# Gray Level OR Point Transformation

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Point transformations OR Intensity transformations are applied dirsctly on the pixel of the images.

The purpose of this transformation is to improve the subjective quality of an image for human viewing.

Point Transformation can be mathematically expressed as

$$\boxed{S(x, y) = T[R(x, y)]}$$

where

$R(x, y)$ = Original Image OR Input Image
$S(x, y)$ = Processed Image OR Output Image
$T$ = Transformation Operator

Since point transformation is a spatial domain transformation therefore,

$$\boxed{s = T * r}$$

# Topics to be covered

- Negative Image
- Log Transformation
- Gamma OR Power Law Transformation
- Auto-contrast Function
- PieceWise Linear Transformation

# Image Negative

The negative point transformation is also known as reverse contrasting. This transformation is used to extract more details from input image according to the task in hand.

**Input Image**

**Negative Image**

# Log Transformation

Log transformation is used to map a narrow range of low-intensity input values to a wide range of output values.

Log transformations is mathematically represented by the following equation

$$\boxed{s = c * log(1 + r)}$$

where
$s$ = the output intensity of the pixel,
$r$ = the input intensity of the pixel,
$c$ = scaling constant

# Log Transformation

scaling constant is given by

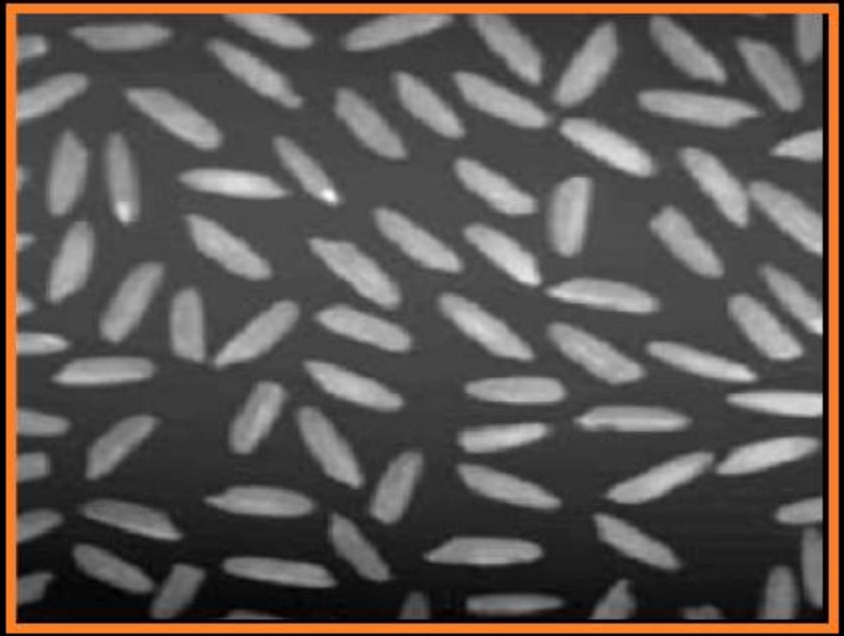
$$\boxed{c = \frac{255}{log(1+m)}}$$

where

$m$ = maximum pixel value in the image. This is to ensure that the final pixel value does not exceed 255.

