

CAMERAS

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FILM OR DIGITAL

Q.: I am planning to replace my film camera with a digital camera. What would be the advantages and disadvantages?

A.: The main advantage of a film camera is the proven storage stability of images on film. Color slides have a proven storage life of several decades. Properly stored Kodachrome slides can last at least fifty years. In contrast, the storage stability of digital images on a CD, a DVD or a hard drive is unpredictable for several reasons.

The advantages of using a digital camera are many:

- No need to buy film with different sensitivity (speed) and daylight or tungsten designation because a digital camera can adjust the ISO values and the white balance.
- The image can be seen and a print can be made immediately after the exposure. A histogram shows the accuracy of the exposure.
- The digital noise up to ISO 400 is insignificant, compared to the grain of film. As a result, the digital images appear sharper and clearer.
- Color correction filters are not needed because photofilters are available in the Photoshop.
- Digital files can be transferred directly from a memory card to a computer. Images on film need a scanner to access the computer.
- Travel with a digital camera is easier than with a film camera. Five small memory cards can hold more images than 50 rolls of film. No hassle with inspection at airports.
- To change memory cards in a digital camera is easier than reloading a film camera.

The digital capture, however, has several deficiencies.

Q.: Which deficiencies of digital cameras are most important?

A.: The blown highlights, the blocked shadows (noise of underexposure), the poor visibility of the LCD screen in sunlight, the contamination of the sensor with dust, and the uncertain archival storage of digital images. In theory, these deficiencies are correctable. Practical solutions will be found eventually.

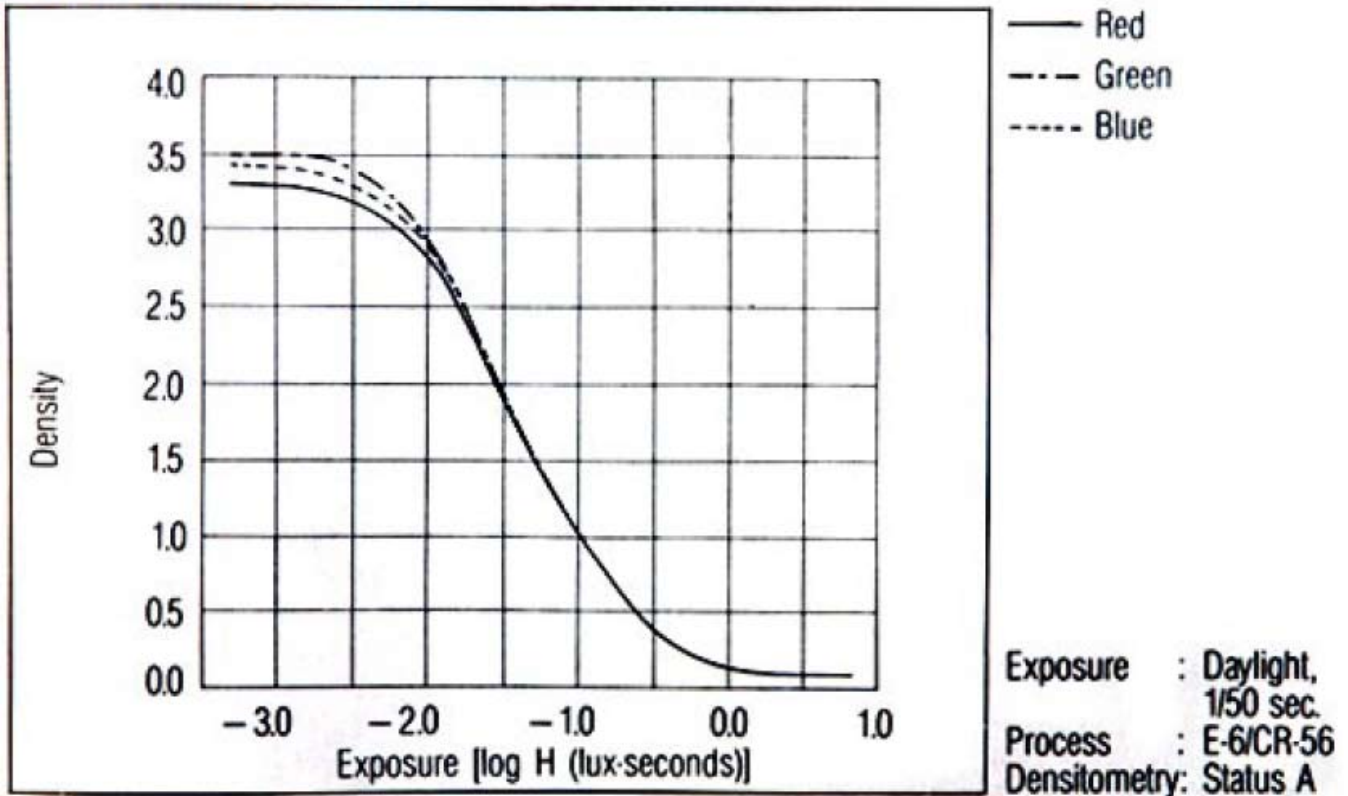
Q.: Why are highlights a problem with a digital camera?

A.: The response of a digital sensor to light is quite different from the exposure characteristics of film. The density of a negative film increases with increasing exposure and forms an S-shaped curve when plotted against the log of exposure (The density means here the darkness of film). The medium section of the curve is approximately a straight line. When the exposure exceeds the straight portion of the curve, the sensitivity of the film falls off. The response of the film to an increasing exposure does not end abruptly at

the level of overexposure but continues with a decreasing effect of light on the density of film. As a result, the highlights are not easily washed out but are recorded. The curved ends of the S-curve, the toe and the shoulder, function as a buffer for under and over exposure, thus preventing blocked shadows and blown highlights.

When a color slide film is processed, the density of the film is reversed. Therefore the density of the processed color slide decreases with increasing exposure. In other words, the S-curve with the rounded ends of a negative film is flipped horizontally but the buffering effect remains. The exposure curve of the Fuji Provia 100F color slide is shown below:

CHARACTERISTIC CURVES



The response of a digital sensor to light is quite different. The sensor is an array of photo sites. Each photo site contains at least one photodiode. Light falling on the photodiode creates a charge which increases with increasing exposure. The signal from the photo site is analyzed and converted by a processor in the camera to a digital readout. When the light falling on the sensor is very dim, the response of the sensor does not exceed the electronic noise and is unnoticed. In other words, the response of the sensor to a low level of light is limited by the electronic noise. Above the noise level, the brightness of the image increases linearly with increasing log of exposure. Unlike the response of film to light, the line is straight and not an S-curve with rounded ends. The straight line ends sharply at the point where the photo sites of the sensor are saturated. In other words, the density of a digital image plotted against the log exposure is a straight line between the recorded noise and a blank image. When the photo sites are saturated, the line ends abruptly because an excess of exposure cannot be recorded. The sensor is like a glass of water. Once the glass is full, more water cannot be stored. A blown highlight means simply that the sensor is exposed to more light than the capacity of the sensor can handle.

The different behavior of film and a digital sensor is caused by the vast difference between the photochemical process on film and the photoelectric response of a digital sensor. The geometry of film and the sensor are quite different as well. A film contains light sensitive particles embedded in a gelatin layer.

The light sensitivity of the particles is not equal. The particles vary in size, orientation and location in the gelatin layer. Their sensitivity to exposure varies accordingly. In contrast, the photo sites of a sensor are similar and become saturated at the same exposure level.

The sensitivity of a photodiode increases with the size of the photodiode. Consequently, the sensitivity of the sensor to light can be broadened by using different size photodiodes in the photo site. The first step in this direction has been made by Fuji. The Fuji film Super CCD sensor contains a large and a small photodiode in the same photo site. Once the large photodiode is saturated, the small photodiode takes over and extends the dynamic range of the sensor.

Q.: Can overblown highlights be restored in the Photoshop?

A.: Once the highlights are blown, there is no remedy to bring them back. A grossly overexposed spot is blank, showing that the light falling on the sensor was excessive.

The shadows/highlights tool helps to balance highlights and shadows but is incapable of recreating lost highlights. Same is true for the burning tool.

