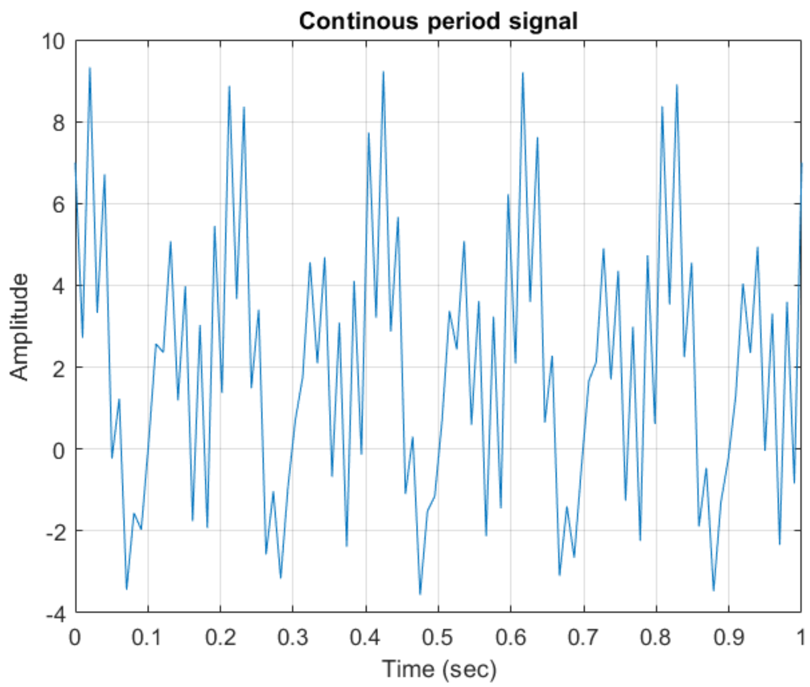
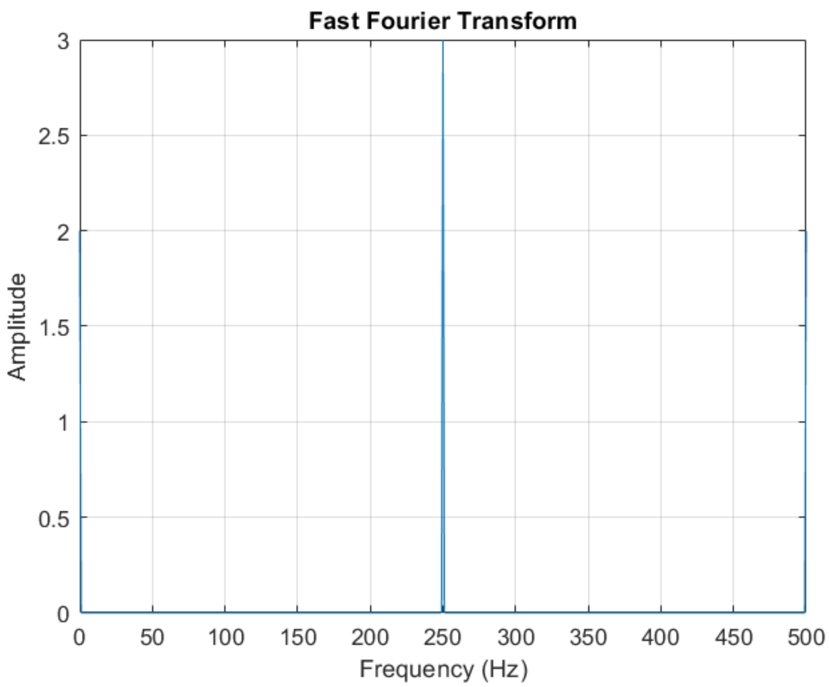
```
% Homework 1: Perceeption
% Question no: 1
% a
% clear all
% close all
% clc
% x = @(t) 2+3*cos(500*pi*t)+2*cos(1000*pi*t)+3*sin(2000*pi*t);
% t = linspace(0, 1);
% figure(1)
% plot(t, x(t))
% xlabel('Time (sec)')
% ylabel('Amplitude')
% title('Continous period signal')
% grid
%
% b
% F_s = 1000;            %Sampling frequency
% T= 1/Fs;             %Sampling period
% L = 1000;             %Length of signal
% t = (0:L-1)*T;        %Time vector
% y= fft(x(t));         %Fast Fourier Transform
% P2 = abs(y/L);        %generating spectrum
% P1 = P2(1:L/2+1);
% P1(2:end-1) = 2*P1(2:end-1);
%
% f = F_s*(0:(L/2))/L;
% figure(2)
% plot(f,P1)
% xlabel('Frequency (Hz)')
% ylabel('Amplitude')
% title('Fast Fourier Transform')
% grid

%Question no: 1
% a
clear all
close all
clc
x = @(t) 2+3*cos(500*pi*t)+2*cos(1000*pi*t)+3*sin(2000*pi*t);
t = linspace(0, 1);
figure(1)
plot(t, x(t))
xlabel('Time (sec)')
ylabel('Amplitude')
title('Continous period signal')
grid
```

