INTENSITY TRANSFORMATIONS

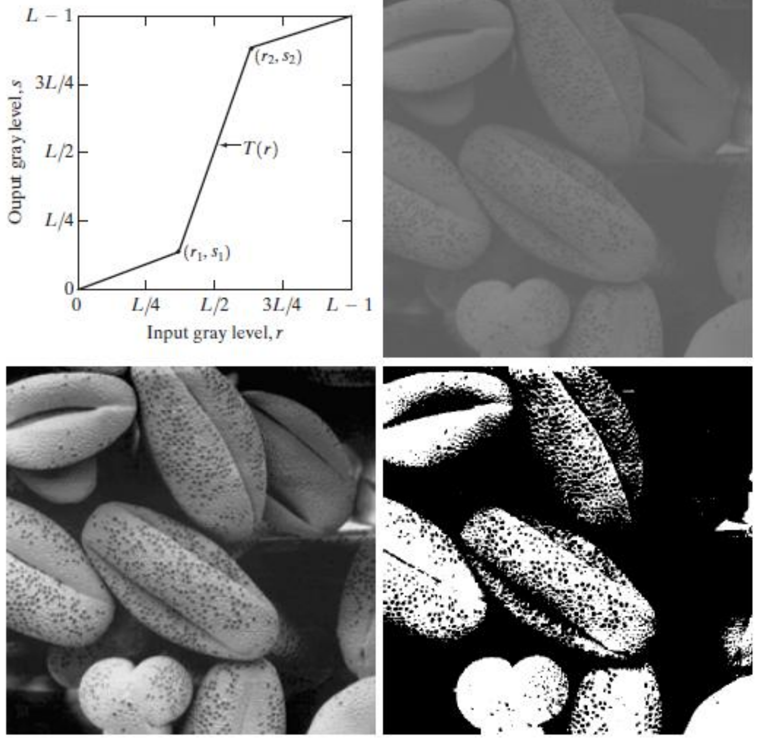
Pixel to Pixel mapping

CONTRAST STRETCHING

Contrast stretching is a process that expands the range of intensity levels in an image

so that it spans the full intensity range of the recording medium or display device.

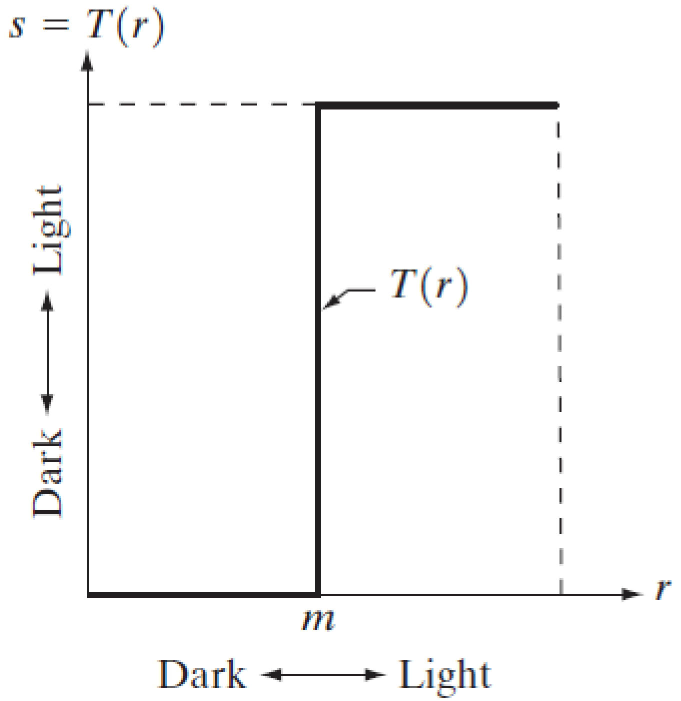
Contrast-stretching transformations increase the contrast between the darks and the lights



