Image Processing and Computer Vision

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Image Enhancement

- **Introduction**
- The principal objective of enhancement is to process an image so that the result is more suitable than the original image for a specific application.
- Image enhancement approaches fall into two board categories.
- Methods

    1. Spatial Domain

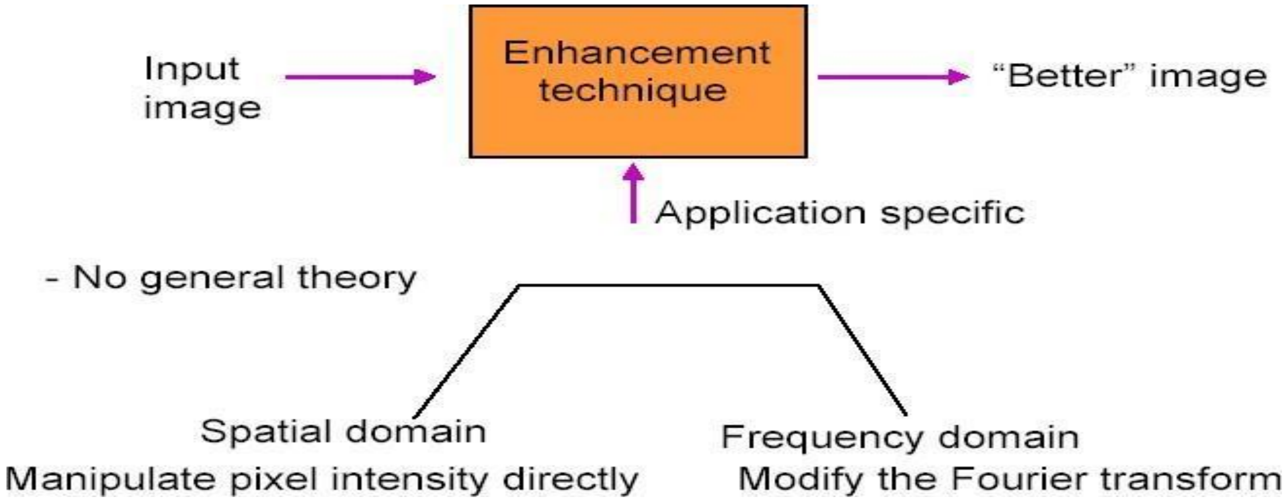
        direct manipulation of pixels of the image

    2. Frequency Domain

        modifying the Fourier Transform of an image

Image Enhancement

- Image enhancement techniques are designed to improve the quality of an image as perceived by a human being.
- **Image enhancement** is the process of making images more useful (such as making images more visually appealing, bringing out specific features, removing noise from images and highlighting interesting details in images).



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Spatial and Frequency Domains

- **Spatial domain techniques** manipulates the pixels of an image directly. This process happens in the image's coordinate system, also known as the spatial domain.

- **Frequency domain techniques** transforms an image from the spatial domain to the frequency domain. In this process, Mathematical transformations (such as the Fourier transform) are used. The image can be modified by manipulating its frequency components.

Image Enhancement in Spatial Domain

- These techniques operate directly on the pixels.

- More efficient computation and requires less processing resources to implement

- Spatial Domain Process is defined by $g(x,y)=T[f(x,y)]$

T is an operator on f defined over a neighborhood of point (x,y)