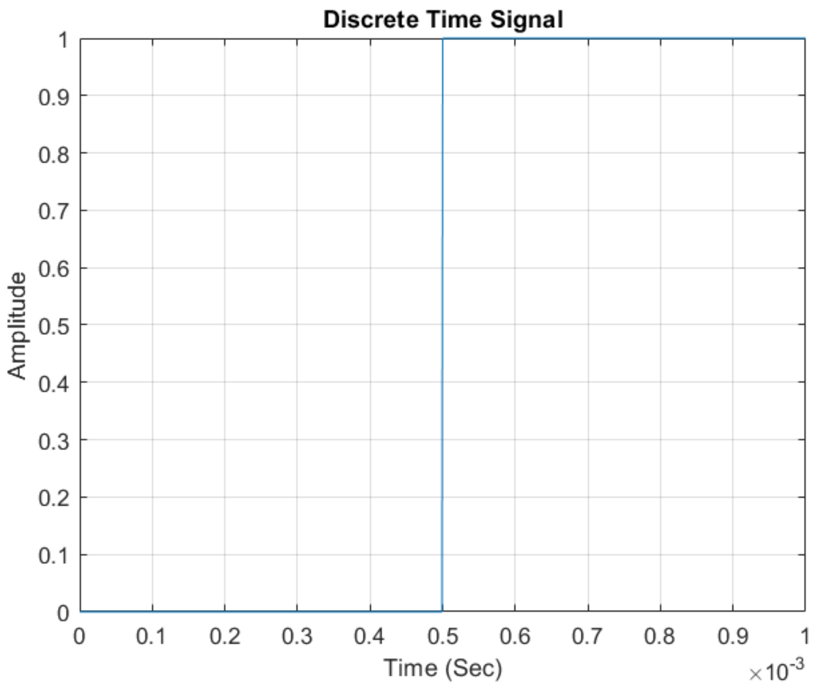



```
%b
Fs = 1000;              % Sampling frequency
T = 1/Fs;               % Sampling period
L = 1000;               % Length of signal
t = (0:L-1)*T;          % Time vector
y= fft(x(t));           %Fast Fourier Transform


P2 = abs(y/L);          %generating spectrum
P1 = P2(1:L/2+1);
P1(2:end-1) = 2*P1(2:end-1);

f = Fs*(0:(L/2))/L;
figure(2)
plot(f,P1)
xlabel('Frequency (Hz)')
ylabel('Amplitude')
title('Fast Fourier Transform')
grid
```