The best approach is to avoid overexposure of highlights. A simple technique for preserving highlights is to decrease the exposure by a 1/3 or 1/2 stop and sacrifice some shadow detail. A better technique is to take two or more different exposures of the same subject and combine the images in the Photoshop. This technique requires mounting the camera to a tripod to assure that the exposures are exactly in the same register. If time does not allow the use a tripod, two bracketed handheld exposure can be useful as well. Although the framing of the two handheld images may not be exactly identical, they can still serve a useful purpose. An overexposed highlight area in the normally exposed image can be replaced with the corresponding area of the underexposed image by cloning the selected area.

If the highlights are not completely washed out, shooting in the RAW format and double editing of the image at two different density levels can be helpful.

Q.: What is the dynamic range?

A.: The dynamic range of a camera is the number of f-stops between the darkest black and the lightest white the camera can capture. The ability of a camera to record blacks is limited by electronic noise. The capture of highlights is limited by the saturation of the photosites. Unlike the gradual response of film to overexposure, the response to a digital sensor to bright light ends abruptly. If a photosite is saturated, more exposure to light has no effect. As a result, the highlights are blown.

A film has a wide latitude of exposure because the light sensitive particles are not uniform. Fuji has used the same principle to expand the dynamic range of its sensors. The sensor has pixels of two different sizes. The different sensitivity of the pixels increases the dynamic range. If the large pixel is saturated with light, the small pixel continues to respond to bright light. Consequently, the sensor of Fuji cameras has the widest dynamic range of all digital SLR cameras, more than 2 stops wider than the dynamic range of Canon or Nikon cameras.

The new Fuji FinePix S5 Pro SLR camera is built on the Nikon D200 chassis and uses the Nikon lens mount. The sensor has 6.17 million high sensitivity S-pixels and 6.17 million R-pixels to increase the dynamic range. The wide dynamic range of the S5 Pro should appeal especially to wedding photographers.

Q.: How can I expand the dynamic range of my camera?

A.: You can expand the dynamic range of your camera by reducing digital noise. The maximum darkness of a shadow in which details can be recorded is limited by digital noise. Consequently, the dynamic range can be extended by using a low ISO value to reduce digital noise. A digital camera increases the ISO value by increasing the amplification of the signal. Amplification increases digital noise as well. As a result, the lowest ISO value has the least noise and the widest dynamic range.

Another way to extend the dynamic range is to use the RAW format. Shooting RAW instead of JPEG adds at least one stop to the dynamic range.

The dynamic range can be expanded by taking two exposures with the camera on the tripod, one exposed for shadows and the other for highlights. The two exposures can be combined in the Photoshop to create a photograph with an unusually wide dynamic range.

Q.: Can I expand the dynamic range and capture highlights by slight underexposure?

A.: An underexposure by a one third or a half a stop helps to capture more highlights but increases noise in the shadows and actually decreases the dynamic range. This popular technique does not increase the overall quality of the photograph.

Q. How can I reduce noise in my digital images?

A.: The noise in digital images resembles superficially the graininess of film. The digital noise and film graininess are both lower when the image is captured at a lower ISO value on film or in a digital camera. Noise and graininess can be reduced during processing: a fine grain developer for film or a noise reduction program. In both cases, a reduction of noise or graininess decreases the sharpness and contrast of the image but the similarities between the graininess of film and the digital noise end here.

The digital noise is mainly luminance noise or chrominance noise (“color noise”). The luminance noise has the appearance of grain. The chrominance noise is evident as a variation in hue of color. Chrominance noise is not only easier to remove than luminance noise but its side effects, such as reduced saturation and color accuracy, are less noticeable.

The luminance noise is more harmful than the chrominance noise. Luminance noise reduces the appearance of the image more than chrominance noise because luminance noise is imbedded in the detail of the image. Luminance noise is difficult to remove because at the pixel level noise cannot be distinguished electronically from the detail of the image. Sometimes, the difference between noise and detail is perceptual. As an example, the texture of concrete and the graininess caused by the luminance noise are similar.

The luminance noise is caused by electronic interactions and cross-talk in the sensor. Consequently, the design and the size of the sensor have a pronounced effect on the noise level. Noise is affected by the sensitivity, spacing and size of the photosite that contains a light sensitive photodiode. In a small sensor the photosites are crammed together and are small. The close spacing of photosites facilitates undesirable electronic interactions. Furthermore, their smaller size means a lower sensitivity of the photosite to light and therefore the need for more amplification of the signal. The digital noise increases with amplification of the signal because noise is amplified together with the signal.

Noise is inevitable, but a small amount of it can be controlled. The noise management consists of two steps: (a) Minimizing noise generated during picture taking, and (b) reducing noise in the resulting image. The noise generated during picture taking can be minimized by using a low ISO value. The ISO value of a film and the ISO setting of a digital camera have a different meaning. In a film camera the ISO values represent the sensitivity of the film. In a digital camera the sensitivity of the sensor does not change and higher ISO values are generated by more amplification. Because amplification of the signal amplifies the noise as well, the lowest ISO setting will produce the least amount of noise.

An underexposure increases noise and must be avoided. For the same reason, noise is more apparent in shadow areas. Because noise increases with increasing exposure time, a long exposure time should be avoided, if possible. A high temperature increases noise and should be avoided as well.

Most DSL cameras have noise reduction programs designed to control either the noise generated at high ISO values or during long exposures. Because noise reduction reduces the sharpness and contrast, the strength of noise reduction can be varied in order to select the minimum amount needed. The reduction of

noise in the computer, instead of in the camera, has the advantage of being selective. Different strengths of noise reduction can be applied to different areas selected. In the Photoshop CS2 noise reduction is available in the RAW editor or in the Filter/Noise/Noise reduction. The noise reduction in the CS2 is basic. The plug-in software for noise reduction is more powerful. The Noise Ninja has two sets of sliders, one for luminance and the other for color. Noise Ninja comes in two versions which are available for purchase at www.picturecode.com.

Noise is more apparent in smooth areas than in texture. Because a sharpness loss in smooth areas is not consequential, a strong noise reduction can be applied to a smooth area, such as the sky, after selecting it.

The noise level of modern DSLR cameras is so low that the graininess of film is no longer a yardstick. The noticeable noise of top quality DSRL cameras begins now at ISO values above 800.

Q.: How can the visibility of the LCD screen in bright light be improved?

A.: At the present time, the only remedy is to shield the screen with a hood. The long term solution is the replacement of the LCD screen with an OLED screen. The LCD panel is illuminated with a backlight but the LCD panel filters most of the light.

The LCD panel passes light through multiple layers, including polarizers, transistors, liquid crystals, a color resist array, and a retardation film. Liquid crystals orient themselves in an electric field and selectively block out light emitted by the backlight. Consequently, most of the light and energy is wasted.

An OLED (Organic Light Emitting Diode) polymers and small organic molecules emit light when exposed to an electric current. In active matrix displays, like the screen of a digital camera, each pixel has its own transistors. The use of OLED panels in Kodak Easyshare cameras in the year 2003 revealed problems with the backplanes of thin-film resistors and the lifetimes of some of the colors. Research to overcome the technical barriers has made considerable progress. Hopefully, future digital cameras will have an OLED panel.

Q.: Contamination of a digital SLR camera with dust is unavoidable. What is being done to facilitate dust removal?

A.: Dust on the sensor is a common problem of digital SLR cameras. Dust particles come from moving parts in the interior of the camera, from the body cap, or are introduced during the lens change. The sensor is charged and attracts dust particles. The seriousness of the dust problem has been recognized by the manufacturers and several techniques have been developed to remove dust:

- (a). A colorless filter below the lens mount has been used to prevent dust from entering the camera, to throw dust
- (b). Several cameras (Olympus, Panasonic, Sony, and now the Canon EOS 400D) have an active protection system. The dust collects on the low-pass filter in front of the sensor and not on the sensor itself. The low-pass filter vibrates at a high frequency to shake off dust every time when the camera is turned off. An anti-static coating on the low-pass filter reduces the adhesion of dust particles.
- (c). A passive dust prevention technique uses a reference photograph of a featureless white surface to map dust and remove the effects of dust by software (Nikon).

