THE LENS

A camera lens (also known as photographic lens or photographic objective) is an optical lens or assembly of lenses used in conjunction with a camera body and mechanism to make images of objects either on photographic film or on other media capable of storing an image chemically or electronically.

There is no major difference in principle between a lens used for a still camera, a video camera, a telescope, a microscope, or other apparatus, but the details of design and construction are different. Just as a film camera works by using a lens to focus light onto a piece of film, a digital video camera uses a lens to focus light onto the imaging window of a CCD (or group of CCDs). A lens might be permanently fixed to a camera, or it might be interchangeable with lenses of different focal lengths, apertures, and other properties.

Camera lenses fall into two categories:
prime lenses and *zoom* lenses.
Prime lenses have a fixed focal length, measured in millimeters, which determines their angle of view. Prime lenses are known for producing a sharper image than zooms, and D.P.s who work in feature films are used to having a selection of high-quality prime lenses for their 35mm film cameras. However, most video cameras are equipped with zoom lenses (Figure 9.5), which offer a range of focal lengths from telephoto (or close-up) to wide angles, and are more suitable to documentary-style photography.

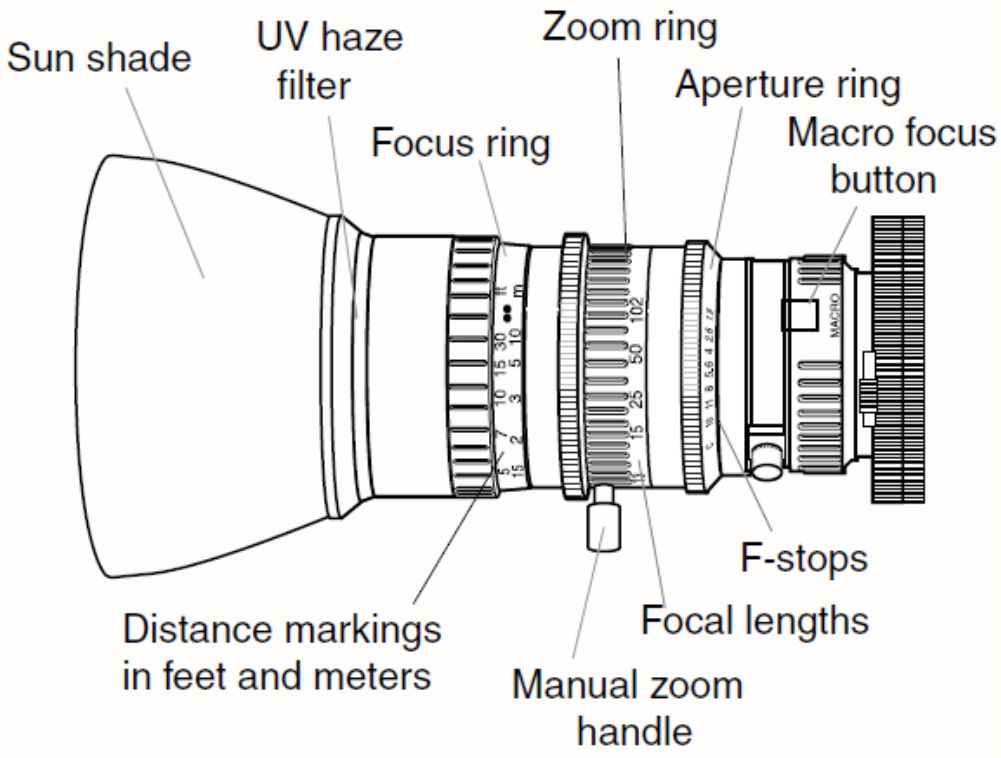

FIGURE 9.5 *Zoom lens diagram.*

Lens Features

Depending on the quality of their controls, some lenses are easier to use than others. To make sure your lens provides controls that let you get the kind of camera movements and effects that you want, consider the following:

- **Zoom control.** Check is the zoom control well-positioned, and does it provide for smooth zooming at variable speeds.
- **Manual focus.** Whether electronic or mechanical, test the camera's manual focus for ease of use and reliability. Also be sure it holds focus when set. If the lens in question has a focusing *ring* (like what you'd find on a 35mm SLR camera), check to see if it has distances marked on it.
- **Aperture.** As with focus rings, some higher-end lenses have manual rings for controlling the lens aperture. Check for f-stop markings, ease-of-use, and accuracy. Though lower-end cameras tend to have lenses built right in to the camera's body, this doesn't mean that they're necessarily low-quality lenses.