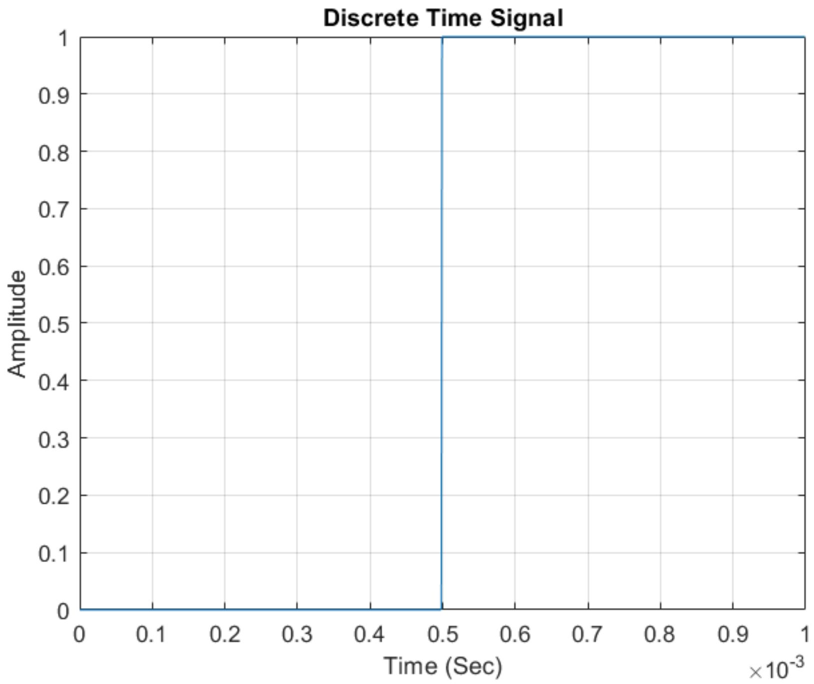

```
%Question no: 2
% a
clear all
close all
clc

k=0:1:1000;
data= zeros(length(k),1);
for c = 1:length(k)
    if (k(c)>=0) && (k(c)<=499)
        data(c)=0;
    else
        data(c)=1;
    end
end

%%Number of samples:
   N = size(data,1);          % assumes data is an N x 1 column vector
   %%Compute the time domain:
   Fs = 1e6;                  % samples per second
   dt = 1/Fs;                 % seconds
   t = dt*(0:N-1)';
   T = N*dt;
   %%Plot the time domain signal:
   figure;
   plot(t,data)
   xlabel('Time (Sec)')
   ylabel('Amplitude')
   title('Discrete Time Signal')
```

```
grid
```




```
%Question no: 2
% a
clear all
clc
% Setting the Grid Parameters
leftBound = 0;
rightBound = 1000;
numSamples = 1000;

% Generating the grid
k = linspace(leftBound, rightBound, numSamples);
k = k(:);
% % Generating the Discrete Signal
data= zeros(length(k),1);
data(500:length(k))=1;


%%Number of samples:
   N = size(data,1);         % assumes data is an N x 1 column vector
   %%Compute the time domain:
   Fs = 1e6;                  % samples per second
   dt = 1/Fs;                 % seconds
   t = dt*(0:N-1)';
   T = N*dt;
   %%Plot the time domain signal:
   figure;
```

```
    plot(t,data)
    xlabel('Time (Sec)')
    ylabel('Amplitude')
    title('Discrete Time Signal')
    grid
```




```
%Question no: 2
% b
   %%two-sided spectrum, centered on DC
   X = fftshift(fft(data))/N;
   %%Compute the frequency domain:
   dF = Fs/N;
   f = (-Fs/2:dF:Fs/2-dF)';
   %%Plot the frequency domain signal:
   figure;
   plot(f,abs(X));
   hold on
   yline(max(abs(X))/2^(1/2))
   xlabel('Frequency (Hz)')
   ylabel('Amplitude')
   title('Fast Fourier Transform')
   grid

% bw - 3db Bandwidth
    %flo: Bandwidth frequency low, fhi: Bandwidth frequency High
    [bw,flo,fhi,powr] = powerbw(data,1000)
```

```
bw = 0.7641

flo = 0
```

```
fhi = 0.7641
```

```
powr = 0.3045
```

