Lecture 8

1- Simple magnifiers and eyepieces

The simple magnifier is essentially a positive lens used to assist the eye in examining small detail in a real object. It is often a simple convex lens but may be a doublet or a triplet, thereby providing for higher-quality images. Figure (2-5) illustrates the working principle of the simple magnifier.

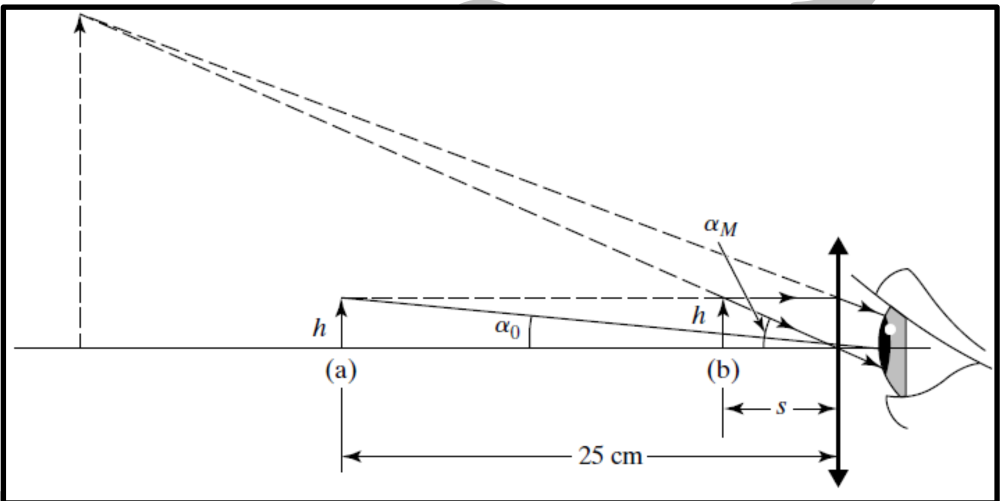

Figure (2-5) Operation of a simple magnifier.

A small object of dimension h, when examined by the unaided eye, is assumed to be held at the near point of the normal eye—nearest position of distinct vision—at position (a), 25 cm from the eye. At this position the object subtends an angle a_o at the eye. To project a larger image on the retina, the simple magnifier is inserted and the object is moved physically closer to position (b), where it is at

or just inside the focal point of the lens. In this position, the lens forms a virtual image subtending a larger angle a_M at the eye. The angular magnification of the simple magnifier is defined to be the ratio α_M/α_o. In the paraxial approximation, the angles may be represented by their tangents, giving

$$\frac{\alpha_M}{\alpha_o} = \frac{h/s}{h/25} = \frac{25}{s} \quad \text{............. (2-7)}$$

If the image is viewed at infinity, $s = f$ and

$$M = \frac{25}{f} \quad \text{........... (2-8)}$$

Simple magnifiers may have magnifications in the range of $\times 2$ to $\times 10$ although the achievement of higher magnifications usually requires a lens corrected for aberrations.

In general, when magnifiers are used to aid the eye in viewing images formed by prior components of an optical system, they are called oculars, or eyepieces. The real image formed by the objective lens of a microscope, for example, serves as the object that is viewed by the eyepiece, whose angular magnification contributes to the overall magnification of the instrument. To provide quality images, the ocular is corrected to some extent for aberrations and, in particular, to reduce transverse chromatic aberration. To accomplish this improvement, two lenses are most often used. The effective focal length f of two thin lenses, separated by a distance L, is given by:

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{L}{f_1 f_2} \quad \text{……………. (2-9)}$$

Where f_1 and f_2 represent the individual focal lengths of the pair. By the lens maker's formula, for lenses made of the same glass,

$$\frac{1}{f_1} = (n-1)\left(\frac{1}{r_{11}} - \frac{1}{r_{12}}\right) = (n-1)K_1 \quad \text{………… (2-10)}$$

$$\frac{1}{f_2} = (n-1)\left(\frac{1}{r_{21}} - \frac{1}{r_{21}}\right) = (n-1)K_2 \quad \text{………… (2-11)}$$

Incorporating Eqs. (2-11) and (2-127) into Eq. (2-9),

$$\frac{1}{f} = (n-1)K_1 + (n-1)K_2 - L(n-1)^2 K_1 K_2 \quad \text{…… (2-12)}$$