Original Image

Log Transformed Image



Original Image

Log Transformed Image

# Gamma Transformation OR Power Law

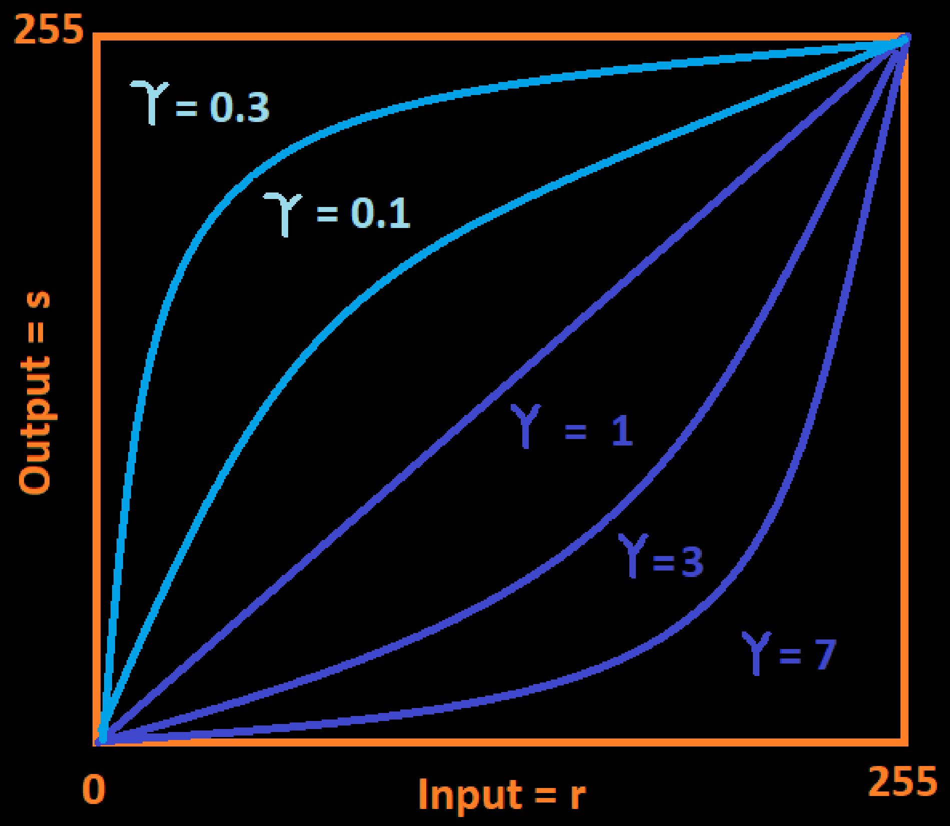
Our eyes perceive images in a gamma-shaped curve, whereas cameras capture images in a linear fashion Thus, gamma correction is important for displaying images to prevent darkening or whitening for better perception of human view.

Gamma Transformation is mathematically expressed as

$$\boxed{s = c * r^{\gamma}}$$

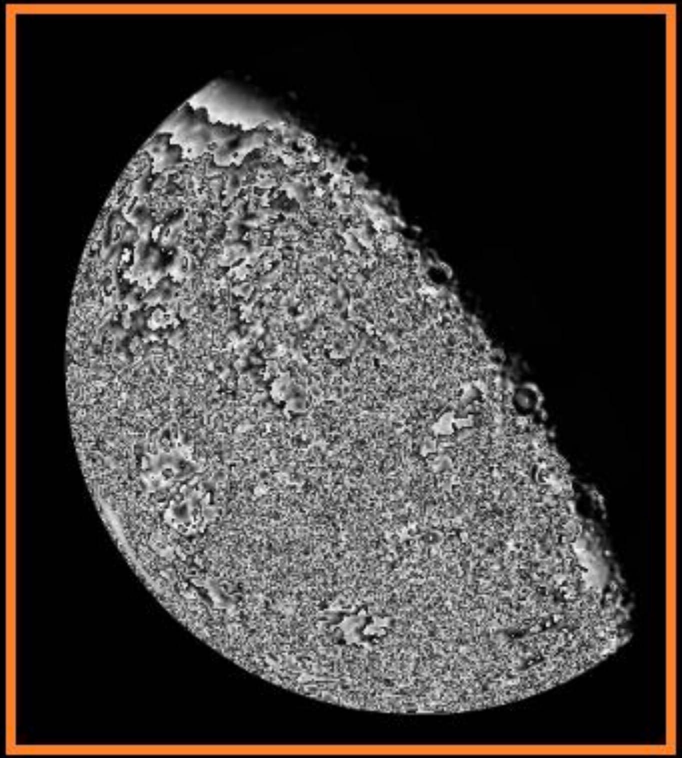
where
$s$ = the output intensity of the pixel,
$r$ = the input intensity of the pixel,
$c$ = scaling constant,
$\gamma$ = positive value

# Gamma Curves




It is clear that for $\gamma < 1$, the output image is brighter than the input image; whereas for $\gamma > 1$, the output image is darker than the input image.