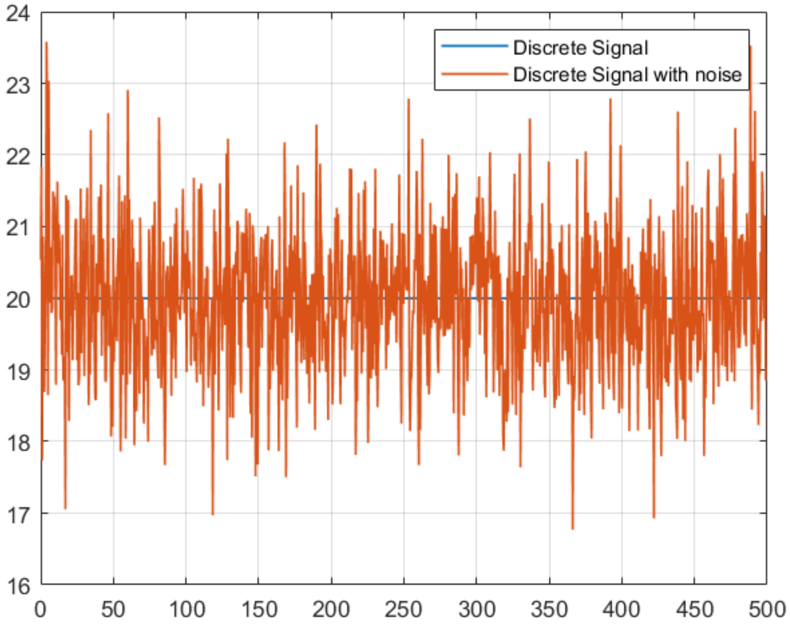
```
fprintf('The 3-dB (half-power) bandwidth is %d . \n',bw);
```

```
The 3-dB (half-power) bandwidth is 7.640781e-01 .
```

```
fprintf('The lower and upper bound frequecy are %d & %d respectively . 
\n',flo,fhi);
```

```
The lower and upper bound frequecy are 0 & 7.640781e-01 respectively .
```

```
%%3.
% Setting the Grid Parameters
leftBound = 0;
rightBound = 499;
numSamples = 1000;

% Generating the grid
k = linspace(leftBound, rightBound, numSamples);
k = k(:);
samplingInterval     = mean(diff(k));

% % Generating the Discrete Signal
X_k(1:length(k))=20;
% %Adding a normally distributed noise with variance 1
X_k1 =X_k  + 1*normrnd(0,1,[1,length(k)]);
%solution for a
figure(1)
plot(k,X_k,k,X_k1, 'LineWidth',1)
legend({['Discrete Signal'], ['Discrete Signal with noise']})
grid
```



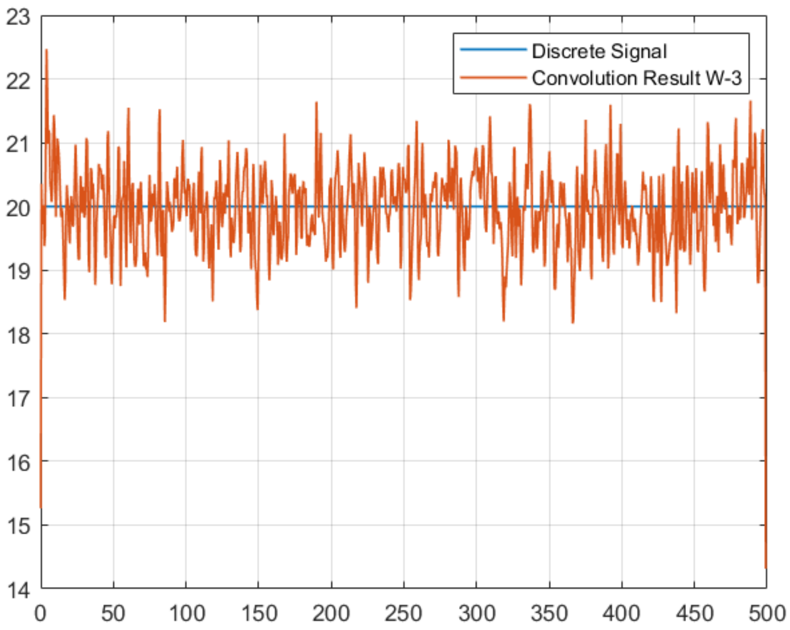

```
% Applying low pass filter
windowSize = [3,11];
sigma_3=3;
sigma_11=11;

% Signals Parameters
gaussianKernelStd    = [3,11];
sigma   = 1;
%Generating the Gaussian Kernel
vkx=fspecial('gaussian',[1,gaussianKernelStd(1)],sigma)
```

```
vkx = 1×3

    0.2741    0.4519    0.2741
```

