**HW4 MATLAB code**

DFT Program

% flag=1:DFT flag=-1:IDFT

function result = dft(data, N, flag)

WN = exp(-1i\*2\*pi/N);

if flag == 1

W = WN.^((0:N-1)'\*(0:N-1));

x = data.';

result = (W\*x).';

end

if flag == -1

W = WN.^(-(0:N-1)'\*(0:N-1));

X = data.';

result = (1/N)\*(W\*X).';

end

1.

%(a)

h = @(t) cos(2\*pi\*t);

T = 0.1;

N1 = 16;

n1 = 0:N1-1;

H1 = fft(h(n1\*T),N1);

figure(1);

plot(n1,abs(H1),'.-');

title('Amplitude of H[k] N=16');

xlabel('k'); ylabel('|H[k]|');

figure(2);

plot(n1,angle(H1),'.-');

title('Phase of H[k] N=16');

xlabel('k'); ylabel('\angleH[k]');

%(b)

N2 = 32;

n2 = 0:N2-1;

H2 = fft(h(n2\*T),N2);

figure(3);

plot(n2,abs(H2),'.-');

title('Amplitude of H[k] N=32');

xlabel('k'); ylabel('|H[k]|');

figure(4);

plot(n2,angle(H2),'.-');

title('Amplitude of H[k] N=32');

xlabel('k'); ylabel('\angleH[k]');

%(c)

H1\_d = dft(h(n1\*T),N1,1);

figure(5);

subplot(1,2,1);

plot(n1,abs(H1),'.-');

hold on

plot(n1,abs(H1\_d),'o');

title('Amplitude of H[k] N=16');

xlabel('k'); ylabel('|H[k]|');

legend('FFT','DFT');

subplot(1,2,2);

plot(n1,angle(H1),'.-');

hold on

plot(n1,angle(H1\_d),'o');

title('Phase of H[k] N=16');

xlabel('k'); ylabel('\angleH[k]');

legend('FFT','DFT');

H2\_d = dft(h(n2\*T),N2,1);

figure(6);

subplot(1,2,1);

plot(n2,abs(H2),'.-');

hold on

plot(n2,abs(H2\_d),'o');

title('Amplitude of H[k] N=32');

xlabel('k'); ylabel('|H[k]|');

legend('FFT','DFT');

subplot(1,2,2);

plot(n2,angle(H2),'.-');

hold on

plot(n2,angle(H2\_d),'o');

title('Phase of H[k] N=32');

xlabel('k'); ylabel('\angleH[k]');

legend('FFT','DFT');

%(d)

h1 = ifft(H1,N1);

h1\_d = dft(H1\_d,N1,-1);

figure(7);

plot(n1,h1,n1,h1\_d,'x');

title('h[n] N=16');

xlabel('n'); ylabel('h[n]');

axis([0 N1-1 -1.5 1.5]);

legend('IFFT','IDFT');

h2 = ifft(H2,N2);

h2\_d = dft(H2\_d,N2,-1);

figure(8);

plot(n2,h2,n2,h2\_d,'x');

title('h[n] N=32');

xlabel('n'); ylabel('h[n]');

axis([0 N2-1 -1.5 1.5]);

legend('IFFT','IDFT');

(a)

Chart, line chart

Description automatically generatedChart, line chart

Description automatically generated

(b)

Chart, histogram

Description automatically generatedChart, line chart

Description automatically generated

(c)

Chart, line chart

Description automatically generatedChart, line chart

Description automatically generated

Chart

Description automatically generatedChart, line chart

Description automatically generated

The results from DFT and FFT algorithms are the same.

(d)

Chart, line chart

Description automatically generatedChart, line chart

Description automatically generated

2.

h = @(t) cos(2\*pi\*t);

T = 0.1;

for i = 8:12

N = 2^i;

n = 0:N-1;

hn = h(n\*T);

tic;

H\_d = dft(hn,N,1);

t1 = toc;

tic;

H = fft(hn,N);

t2 = toc;

plot(i,t1/t2,'o');

hold on

title('Time comparison between DFT and FFT for N=2^i');

xlabel('i'); ylabel('t\_1/t\_2');

end

Graphical user interface, application

Description automatically generated