CHAPTER 5

1

The mean exoatmospheric irradiance due to the Sun at the Earth is (page 34) 1.37 kW m^{-2}, and the fraction of this power that is radiated between 0.51 µm and 0.61 µm is about 0.127 (using the results of section 2.6), so we can estimate the value of

$$\int_0^\infty E_\lambda V(\lambda) d\lambda$$

as 174 W m^{-2}. Multiplying this by K = 680 lumens per watt gives the exoatmospheric illuminance as 118 klx. We can take the optical thickness of the atmosphere as around 0.3 for vertical propagation (see figure 4.4 and the discussion of aerosols in section 4.3), which should be increased by a factor of 1/cos(45˚) to 0.42 to allow for the oblique propagation. Thus we expect the illuminance at the surface to be roughly

$$118 \times e^{-0.42} = 77\,\text{klx} \quad .$$

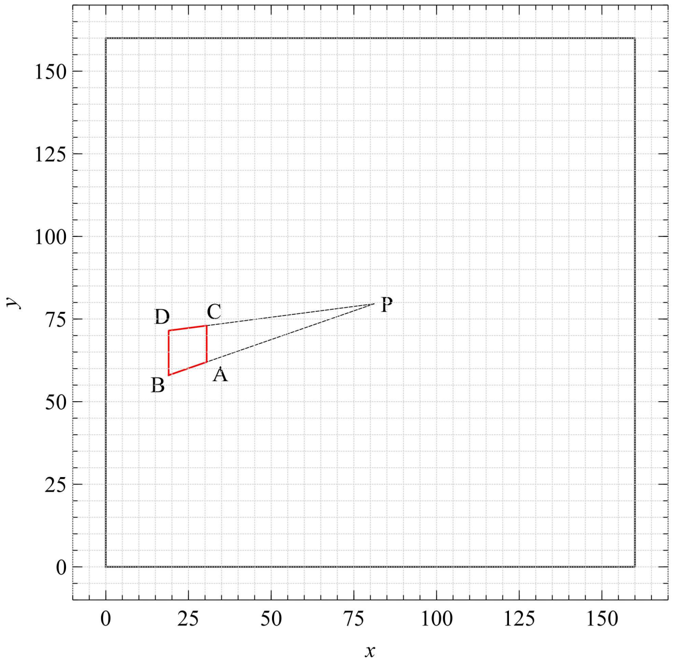
For a horizontal surface this should be further reduced by a factor of sin(45˚) to allow for the oblique illumination. This gives a figure of around 55 klx. Figure 5.18 shows a value of around 60 klx for a solar elevation of 45˚, so our estimate is rather good.

2

Scale of negative:	1/100000 (equation 5.6).
Spatial coverage:	2.5 × 3.5 km (equation 5.7).
Horizontal resolution:	1.25 m (equation 5.8).
Vertical resolution (relief displacement):	29 m (equation 5.19).

3

A diagram is helpful!



(a) The principal point P is where the projections of the lines BA and DC meet. It is difficult to find this position sufficiently accurately by geometrical construction, but it can be found by simple coordinate geometry. Writing (x, y) for the coordinates of P, we must have

$$\frac{y-73}{73-71.5}=\frac{x-30.5}{30.5-19}$$

and

$$\frac{y-62}{62-58}=\frac{x-30.5}{30.5-19} \quad .$$

These equations can easily be solved to give $x = 81.1$ and $y = 79.6$.

(b) The height of the building can be found from the relief displacement using equation (5.18). Using the edge CD of the building as the vertical object, the distance r' is the length of the line CP which we can calculate as 51.03 mm, and the distance h' is the length of the line CD which is 11.60 mm. Rearranging (5.18) gives

$$h=\frac{H\,h'}{h'+r'}=\frac{212\times 11.60}{11.60+51.03}\,\mathrm{m}=39.3\,\mathrm{m} \quad .$$

This could be checked using the edge AB of the buidling.

(c) The width of the building can be calculated by measuring the length AC = 11.0 mm and determining the ground-level scale of the image from equation (5.6). This is given by f/H as 1/2409, so the width of the building is

$$2409\times 11.0\,\mathrm{mm}=26.5\,\mathrm{m}$$

4

(i) The analysis on page 153 shows that the difference in the relief displacement between two vertical aerial photographs is

$$D = \frac{bf}{H-h} \quad .$$

Differentiation of this expression with respect to h gives

$$\frac{\partial D}{\partial h} = -\frac{bf}{(H-h)^2}$$

which we can approximate as

$$-\frac{bf}{H^2} \quad .$$

Thus a difference in relief displacement of $\Delta D = a$ corresponds to a height difference $\Delta h = H^2 a/bf$ as required.

(ii) The proof that the width of the overlap between the two photographs is given by $sH/f - b$ is given on page 154.

(iii) From these two results we can write

$$\frac{w}{\Delta h} = \frac{s}{a}\beta - \frac{f}{a}\beta^2$$

where $\beta = b/H$. Differentiating with respect to β:

$$\frac{d}{d\beta}\frac{w}{\Delta h} = \frac{s}{a} - \frac{2f}{a}\beta \quad .$$

This is equal to zero when $\beta = s/2f$, so this is the value of b/H that maximises the value of $w/\Delta h$ as required. Substituting this value of b/H into the result in part (i) gives

$$\Delta h = \frac{2Ha}{s}$$

as required.

(iv) A typical mapping camera has roughly equal values of s and f, so that the optimum base:height ratio in the sense in which it has been defined in this question is around ½, not very different from the commonly adopted value of 2/3. If we take $a = 0.1$ mm and $s = 200$ mm, again corresponding to a typical mapping camera, we find that that $\Delta h \approx H/1000$, which again is a commonly adopted result. Thus we can conclude that the usual configuration for stereophotography does indeed have the effect of approximately maximising the value of $w/\Delta h$.