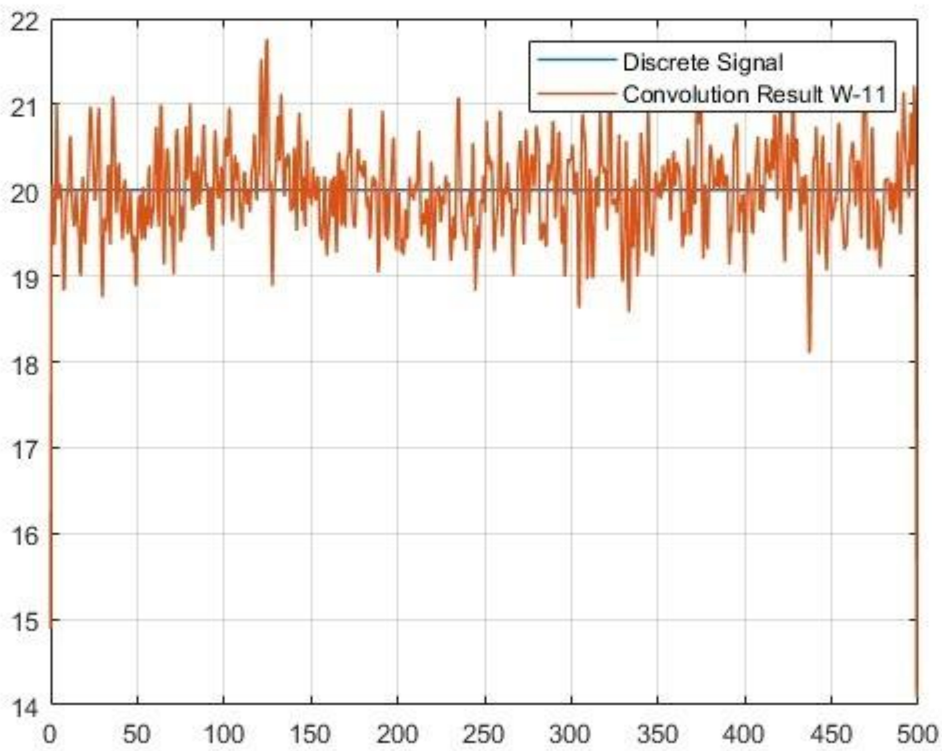
```
vky=fspecial('gaussian',[1,gaussianKernelStd(2)],sigma)
```

```
vky = 1×11

    0.0000    0.0001    0.0044    0.0540    0.2420    0.3989    0.2420 ⋯
```

```
Y_k_3 = conv(X_k1, vkx, 'same');
Y_k_11 = conv(X_k1, vky, 'same');

%solution for b
figure(2)
%plot(k,[X_k,Y_k_3]);
plot(k,X_k,k,Y_k_3, 'LineWidth',1)
legend({['Discrete Signal'], ['Convolution Result W-3']});
grid
```




```
%solution for c
figure(3)
plot(k,X_k,k,Y_k_11, 'LineWidth',1)
legend({['Discrete Signal'], ['Convolution Result W-11']});
grid
```



4. Write a 2~3 pages of survey on the sensing and measurement of a specific 1D physical quantity related to the automotive (vehicles, manufacturing, etc) such as: vibration, friction, temperature, speed, or distance. The grading of this question is based on the contents which the survey.