Types Of Lenses

"Close-up" or macro

A macro lens used in macro or "close-up" photography (not to be confused with the compositional term "Close up") is any lens that produces an image on the focal plane (i.e., film or a digital sensor) that is the same size or larger than the subject being imaged. This configuration is generally used to image close-up very small subjects. A macro lens may be of any focal length, the actual focus length being determined by its practical use, considering magnification, the required ratio, access to the subject, and illumination considerations. They can be special lens corrected optically for close up work or they can be any lens modified (with adapters or spacers) to bring the focal plane "forward" for very close photography. The depth-of-field is very narrow, limiting their usefulness. Lenses are usually stopped down to give a greater depth-of-field.

Zoom

Some lenses, called zoom lenses, have a focal length that varies as internal elements are moved, typically by rotating the barrel or pressing a button which activates an electric motor. Commonly, the lens may zoom from moderate wide-angle, through normal, to moderate telephoto; or from normal to extreme telephoto.

The typical zoom lens on a DV camera covers a range from telephoto to wide angle. In addition to letting you choose an appropriate focal length when you frame a shot, zoom lenses allow you to change focal length during a shot, using either a mechanical control button or by manually turning the zoom ring on the lens itself. You can also conceal a zoom by combining it with a pan or tilt.

FIGURE 9.6 *The left four (a–d) images show the same subjects at the same distance from the camera shot with four different focal length lenses. The right four images (e–h) show the same subjects shot with the same four lenses, but with the camera distance adjusted to keep the subjects the same size within the frame. Notice how the size of the tree in the background changes even though the subjects stays the same. Courtesy of Gregg Rossen.*

Telephoto Lenses

A lens is considered "telephoto" (Figure 9.6d) if it magnifies the image at least 50% more than a normal lens (Figure 9.6c). As a lens gets more telephoto, its angle of view gets narrower and the

sense of perspective in the image gets shallower. This shallow perspective results in images that have a very compressed sense of depth. In addition to allowing you to shoot close-up shots of faraway objects, telephoto lenses allow you to shoot with a very shallow depth of field, as we'll explain later.

Wide Angle Lenses

A wide angle lens provides a wide field of view, allowing you to get closer to your subject, or display more background (Figure 9.6b). A wide angle lens is handy when you're shooting in a small space and don't have room to back away from your subject. Wide angle lenses are not especially flattering, as they can add distortion around the edges, an effect that may or may not be desirable. An image shot with an extremely wide angle lens, or *fish-eye lens*, will be very distorted, resulting in a rounded looking image, as if seen through a peep-hole (Figure 9.6e).

Aperture

Aperture refers to the opening at the rear of the lens. The camera's lens focuses light through the aperture, and onto the *focal plane*. In the case of a digital video camera, the focal plane is a CCD. (Video cameras use special imaging chips called CCDs, or charge-coupled devices for capturing images.) The size of the aperture is controlled by the *iris*, a series of metal leaves that can expand and contract like the iris in your eye. High-end cameras measure the aperture in f-stops, which are marked on the exterior of the lens itself (Figure 9.5). Higher-numbered f-stop values stop more light. That is, a higher-numbered value represents a *smaller* aperture, which results in less light passing through the lens. Smaller numbers stop less light (Figure 9.7).

