• Digital Image

Early 1920s: One of the first applications of digital imaging was in the news- paper industry

- Images were transferred by submarine cable between London and New York
- Pictures were coded for cable transfer and reconstructed at the receiving end on a telegraph printer

Early digital image 

1960s: Improvements in computing technology and the onset of the space race led to a surge of work in digital image processing

- **1964:** Computers used to improve the quality of images of the moon taken by the *Ranger 7* probe
- Such techniques were used in other space missions including the Apollo landings

A picture of the moon taken by the Ranger 7 probe minutes before landing

1980s - Today: The use of digital image processing techniques has exploded and they are now used for all kinds of tasks in all kinds of areas

- Image enhancement/restoration
- Artistic effects
- Medical visualisation
- Industrial inspection
- Law enforcement
- Human computer interfaces

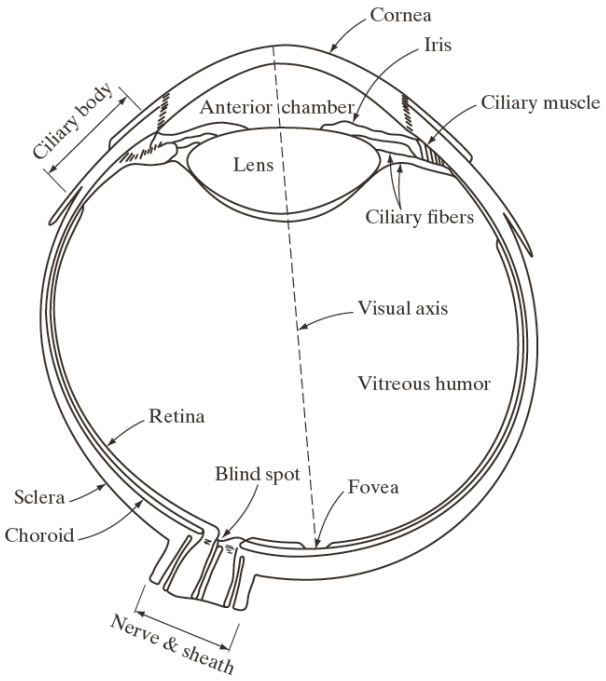
Elements of Visual Perception

Although the field of digital image processing is built on a foundation of mathematical and probabilistic formulations, human intuition and analysis play a central role in the choice of one technique versus another, and this choice often is made based on subjective, visual judgments. Hence, developing a basic understanding of human visual perception as a first step in our journey through this book is appropriate. Given the complexity and breadth of this topic, we can only aspire to cover the most rudimentary aspects of human vision.

In particular, our interest is in the mechanics and parameters related to how images are formed and perceived by humans.We are interested in learning the physical limitations of human vision in terms of factors that also are used in our work with digital images. Thus, factors such as how human and electronic imaging devices compare in terms of resolution and ability to adapt to changes in illumination are not only interesting, they also are important from a practical point of view.

- **Structure of the Human Eye**

Figure below shows a simplified horizontal cross section of the human eye. The eye is nearly a sphere, with an average diameter of approximately 20 mm. Three membranes enclose the eye: the *cornea* and *sclera* outer cover; the *choroid*; and the *retina*. The cornea is a tough, transparent tissue that covers



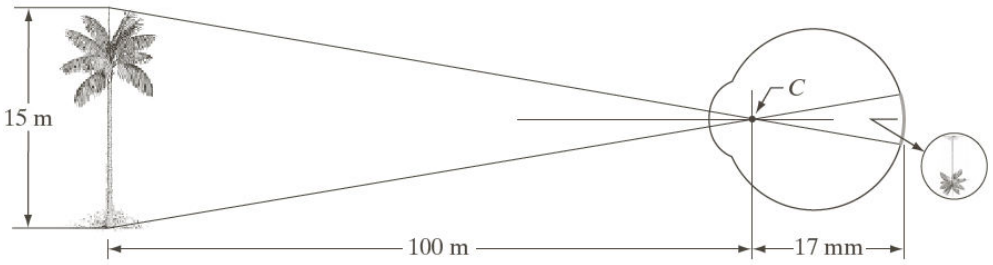


FIGURE 2.3
Graphical representation of the eye looking at a palm tree. Point *C* is the optical center of the lens.

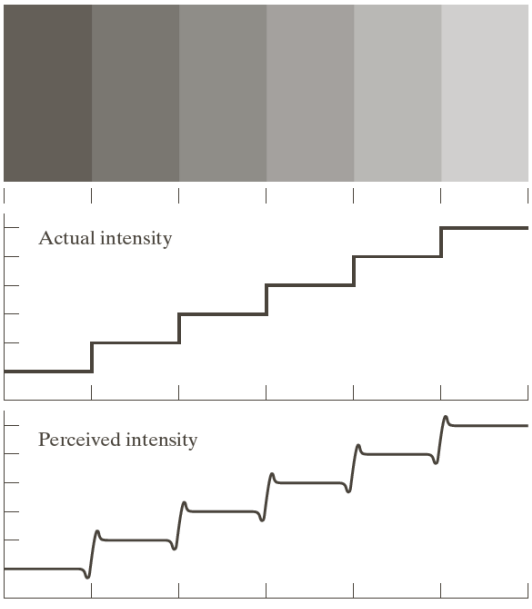


FIGURE 2.7
Illustration of the Mach band effect. Perceived intensity is not a simple function of actual intensity.

a b c

FIGURE 2.8 Examples of simultaneous contrast. All the inner squares have the same intensity, but they appear progressively darker as the background becomes lighter.