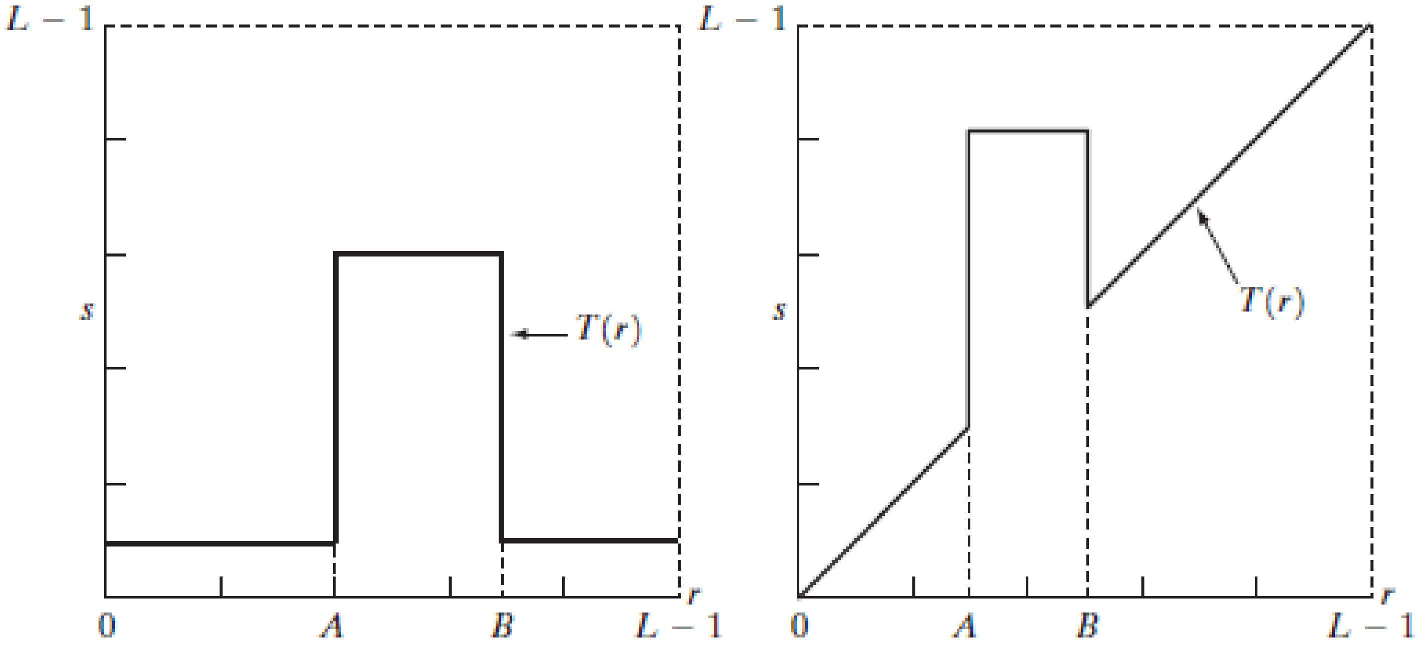
a b
c d

FIGURE 3.10 Contrast stretching. (a) Form of transformation function. (b) A low-contrast image. (c) Result of contrast stretching. (d) Result of thresholding. (Original image courtesy of Dr. Roger Heady, Research School of Biological Sciences, Australian National University, Canberra, Australia.)

