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Department of Biomedical Engineering

Course Name: **19BMB304 & Biomedical Image Processing**

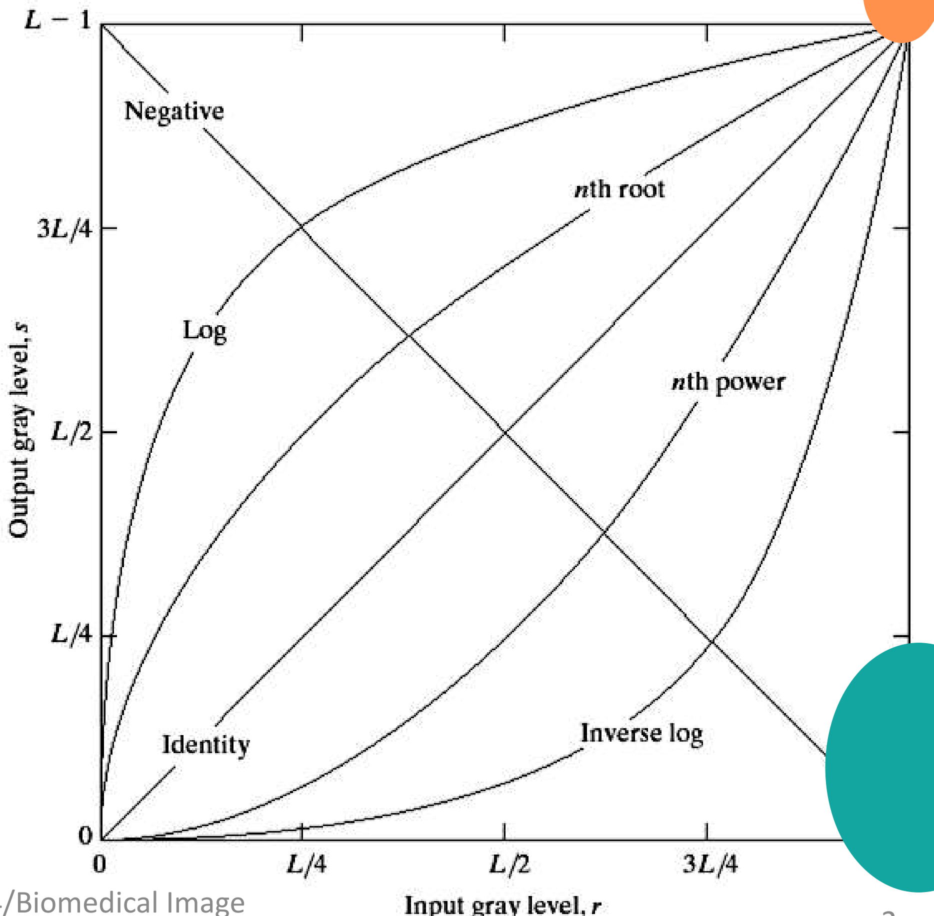
III Year : VI Semester

Unit II –IMAGE ENHANCEMENT

Topic : **Grey Level Transformations**

Basic Grey Level Transformations

- There are many different kinds of grey level transformations
- Three of the most common are shown here
  - Linear
    - Negative/Identity
  - Logarithmic
    - Log/Inverse log
  - Power law
    - n^{th} power/n^{th} root

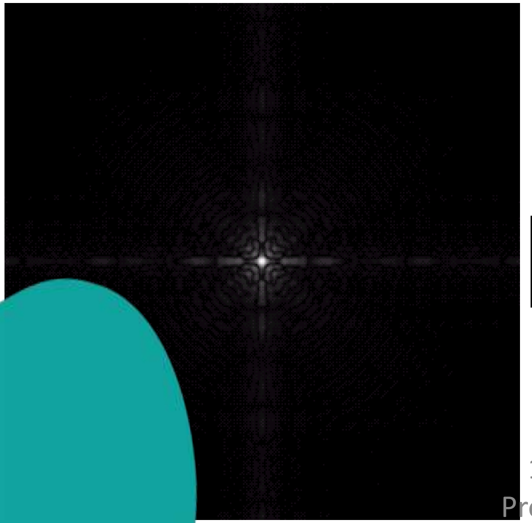


Logarithmic Transformations

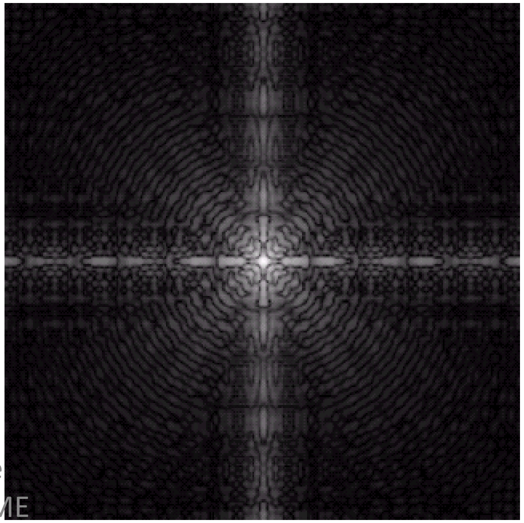
- The general form of the log transformation is
  - $s = c * log(1 + r)$
- The log transformation maps a narrow range of low input grey level values into a wider range of output values
- The inverse log transformation performs the opposite transformation

Logarithmic Transformations (cont…)