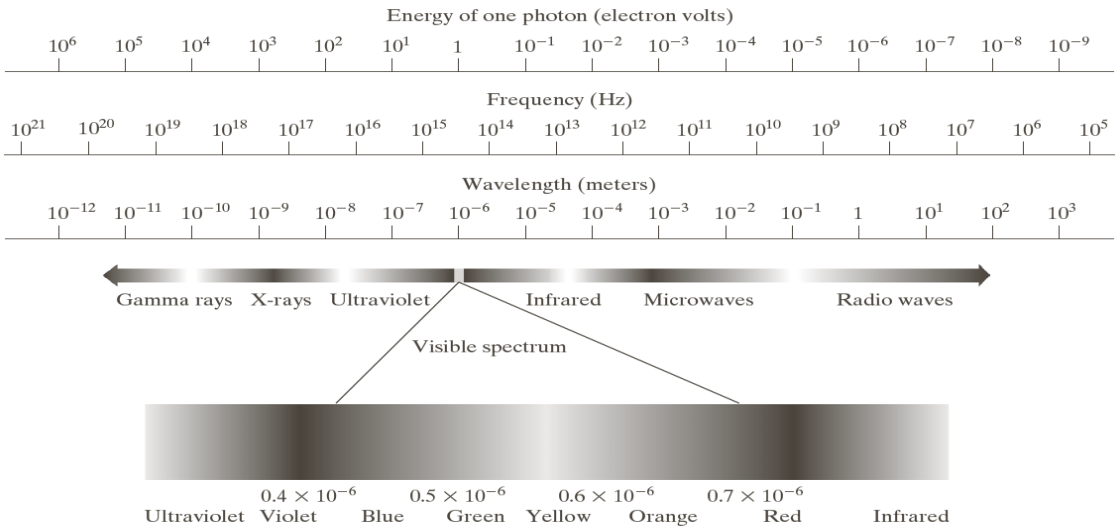
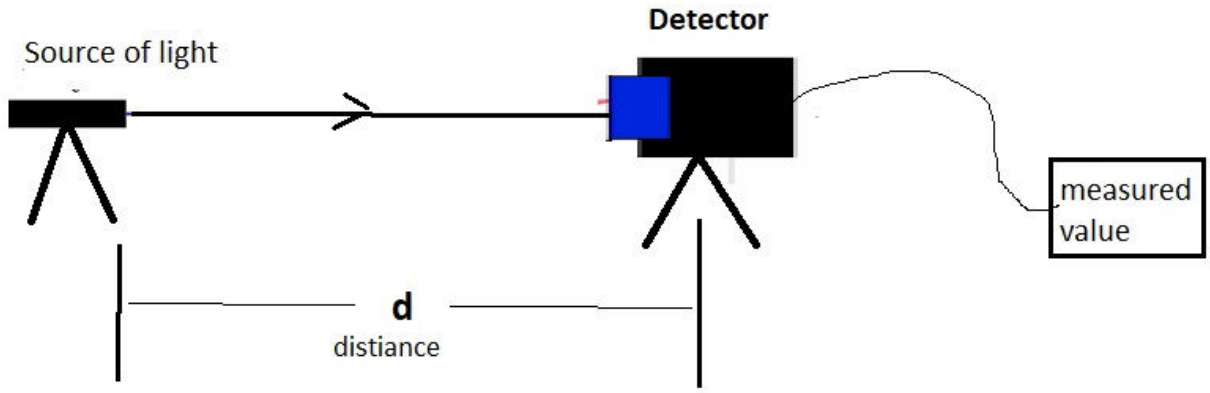


FIGURE 2.10 The electromagnetic spectrum. The visible spectrum is shown zoomed to facilitate explanation, but note that the visible spectrum is a rather narrow portion of the EM spectrum.

Conventional Physical Measurement

The physics experiments are usually performed by reading and recording the calculations of limited physical parameters. For example, we can measure the light intensity as a function of distance. Where the light intensity is measure as a function of distance between source of light and detector (represented by 1D signal) see the figure below. So can be recorded limited data that can be easily handled and can be drawn on the graph paper easily and directly. This happens in most of the experiments and research of ancient traditional physics.



The process of recording or capturing photos (2D signal) is a process usually requires a light source within a specific spectral range that is used to illuminate a scene and then take a picture of this scene using the camera, where the camera represent an optical system. That used to recorded or captured images, according to the concepts of optics. Here the image is formed on a light sensitive surface 2D plane that records light intensity coming from the scene objects. This plane surface is a light intensity detector. It consists of two light intensity detectors types:

- The first type is the light-sensitive chemical films that were widely prevalent before the advent of digital cameras in recent decades.
- The second type, it consists of 2D electronic sensors that record the optical intensity and creates a digital matrix representing the detected optical intensity that can be displayed in the form of numbers in a 2D matrix or displayed as an image in the screens of special devices such as mobile phones, digital cameras, computers and others.