THRESHOLDING FUNCTION



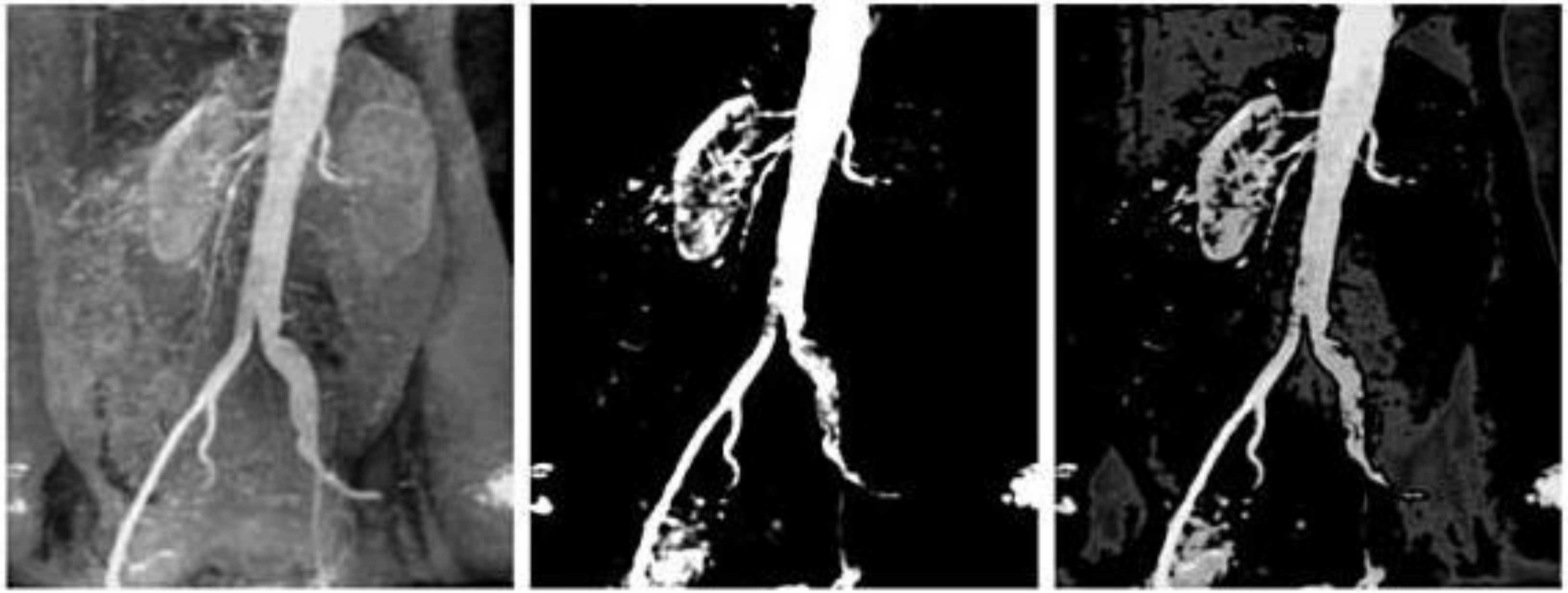
INTENSITY-LEVEL SLICING



a b
c d

FIGURE 3.11
(a) This transformation highlights range $[A, B]$ of gray levels and reduces all others to a constant level.
(b) This transformation highlights range $[A, B]$ but preserves all other levels.