If the camera does not have a dust removal feature, the sensor must be cleaned. The sensor can be cleaned by the manufacturer of the camera, a repair shop, or the photographer. The low-pass filter in front of the sensor is delicate and can be easily damaged. Numerous brushes and cleaning devices for cleaning the sensor are on the market, some are more effective and expensive than others. The dust removal requires lifting of the mirror with the camera in the Cleaning Mode. To make sure that the mirror does not close inadvertently when removing dust particles, the camera should have a fully charged battery or be connected to a power supply.

Because dust is not on the sensor but on the filter in front of the sensor, dust particles are not always

visible in the photograph. When the aperture of the lens is large, the dust particle on the low-pass filter is out of focus and does not interfere with the image. This is similar to shooting animals in the cage. A large aperture reduces the depth-of-field and when the camera is close to the cage, the bars of the cage are out of focus and invisible. The spotless region of the camera depends on the aperture and the focal length. When using a large aperture, dust may not be noticeable. However, to make dust visible for cleaning purposes, a white sheet or the sky should be photographed using a small aperture.

At the present time Nikon is the only major DSLR manufacturer without an active dust removal system. This is interesting because the CCD sensor in Nikon DSLR cameras is made by Sony. The Alpha A100 DSLR made by Sony has a 10.2 MP sensor with a vibration mechanism for dust removal. For some reasons, this dust removal technique is not available in the Nikon D80 or D200 (The Nikon D2Xs has a CMOS sensor). It is probable that all future DSLR cameras, including the Nikons, will have an active dust removal feature.

DIGITAL CAMERAS WITH A FIXED LENS

Q.: I am a beginner interested in photography. Which camera is better for learning photography, a film camera or a digital camera?

A.: A digital camera is a much better learning tool than a film camera. A digital image can be seen immediately after squeezing the shutter release. Some digital cameras show the scene even before photographing it. A live LCD screen of digital cameras with a fixed lens helps to compose the picture (Only one digital SLR camera, the Olympus EVOLTE-330, has a live LCD screen). The LCD screen is too small for judging the sharpness, the color and the exposure of the picture. The digital image must be downloaded to a computer and viewed on the computer screen. This is the first step of the learning process. The final step is to make a print and have a photograph to hold in your hand. The Adobe Photoshop Elements software makes it easy to organize and edit images for printing. A photo quality printer is not expensive but the ink and the paper add to the expense. A small (4x6, A6) print size keeps the cost down and is sufficient for learning composition and exposure.

A totally automatic camera is not useful for learning. The camera must have some manual controls and overrides, at least for controlling the shutter speed and the aperture (the F-stop). An option supporting the RAW file format allows more adjustments afterwards.

Q.: I would like to switch from film to digital capture. Would a digital camera with a built-in zoom lens be useful for entering digital photography?

A.: The digital cameras with a built-in lens are 5 to 12 MP cameras. They come in three sizes: a lightweight (5-7 oz) subcompact, a medium weight (6 to 12 oz) compact, and a SLR-like (16 to 27 oz) camera. The subcompact cameras can fit into a shirt pocket or purse. They can be taken along when a large camera is inconvenient to carry. A small point and shoot digital camera is useful for its intended purpose but a limited tool for learning digital photography. The small lightweight cameras are difficult to hold steady and they lack controls for manual adjustment.

The medium size digital cameras have a decent zoom lens for sharp 8x10 (A4) pictures and some adjustments for improving the picture. They are a good choice for a casual snaphooter but disappoint a serious photographer. The autofocus may be sluggish, the optical viewfinder is squinty, and the LCD screen is difficult to see in bright light.

The upper end digital cameras with a built-in lens look like a SLR camera but are smaller and lighter. Most of the advanced “digicams” have good optics, an optical stabilization to counteract camera shake,

and a live LCD screen which may tilt and rotate. The cameras have most of the exposure controls a student or a serious photographer may need: exposure metering with spot, center weight, and evaluative options. The autofocus is generally fast but slower than the autofocus of the DSLR cameras. Tracking action may not function during multiple frame bursts.

The electronic viewfinder of digital cameras is accurate and covers 100% of the frame. An optical viewfinder is not as accurate because of the parallax error. However, the electronic viewfinder is dim. The clarity of view makes an optical viewfinder more convenient to use. An electronic viewfinder can be jerky and lag behind when the camera is panned or a fast moving object is photographed.

Another disadvantage of digital cameras with a fixed lens is the absence of a flash shoe for an accessory flash or a sync cord. The built-in flash used as a single light source has a limited value in flash photography.

The most important limitation of digital cameras with a fixed lens is a small sensor, about 4.8 x 6.4mm. The short normal focal length of 8mm makes it possible to equip the camera with long zooms having a 35mm equivalent focal length of 35 to 420mm. The disadvantage of the small sensor is that the pixels are small as well. A resolution of 5 MP or higher requires a large number of pixels which must be small in order to fit onto the small sensor. Because a small photo site means less sensitivity, the signal needs more amplification. As a result, the quality of the images is usually good only at the lowest ISO settings. The noise increases steeply with the increasing sensitivity and becomes noticeable already at the ISO 200 setting.

The lens of the digital cameras with a small sensor has a very short focal length and consequently, a small aperture. The depth of field is therefore very wide which is either beneficial or undesirable, depending on the situation.

The Sony Cyber-shot DSC-R1 camera has counteracted the sensor size problem with the APS-C size sensor of 10.3 MP resolution. The pixel size has been increased from 2.7 to 5.49 micrometers and the noise level has been reduced. The camera has an undesirable electronic viewfinder like the other “digicams” but, unlike the others, has a flash shoe. The optical quality of the 14.3 -71.5mm f/2.8 - 4.8 Zeiss lens is very good and the picture quality is comparable to that of the DSLR cameras. The flash can sync with every shutter speed. The start up time of 1 s and the shutter lag of 0.5 s may be acceptable but the three frame burst is too short and the 5 s write time is too long. The DSC-R1 is one of the best digital cameras with a fixed lens but the high price places it into the price range of versatile DSLR cameras.

The price range of the upper end digital cameras with a fixed lens is close to the price of the lower end DSLR cameras. The DSLR cameras have an interchangeable lens and are more versatile than the digital cameras with a fixed lens. This justifies the question – why would a digital camera with a fixed lens be preferable to a DSLR? A fixed lens avoids contamination with dust but a DSLR camera can be used without changing the lens to keep dust out. The only valid reasons for buying a digital camera with a fixed lens, instead of a DSLR camera, are the lower price and the smaller size.

Q.: Will the long delay between clicking of the shutter release and the moment of actual picture taking by digital cameras be eventually eliminated?

A.: The shutter-release lag has been essentially eliminated for the digital SLR cameras. For the upper end digital cameras with a built-in lens the shutter lag is about 0.2 s. The medium priced PS digital cameras have a shutter- release lag time of less than a second or longer. Test the shutter lag of the camera before you buy it. In all fairness, the point-and-shoot film cameras have a noticeable lag time as well, caused mainly by a slow autofocus response.

The point-and-shoot (PS) digital cameras have another annoying feature. Unlike film cameras, digital PS cameras have a battery saving “sleep” mode and require time to become operational when the camera is turned on. The start up time camera of the latest PS cameras varies from several seconds to less than a

second. Again, test the camera before you buy it.

Q.: My point-and shoot (PS) digital camera is small and it is difficult to hold it steady while looking at the LCD screen.A: To hold the camera steady, support your elbows against your chest. Some PS digital cameras have an optical stabilizer

Q.: My digital SLR camera is too bulky to have it always with me. I need a small digital camera which fits into my pocket and makes pictures of good quality. The number of small point and shoot cameras is bewildering. How can I choose one?

A.: The number of small point and shoot cameras are on the market is huge indeed and new models appear in a steady flow. In order to make a selection, you will have to decide which specifications are important for you.