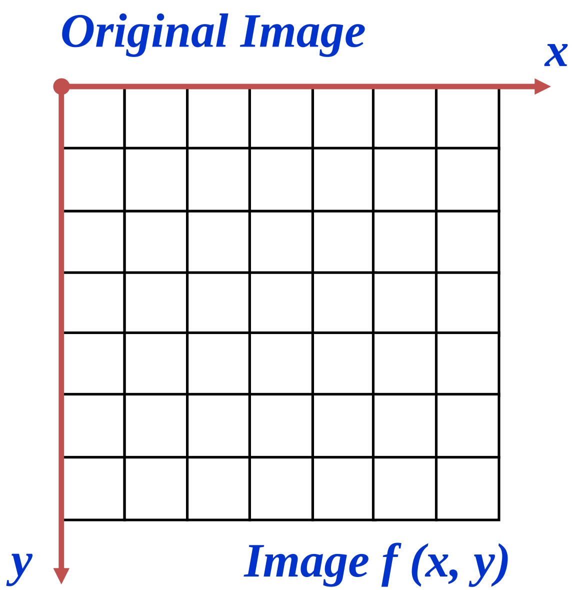
- Log functions are particularly useful when the input grey level values may have an extremely large range of values
- In the following example the Fourier transform of an image is put through a log transform to reveal more detail

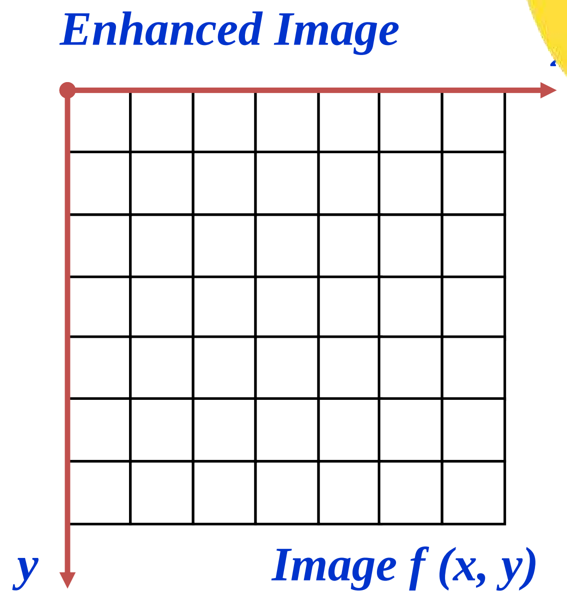


$s = \log(1 + r)$



Logarithmic Transformations (cont..





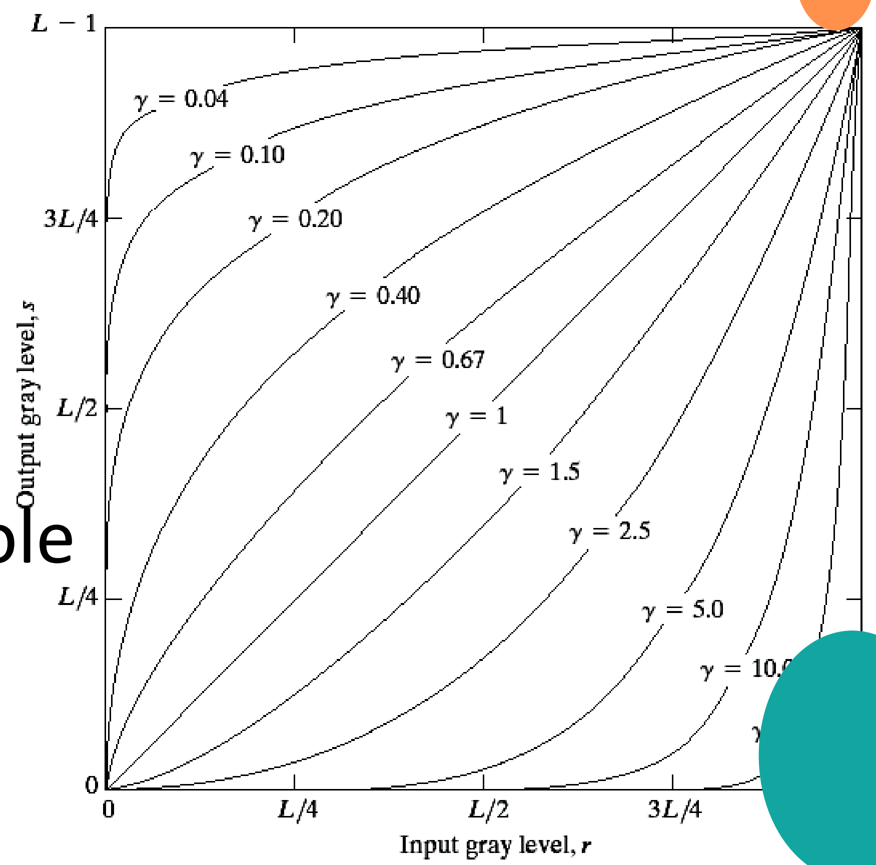
$$s = \log(1 + r)$$

We usually set c to 1

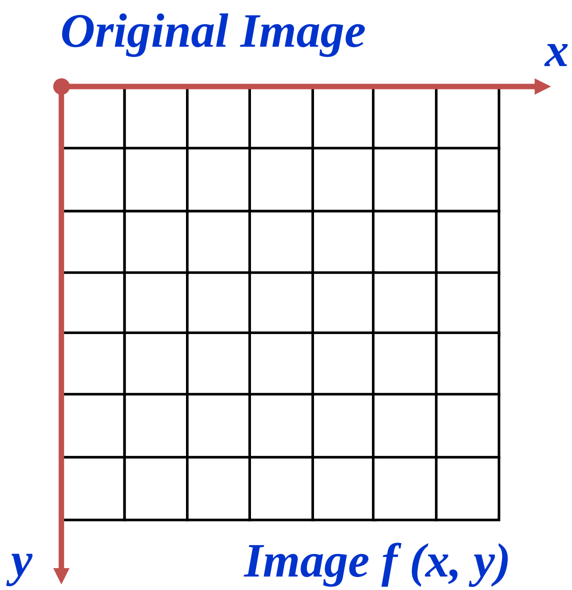
Grey levels must be in the range [0.0, 1.0]