OUTPUT IMAGE

INPUT IMAGE

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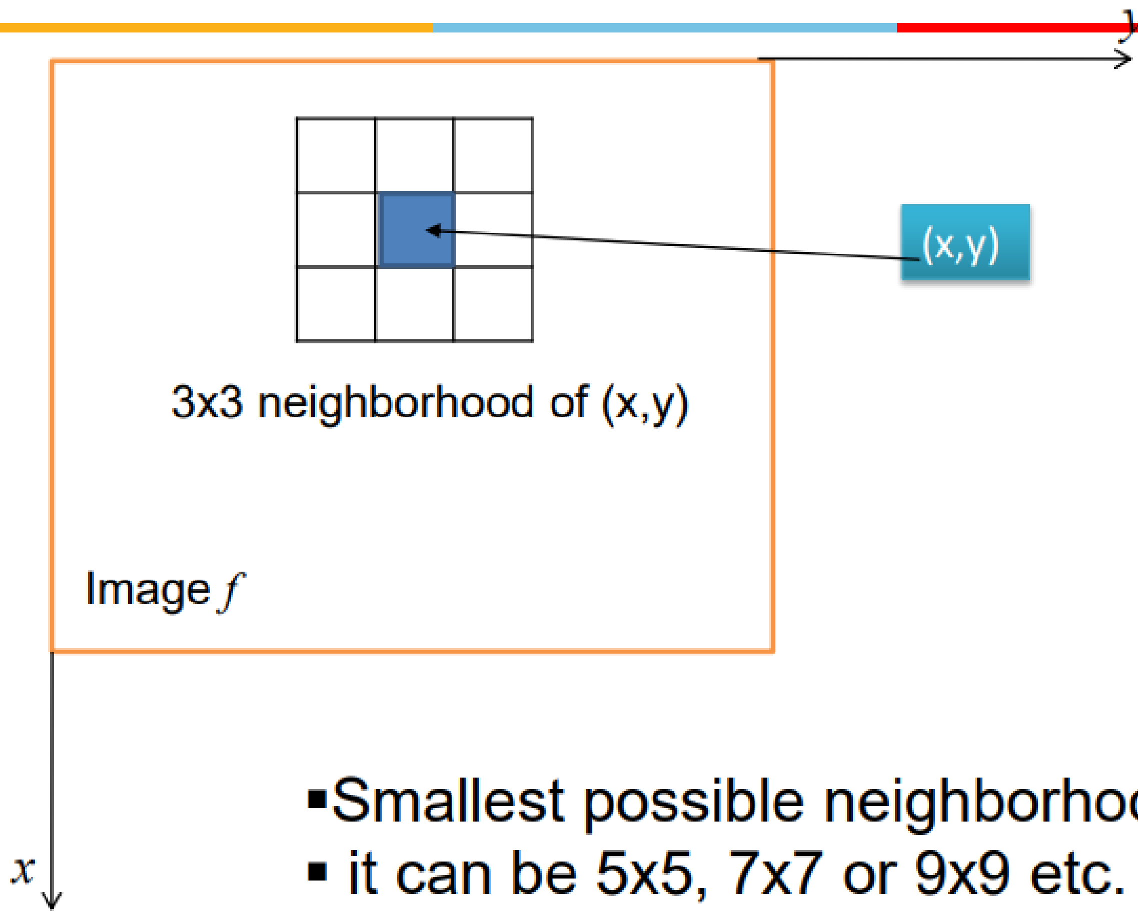
Image Enhancement in Spatial Domain



- Smallest possible neighborhood size is 1x1,
- it can be 5x5, 7x7 or 9x9 etc.

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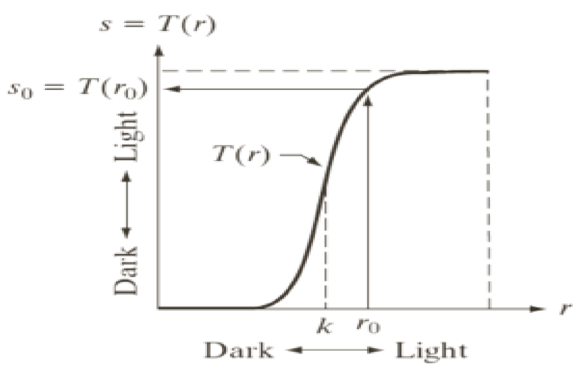
Image Enhancement in Spatial Domain

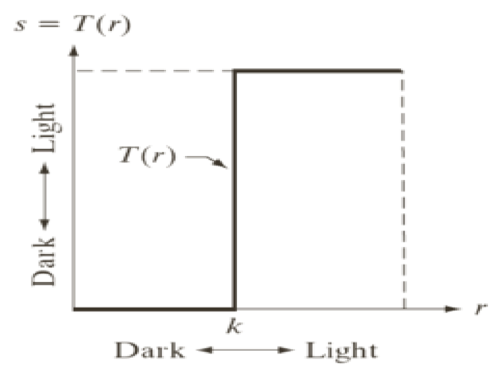
Spatial Domain

Intensity Transformation | **Spatial Filtering**

1x1 neighborhood operation is called as point processing and is represented by the transformation function s= T(r). Where s and r represents the intensity of g and f respectively



