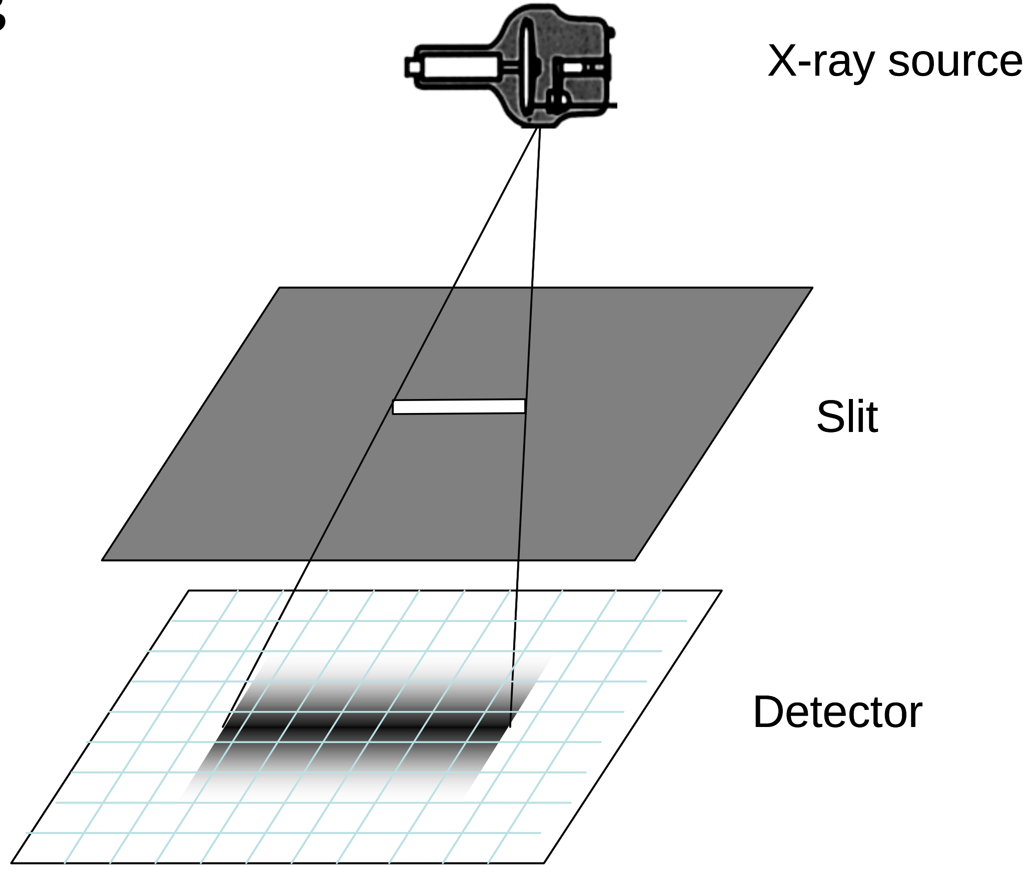
MTF Exercise

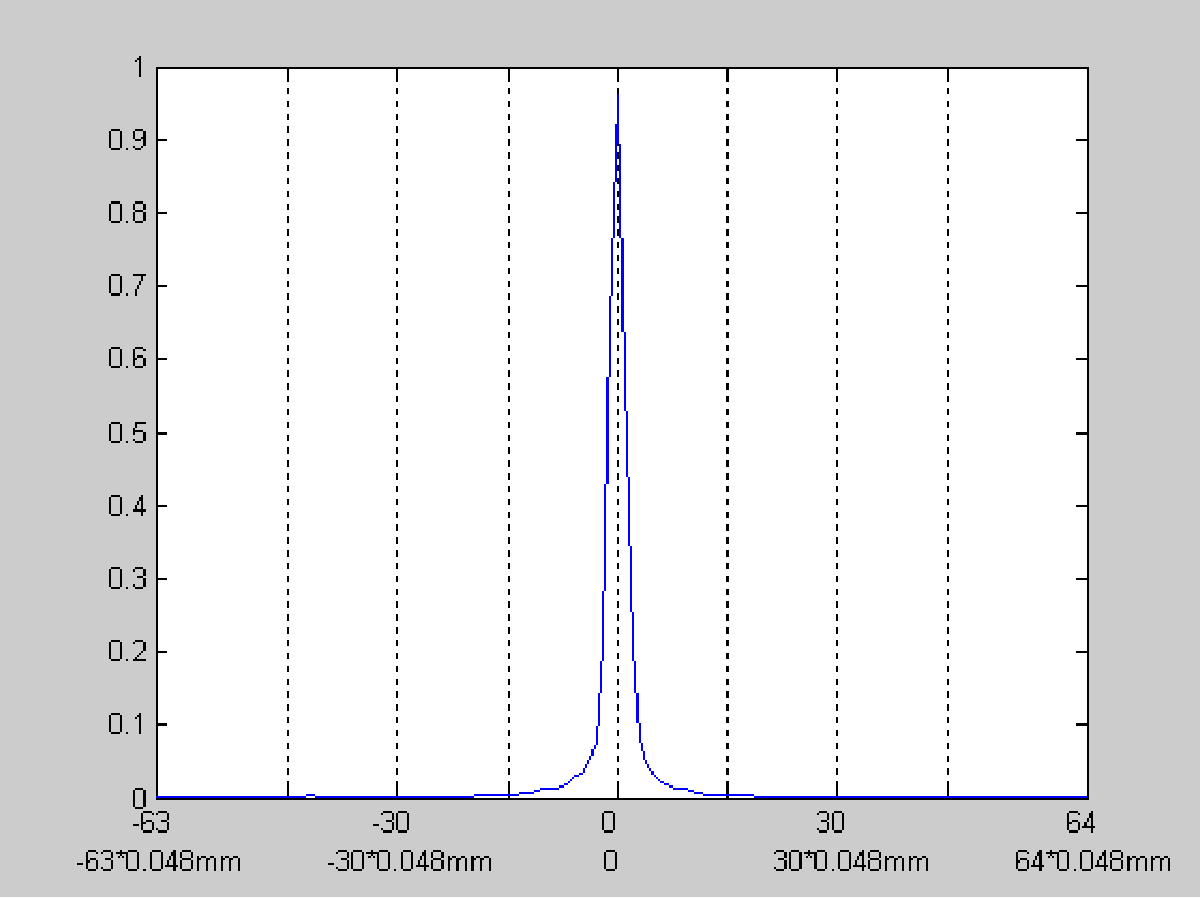
Discussion on the problem solving exercise:
A numerical method to calculate MTF

1. Method Based on the Basic Concept

(1) Imaging



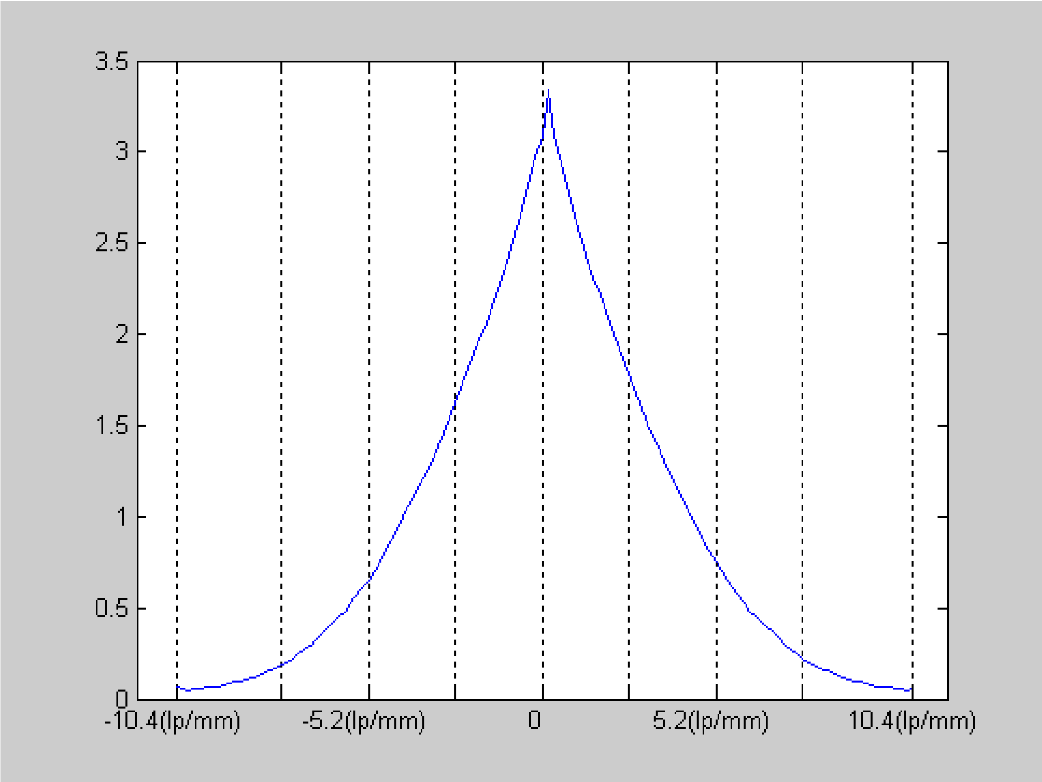
(2) Line spread function (LSF)