**Input Image**



**Gamma Transformed for gamma = 1.5**

Input Image

Gamma Transformed
for gamma = 0.3

# Auto-contrast Function

The autocontrast function is described by following mathematical function.

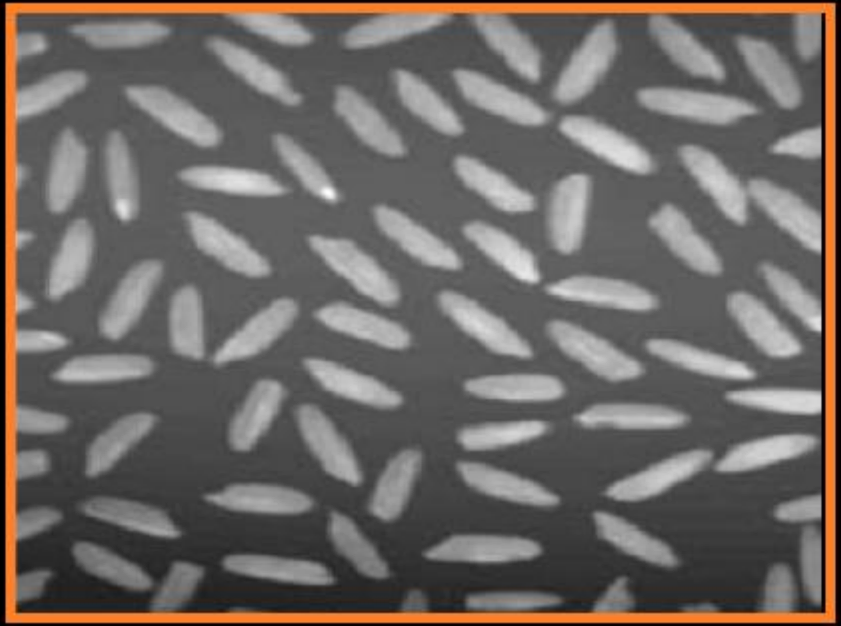
$$\boxed{s = 255 * \frac{r - r_{min}}{r_{max} - r_{min}}}$$

where

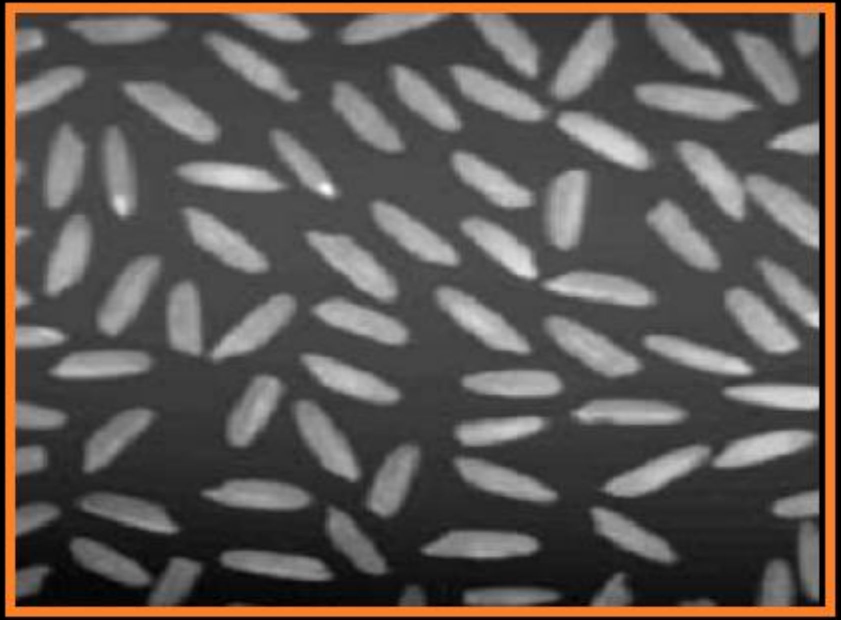
$r_{min}$ = minimum value of input pixel

$r_{max}$ = maximum value of input pixel

The auto-contrast function maps the darkest pixel value in the input image to 0 and the brightest pixel value to 255 and redistributes the intermediate values linearly.