Contrast stretching function



Thresholding Function

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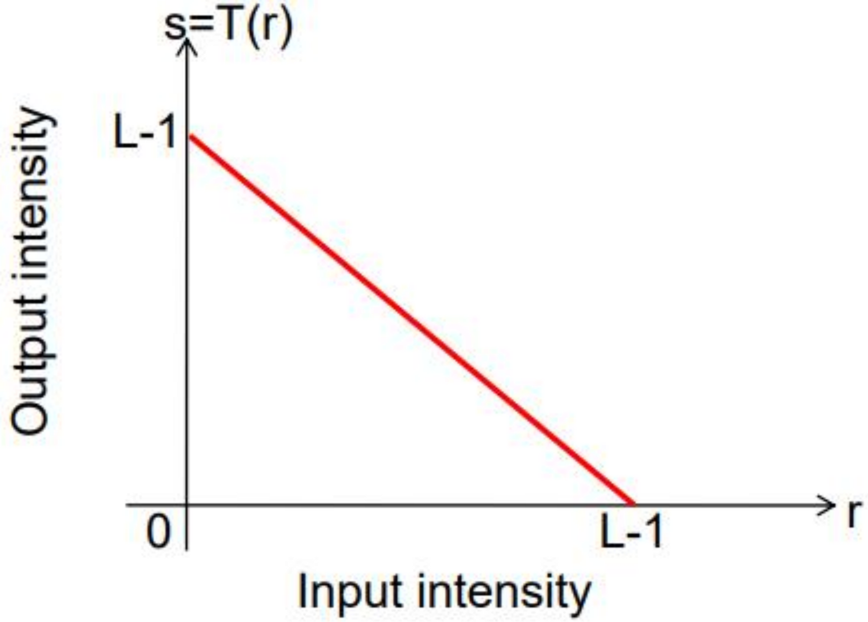
Intensity Transformation Function

Image Negative

Let the image has an intensity level in the range [0 L-1], then the intensity transformation is given by s=L-1-r



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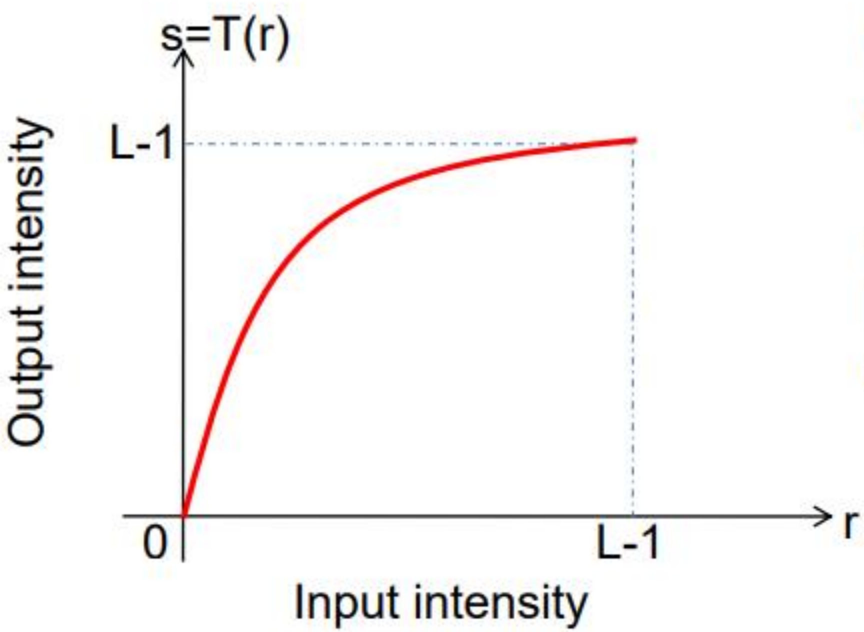
Intensity Transformation Function

Log Transformations

For an image having intensity ranging from [0 L-1], log transformation is given by **s=c log(1+r)** , where c is a constant



- Maps the narrow range of low intensity values of input levels to wider range of output levels.
- Higher range of high intensity input levels is mapped to narrow range of out put levels.

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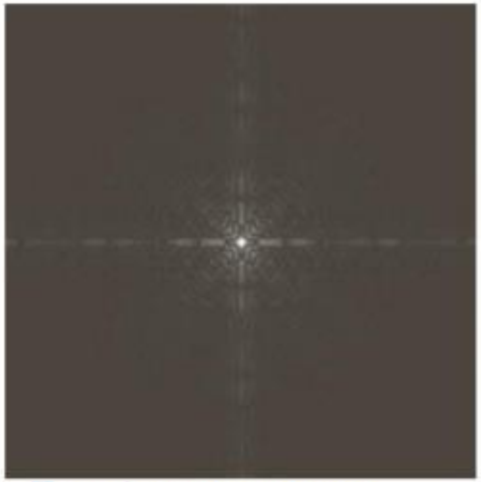
Intensity Transformation Function

Log Transformations

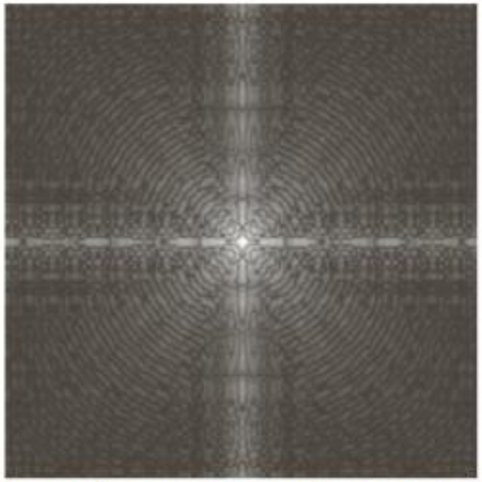
➢The Log function has the important characteristic that it compresses the dynamic range of images with large variation in the pixel value.