--- **Spatial Domain**

Line Spread Function (LSF)

Sampling Interval: Δx=0.048mm



Frequency Domain

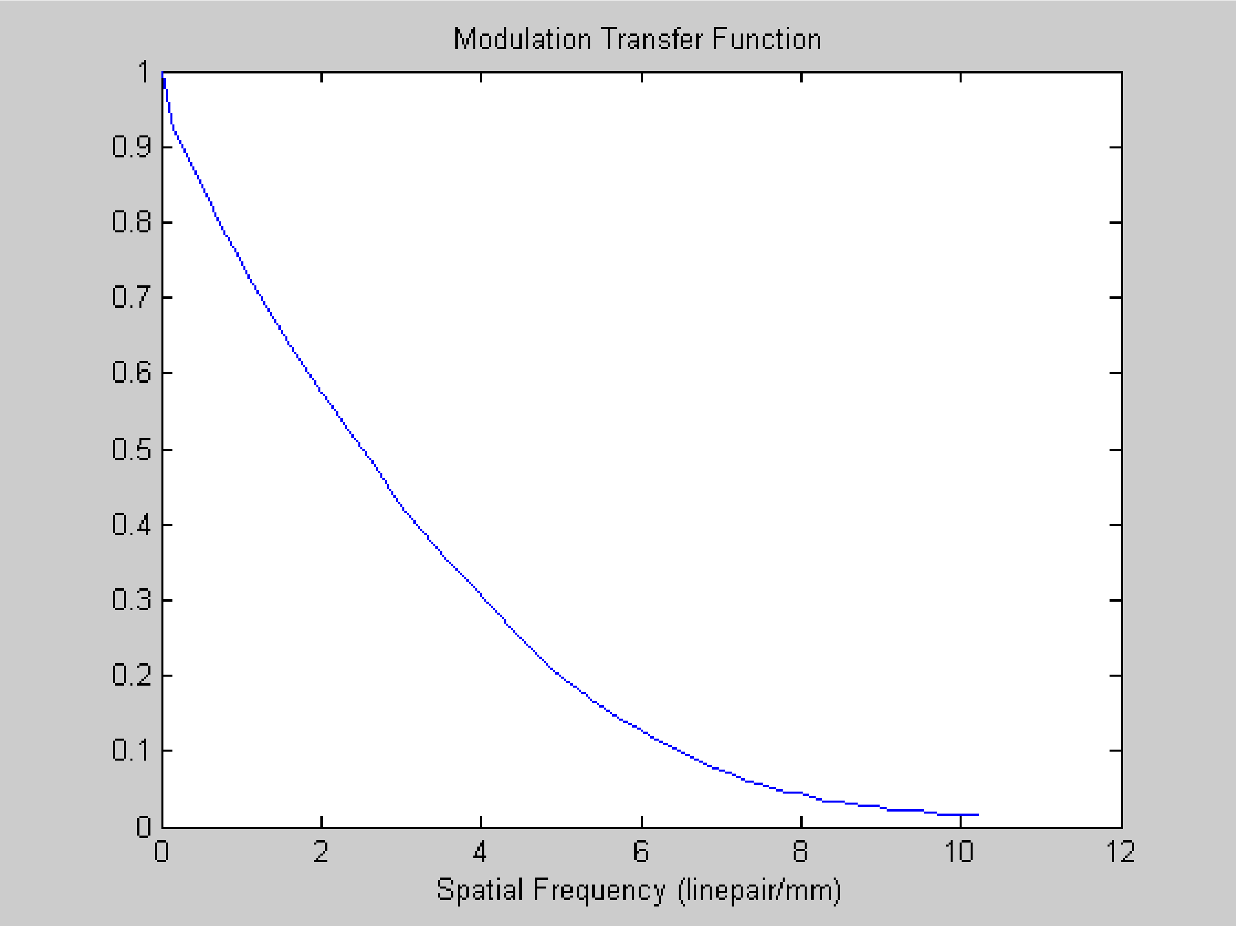
--Fourier Transform

Obtain: the complex magnitude of the FT of LSF

$$MTF'(f) = \left| F\{LSF\} \right|$$

Nyquist frequency:

$$f_q = \frac{1}{2\Delta x}$$



--Normalization

$$MTF(f) = \frac{MTF'(f)}{MTF'(0)}$$

2. Practical Method

Over-sampling techniques, etc.