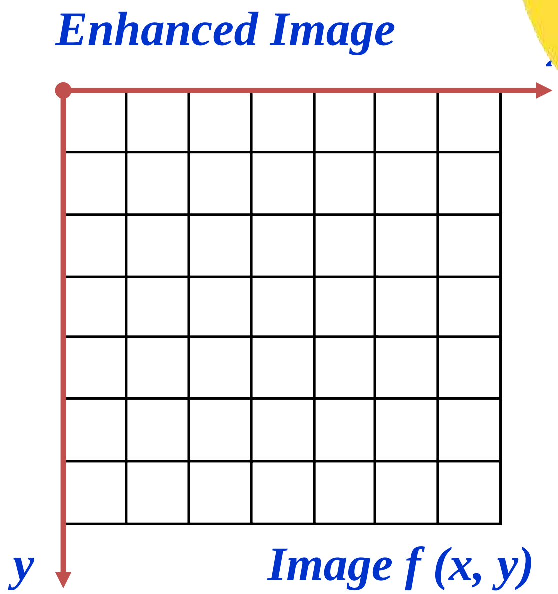
Power Law Transformations

- Power law transformations have the following form
- $$s = c * r^{\gamma}$$
- Map a narrow range of dark input values into a wider range of output values or vice versa
- Varying γ gives a whole family of curves



Power Law Transformations (cont…)





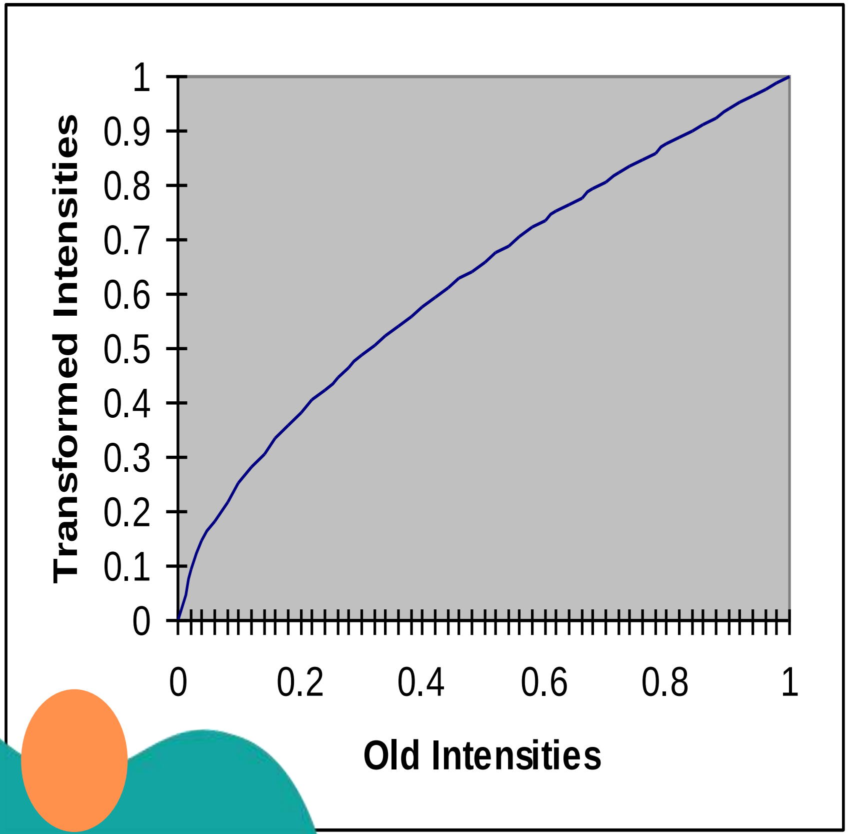
$$s = r^{\gamma}$$

- We usually set c to 1
- Grey levels must be in the range [0.0, 1.0]

Power Law Example

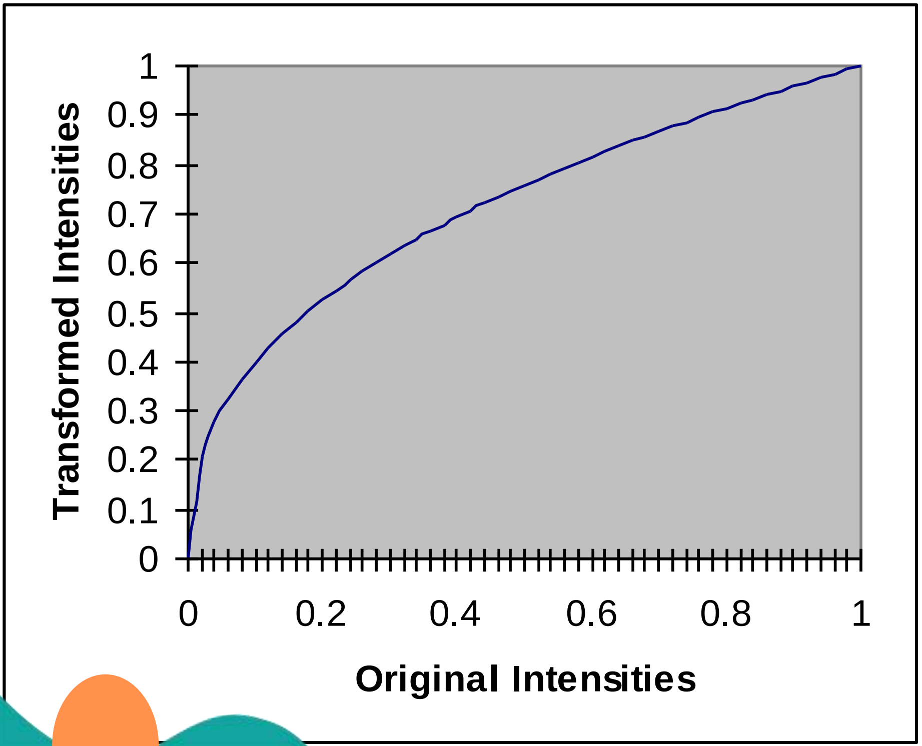
Power Law Example (cont…)