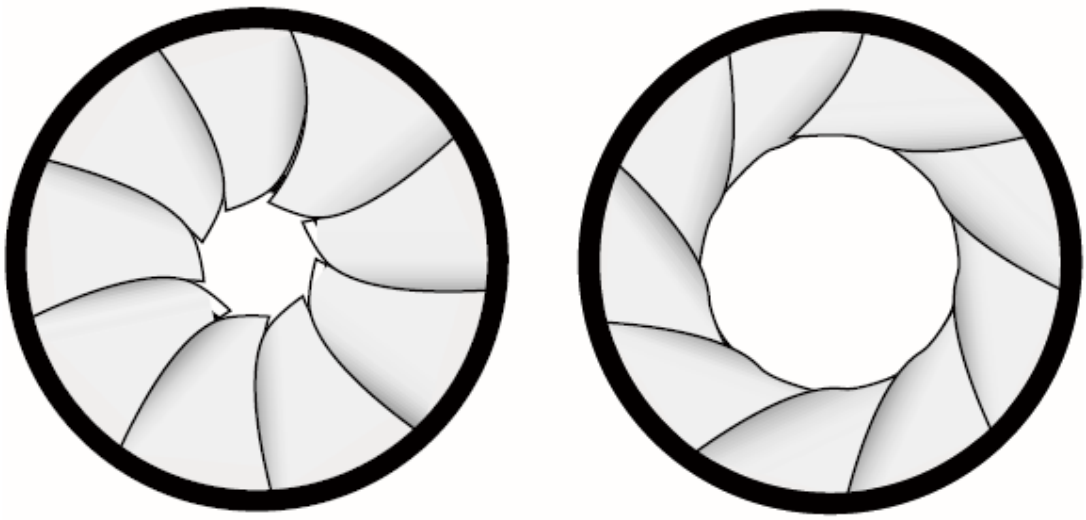

FIGURE 9.7 *The iris on the left is stopping more light than the iris on the right. Therefore, it has a higher f-stop value, and makes a smaller aperture.*

Mid-range cameras do not have f-stops on their lenses, but provide control of the lens aperture with special dials, and with f-stop settings shown in the digital menu display. Lower-end cameras do not

display f-stops, but allow for manual iris adjustment and iris locking. Bottom-line cameras do not allow for any manual control of the lens aperture, and rely solely on automated iris settings.
Having control of the iris gives you the freedom to select faster or slower shutter speeds (for stopping or blurring fast-moving action), and to control *depth of field*, which we'll discuss later. While the auto iris function may work fine in "normal" lighting situations, it's usually the wrong choice in more complicated scenes. Leaving the auto-iris on may result in changes in the exposure in the middle of a shot—even the movement of your subjects within the frame can change the exposure. As they pass in front of light sources, the iris will fluctuate. If your camera allows it, you should always work with the auto iris function turned off.

FOCUS

Before you can focus your camera, you need to make sure the viewfinder is adjusted to match your vision. Most cameras, have an adjustment ring, or *diopter*, on the viewfinder. Set the camera lens out of focus, then look through the viewfinder and move the viewfinder focus adjustment until you can see the grains of glass or the display information in the viewfinder itself.

If your camera allows, turn off the autofocus mechanism. Autofocus will always focus on the middle of the frame. Since you may want to be more creative than this, stick with manual focus.
To focus a zoom lens manually, zoom all the way in to the image on which you wish to focus and focus the image. Now you can zoom back to compose the shot at the focal length you desire. As long as your subject doesn't move forward or backward, your image will be in focus at any focal length available.

Depth Of Field

In optics, particularly as it relates to film and photography, depth of field (DOF) is the distance between the nearest and farthest objects in a scene that appear acceptably sharp in an image.

- In some cases, it may be desirable to have the entire image sharp, and a large DOF is appropriate.
- In other cases, a small DOF may be more effective, emphasizing the subject while de-emphasizing the foreground and background.
- In cinematography, a large DOF is often called **deep focus**, and a small DOF is often called **shallow focus**.

Affecting DOF are camera-to-subject distance, lens focal length, selected lens *f*number, format size, and circle of confusion criterion.