Basics of Digital Image Processing

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Digital Image Processing

- Digital Image Processing means processing digital image by means of a digital computer.

- We can also say that it is a use of computer algorithms, in order to get enhanced image either to extract some useful information.

Steps

- 1. Importing the image via image acquisition tools;

- 2. Analysing and manipulating the image;

- 3. Output in which result can be altered image or a report which is based on analysing that image.

What is Image?

- An image is defined as a two-dimensional function, $F(x,y)$, where x and y are spatial coordinates, and the amplitude of F at any pair of coordinates (x,y) is called the intensity of that image at that point.

- When x, y, and amplitude values of F are finite, we call it a digital image.

- In other words, an image can be defined by a two-dimensional array specifically arranged in rows and columns.

What is Image?

- Digital Image is composed of a finite number of elements, each of which elements have a particular value at a particular location.

- These elements are referred to as picture elements,image elements,and pixels.

- A Pixel is most widely used to denote the elements of a Digital Image.

Types of Image?

- BINARY IMAGE– The binary image as its name suggests, contain only two pixel elements i.e 0 & 1,where 0 refers to black and 1 refers to white. This image is also known as Monochrome.

- BLACK AND WHITE IMAGE– The image which consist of only black and white color is called BLACK AND WHITE IMAGE.

Types of Image?

- 8 bit COLOR FORMAT– It is the most famous image format.It has 256 different shades of colors in it and commonly known as Grayscale Image. In this format, 0 stands for Black, and 255 stands for white, and 127 stands for gray.

- 16 bit COLOR FORMAT– It is a color image format. It has 65,536 different colors in it.It is also known as High Color Format. In this format the distribution of color is not as same as Grayscale image.

  - A 16 bit format is actually divided into three further formats which are Red, Green and Blue. That famous RGB format.

Image as a matrix

- As we know, images are represented in rows and columns we have the following syntax in which images are represented:

$$f(x,y) = \begin{bmatrix} f(0,0) & f(0,1) & f(0,2) & \ldots & f(0,N-1) \\ f(1,0) & f(1,1) & f(1,2) & \ldots & f(1,N-1) \\ . & . & . & & . \\ . & . & . & & . \\ . & . & . & & . \\ f(M-1,0) & f(M-1,1) & f(M-1,2) & \ldots & f(M-1,N-1) \end{bmatrix}$$

- The right side of this equation is digital image by definition. Every element of this matrix is called image element , picture element , or pixel.

Image Processing Phases

- 1.ACQUISITION– It could be as simple as being given an image which is in digital form. The main work involves:
    - a) Scaling
    - b) Color conversion(RGB to Gray or vice-versa)
- 2.IMAGE ENHANCEMENT– It is amongst the simplest and most appealing in areas of Image Processing it is also used to extract some hidden details from an image and is subjective.

- 3.IMAGE RESTORATION– It also deals with appealing of an image but it is objective(Restoration is based on mathematical or probabilistic model or image degradation).

- 4.COLOR IMAGE PROCESSING– It deals with pseudocolor and full color image processing color models are applicable to digital image processing.

- 5.WAVELETS AND MULTI-RESOLUTION PROCESSING– It is foundation of representing images in various degrees.

- 6.IMAGE COMPRESSION-It involves in developing some functions to perform this operation. It mainly deals with image size or resolution.

- 7.MORPHOLOGICAL PROCESSING-It deals with tools for extracting image components that are useful in the representation & description of shape.

- 8.SEGMENTATION PROCEDURE-It includes partitioning an image into its constituent parts or objects. Autonomous segmentation is the most difficult task in Image Processing.

- 9.REPRESENTATION & DESCRIPTION-It follows output of segmentation stage, choosing a representation is only the part of solution for transforming raw data into processed data.