$\gamma = 0.6$



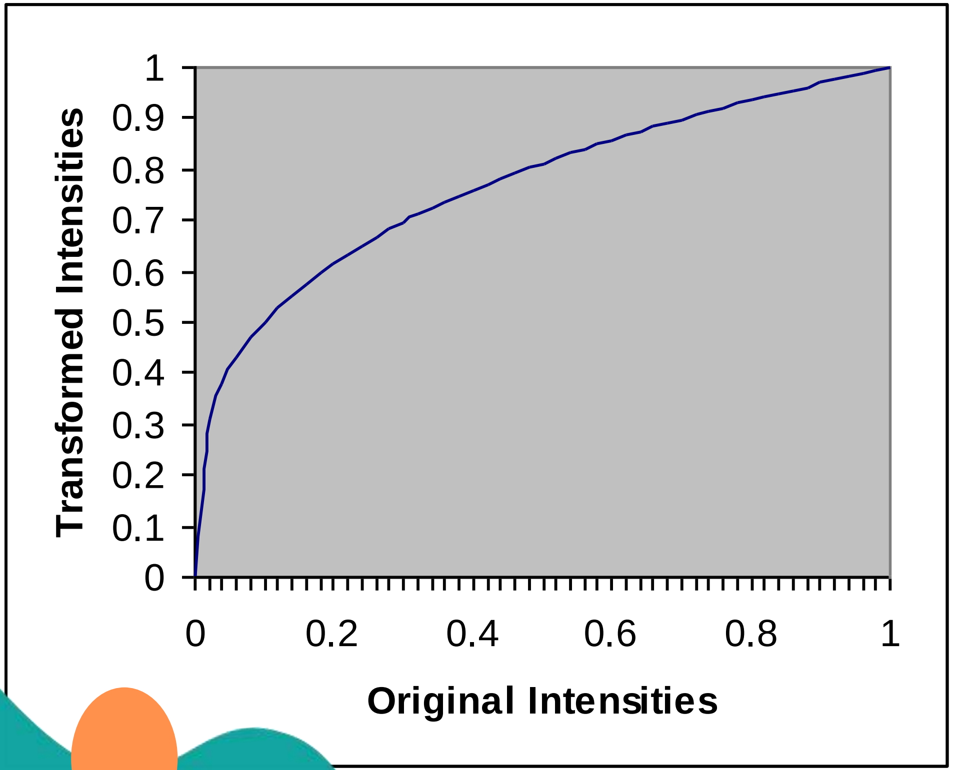
Power Law Example (cont…)

$\gamma = 0.4$



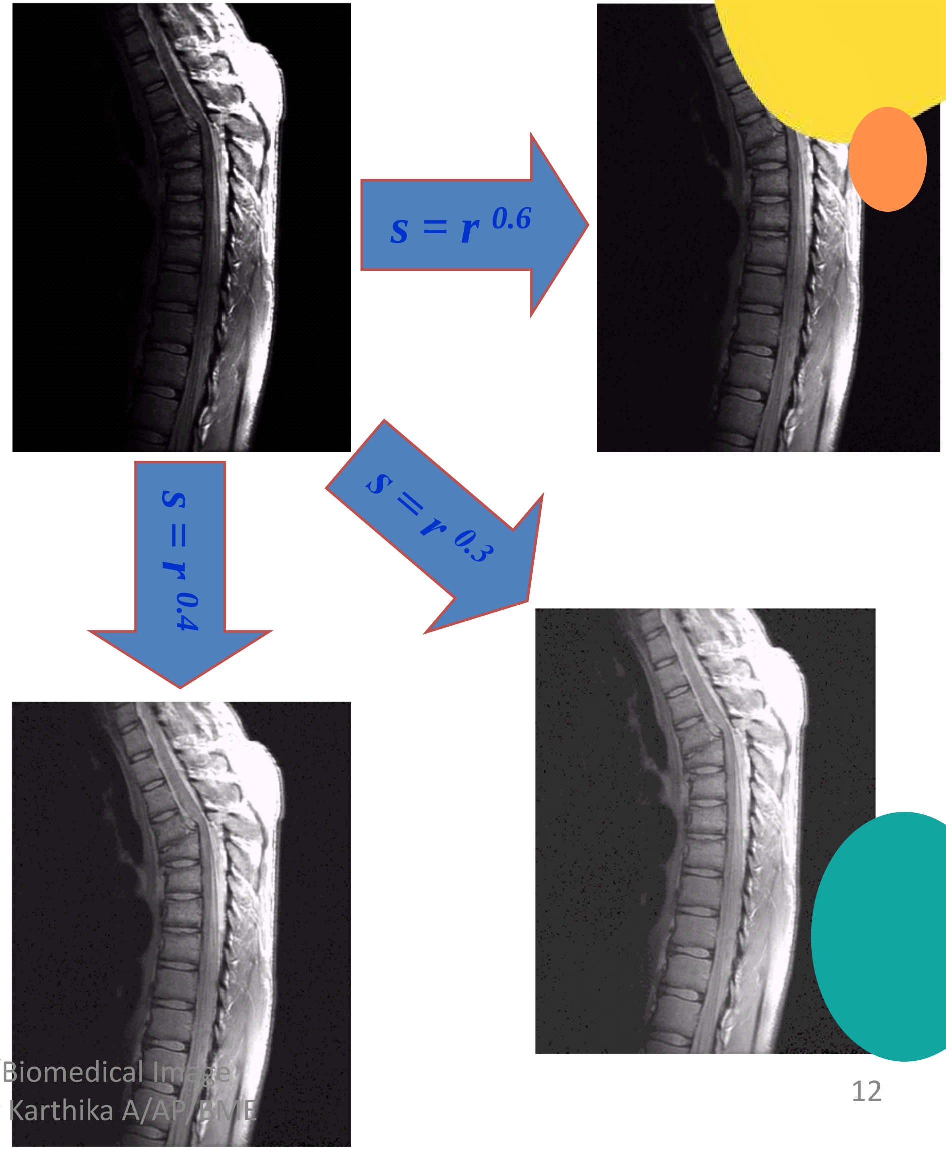
Power Law Example (cont…)

