquart+1)
fig.ax = plt.subplots()
ax.plot(x, f, '-', color = 'k', linewidth = 2)

28th may/2020 Afternoon session Python

* fixing programming errors:

- Syntax error:-

```
print(1)
int(9)
int 9
print(2)
print 3
```

o/p : file "errors.py", line 3
int 9
invalid syntax

* int is a function in python, therefore the 9 should be enclosed in bracket & even print

→ Exceptions:

```
a=1
b="2"
print(int 2.5)
print(a+b)
```

we get error at print(a+b) bt we got the error due to previous line, i.e. print(int(2.5) here we are missing the print closing bracket.

- How fix error if we don't understand the message just copy the instruction & search in google

* Application 3: Build a website Blocker

Program architecture

windows: c:\windows\system32\drivers\etc (host file)

* Setting up the infinite loop

```
while True:
    if dt(dt.now().year, dt.now().month, dt.now().day, 8)
```

```
< dt.now() < dt.now().year, dt.now().month,
        dt.now().day 16):
print("working hours...")
else:
    print("fun hours...")
time.sleep(5)
```