- 10.OBJECT DETECTION AND RECOGNITION-It is a process that assigns a label to an object based on its descriptor.
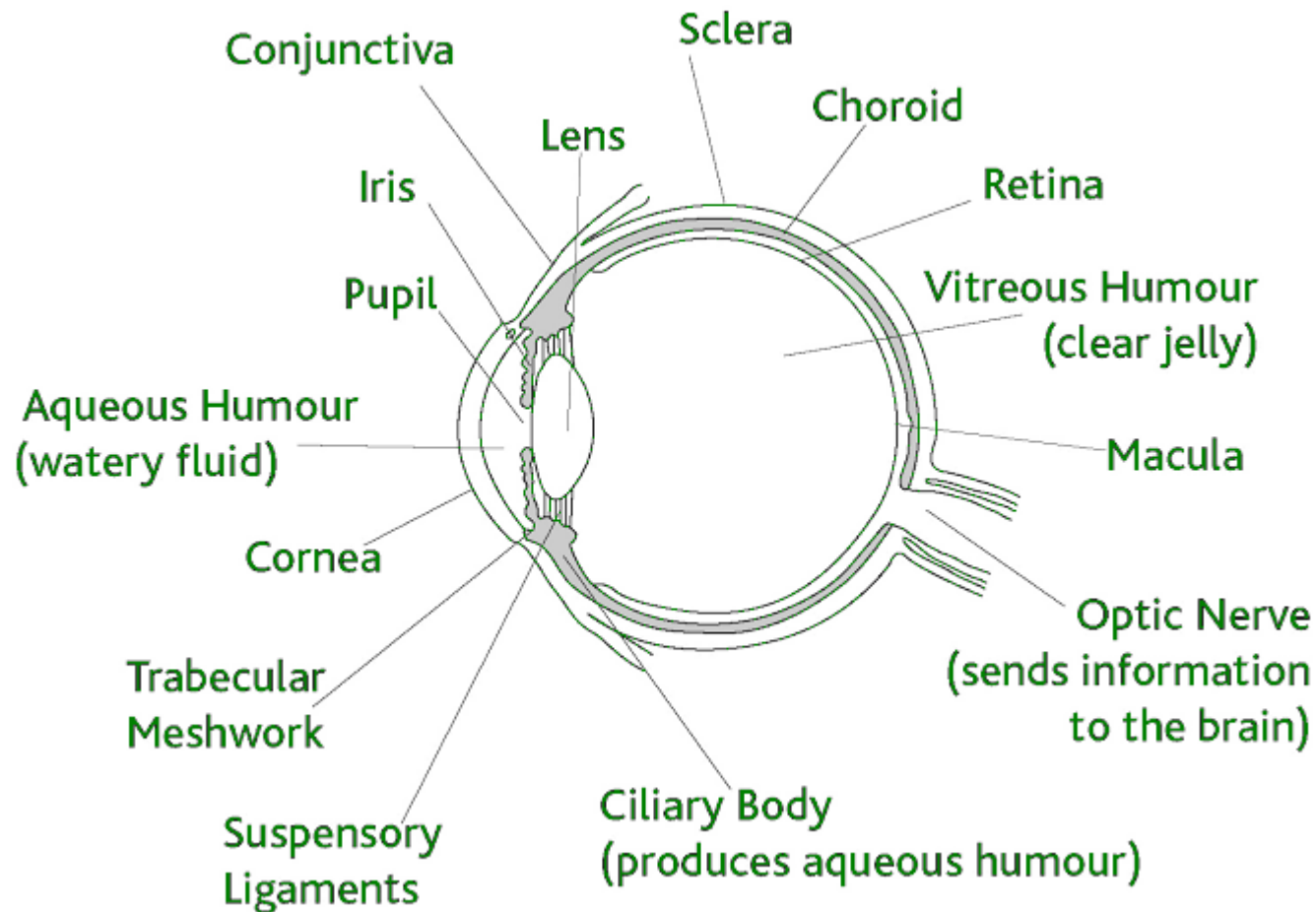
Elements of Visual Perception

- The field of digital image processing is built on the foundation of mathematical and probabilistic formulation, but human intuition and analysis play the main role to make the selection between various techniques, and the choice or selection is basically made on subjective, visual judgements.

- In human visual perception, the eyes act as the sensor or camera, neurons act as the connecting cable and the brain acts as the processor.

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Elements of Visual Perception

- The basic elements of visual perceptions are:
  - Structure of Eye
  - Image Formation in the Eye
  - Brightness Adaptation and Discrimination

Structure of eye

- The human eye is a slightly asymmetrical sphere with an average diameter of the length of 20mm to 25mm.