$\gamma = 0.3$



Power Law Example (cont…)

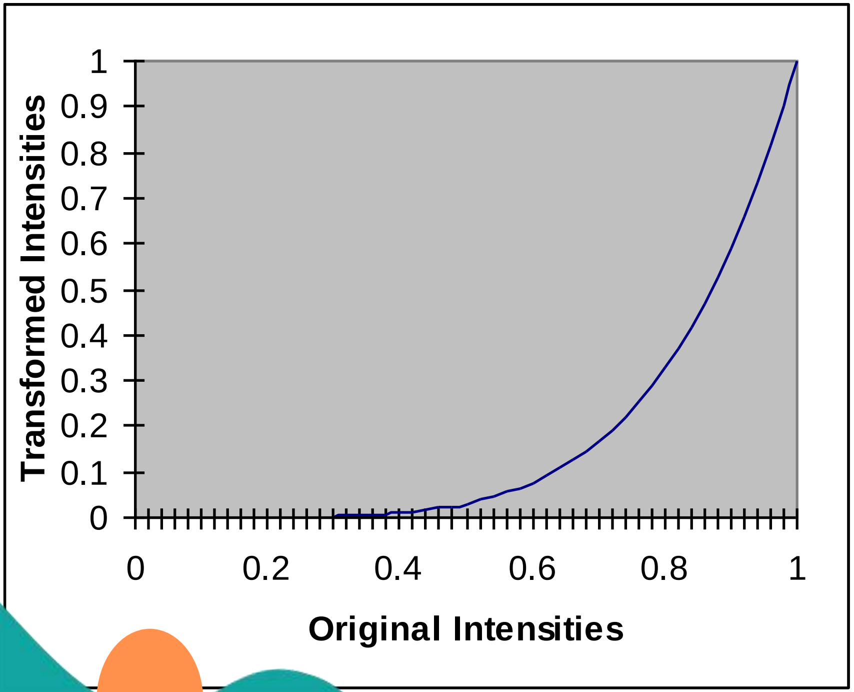
- The images to the right show a magnetic resonance (MR) image of a fractured human spine
- Different curves highlight different detail