- The size should be small enough to fit into a shirt pocket, about 3.5 x 2.5 x 1”.
- The weight should be 6 oz. or less.
- The resolution of a 6 MP sensor is adequate. To cram more pixels into the very small sensor may increase noise without a useful benefit.
- The lens should be of good optical quality, indicated by high resolution, low distortion and sufficient resistance to flare. The lens should produce a sharp 8x10” print, or a 13x19” print with upscaling (interpolation) in the Photoshop. The 3x range of the zoom lens, equivalent to a 35-110 mm lens on a 35mm film camera, is adequate. Extending the zoom range may lower the optical quality of the lens.
- Optical stabilization is essential because the small camera is difficult to hold steady. Most cameras stabilize the image by a lens-shift or a sensor-shift correction. Some cameras with electronic stabilization have motion detectors which provide data for sharpening the image by in-camera processing. The electronic system is less costly but less effective. Some cameras use an ISO shift to increase the shutter speed. This is not real stabilization but an Auto ISO mode.
- The size of the LCD screen has been increased and the 2.5” size is now the standard. The brightness and resolution of the screen are as important as its size.
- An optical viewfinder is in my opinion very important. I would not buy a camera without a viewfinder. In bright sunlight the LCD screen may be very difficult to see. Framing fast moving subjects on the LCD screen is difficult. Under these conditions an optical viewfinder of a compact camera is very helpful, although the viewfinder is usually not quite accurate. A comparison of the areas seen by the viewfinder and the LCD screen in good light gives an approximate idea what to expect when the screen is too dark. As another advantage, the optical viewfinder allows the camera to rest on the face of the photographer to reduce camera movement. Unfortunately, the optical viewfinder of a compact camera is disappearing. Only a few compact cameras have a viewfinder.
- The start up time and the shutter lag are important. Although compact cameras have made a great improvement in this area, many cameras are still deficient.
- Exposure compensation is not as important as it sounds. The exposure accuracy of a compact camera is usually adequate or correctable in the computer. A correction of exposure with the tiny buttons of the subcompact camera is too cumbersome to be practical.
- The in-camera electronic flash of compact cameras is usually weak, do not expect much.

Many compact cameras fit the size requirement. Optical stabilization is offered by Canon, Kodak, Leica, Nikon, Olympus, Panasonic, Pentax, Samsung, and Sony. However, if an optical viewfinder is important, the Canon Elph cameras are the only ones to consider.

The Canon SD700IS Elph camera meets the requirements listed above. The camera I have was built in Japan and its finish is beautiful. The f/2.8 to f/5.6 zoom lens, equivalent to a 35-140 mm lens of a 35mm

film camera, is quite good. With the lens of my camera in the short or medium zooming position, I have made 8x10" prints sharp from corner to corner. When increasing the print size to 24x30", the right edge became noticeable softer but was not objectionable after sharpening. The lens handles flare very well. Distortion is very low in short and medium zoom ranges but noticeable at the long end of the zoom range. The lens is better than some of the SLR lenses I have tested! The viewfinder shows slightly less than the actual image recorded but does not require extensive cropping. The LCD screen is bright but, like the LCD screens of other digital cameras, difficult to read in very bright light. The menu is well organized and easy to use.

I have only four negative comments. The camera is expensive, especially when comparing it to the slim SD1000Elph which costs about \$150 less. The SD1000 does not have image stabilization, however.

The other three negative comments are typical for all compact cameras.

The power on-off switch and the other buttons are small and difficult to find in a hurry.

The flash is notably weak. The flash output of the SD700IS is limited to 11 ft in the wide angle, and 6 ft in the tele position, even with Auto ISO. An auxiliary flash is available to boost the flash output but negates the benefits of having a compact camera.

The lens of the camera does not have a mount for filters.

Overall, the Canon SD700IS Elph is an amazing little camera but it has been discontinued. The SD800IS has a 7.1 MP sensor and a new slightly wider (a 28-110mm 35mm film camera equivalent) zoom lens. According to some reports, the lens is not as sharp as the old lens. I have not compared the two cameras and cannot verify the sharpness difference. The new SD850IS camera is similar to the SD700IS, except for the 8MP sensor. The lens is the same 35-140mm (35mm equivalent) zoom. Although the camera is already an improvement of the highly successful SD700IS, new Elph models fill follow.

When looking for a subcompact pocket size camera, Canon is the place to start with.

DIGITAL SLR CAMERAS

SENSOR

Q.: Some Canon digital SLR cameras have a full size sensor. What are the advantages of the full size sensor?

A.: The full size (24x36mm) sensor has the same picture angle as the 35mm film cameras. The lenses of a 35mm film camera function the same way on the digital camera without a focal length "conversion factor". This is especially advantageous for wide angle photography. The existing wide angle lenses do not have to be replaced with new shorter focal length wide angle lenses. In other words, a digital camera with the full size sensor is a digital equivalent of a 35mm film camera.

The APS-C size sensor in all Nikon, Konica Minolta, Pentax, and some Canon DSRL cameras is smaller (about 15 x 23mm). The "normal" focal length for the APS-C format is 28 mm, instead of 43mm (or 50mm conventionally) for a 35mm camera. Therefore, a 28mm wide angle lens of a 35mm camera is now a normal lens and shorter focal lengths are needed for wide angle photography. The 4/3 format sensor of Olympus digital cameras is even smaller (17.3 x 13.0mm) and the normal focal length is only 22mm. The wide angle lenses have a very short focal length, one half of the focal length of the corresponding 35mm camera lenses. At least theoretically, the sensor size affects image quality. If the total number of pixels of the sensor is the same, the smaller sensor must have smaller pixels. The area allocated to each pixel is smaller. This means less sensitivity and more noise, especially at higher ISO values. Unlike a film camera with films of different sensitivity and speed, the sensitivity of the digital sensor is fixed. The high "speeds" (ISO settings) are obtained by extensive amplification of the signal. Amplification increases the electronic

noise of the digital sensor. The digital camera with a full size 24x36mm sensor is a real 35mm camera like the 35mm film camera. A camera with the APS-C (15.1 x 22.7mm) sensor is a smaller format camera. A comparison of the two cameras is like comparing a 35mm camera with a medium format camera. For most applications a 35mm film camera can perform as well as a medium format film camera. The same is true here. Except for very large prints and high ISO settings the difference in sensor size (24x36mm or APS-C) on image quality may not be noticeable.

Q.: Does a digital camera magnify the image? Are images obtained by a digital camera larger than the images formed by a film camera using the same lens?

A.: The image magnification is a myth. The image size depends only on the focal length of the lens and the distance of the subject. The format of the capture area has no effect. An image photographed at the same distance with a lens of the same focal length has the same size, regardless whether the image is captured on a 4x5" film or on a small digital sensor. When an image is printed, the image captured on film or on a digital sensor must be enlarged. If a 4x6 print is made from a 35mm film or by a digital camera with a full sized (35mm) sensor, the image must be enlarged 4.2 times linearly. An image captured on a APS-C size (15.1 x 22.7mm) sensor needs to be enlarged 6.7 times linearly. This is where the magnification comes from. The smaller area needs to be enlarged more to give a print of the same size. Because the size of the image on film or sensor is the same, the larger enlargement (6.7 vs. 4.2 times) will make a 1.6x larger image on the 4x6" print. This leaves the impression that the picture was taken with a longer focal length lens. The same "magnification" effect can be obtained by cropping a frame of 35mm film to the APS-C size. Unlike the image size, the view angle (picture angle) depends on the format of the film or sensor. A lens is considered to be "normal" lens if it has the same view angle as the human eye. As an approximation, the normal focal length is the length of the diagonal of the film. For 24x36mm film the normal focal length is 43 mm (The conventional normal focal length is 50mm.). For the medium format 4.5x6cm (645) the normal length is 75mm. For the APS-C size digital sensor of 22.7 x 15.1mm, the normal focal length is 27.3 mm and for the Olympus 4/3 format (17.3 x 13.0mm) the normal focal length is 22 mm. The wide angle lenses have a focal length shorter than the normal length. Consequently, digital cameras with a small sensor need wide angle lenses which have very short focal lengths and are expensive. As an example, the price of a wide angle 28mm f/2.8 lens for a 35mm film camera is \$ 235. The equivalent lens for a Nikon DSLR camera, the 18mm f/2.8 lens, costs \$970!

Q.: I have read that the pixel count is unimportant. If this is true, why do professional DSLR cameras have a higher pixel count than the entry level cameras?

