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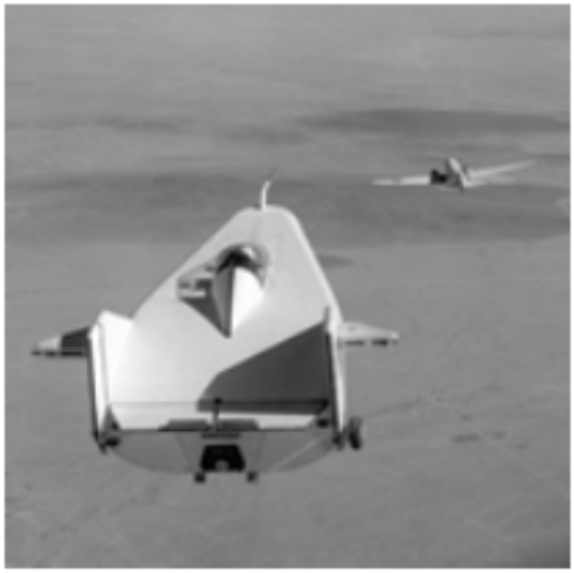
Question: **Identify and briefly explain which intensity transformation is used on the input image to create each of the four results shown in Figure 3. Hint: Select the intensity transformations from the following list: Photographic Negative, Gamma, Logarithmic, and Contrast Stretching**.

Solution:

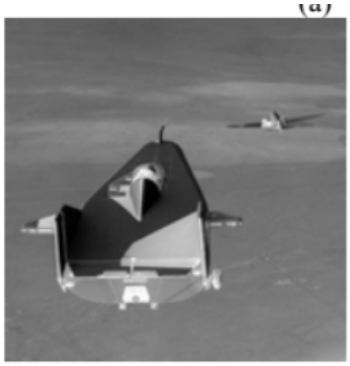
There we were provided by an input image that's following –



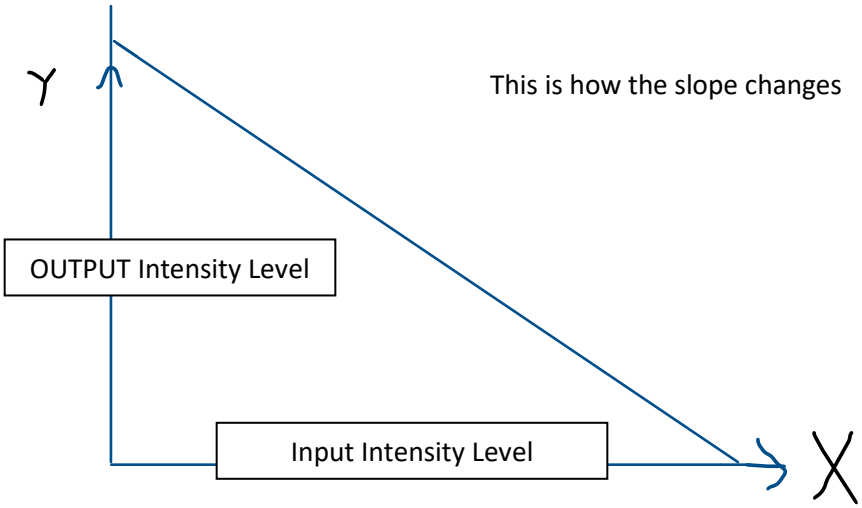
(a) Input image

That image has four different outputs in visual scale.

The first one [output] is Negative Intensity Transformation. In negative intensity transformation, output intensity pixel level is decreased with the increment of input intensity pixel level. As a result, we find a negative sloped curve like following. However, the darked pixels got lightened and the light pixels got lightened according to this negative transformation. In the range of [0, L − 1], negative transformation is obtained by **s = L – 1 – r.**



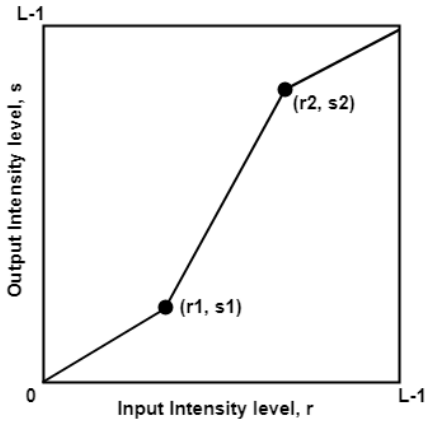
(b) Output image 1



The second output is contrast stretching. **Contrast-Stretching** transformation that uses Piecewise Linear functions while Non-linear method includes **Histogram Equilization**, **Gaussian Stretch** etc. which uses Non-Linear transformation functions that are obtained automatically from the histogram of the input image

(c) Output image 2

Here the intensity level which have lower values are decreased in a wide range of values. As a result, the lower intensified pixel values have large scaled decrement meanwhile others have large scaled transformation as they have.



The lower and upper values of the input image are made to span the full dynamic range. In other words, Lower value of the input image is mapped to 0 and the upper value is mapped to 255. All other intermediate values are reassigned new intensity values according to the following formulae

$$Xnew = \frac{Xinput - Xmin}{Xmax - Xmin} \times 255$$

The third output image shows gamma correction where the value of gamma might be less than 1 approximately. Gamma transform is also called power-law transform. It is mathematically denoted as follows:

$$\tilde{f}(x,y) = c * f(x,y)^{\gamma}$$

Where gamma and c are two constants. The gamma transform can make pixels look brighter or darker depending on gamma. When gamma is within the range [0,1] and gamma is larger than one, it makes the image darker. When gamma is smaller than one, it makes the image look brighter. The following graph shows the expansion