Power Law Example

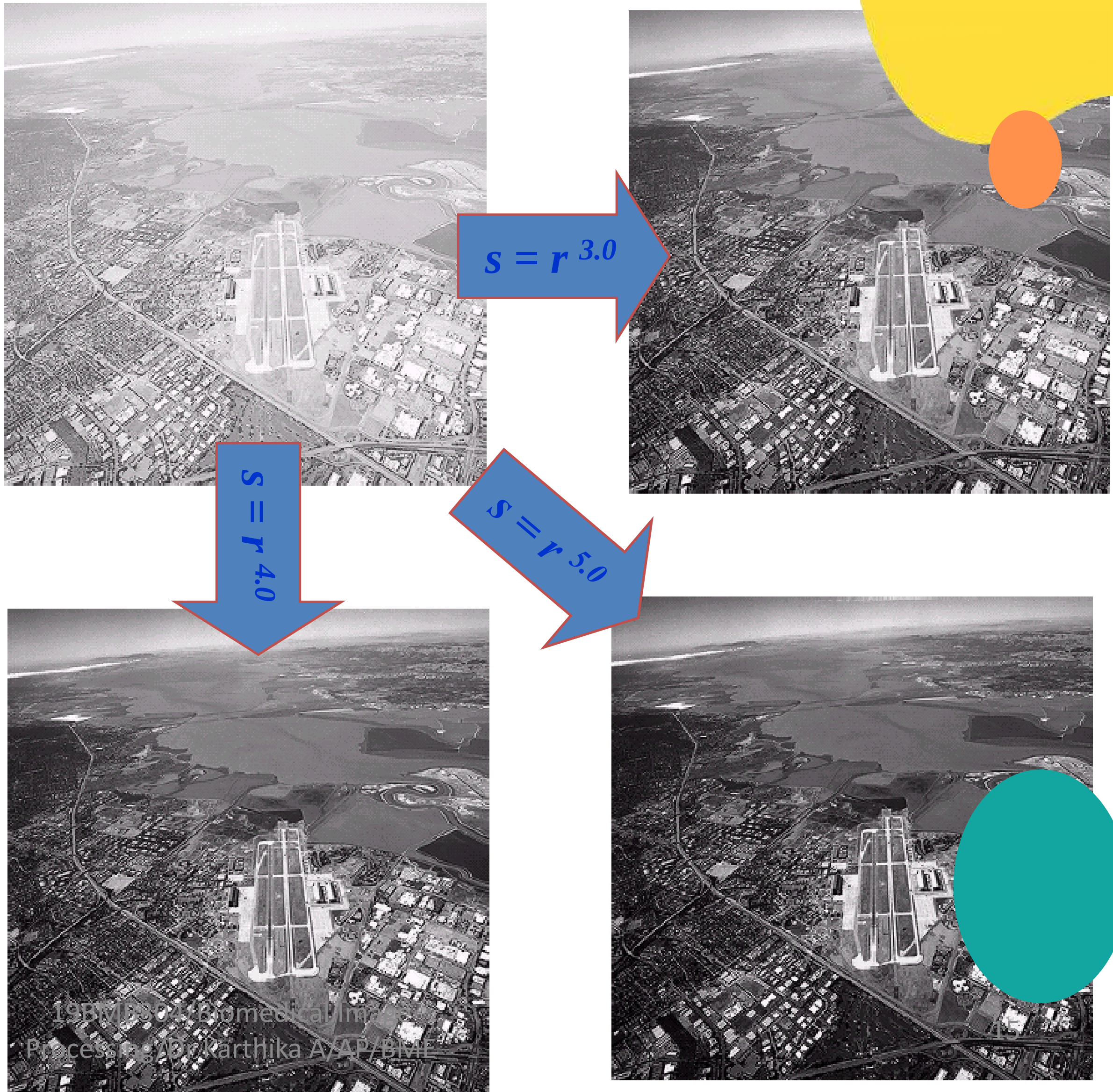
Power Law Example (cont…)

$$\gamma = 5.0$$



Power Law Transformations

- An aerial photo of a runway is shown
- This time power law transforms are used to darken the image
- Different curves highlight different detail



Gamma Correction

- Different camera sensors
- Have different responses to light intensity
- Produce different electrical signals for same input

- How do we ensure there is consistency in:

a)Images recorded by different cameras for given light in put

b)Light emitted by different display devices for same ima ge?

Gamma Correction

- What is the relation between:

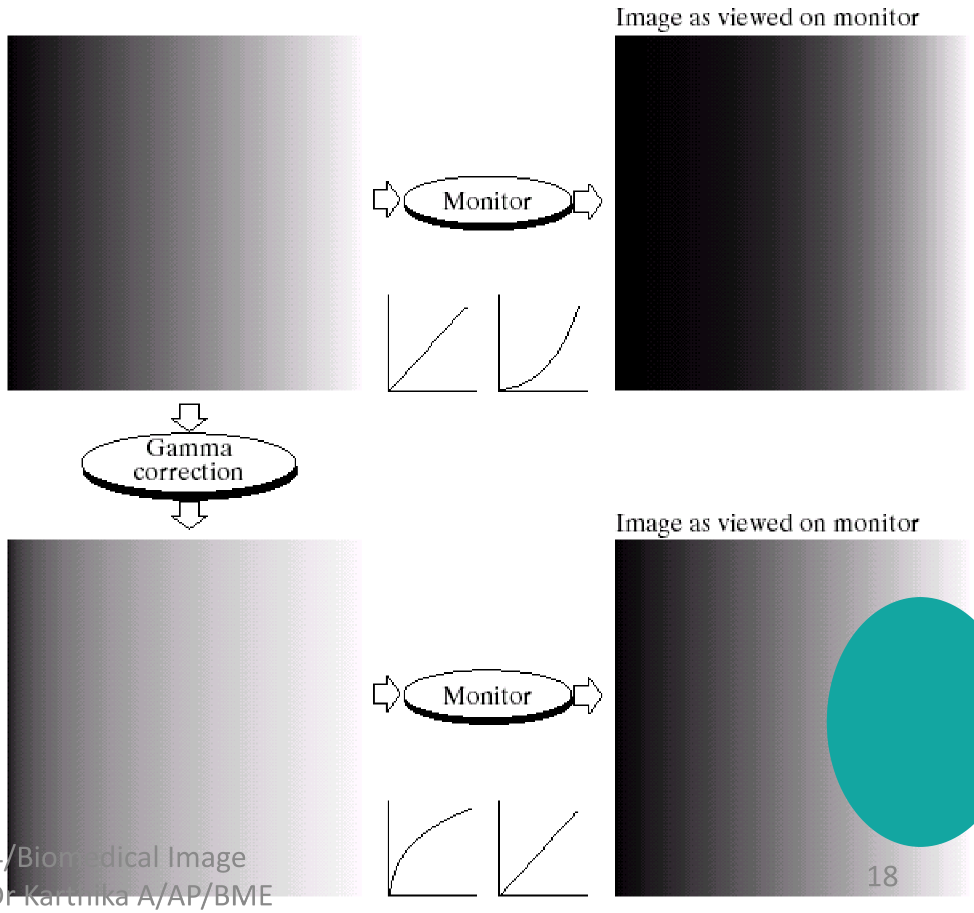
Camera: Light on sensor vs. "intensity" of correspon ding pixel