A.: The pixel count matters, of course. The number of pixels determines the resolution of the image and the maximum size of a print that can be made without increasing the file size by upsampling. An image with a large pixel file can make a large print, even after extensive cropping. A 6.1 MP camera produces a Photoshop PDS file of about 17.5 MB. This means that the maximum print size is 6.7 x 10.2" if we print with the ideal 300ppi resolution. If we accept a 200 ppi resolution, the print size will be 10 x 15". A camera with a 10MP sensor can make a 13 x 19" print at 200ppi resolution. Actually, very good 13 x 19" prints can be made with a 6 MP camera as well. This is possible with upsampling and interpolation of data. In the Photoshop the Bicubic and the Bicubic Sharper methods are more precise than the Nearest Neighbor and Bilinear methods. The plug-in programs Genuine Fractals, PhotoZoom, and SmartScale use more complex algorithms for interpolation than the Bicubic. The results are quite satisfactory after additional sharpening but the digital wizardry cannot generate data like a camera. The number of pixels a camera may have has an upper practical limit, determined by the sensor size. The size of the pixel (photo site) and the pixel density (number sites per unit area) are important factors. A larger pixel collects more light and requires less amplification than a smaller pixel to achieve the same ISO value. Cramming more pixels

onto a sensor means making the pixels smaller. As a result, the sensitivity of the pixels drops and more amplification is needed. The noise level increases, especially at higher ISO settings. Another potential problem with high pixel density is the risk of crosstalk and, subsequently, more noise. Consequently, the maximum pixel count is limited by the sensor size. For point-and-shoot cameras and digicams the upper practical limit seems to be 6 MP, for DSLR cameras with a APS-C sensor the limit is 12 MP, and for the full size 35mm sensor, the practical maximum appears to be 16 MP.

More pixels mean more resolution although not necessarily a better picture quality. Sharpness is not determined solely by the number of pixels. Sharpness depends on the processor in the camera, the format of files, and the quality of the lens as well. Some cameras reduce edge contrast to mask noise, at the expense of the apparent sharpness.

Q.: Is the CCD a better sensor than the CMOS?

A.: Initially, the CCD (Charge-coupled Device) sensor was said to produce brighter colors. However, the CCD sensor uses more power and is susceptible to blooming. This happens when some of its photo sites are over saturated by the highlights and a charge leaks to an adjacent photo site. The CMOS (Complementary Metal Oxide Semiconductor) is less expensive to make than a CCD and is less prone to blooming. The response of the CMOS sensor to light is faster than that of CCD. Each photo site of the CMOS sensor is equipped with a light sensing photodiode, a transistor to amplify the signal and a circuitry to reduce noise. The response of the photo sites to light can be read directly. In contrast, the CCD sensor moves the charge from each photodiode into the transfer register where the charges of the photo sites are read one by one and amplified. The more elaborate circuitry slows the response time and consumes more power. However, the CMOS sensors have more noise because the tiny amplifiers of the photo sites are not perfectly identical and equally efficient. Both sensors have been improved and additional circuitry developed to increase the readout speed of the CCD sensors and reduce the noise of CMOS sensors. As a noise reduction measure, the new CMOS sensor of the Canon 20D camera no longer has transistors at each photo site to read the amplified response individually. The image processing software in digital cameras has been improved as well. As a result, the overall quality of an image is not determined by the sensor alone. All fixed lens digital cameras have CCD sensors. All cameras with a full size (35mm) or a larger sensor have CMOS sensors. Canon cameras with a fixed lens have a CCD sensor and the Canon SLR cameras have a CMOS sensor. Until recently, all Nikon DSLR cameras had a CCD sensor. Interestingly, the 12.4 MP Nikon D2X camera has a CMOS sensor, apparently to save battery power. The 10.2 MP Nikon D200 camera has a CCD sensor and the professional users of the camera complain about a short battery life.

Q.: Does the Nikon D70s camera require as much care as other digital SLR cameras when changing lenses, i.e. is its sensor as sensitive to picking up dust?

A.: The D70s camera has a CCD sensor, like the Nikon, Konica Minolta, and Pentax cameras. The CCD sensor is more prone to pick up dust than the CMOS sensor used in Canon SLR cameras and in the Nikon D2x. This does not mean that the cameras with a CCD sensor have a dust problem. The CMOS sensor in Canon cameras pick up dust as well. The bottom line – all digital sensors can attract dust.

Q.: How can I prevent the contamination of the sensor with dust?

A.: Dust on the sensor is a common problem of digital SLR cameras. Dust particles come from moving parts in the interior of the camera, from the body cap, or are introduced during a lens change. The sensor is charged and attracts dust particles. The best protection against dust is not to remove the lens. A zoom lens with a very wide zoom ratio may eliminate the need to change the lens or, at least, reduce the frequency of lens changes. Realistically, a lens change cannot be avoided. When changing lenses, all precautions must be taken to eliminate dust entering the camera. The camera must be turned off because a charged

sensor may pick up all the dust floating around. The lens change must be quick in order to minimize the time during which the camera is open. Before changing lenses, clean the rear mount of the other lens to make sure that no dust will be introduced with the lens. When removing the lens on the camera, hold the camera with the lens mount pointing down to reduce the risk of dust falling into the camera. Mount the other lens immediately.

Q.: What is being done to facilitate dust removal?

A.: The seriousness of the dust problem has been recognized by the manufacturers and several techniques have been developed to remove dust:

- (a). A colorless filter below the lens mount has been used to prevent dust from entering the camera, to throw dust particles out of focus, and to make it easier to remove dust (Sigma). This design has a disadvantage as well. Any particles generated by the moving parts inside the camera are not accessible and cannot be removed.
- (b). Several cameras (Olympus, Panasonic, Sony, and now the Canon EOS 400D, alias Rebel XTi) have an active protection system. The dust collects on the filter in front of the sensor and not on the sensor itself. The filter vibrates at a high frequency to shake off dust every time when the camera is turned on or off. An anti-static coating on the filter reduces the adhesion of dust particles.
- (c). A passive dust prevention technique uses a reference photograph of a featureless white surface to map dust and remove the effects of dust with the software (Canon, Nikon).

Because dust is not on the sensor but on the filter in front of the sensor, dust particles are not always visible in the photograph. When the aperture of the lens is large, a dust particle on the filter is out of focus and does not interfere with the image. This is similar to photographing animals in the cage. A large aperture reduces the depth-of-field and when the camera is close to the cage, the bars of the cage are out of focus and invisible. The spotless region of the camera depends on the aperture and the focal length. When the aperture is large, dust may not be noticeable. However, to make dust visible for cleaning purposes, a white sheet or the sky should be photographed using a small aperture.

At the present time Nikon is the only major DSLR manufacturer without an active dust removal system. This is interesting because the CCD sensor in Nikon DSLR cameras is made by Sony. The Alpha A100 DSLR made by Sony has a 10.2 MP CCD sensor with a vibration mechanism for dust removal. For some reasons, this dust removal technique is not available for the Nikon D80 or D200 (The Nikon D2Xs has a CMOS sensor.). It is probable that all new DSLR cameras, including the Nikons, will have an active dust removal feature.

Q.: How is the digital sensor cleaned?

A.: If the camera does not have a dust removal feature, the sensor must be cleaned. The sensor can be cleaned by the manufacturer of the camera, a repair shop, or the photographer. Actually dust does not collect on the sensor but on the IR cut-off and anti-aliasing filter in front of the sensor. The low-pass filter is delicate and expensive to repair if damaged.

The dust removal requires lifting of the mirror. The camera is placed on a tripod and the mirror is locked up with the camera in the cleaning mode. A bulb (B) or time (T) setting of the shutter would keep the sensor charged and allow more dust may to be picked up. To make sure that the mirror does not close inadvertently during the cleaning process, the camera should have a fully charged battery or be connected to a power supply.

Particles on the low-pass filter are very small and difficult to see. A photograph of a white sheet or the sky may help to locate the dirt. The simplest cleaning technique is to use a bulb blower, such as the Giottos Rocket-Air. Compressed air should not be used. If removing dust and dirt with a bulb blower is not successful, numerous brushes, swabs, and cleaning devices are available from Green Clean, Intemos, Photographic Solutions, Visible Dust, and others. Some are more effective or expensive than others. If

wiping with a dry brush or swab does not remove the dust particles, a wet swab has to be used. The liquid, usually highly pure methanol, is applied to the swab, not directly onto the low-pass filter. The liquid must be volatile and vaporize without leaving a residue.

Follow the manufacturer's directions for using the brushes or swabs.

Before cleaning the sensor, practice the cleaning technique on a coated filter.

CAMERA DESIGN

Q.: Which digital SLR camera should I buy?