Input Image



Contrast Enhanced
by auto-contrast function

# Piece Wise Linear Function

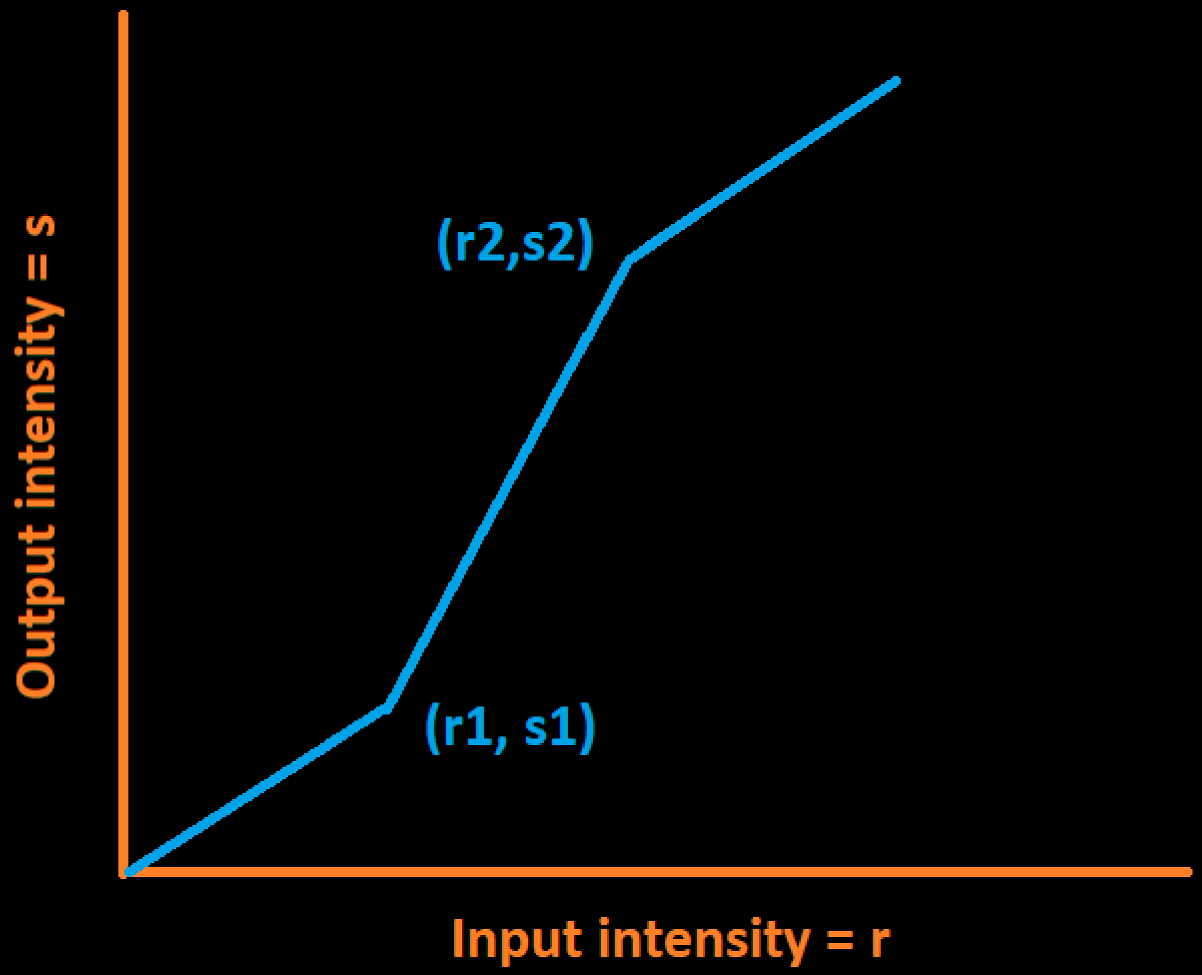
In this transformation we apply linear transformation after certain intervals. Thus, the entire transformation is not linear.