- It has a volume of about 6.5cc. The eye is just like a camera. The external object is seen as the camera take the picture of any object.

- Light enters the eye through a small hole called the pupil, a black looking aperture having the quality of contraction of eye when exposed to bright light and is focused on the retina which is like a camera film.

Structure of eye

- The lens, iris, and cornea are nourished by clear fluid, know as anterior chamber.

- The fluid flows from ciliary body to the pupil and is absorbed through the channels in the angle of the anterior chamber.

- The delicate balance of aqueous production and absorption controls pressure within the eye.

- Cones in eye number between 6 to 7 million which are highly sensitive to colors. Human visualizes the colored image in daylight due to these cones. The cone vision is also called as photopic or bright-light vision.
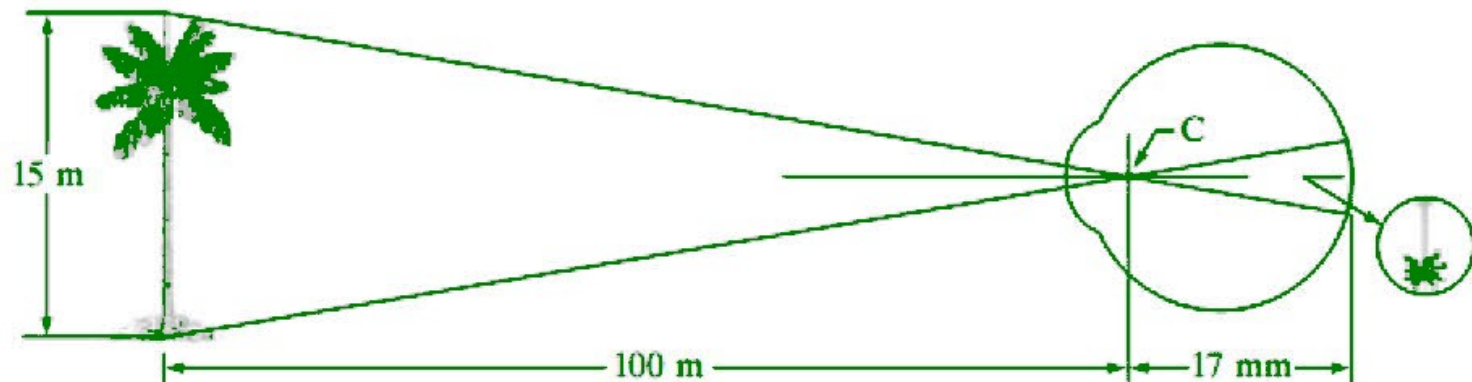
Structure of eye

- Rods in the eye are much larger between 75 to 150 million and are distributed over the retinal surface.

- Rods are not involved in the color vision and are sensitive to low levels of illumination.

Image Formation in the Eye

- When the lens of the eye focus an image of the outside world onto a light-sensitive membrane in the back of the eye, called retina the image is formed.

- The lens of the eye focuses light on the photoreceptive cells of the retina which detects the photons of light and responds by producing neural impulses.
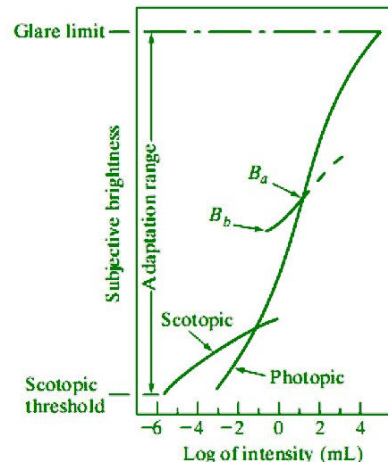
- The distance between the lens and the retina is about 17mm and the focal length is approximately 14mm to 17mm.

- Digital images are displayed as a discrete set of intensities.

- The eyes ability to discriminate black and white at different intensity levels is an important consideration in presenting image processing result.

- The range of light intensity levels to which the human visual system can adapt is of the order of 10^{10} from the scotopic threshold to the glare limit. In a photopic vision, the range is about 10^{6}.

Thank you

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