A.: The first feature to consider is the size of the sensor. The sensors in digital SLR cameras have four formats: the medium format (36 x 48mm or larger), 35mm full frame format (24x36mm), the APS-C (about 16 x 24mm), and the 4/3 format (13 x 17mm).

The sensor in a digital back for medium format cameras is larger than the 35mm sensor but smaller than the film in the same camera. The high resolution of 35mm digital cameras has reduced the need for a medium format camera. A medium format digital camera is attractive mainly to photographers who like to use their existing medium format equipment with digital technology.

If you prefer a sensor as large as the 35mm film frame, you need a Canon camera. At the present time, the Nikon DSLR cameras come only with APS-C size sensors. A full size (the traditional 35mm film size) sensor has several advantages over the APS-C size sensor. The larger sensor can hold more pixels needed for huge prints or extensive cropping. The pixels can be made larger to increase sensitivity and consequently reduce noise. The full size sensor does not have a "conversion factor". A wide angle lens of a 35mm film camera is a wide angle lens on the digital camera. The top of the line Canon EOS -1DS Mark II with a 16.7 MP sensor is still considered the best digital image maker, although it is heavy and not very convenient to handle. However, the differences in the image quality have narrowed and are no longer the main factor to consider when choosing a camera, especially for A3 size prints or smaller. The cameras with a full 35mm sensor are expensive. Their price starts at \$ 2500 (Canon EOS 5D, 12.8 MP). The price will eventually come down, hopefully below \$ 2000.

Canon also has a camera, the EOS-1D Mark II N, with an intermediate size sensor and the cropping factor of 1.3x.

If you would be happy with a APS-C size sensor, the selection process is quite simple when you have Canon, Nikon, or Minolta lenses. Unless some features are important, switching brands and buying new lenses makes very little sense. If you have Nikon lenses, buy a Nikon. If you have already Canon lenses buy a Canon camera. Owners of Konica-Minolta cameras are helped by Sony cameras reviving the Konica-Minolta technology. Canon and Nikon are the real contenders with huge systems of lenses and accessories. Canon is the leader in digital photography but Nikon has come up with very attractive cameras. Canon has two cameras with a APS-C size CMOS sensor: the Rebel XTi (D400) and the D30. The Rebel XTi has a 10.1MP sensor. The higher priced D30 with an 8.2 MP sensor seems to be ready for a replacement. The Nikon line has four current cameras, the D50, D80, D200, and the D2Xs. The D50 is a low cost entry-level camera with a 6 MP sensor. The D80 and D200 have 10.2 MP CCD sensors, and the DX2s has a 12.4 MP CMOS sensor. Which of these cameras is the best camera for you depends on the features you need and the amount of money you are willing to spend.

If you do not have Canon, Nikon, or Minolta lenses, the selection process is not as simple. The Sony A100 camera has a 10.2 MP sensor like the Nikon D80, but costs about \$200 less, has a self-cleaning sensor and in camera image stabilization. Pentax in a partnership with Samsung has entered the 10.2 MP sensor class with the K10D. The Samsung GX-10 is almost identical. This has caused speculation about the future of Pentax.

The Sigma SD 14 uses the Foveon X3 three-color stacked sensor with 4.6 M photo sites. Sigma claims the sensor is equal to a 14.4 MP (3 x 4.6) sensor but this is being debated. The color quality is excellent.

On the smaller end of the sensor size line-up is the 4/3 format camera, introduced by Olympus. Although the Olympus cameras are built well and have good optics, the advantage of having a small 4/3 size sensor is not obvious, if real. Olympus has been struggling because of their low DSLR sales volume. The partnership with Panasonic strengthens the competitive position but raises a question about the future of Olympus.

All digital SLR cameras are good picture makers without serious deficiencies. They all have a fast start up, short shutter lag, acceptable noise, high synch speed, a reasonably high fps firing rate, and an acceptable write time. A higher price gives you a camera with a sturdier construction, more features or a better picture quality. A sports photographer may be willing to pay a higher price for a very fast cps rate but most photographers find a 4 fps rate to be sufficient.

A higher price does not improve all features. As an example, the lowest priced Nikon D50 has the highest synch speed of 1/500 s.

A camera which produced good pictures last year makes good pictures today. A new model is an improvement but does not make the old model useless. If money is an important consideration, a used camera may be an attractive buy.

Q. I have Nikon lenses. Which digital camera should I buy, the Nikon D80 or the D200?

A.: The Nikon D80 and the Nikon D200 are different cameras designed for different photographers. The image quality (color accuracy and low noise) of both cameras is very high and not a reason for choosing either one of the two. The main differences are in the construction and features.

The D200 is a pro-oriented camera with a metal body sealed against dust and moisture. The shutter is rated for 100,000 exposures. The rugged body of the D200 is heavier (29.3 oz.) than the polycarbonate body of the D80 (21 oz.). Manual focus Nikon AI-S and E lenses, as well as the PB-6 bellows, are compatible with the D200 camera in the A (Aperture-Priority) or M (Manual) mode. The matrix, center weighted, and spot metering are operable. This feature is useful if you have manual focus macro lenses or other old lenses you are fond of.

The D80 is designed for photo enthusiasts who do not need the speed, weatherproofing, and ruggedness of a professional camera. The D80 has picture modes and in camera post-exposure editing functions: shadow and highlight adjustment, redeye elimination, color filter effects, monochrome mode, cropping and image overlay.

The other differences are:

	D80	D200
Shutter speed, s	30-1/4000	30-1/8000
Burst rate, JPEG	2.6 fps	5 fps
Flash, sync speed, s	1/200	1/250
Start-up time, s	0.18	0.15
Shutter lag, s	0.008	0.005
Memory card	SD	Compact Flash
Price, body, \$	1000	1700 (1550)

The D200 feels solid like the Nikon F100 film camera popular with the pros. The Nikon D200 is for photographers who do not need the very rapid burst rate and the slightly larger resolution (12.1 MP) of the Nikon D2Xs but like the lighter weight and the lower price of the D200.

The D80 is a better value for the money. The picture modes and the in camera editing functions can be ignored, if not needed. The D200 was in short supply but when the D80 arrived, the street price of the D200 dropped.

Q.: The Konica Minolta stabilization mechanism built into the camera body is a great concept. Do you

agree?

A.: Image stabilization by moving the sensor in the camera body is a great concept indeed. One mechanism in the body of the camera stabilizes all lenses and eliminates the need to build a stabilization mechanism into every lens. Many years ago, Nikon had a great concept too. Nikon decided to build a motor in the camera body for autofocusing all lenses, instead of having a motor in every lens. The Nikon concept made the autofocus lenses smaller, lighter and less expensive. What did happen years later? Nikon built motors into the lenses because the lens with the built in motor focuses faster. Now we have two lens stabilization systems: stabilization in the camera body or in the individual lenses. Time will tell which of the two stabilization mechanisms is more effective, easier to build, less expensive, produces sharper images, and is more rugged.

Q.: Does the D70 take a cable release, and if so, what kind?

A.: The D70 uses an infrared (IR) remote release (LM-L3, \$ 16.95) instead of a cable release. Pressing the transmit button of the ML-L3 sends an IR signal to the receiver on the front side of the camera, just below the mode dial. The IR beam can be aimed directly to the window of the receiver or bounced off a reflective surface. The remote release is great for self portraits.

Q.: You have given your D70 a good workout. Can you tell me what features you wish it had?

A.: I have used the D70 for shooting landscapes, people (including portraits), and even sports with very satisfactory results. I use the digital camera more often than my film cameras because I can process and view the images the same day. Of course, I have a wish list.

All Nikon SLR cameras, including the D70, have an APS-C size sensor which has a smaller picture angle than a 35mm camera. The equivalent focal lengths are 1.5x shorter than the focal lengths of 35mm camera lenses. At first, I did not like the picture angle decrease but I got used to it after I bought the Nikkor 12-24mm f/4.0. An advantage of using 35mm camera lenses on a camera with an APS-C sensor is the improved optical performance. The smaller sensor uses only the center part of the optical field where the sharpness of the lens is higher.