MTF Problem solving exercise: A numerical method to calculate MTF based on measured slit and line spread function

(1) A LSF of an X-ray imaging system was determined by imaging a 0.01mm slit. The system is a 1024 by 1024 pixels array, and the pixel pitch is 0.048 mm. The slit image is shown in Fig 1, and the corresponding line spread function (LSF) is in Fig. 2, The LSF dataset is attached (RawLSF1.txt).

Please calculate and plot the MTF of the system using Matlab. A flowchart is given as follows for your reference.

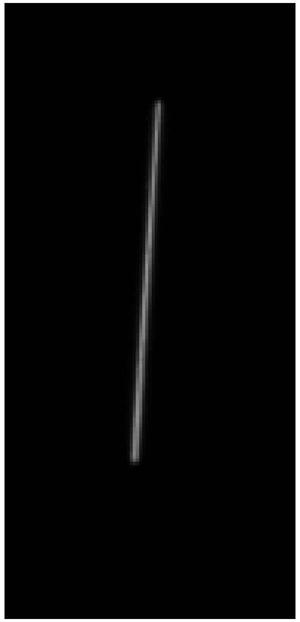


Fig. 1 A slit image

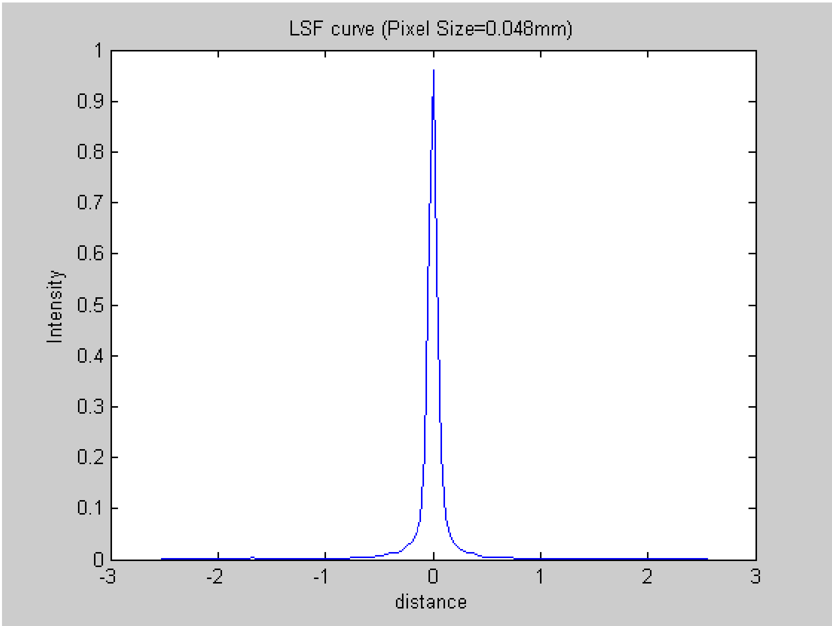
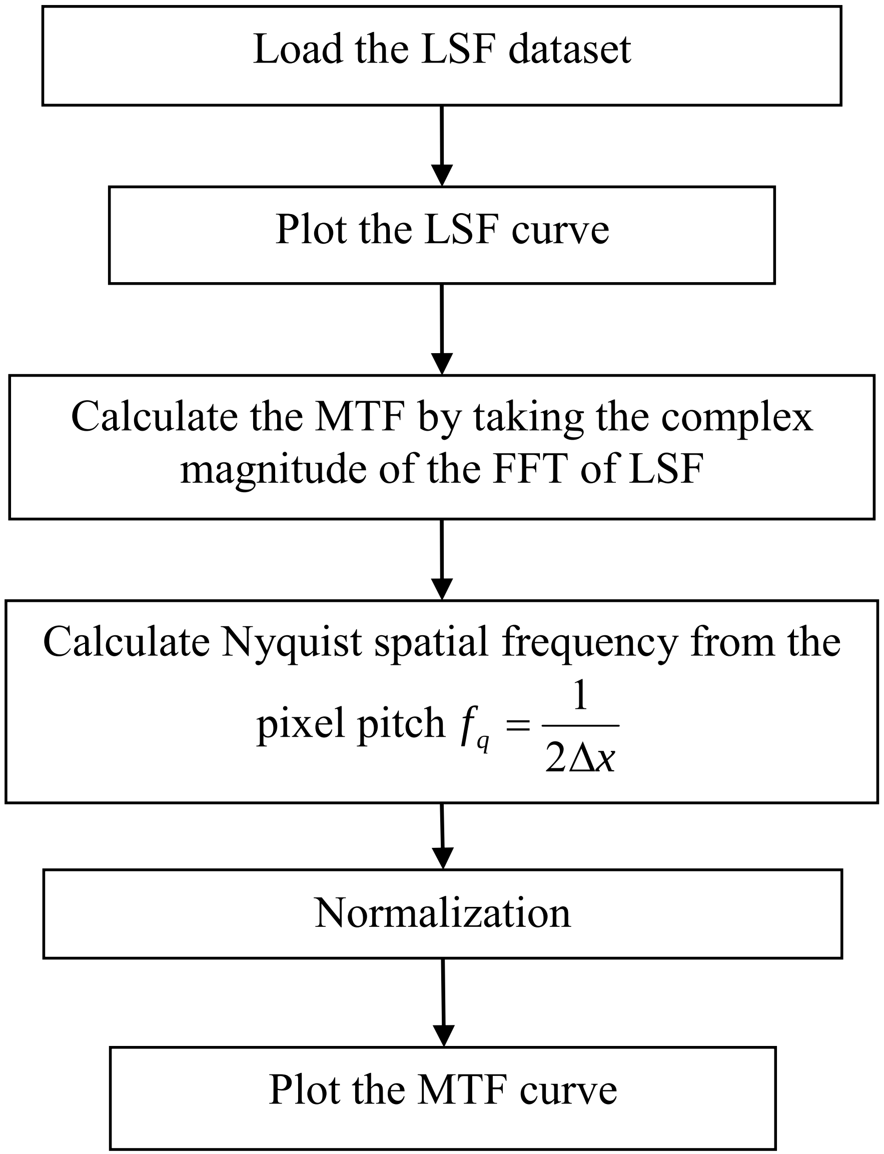