Classical example is displaying Fourier spectrum.

▪Fourier spectrum has the values in the range 0 to 1.5x106. These values are scaled linearly for the display in 8 bit system.



Fourier spectrum



Log transformation with c=1

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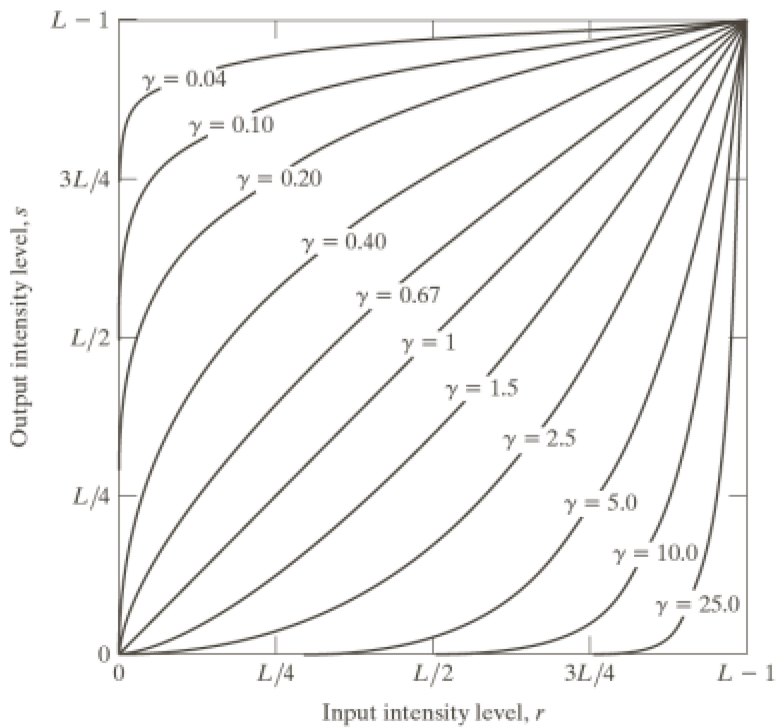
Intensity Transformation Function

Power-law (Gamma) Transformations

This has the basic form $s=c\,r^{\gamma}$,where c and γ are positive constants



Plot for c=1

Fractional values of γ maps a narrow range of dark input values into a wider range of output values. Opposite of this also true for higher values of input levels.

These are also called as gamma correction due to the exponent in the power law equation.

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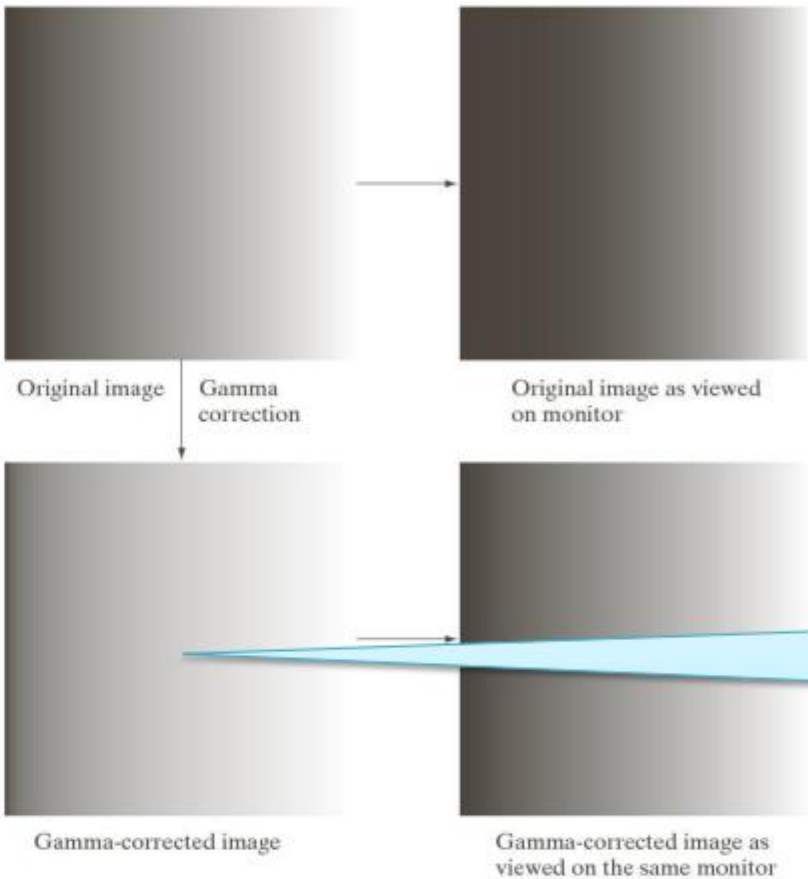
Intensity Transformation Function