The 6.1 MP resolution of the D70(s) is low by today standards. I would prefer a sensor with a resolution of at least 12 MP. The viewfinder magnification, 0.76x, of the D70 is on the low side. The noise level is insignificant at ISO 200 but could be lower at ISO 400-1600. Having said that, at ISO 400 the digital noise of the D70 is less obtrusive than the grain of the best ISO 400 film (Provia 400F. Note that the new Fuji 400X film has a fine grain like the Provia 100F.).

My real gripe is the flash system. The new Nikon cameras (D70(s), D2x, and F6) have the advanced i-TTL flash system which is compatible only with the new SB-800 and SB-600 flash units. Older flash units, including the SB-80DX and the macro SB-29s, do not function in the TTL mode.

Digital SLR cameras are vulnerable to contamination of the sensor (the low-pass filter) with dust and the D70 is not an exception. I wish all camera manufacturers would like Olympus do something to solve this annoying problem. A theoretical but perhaps not a practical solution would be to use a fixed semitransparent mirror like some Canon film cameras used to have. The mirror would seal off the sensor and not attract dust because it does not have an electrostatic charge. The stationary mirror in the digital camera would be just as easy to clean as a mirror in the film camera. A simpler design is used by Sigma. The Sigma SD9 and SD10 digital SLR cameras have a glass dust protector built inside the lens mount. The glass disk seals off the camera chamber and is easily accessible for cleaning. Eventually all digital SLR cameras will have some dust protection.

Q.: Can a digital camera do infrared photography?

A.: Not very conveniently, digital cameras are not designed for infrared photography. Digital cameras have a dichroic mirror to reflect infrared light and a cut-off filter to block infrared light. The blocking of infrared light is not complete and some of it reaches the sensor. The response of a sensor to infrared illumination depends on the design of the infrared cut-off filter and this is proprietary information. Infrared photography with a digital camera requires an infrared filter on the lens to reduce visible light and allow mainly infrared light to enter the camera. Because most of the infrared light does not pass the cut-off filter, the exposure times are long.

Q.: I like the Nikon D70 camera but miss the grip with the vertical shutter release.

A.: A vertical grip, the PowerGrip, is available from Hoodman (www.HoodmanUSA.com) for the Nikon D70, Canon D20, and Canon Rebel XT. The grip uses a fiberoptic cable to operate the infrared shutter release.

Q.: I will buy a digital SLR, either the Nikon D70s or the Nikon D100. Which camera is better?

A.: The Nikon D70, or the D70s, is a better camera than the Nikon D100. The D70s does almost everything better than the D100, although it does not have all the features of the D100. The D100 is obsolete by now but some of its features may be important to you. Unlike the D100, the D70s is fully compatible only with the new Nikon SB-800 and SB-600 electronic flash units.

By the way, the designation D100 may have been a marketing ploy. The D100 is not a digital F100 but is built on the N80 chassis. The logical name should have been Nikon D80. The digital successor of the F100 is the Nikon D200, which is built like a pro camera and feels like the F100, a favorite of many professional photographers.

Q.: Will the vibration stabilization in the camera replace the stabilization mechanism built into the lens?

A.: Vibration stabilization in a camera is not possible for film cameras. For digital cameras stabilization in the camera is an attractive option. The vibration of a hand held camera is reduced without the need to buy special lenses. At the present the slow response in low light is a limitation of the image stabilization in the camera but this may be corrected in the future.

Q.: Is the accessory grip for the Nikon D200 camera useful?

A.: The MB-D200 battery pack (grip) is a must to have accessory for vertical shooting. The grip has an AF-on button, a vertical shutter release, and a front and rear command dial. The MB-D200 holds one or two EN-EL3e Li rechargeable batteries or six AA batteries. When two Li rechargeable batteries are installed, one battery is used first, followed by the other battery. Both batteries are not used at the same time. The grip is great for horizontal shooting as well. The added weight helps to hold the camera steady, especially when shooting with long and heavy lenses.

I have read complaints that the neck strap has the tendency to slip between the viewfinder and the eye. This problem can be avoided by crossing the neck strap when the camera is in the horizontal position. Rotate the neck strap so that the strap coming from the left corner of the camera will go to the right shoulder.

The MB-D80 battery pack for the Nikon D80 camera is similar and the same comments apply there.

EXPOSURE

Q.: Does a digital camera have less exposure latitude than film?

A.: The response to light of digital sensors is frequently compared to the narrow latitude of a transparency (slide) film. This comparison does not adequately describe the true characteristics of digital capture. Blown highlights are a plague of digital cameras but seldom a problem with slide film.

The difference between film and digital capture is fundamental. The response of a sensor to light is quite

different from that of film. The difference is evident when plotting the optical density of a negative film and the brightness of a digital image against the logarithm of exposure. The relation of the optical density of film to log exposure exhibits an S-shaped curve with a long apparently straight line in the middle. In the straight line portion the density is proportional to log exposure. The length of the log exposure range corresponding to the straight line portion is called the latitude of film. The gamma is the tangent of the angle formed by the straight-line portion of the density-log exposure curve and the log exposure axis. The gamma indicates the contrast of the negative and the optimum development time.

The non-linear end sections at the ends of the S-curve, the toe on the left and the shoulder on the right, are important because they extend the response of the film to light and buffer under and overexposure. When illumination is weak, the film does not respond proportionally to exposure. When illumination increases, the response of the film increases gradually until, at the lower end of the straight line, the density of film becomes proportional to the log of exposure. Above the upper end of the straight line section, the response of film to an illumination is no longer proportional. In this shoulder region the effect of light on the density of film decreases gradually with the increasing exposure but does not end abruptly. This means that the highlights are not blown out.

The response of a sensor to light is quite different. The relation of the brightness of the image to log exposure (subject luminance) is linear. A plot of brightness versus log exposure yields a straight line, unlike the S-curve for film. The straight line begins at the noise level and ends abruptly when the photo sites are saturated. The digital response curve does not have the end sections (the toe and the shoulder) to cushion underexposure and prevent blown highlights.

Film has wide exposure latitude, because the light sensitive silver halide particles are not uniform. The particles vary in size, shape and sensitivity and are distributed in the gelatin layer of a considerable thickness. The photosensitive sites, pixels, of a digital sensor are almost uniform in size and sensitivity. They cannot tolerate an overload of light and become noisy when underexposure is compensated by increasing the amplification of the signal.

The comparison of film with a sensor shows clearly that the sensors we are using are inadequate and must be improved. The first step in this direction was made by Fuji. The Super CCD sensor designed by Fuji film has a large and a small photodiode in the same photo site. The large diode is more sensitive to light than the small one. When the large photodiode is saturated, the small photodiode can still respond to light and capture highlights the large photodiode is not able to do. The technology of digital capture is still developing and new sensor designs will appear.

To a considerable extent, the exposure latitude of digital cameras depends on the sensor and the processor in the camera as well. The conversion of their electric signal to a final image involves the demosaicing of color and is a very complex process using proprietary algorithms.

Q.: How can Photoshop extend the exposure latitude?

A.: The exposure latitude of stationary scenes can be extended by taking two photographs: one exposed for the shadows and one for the highlights. The two images can be combined in the Photoshop CS2 by the High Dynamic Range command. Go to Files>Automate>Merge to HDR. More than two photographs can be made and combined to cover the full dynamic range of the scene. When the photographs are made, the exposure should be changed without moving the camera. A movement of the camera can be avoided by measuring the exposures before taking the pictures and then set the auto bracketing accordingly. A remote control eliminates the need to touch the camera. The full dynamic range of a HDR image has the unwieldy 32-bits per channel depth. Saving the file as the 8- or 16-bit image loses some information but is eventually unavoidable.

Exposure latitude of film or color slides can be extended by making two scans – one for shadows and one for highlights.

Q.: What is gamma?

A.: The gamma has several definitions. For a film, gamma is the slope of the straight-line section of the S-curve representing the optical density of film versus log exposure.

In digital photography gamma has been used to describe the brightness of midtones. In the Levels adjustment of the Photoshop the value indicated by the middle slider is called the gamma. The adjustment of midtones by dragging the slider is called the gamma control. The term gamma is used also for the calibration of the monitor. The response of a monitor to the voltage applied is non-linear and exhibits a curve when plotted. By one definition, the gamma value defines the slope of that curve halfway between black and white. By another definition, the gamma of a monitor indicates in the 50% brightness area the non-linearity of the monitor response to the voltage applied.

Q.: Does cold weather cause exposure problems for a digital camera?