Display: Pixel intensity vs. light from that pixel

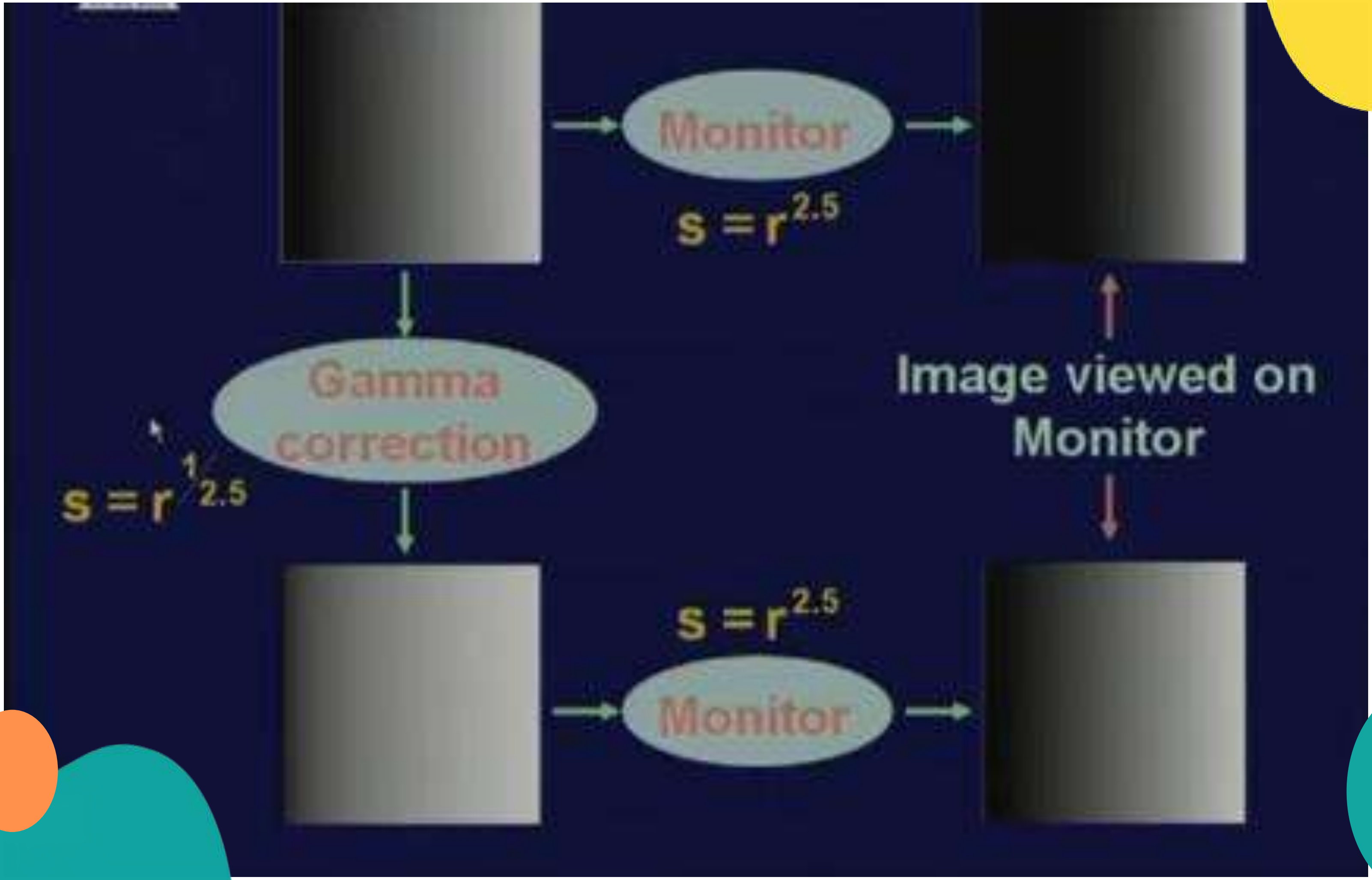
- Relation between pixel value and correspo nding physical quantity is usually comple x, nonlinear

Gamma Correction

- Many of you might be familiar with gamma correction of computer monitors
- Problem is that display devices do not respond linearly to different intensities
- Can be corrected using a log transform

