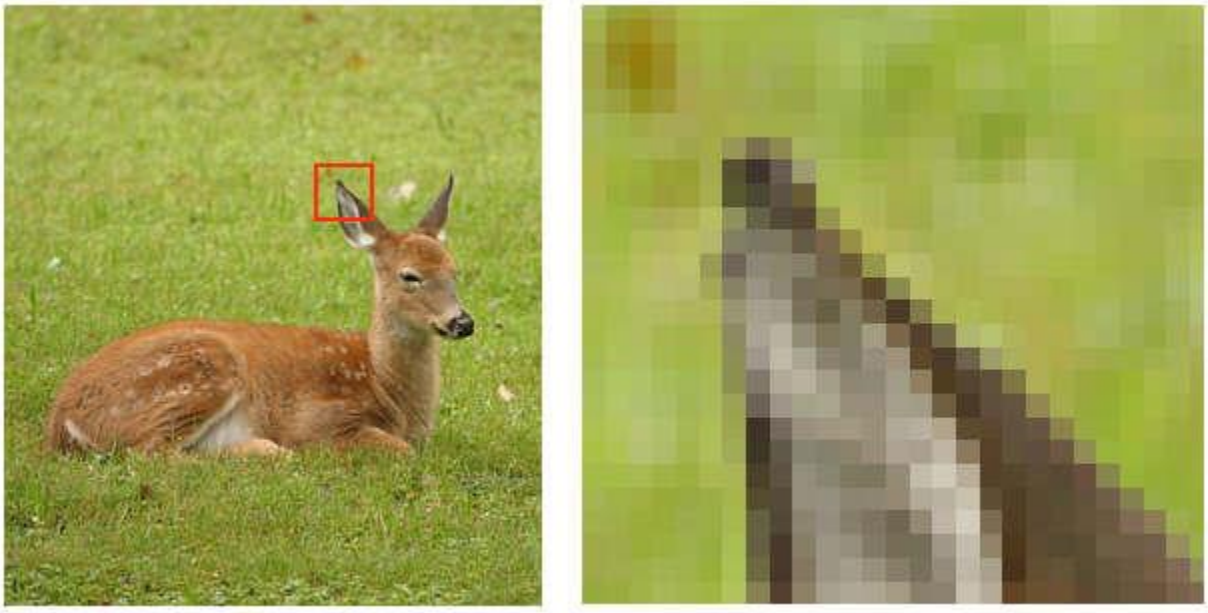
## Digital Camera Basics - A primer

Digital cameras are confusing to a lot of new users. In this **basic guide to digital camera technology** we hope to try to give digital beginners at least some basis to use in deciding which digital camera is appropriate for them. When shopping for a digital camera it's at least good to know what the basic terms like *white balance*, *pixel*, *ppi* and *dpi* mean and how they affect image and print quality. It's also important to know the difference between things like *optical zoom* and *digital zoom* as well as the advantages and disadvantages between storage formats such as *Compact Flash* (CF), *Microdrives*, *Sony Memory Stick*, *Secure Digital* (SD), *Multimedia* and camera interface technologies such as *USB 1.1*, *USB 2.0* and *Firewire IEEE 1394*.

## Pixels

A pixel is a contraction of the term **PI**cture **EL**ement. Digital images are made up of small squares, just like a tile mosaic on your kitchen or bathroom wall. Though a digital photograph looks smooth and continuous just like a regular photograph, it's actually composed of millions of tiny squares as shown below.



*On the left the full image, on the right the area in the red square magnified to show individual pixels*

Each pixel in the image has a numerical value of between 0 and 255 and is made up of three color channels. So for example a pixel could be 37-red, 76-green and 125-blue and it would then look like this . If it was 162-red, 27-green and 12-blue, it would look like this .

There are over 16 million possible combinations using this scheme and each one represents a different color. Computer savvy readers will note that each color in this scheme can be represented by an 8-bit number (byte), so the color of each pixel is defined by three color bytes. This scheme can be expanded, for example to use 16-bits (two 8-bit bytes) for each color. Images using three 8-bit values are sometimes called *24-bit color images*. Images using three 12-bit values for color definition are called *36-bit color images*, and those using three 16-bit values are called *48-bit color images*.