Power-law (Gamma) Transformations



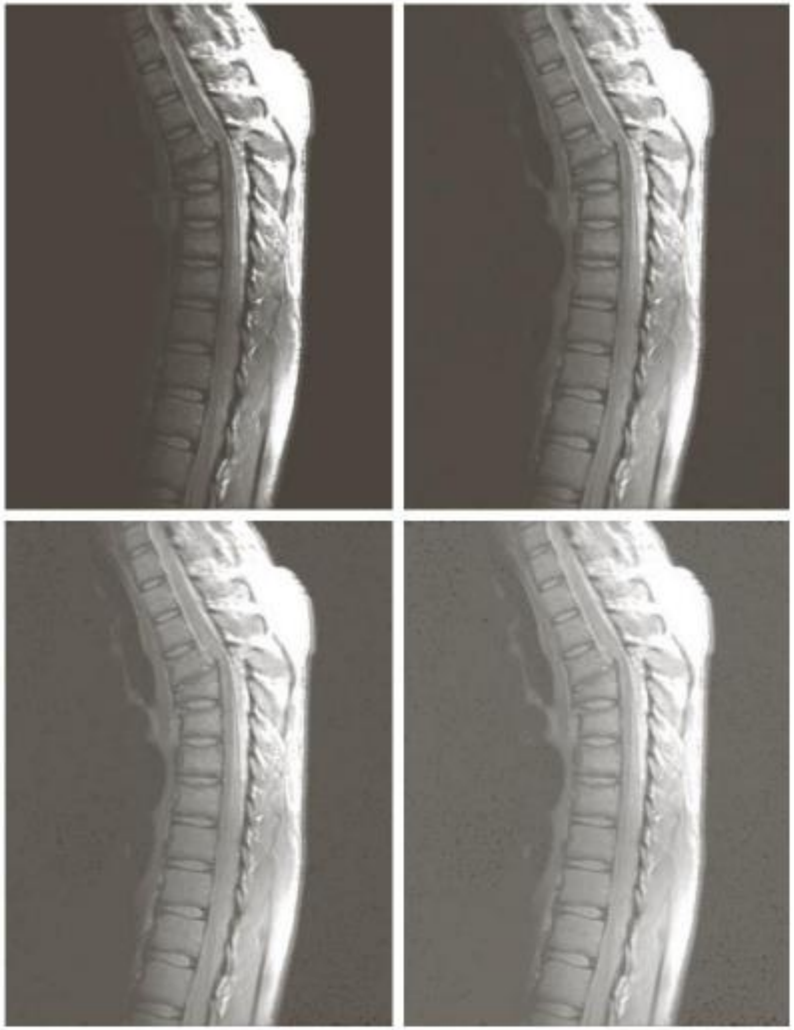
CRT device have an intensity to voltage response that is a power function with exponent varying from approximately 1.8 to 2.5. Such display system would produce images that are darker than intended.

Pre-processed image with gamma correction $s=r^{1/2.5}=r^{0.4}$. before input to the display device

Intensity Transformation Function

- Gamma correction is very important when to reproduce an image exactly on a display system.
- Power-law transformations are also used in general purpose contrast manipulation.

```
close all
clear all;
clc;
[filename, pathname] = uigetfile('*.tif');
im = imread([pathname filename]);
imshow(im);
im1=double(im).^0.3;
im1=mat2gray(im1);
figure,imshow(im1);
```



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Intensity Transformation Function

MRI of fractured human spine

Result of a transformation for γ=0.6

Result of a transformation for γ=0.4

Result of a transformation for γ=0.3

Intensity Transformation Function

Arial image

Result of a transformation for c=1 and $\gamma=3$

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Intensity Transformation Function

Result of a transformation for c=1 and $\gamma=4$

Result of a transformation for c=1 and $\gamma=5$

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