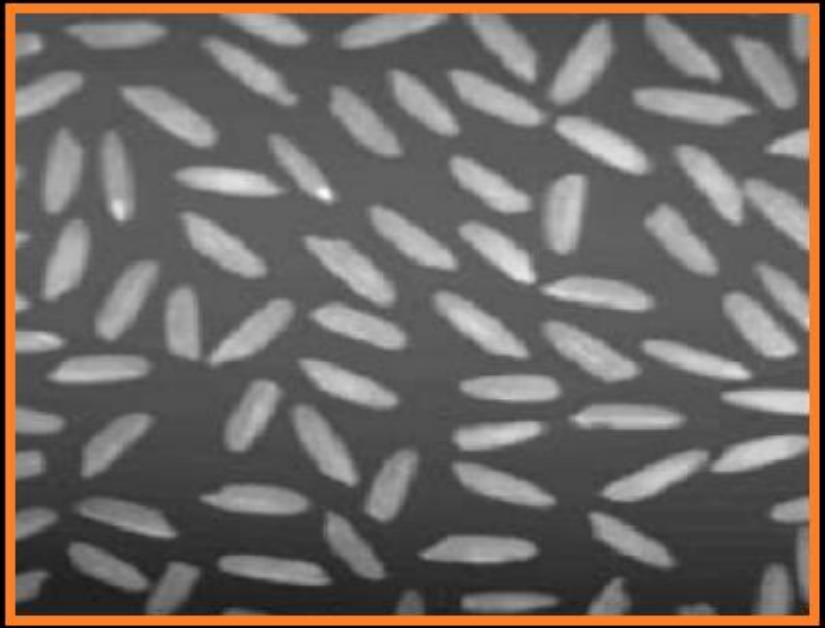
The contrast enhancement equation used in linear transformation is given by

$$\boxed{s = \frac{s_{max} - s_{min}}{r_{max} + r_{min}} * (r - r_{min}) + s_{min}}$$

This technique expands the range of intensity levels according to the intensity range of the camera or the display device.

# Plotting Piece Wise Linear Function





Input Image

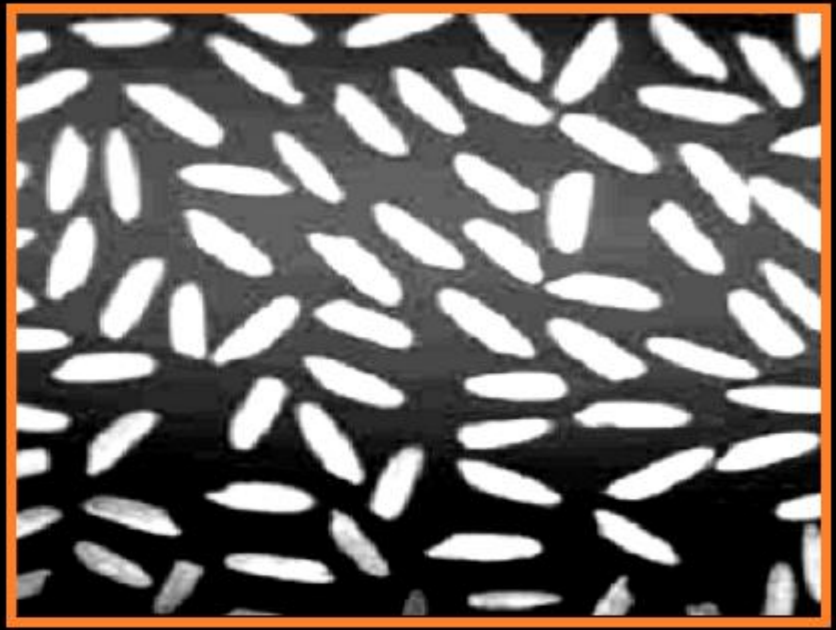


Image Enhancement by
Piece Wise Linear Transformation