Introduction:

- Speed is defined as rate of change of distance travelled by the object in the unit time. The SI unit of speed is meter per second. The speed is the scalar type physical quantity that is the magnitude of the velocity vector.
- ➢ The speed is directly proportional to the distance when the time is constant.
- ➢ The speed is inversely proportional to the time taken when the distance is constant.

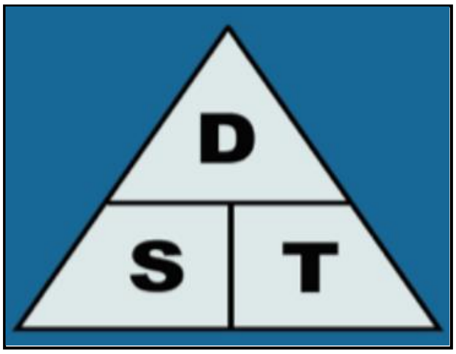


Figure 1

The importance of measuring the speed:

- ➢ A characteristic of an object that can be calculated from other measurements is defined as physical quantity. In addition, the speed is the physical quantity which is used to describe the motion of objects and compare them.
- ➢ The factors necessary to describe the speed are its distance covered by moving body from point to other and the time travelled by the moving object to reach the distance.
- ➢ The speed increases by decreasing the time travelled to reach the certain distance. So, the object is inversely proportional to the time taken when the distance is constant.
- ➢ Here, if the vehicle is moving faster then its higher speed and if it's slower it is Lower speed. If the vehicle isn't moving then it is zero speed.

- ▪ The measurement of speed can reflect three different scalar quantities;
  - a. Instantaneous speed
  - b. Average speed
  - c. Tangential speed

a. Instantaneous speed:

- ➢ The speed of the vehicle at the given moment or it's assumed constant a very short period of the time called instantaneous speed of the vehicle.

b. Average Speed:

- ➢ The distance travelled by the vehicle at the given period of time is the average speed of the vehicle.

c. Tangential speed:

- ➢ The distance travelled by the vehicle per unit time is the tangential speed pf the vehicle.

- ➢ We all need to know the importance of speed of a vehicle so that we can estimate the time it takes to travel at a at a certain speed and distance. For an example, if we take GPS it tells us the how much time does it take arrive to our destination. And depending on what speed we are traveling to.
- ➢ The drivers should know the vehicle estimated speed so that to avoid accidents such as vehicle maneuverings.

The challenges of measuring speed:

- During measuring the vehicle speed by wireframe sensor networks method, the challenges encountered would be during deploying with better transmitting power range.
- Another challenge is faced by the wireframe sensor networks method, scalability of the wireframe sensor network during measuring the vehicle speed.
- In modern speedometer the challenges is faced during counting of number of revolutions made by the wheel and that counted number of revolutions relating to distance of the vehicle.
- The radar and laser sensors challenges faced during detecting the vehicle should be in the range of waves to measure the speed of the vehicle.
- During using the normalized -correlation method the challenges faced when the template images don't match with in the given area of the image.

Existing approaches of measuring the speed:

- ➢ Using Wireless Sensor Networks to measure the speed of the vehicle.
- ➢ Speedometer to measure the speed of the vehicle
- ➢ Using the laser and radar sensors to measure the speed of the vehicle.
- ➢ Using Normalized-cross correlation method to measure the speed of the vehicle.

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Problems for the existing approaches:

- ➢ During using the wireless frame networks sensor, there is the possibility that the vehicle speed could exceed that which our existing motes can be shown at where the packets doesn't arrive at the required time which tends to miscalculations.
- ➢ The biggest of using the wireframe sensor networks method is that the vehicle requires wireless sensor mote fixed to it.

- The problem is occurred when the outside wheel of the vehicle moves faster than the inner wheel of the vehicle during a vehicle about a corner.
- when the vehicle id not in the range of detection the radar and laser cannot measure the speed of the vehicle.
- There may be mismatching of images during measuring the vehicle speed correlation should always be correct to estimate the speed of the vehicle.

References:

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