What Is... Noise?

One of the major difference between a 'Point & Shoot' digital camera and a digital Single Lens Reflex (DSLR) is that the former produces images with a lot of noise when using higher ISOs (generally anything from ISO400 and up) and long exposure times, and the latter has much less noise even at higher ISO (depending on camera manufacturer and model). Noise is apparent by the presence of coloured specks where there should be none. For example, instead of a clear blue sky, you notice faint pink, purple and other colour spots.

Digital Image

When we hear 'digital' we automatically tend to think of high quality. Digital sound does not degrade no matter how many times you play it. Digital images can, theoretically, be saved forever and will still print in its pristine form.

But the image in a digital camera is sourced from a non-digital component: the CCD or CMOS image sensor. Understanding how light striking the image sensor is converted into digital form makes clear what noise is and why it is present.

From Analog To Digital

An image sensor is typically comprised of a matrix of light sensors. A light sensor can be thought of as simply a device that converts light into an electric charge.

Each square of the image sensor matrix is a photosite, usually with one light sensor 'painted' on it. A photosite generally corresponds to one pixel in your digital image.

When light (photons) strike the image sensor, electrons are produced. These "photo-electrons" give rise to analog signals which are then converted into digital pixels by an Analog to Digital (A/D) Converter.

Causes of Noise

There are a number of sources of noise contamination.

Heat generated might free electrons from the image sensor itself, thus contaminating the "true" photoelectrons. These "thermal electrons" give rise to a form of noise called thermal noise or dark current.

Another type of noise is more akin to the 'grain' obtained by using a high ISO film. When we use a higher ISO, we are amplifying the signal we receive from the light photons.

In low light, there is not enough light for a proper exposure and the longer we allow the image sensor to collect the weak signal, the more background electrical noise it also collects. In this case the background electrical noise may be higher than the signal.

So why is using a larger image sensor better?

Each photosite itself generates electrical noise that can contaminate its neighbour In a larger image sensor, the photosites can be physically further apart and thus be less affected by that contamination.

A larger image sensor also means that the photosite can be larger, thus have a larger light gathering capacity. It is therefore able to generate a larger signal to noise ratio.

That is why a digital camera with 12 million pixels crammed into a 1/1.8 in. image sensor

has more noise (especially at high ISOs) than a 12MP digital camera using the much larger half-frame (APS-sized) image sensor. If a full-frame sensor were to be packed with photosites as densely as they are packed onto an APS-C sized sensor, they would cause just as much digital noise – though, being a much more sophisticated camera, the analog-digital converter can look after the problem better.

In-Camera Reduction Of Noise

Camera manufacturers have incorporated noise reduction algorithms in their firmware that kick in when a slow shutter speed and/or high ISO is used, to try to reduce the noise. Depending on the quality of the algorithms, these work only to a certain extent: they do not completely remove all noise and the smoothing effect of noise reduction is frequently accomplished at the expense of fine image detail.

Noise Reduction Software

Software that can be used to reduce noise in a digital image in your computer. Your image editing software may already have such an action, or you may download one from the Internet. The better noise reduction software applications (such as NeatImage, Noise Ninja and NoiseWare Pro) can take a long time to process one image and so may not really be a viable solution if you have lots of pictures with noise. They have their place in a photographer's toolbox,though, and for that one photograph that you have to take with noise or else miss an incredible shot, these software applications are your answer. If you're shooting Raw, the noise reduction of Adobe Camera Raw (and in every other Raw processing software) can do a really good job.

Why Are DSLRs less Noisy?

With a larger image sensor, each pixel can be larger and each photosite can be a bit further away from its neighbour (of course, there is an optimum distance beyond which we'll have 'gaps'). This extra distance is often enough to prevent signal leakage from one photosite onto another -- hence much less noise!

You will find that the high ISO performance of a DSLR varies. Entry-level DSLRs are practically noise-free up to ISO 400. Better models can capture noise-free images up to ISO 1600. ISO 3200 is a stretch, even for the top line models. Turning noise reduction (NR) ON will help eliminate noise but this can happen at the expense of losing fine image detail (and only applies when shooting Jpeg).

Yippee for Bigger Image Sensors!

Why don't camera manufacturers use bigger image sensors in P&S digital cameras? A bigger image sensor means the need for a bigger lens. Unlike film that can capture light at an angle, an image sensor requires that light falls on it straight on. Bigger lenses add costs, need a bigger body, etc. You quickly end up with a camera body the size of a... DSLR. A 'full-frame' DSLR is an altogether bigger beast again.

Notice how camera manufacturers have 'squeezed' more megapixels into the same sized image sensor. That is one reason some people say that a digital camera with less MegaPixels gives images that are less noisy than one with more MegaPixels -- on the same size image sensor. Progress is also being made towards better in-camera noise reduction.

The dSLRs have image sensors that are much larger than 2/3 in. Most 'Enthusiast' dSLRs have an APS-C sized (or, 'half-frame', approx. 23.7 x 15.6 mm) image sensor.

When we talk about a 'full-frame' image sensor, it is in relation to a 35mm film and is therefore sized at 36 x 24 mm. Compared with the 2/3 in. image sensors in 'point and shoot' digital cameras sized at 8.8 x 6.6 mm, and you'd agree that the size difference is indeed substantial. The 'full-frame' (and expensive) dSLRs produce practically noise-free images.

What Can You Do?

There are a number of things to remember about noise:

- A slow or long exposure introduces noise.
- A higher ISO introduces noise.
- Noise Reduction Software will clean up the noise in some images, and sometimes it's done well enough that you can't really tell the original image had unacceptable noise level in it.
    - If you *must* have the option of using high ISOs, then get a DSLR. If it has to be just about noise-free, you need a full-frame DSLR.

What can you do to reduce the amount of noise in your digital images?

1. Avoid slow or long exposures.
2. Avoid using high ISOs.
3. Purchase noise reduction software. This will allow you to take pictures and not miss some great shots. You'll find that a good noise reduction software usually does a pretty good job of 'cleaning' up the noise to an acceptable level in most of your noisy images.
4. Keep your camera cool – yes, warm sensors give more noise! If travelling a long journey with it, wrap it in some form of insulation, like bubble-wrap.

Here is a comparative illustration of the approximate sizes of the currently most popular image sensors:

Image Sensor	Size (approx.)
full frame	36 x 24 mm
half frame (APS)	24 x 15 mm
2/3 in.	8.8 x 6.6 mm
1/1.8 in.	7.2 x 5.3 mm
1/2.7 in.	5.3 x 4.0 mm