A.: A cold weather can cause problems for any camera, mainly because the batteries may fail. Some cameras have an accessory battery holder which can be placed under the coat and connected to the camera with a cable. My experience with a digital camera at the 20 degree temperature has been quite encouraging, though. The camera functioned well and tolerated the cold temperature better than my fingers after 60 exposures.

Certain precautions are needed to operate at low temperatures. Set the camera controls to manual focus, to manual exposure and turn the image stabilizer off. Keep the camera in an insulated camera bag from which the camera can be easily retrieved. I have found the Adorama Slinger to be very convenient. When the camera is not in the bag, keep your hand on the grip where the batteries are to protect them against cold.

Place the camera in a plastic bag before taking to the inside of the house and let the camera warm up before taking it out of the bag. Otherwise moisture may condense on the camera.

FLASH

Q.: I am considering the Nikon D70s digital camera but would like to avoid buying a new flash unit. Is there any reason I could not use my SB-25 Nikon Speedlight?

A.: Electronic flashes mounted on digital cameras need additional electronic circuitry which the old flashes do not have. However, even the SB-80DX designed for the digital cameras does not work properly on the Nikon D70 or the D70s. The D70 has the latest Nikon i-TTL flash system with a 1005 segment TTL sensor. The top sync speed is 1/500s. The new system is fully compatible only with the SB-800 and SB-600 Speedlights.

Q.: Does this mean that I could not use the SB-25 on the D70s at all, or would I lose some capability?

A.: When an old Speedlight, such as the SB-25 or the SB-80DX, is in the TTL mode, the shutter release is locked and the flash cannot be fired. The flash will fire only when the flash is in the Auto or Manual mode. In other words, the TTL exposure control is not possible.

An old flash unit can be used in the TTL mode as a slave on the SU-4 slave flash controller (Nikon Part No. 3073NCP). The flash can be in any place where the sensor of the slave controller is exposed to the light beam of the built-in flash.

Q.: The manual of the Nikon D70 camera is very confusing. What can you tell me about the i-TTL flash system?

A.: The manual of the Nikon D70 is very confusing indeed and the manual of the SB-800 Speedlight is

not any better. One word has two meanings and two words have the same meaning. The i-TTL system consists of a SB-800 Speedlight as the master unit (alias the Commander) and one or more SB-600 or SB-800 remote units. The master unit can be mounted on the camera or can be connected to the camera via synch cable. The SB-600 Speedlight cannot be used as the master. (The Magic Lantern Guide of Nikon D70(s) states incorrectly that the SB-600 can be used as the master unit). Older Nikon Speedlights are not compatible with the i-TTL system of the D70(s). The master flash unit sends and receives light pulses to communicate with the remote flash units. The pattern of the light pulses is specific for each channel communicating with the remote unit(s). The channel number (1, 2, 3, or 4) can be changed, to prevent accidental triggering of the flashes by a photographer using the same flash setup. All flash units must have the same channel number. Otherwise, they do not fire.

The light output compensation values may be selected separately for each flash. Three different light output compensation values can be used. Flash units with the same compensation value belong to the same group, called A, B, or C.

If the built-in flash of the D70(s) is used as the master unit (called the Commander) the channel number must be 3 and the system is limited to one group, the group A. Otherwise, the flash does not fire. The Commander mode is accessible in the menu by the Custom Setting 19: Flash Mode.

The built-in flash of the new Nikon D200 camera can control two groups of remote Speedlight SB-800 or SB-600 flashes.

FILE FORMAT

Q.: What is the RAW format of digital files?

A.: Raw files contain digitalized data originating from the sensor of the camera and proprietary information added by the camera maker. As a consequence, different camera manufacturers have a different RAW file formats and need special conversion software. The development of third party software for the conversion of RAW files is hampered by the unwillingness of the camera makers to share the proprietary information of their RAW files. A standard RAW format, the DNG proposed by Adobe, has been accepted by Leica and Hasselblad but faces a tough road to a wider acceptance.

A RAW file is functionally the digital equivalent of the film negative. The RAW is an uncompressed and unaltered data file containing the full range of information captured by the camera. The statements, that the RAW files contain only pure data generated by a digital sensor, are not true. Some processing is necessary. The charge formed by light on the sensor is an analog quantity and must be digitalized by the analog-to-digital (A/D) converter to be expressed by numbers 0 and 1.

The Nikon NEF format is an exception among the RAW files. The NEF format has two RAW versions: one is uncompressed and the other one is compressed. Strictly spoken, the compressed NEF is not a true RAW file because the digital data coming from the sensor have been altered. The 2:1 compression of the NEF format is not without a loss but Nikon claims that the losses are insignificant. Nikon uses a complicated partial compression process claimed to be visually lossless.

Q.: Why do you use the RAW format? I use the JPEG format with very satisfactory results.

A.: Both file formats have advantages and disadvantages. I use mainly the RAW format and occasionally the JPEG format, depending on the intended use of the images.

The main advantage of the RAW format is its flexibility. The color and the exposure can be corrected by the photographer. When shooting with RAW the white balance does not have to be meticulously programmed for each shot but can be accurately adjusted later on when processing the images. If the edited image is not satisfactory, the original RAW data can be used again to make another one. In other words, the RAW file is like a negative of a film camera which the photographer processes to get the

desired result. The RAW format is desirable for pictorial photography requiring the best quality possible the camera has to offer.

The JPEG format has several important advantages over the RAW format: more images can be stored in the memory card, less battery power is consumed, and less time is needed for processing the images. In continuous shooting mode the JPEG format allows a longer sequence than the RAW format.

The JPEG uses compression to reduce the file size but the compression causes a loss of data and may cause artifacts. The loss is very small at a low (4x) compression but increases with the increasing compression ratio. The images saved in the JPEG files are processed in the camera. This simplifies the workflow but reduces the tonal range by converting the 12-bit sensor data to 8-bit data. In contrast, data saved in the RAW format are not manipulated by the camera and saved in the 16-bit space of the RAW format.

The JPEG format is the best option for photojournalism type of shots when the storage capacity and the burst length in continuous shooting are important.

OUTPUT

Q.: Are digital prints from a digital camera as sharp as the digital prints originating from a film camera?

A.: The prints made by using a good digital camera are sharper than the prints originating from negative film or a slide. The difference is in the grain or noise. Images made by a good SLR digital camera are virtually noiseless, even at the ISO 400 setting. I have compared two prints, one from a Provia 100F slide and the other from a digital camera (Nikon D70 at ISO 200). The Provia 100F is one of the films with the finest grain and my Nikon Coolscan 4000 is a good scanner, 16 bits per color and a dynamic range of 4.2. I asked a group of experienced photographers to identify which of the prints was from the digital camera and they all picked the wrong print. They assumed correctly that film has more information and expected therefore film to give a sharper print. What had made a difference were the grain of the film and the loss of sharpness in the scanner.

Sharpness is not the only factor, of course. The 8 bit file size of a 6MP digital camera is about 17 MB. This is sufficient for the 8x10" print with 300ppi resolution, and for a 13x19" print with 160ppi resolution. Film has much more information and its 55 MB file size allows very large prints and extensive cropping. The tonality of the print depends on the amount of information in the digital file. In my opinion, the size of the digital sensor should be least 12 MP to approach the amount of information on a film scan.

Q.: An image edited in the Photoshop can be converted to a slide. Which slide is sharper, the one made by scanning a slide into the Photoshop or a slide made by downloading a digital file from a digital camera?

A.: A comparison of the sharpness of slides is more complicated than the sharpness of prints. Let us assume that the edited file from the Photoshop is converted to a Provia 100F slide by a film recorder. If a Provia 100F slide is scanned into the Photoshop and the grain does not increase during editing, then the grain of the new slide made is about the same. If ISO 400 film is used in the camera, however, the new slide from the film recorder is grainy. The images on 400 ISO (Provia 400F) film are noticeably grainy and the grain is carried over into the new Provia 100F slide from the film recorder.(Note: The new Provia 400X has a finer gain).

If a good digital camera is essentially noiseless at the ISO 400 setting and the new slide from the film recorder is noiseless as well. At film speeds above ISO 100 the digital camera is a clear winner for making edited slides. At ISO 100, the scanned slide has a larger file with more information than the file from a digital camera.