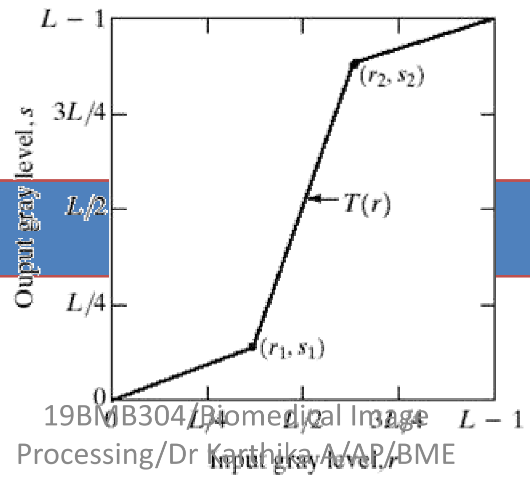


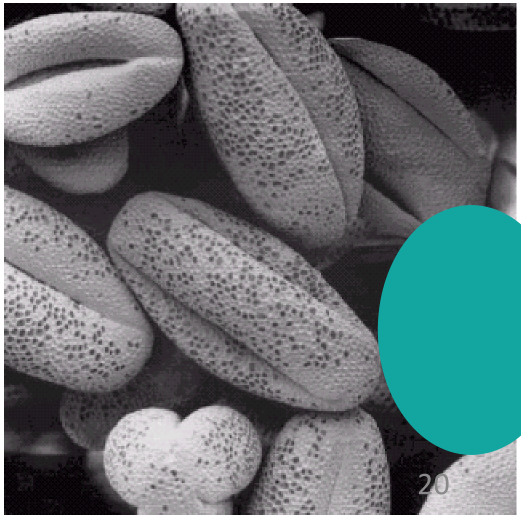
Gamma Correction



cewise Linear Transformation Funct

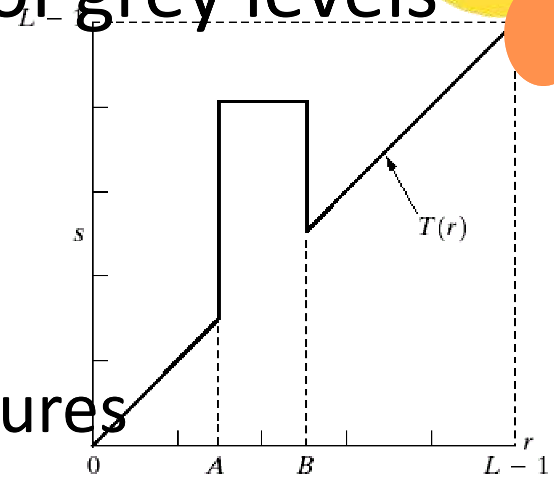
- Rather than using a well defined mathematical function we can use arbitrary user-defined transforms
- The images below show a contrast stretching linear transform to add contrast to a poor quality image

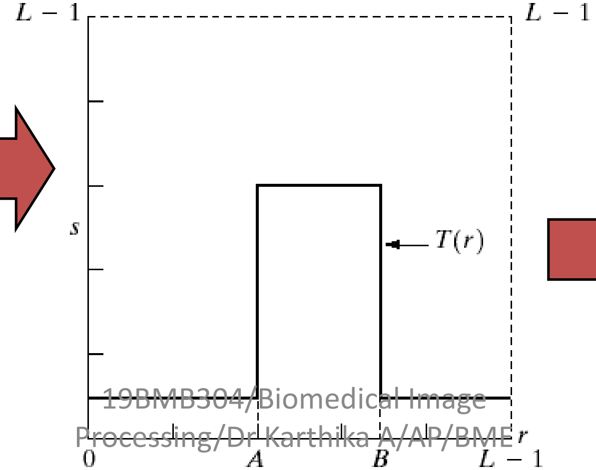


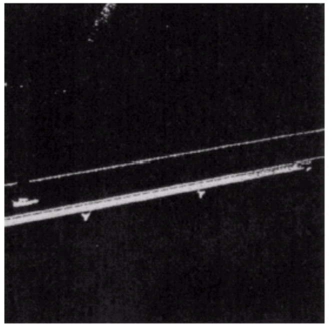


Gray Level Slicing

- Highlights a specific range of grey levels
  - Similar to thresholding
  - Other levels can be suppressed or maintained
  - Useful for highlighting features in an image

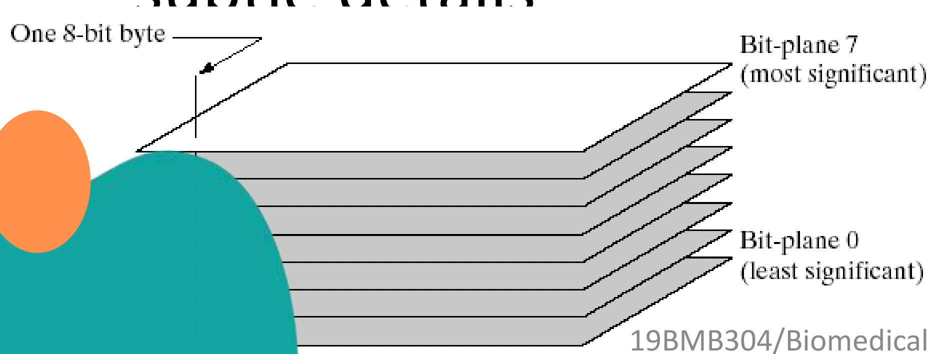


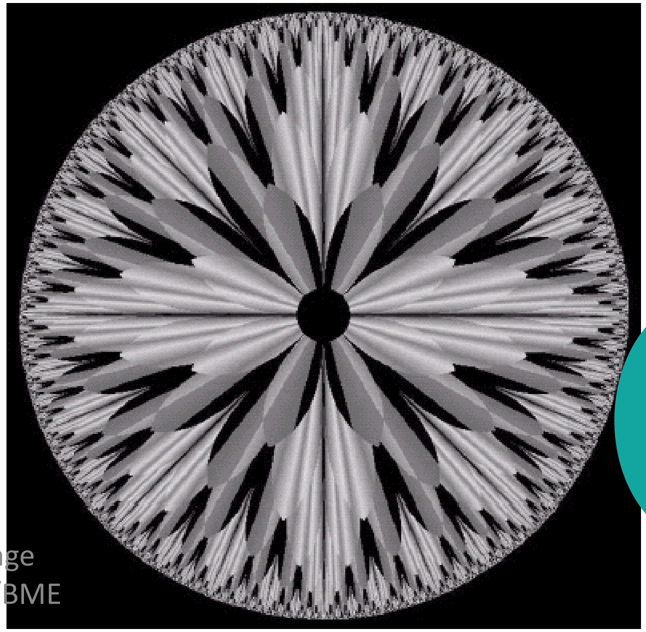




Bit Plane Slicing

- Often by isolating particular bits of the pixel values in an image we can highlight interesting aspects of that image
  - Higher-order bits usually contain most of the significant visual information
  - Lower-order bits contain subtle details





Thank You