6.163 Strobe Project Laboratory

Sample quiz

1

Your camera is loaded with ASA 400 film. You need to take a flash-only photograph in a laboratory in which you cannot turn off the lights. Using a light meter you determine that the ambient light would produce a properly exposed photograph at f/5.6 and a shutter speed of 1/125 second. However, your camera cannot flash sync at shutter speeds shorter than 1/60 second. The camera-to-subject distance is 6 feet, and magnification can be neglected. What BCPS flash is required?

ANSWER

To make this a strobe-only photograph you need to underexpose the ambient light by about a factor of 10, or three f-stops (factor of 8). Since you must use a shutter speed of 1/60 second to synch with the flash, you first need to determine what the ambient light exposure would be: f/8 at 1/60 second. In order for that to be 3 stops underexposed the actual f-stop that you use must be 3 stops greater, or f/22. You now have all the information you need to solve the flash exposure equation:

$D^2A^2 = BCPS*s/c$

Using $c = 20$,

$BCPS = D^2A^2*c/s = 62222*20/400 = 871$

Alternate approach:

$I = A^2*c/sT = 5.62*20*125/400 = 196$

At 1/60 second, $IT = 196/60 = 3.27$

We then want $BCPS/D^2 > 10*IT = 32.7$

BCPS = 62*32.7 = 1176

Why the big discrepancies in the answers? One method is based on a factor of 10, the other on 3 f-stops, nominally a factor of 8. I say nominally, because if you work the numbers out you find (22/8)2 = 7.56. The f-numbers are an approximation, keeping decimal points out of the hands of untrained users.

2

The CCD imaging chip in the Kodak Ektapro High Speed Video System is a 2-dimensional array of sensing elements (pixels). The size of an individual pixel defines the highest resolution the system can achieve. The sharpest images are obtained when the blur is restricted to a single pixel.

2-A Assume that you will be collecting images using a steady light source. In this situation the exposure time is the reciprocal of the frame rate (number of images per second). Devise a general equation for the maximum permissible subject velocity as a function of frame rate, image magnification, and pixel width, allowing no more than one pixel's width of movement during the exposure.

ANSWER

Call the subject velocity v, the frame rate f, the width of a pixel w, and the magnification m. The exposure time is 1/f. During this time the subject moves a distance v/f. Due to the effect of magnification, the image moves a distance m*v/f. We want this to be less than a pixel width, w. Therefore m*v/f < w, or v < w*f/m. The maximum velocity is vmax = w*f/m.

2-B Now assume that you have a choice of flash sources that can be synchronized to the video system. In this situation it is the flash duration and not the frame rate that determines exposure. Devise a general equation for the maximum permissible subject velocity as a function of flash duration, image magnification, and pixel width, allowing no more than one pixel's width of movement during the exposure.

ANSWER

Call the subject velocity v, the flash duration t, the width of a pixel w, and the magnification m. The exposure time is t. During this time the subject moves a distance v*t. Due to the effect of magnification, the image moves a distance m*v*t. We want this to be less than a pixel width, w. Therefore m*v*t < w, or v < w/m*t. The maximum velocity is vmax = w/m*t.

3

You have been hired to take photographs of an atomic bomb blast. Clearly, your equipment cannot be too close to the subject -- in fact, it has to be 7 miles away. You will be using 4x5 film (4 in. x 5 in. format). Your image must cover an area that is 700 feet wide (with the 5" film dimension). What focal length optical system do you need? Express the answer in metric units.

ANSWER

Calculate the magnification from the problem specification and use this to solve for focal length with the equation o = F(1+1/m). The object distance is 7 miles.

1/m = 700*12/5 = 1680

F = o/(1+1/m) = 5280*7/1681 = 22 ft. = 6.7 m

4

A typical small point-and-shoot camera has a fixed-focus 35mm f3.5 lens. The small flash unit that comes with it has a flash energy of approximately 8 joules. What is the maximum distance at which you could use this camera to take a flash-only picture with 400 ASA film? Assume a photometric efficiency of 3 and a reflector factor of 6.

ANSWER

First compute the BCPS = 8*3*6 = 144. Then use the guide number equation, with 3.5 for the aperture.

DA = [BCPS * s/c]^.5 = [144*400/20]^.5 = [2880]^.5 = 53.7

D = 53.7/3.5 = 15 feet