Fig. 2 Line spread function

(2) A LSF of another X-ray imaging system was also determined by imaging a 0.01mm slit. The system is again a 1024 by 1024 pixels array, but with different spatial resolution. The pixel pitch is 0.024 mm. The LSF dataset is attached (RawLSF2.txt).

Please plot the LSF, and calculate/ plot the MTF of the system using Matlab.

Flowchart (MTF calculating)



MATLAB Program

```
%1. For pixel size = 0.048 mm
% 1.clear up the workspace and define the pixel size
clear;clc;close all;
DeltaX1=0.048;% pixel size = 0.048 mm
kkk=(-63:1:64);

% 2.load the LSF data from RawLSF.txt whose size is 128
load RawLSF1.txt;
distance = kkk*DeltaX1;% distance from each pixel to the slit line
LSF = RawLSF1(:)';% intensity of each pixel

% 3. plot the LSF curve
figure;
plot(distance,LSF);
title('LSF curve (Sampling Interval=0.048mm)');
xlabel('distance');
ylabel('Intensity');

% 4. calculate the MTF by taking the complex magnitude of the fft of LSF
MTF = abs(fft(LSF));
figure, plot(MTF);
```

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%5. Shift MTF curve
MTF=fftshift(MTF);
figure, plot(kkk,MTF);

% 6. save the positive frequency part of the MTF
N=length(MTF);
MTF = MTF(floor(N/2)+1:N);

% 7. Normalize the MTF by dividing the MTF by its zero-frequency element
MTF = MTF/MTF(1);

figure, plot(MTF);

% 8. calculate the spatial frequency from the pixel size and the point
% number
f = (0:floor(N/2)-1)/(N/2)/(2*DeltaX1); % spatial frequency, linepair/mm
% the Nyquist frequency is set as the max frequency

% 9. plot the MTF vs frquency curve
figure;
plot(f,MTF,'-k');
xlabel('Spatial Frequency (linepair/mm)');
title('Modulation Transfer Function');
```