INTENSITY-LEVEL SLICING

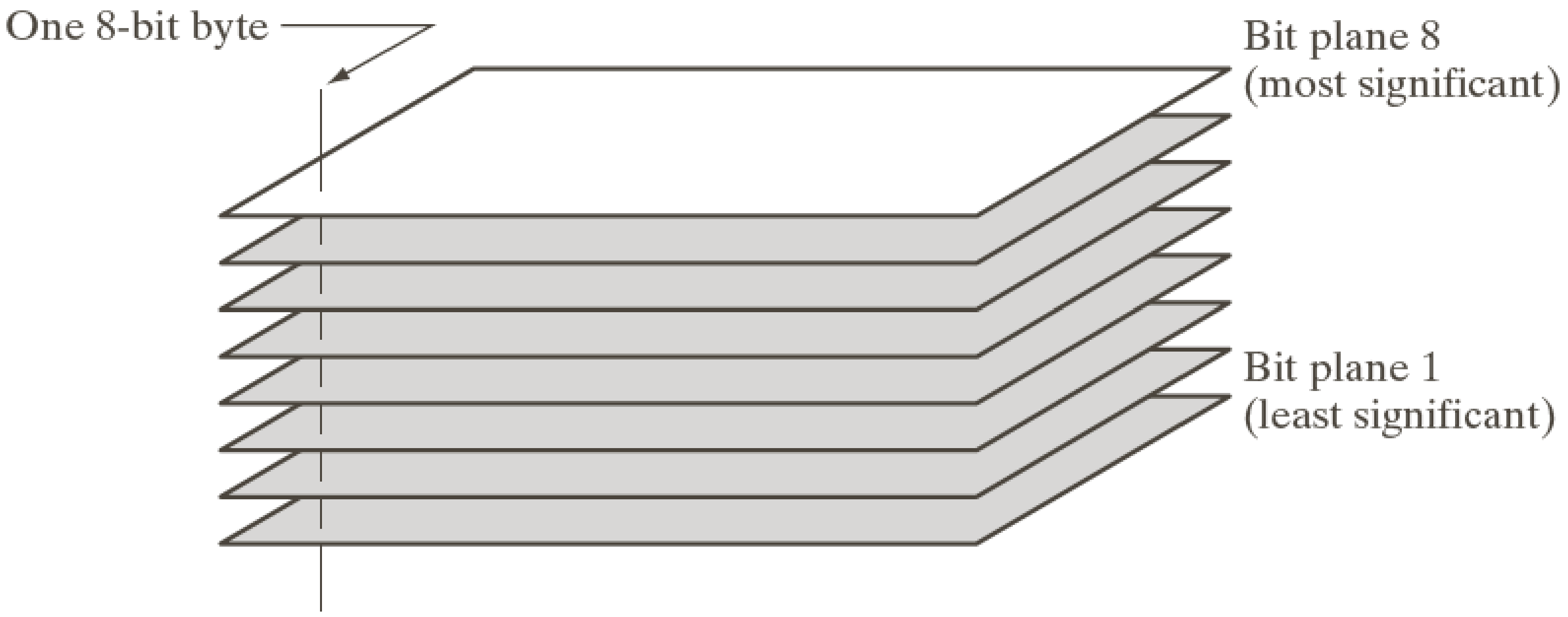


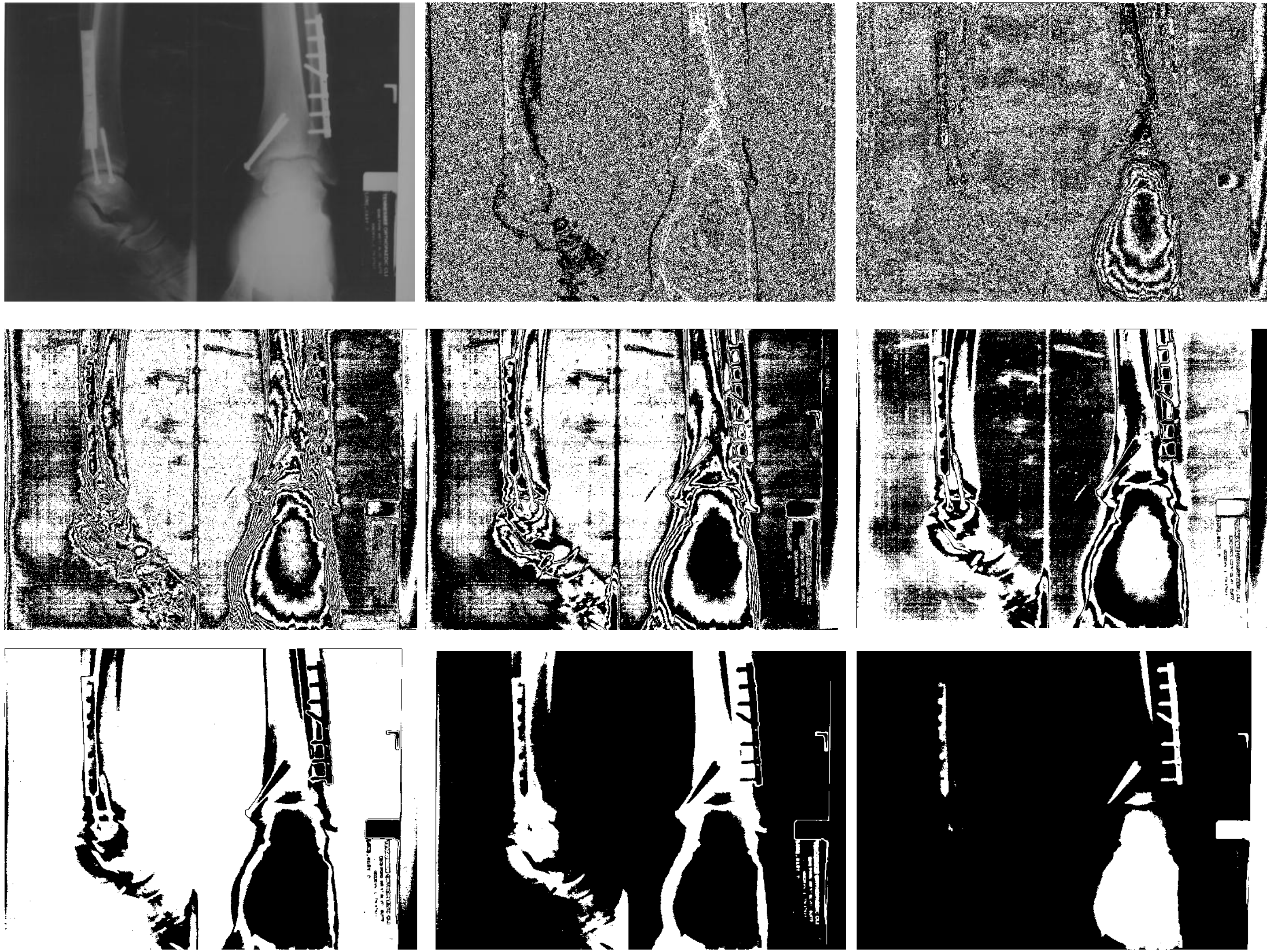
a b c

FIGURE 3.12 (a) Aortic angiogram. (b) Result of using a slicing transformation of the type illustrated in Fig. 3.11(a), with the range of intensities of interest selected in the upper end of the gray scale. (c) Result of using the transformation in Fig. 3.11(b), with the selected area set to black, so that grays in the area of the blood vessels and kidneys were preserved. (Original image courtesy of Dr. Thomas R. Gest, University of Michigan Medical School.)

BIT PLANE SLICING

- Highlighting the contribution made by a specific bit.
- For images, each pixel is represented by 8 bits.
- Each bit-plane is a binary image





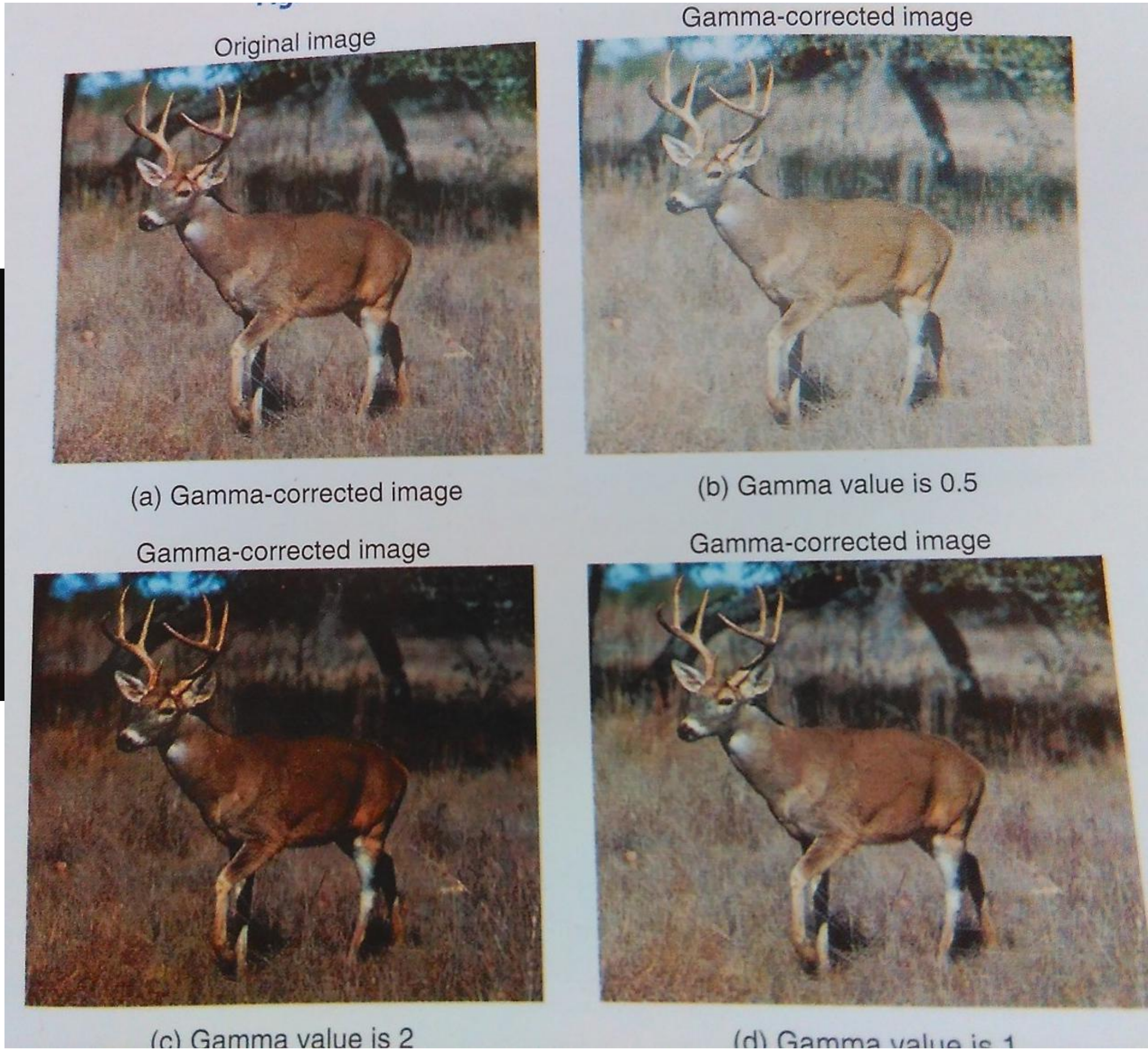
GAMMA CORRECTION

1. Input image
2. Determine the maximum pixel intensity
3. Select the value of Gamma
4. Look-up table formation
5. Mapping of input pixel values to values in Look-up-table

GAMMA CORRECTION

Look-up-table = Max intensity * $\{[0 : \text{Max intensity}]/\text{Max intensity}\}^{\gamma}$

GAMMA CORRECTION



Food for thought!

1. What is meant by pixel-to-pixel (intensity) transformation?
2. What is contrast stretching and why is it used?
3. What is thresholding in image processing?
4. What is the purpose of bit-plane slicing?
5. What is gamma correction and how does the value of gamma affect an image?

Programming assignment

- Implement and analyze various intensity (pixel-to-pixel) transformation techniques to enhance contrast and highlight image features.
- **Concepts Used**
  - Pixel-to-pixel intensity transformation
  - Contrast stretching
  - Thresholding
  - Intensity-level slicing
  - Bit-plane slicing
  - Gamma correction (lookup table based)
- **Tasks**
  - Read a grayscale image.
  - Apply contrast stretching to expand the image intensity range.
  - Perform thresholding using a chosen threshold value and generate a binary image.
  - Apply intensity-level slicing to highlight a specified gray-level range.
  - Perform bit-plane slicing and display at least the 1st, 4th, and 8th bit planes.
  - Implement gamma correction using a lookup table for two different values of γ ($\gamma < 1$ and $\gamma > 1$).

AI supported self-learning (Prompts compatible with ChatGPT)

Active Learners (Learning by Doing)

1. Give me a small grayscale image with pixel values and ask me to perform contrast stretching step by step. Let me attempt first, then explain the correct solution.
2. Create a numerical example where I apply thresholding and intensity-level slicing to highlight a gray-level range. Ask me to predict the output before explaining.

Reflective Learners (Learning by Thinking)

1. Explain pixel-to-pixel intensity transformations step by step and summarize why they are called single-pixel operations.
2. Explain the purpose of contrast stretching, thresholding, and bit-plane slicing, and compare their effects on an image.

Sensing Learners (Concrete & Practical)

1. Explain contrast stretching, thresholding, and gamma correction using real pixel values and small grayscale matrices.
2. Show practical examples where bit-plane slicing helps highlight important image information.

Intuitive Learners (Concepts & Patterns)

1. Explain the concept of intensity transformation functions and how they modify the distribution of gray levels.
2. Explain conceptually how gamma correction changes image brightness and contrast for different gamma values.

Visual Learners (Diagrams & Structure)

1. Explain contrast stretching and gamma correction using plots of s = T(r) showing input-output intensity mapping.
2. Visually show how bit-plane slicing separates an image into individual binary bit planes.

Verbal Learners (Words & Explanation)

1. Explain intensity transformations in simple language using everyday examples like adjusting brightness or contrast.
2. Explain thresholding, intensity-level slicing, and bit-plane slicing as if teaching a beginner.

Sequential Learners (Step-by-Step Logic)

1. Explain step by step how contrast stretching maps original pixel values to a new intensity range.
2. Explain step by step how gamma correction is implemented using a lookup table for $\gamma < 1$ and $\gamma > 1$.

Global Learners (Big Picture First)

1. First explain the overall role of intensity transformations in image enhancement, then explain each technique.
2. Explain why pixel-to-pixel transformations are fundamental before studying spatial filtering and neighborhood operations.