## Pixel Count

One of the main ways that manufacturers categorize their digital cameras is in terms of *pixel count*. What this is is the number of individual pixels that go into making each image. Today this number varies between 1 million (*1 Megapixel*) to around 14 million (*14 Megapixels*). A million pixels is abbreviated to MP, so a 1MP camera has 1 million pixels and a 3MP camera has 3 million pixels. Currently most popular consumer digital cameras have between 2MP and 5MP. A 3MP camera can make excellent 4"x6" prints and very good 5"x7" prints. If you intend to make lots of 8"x10" prints, then perhaps a 4MP or 5MP camera would be a better choice. Sometimes two numbers are given, total pixels and effective pixels. Total pixels count every pixel on the sensor surface. Usually the very edge pixels aren't used in the final image. Effective pixels are the number of pixels actually used in the image after the edge pixels have been dropped.

| | 3MP | 4MP | 5MP |
|---|---|---|---|
| Largest Image (typical) | 2048 x 1536 | 2272 x 1712 | 2592 x 1944 |
| Print size at 320dpi | 6.5" x 4.8" | 7.1" x 5.4" | 8.1" x 6.1" |
| Print size at 240dpi | 8.5" x 6.4" | 9.5" x 7.1" | 10.8" x 8.1" |

**Updated Table 2013**

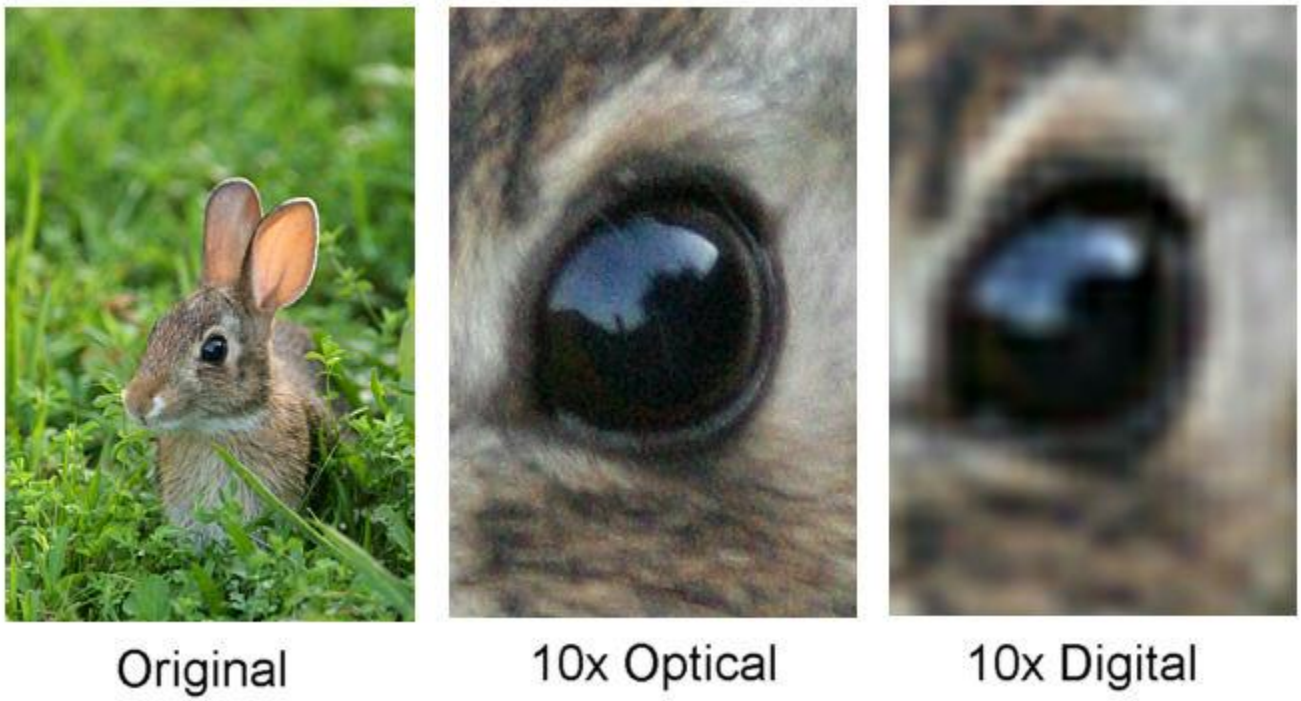
| ***sensor*** | ***8x10"*** | ***11x14"*** | ***13x19"*** | ***24x36"*** |
|---|---|---|---|---|
| **4mp** 2464x1632 | **good** 204 dpi | **poor** 148 dpi | **poor** 130 dpi | **poor-** 68 dpi |
| **6mp** 3008x2000 | **good** 250 dpi | **good-** 181 dpi | **poor** 158 dpi | **poor-** 83 dpi |
| **8mp** 3504x2336 | **excellent** 292 dpi | **good** 212 dpi | **good-** 184 dpi | **poor** 97 dpi |
| **10mp** 3872x2592 | **excellent** 324 dpi | **good** 235 dpi | **good** 203 dpi | **poor** 108 dpi |

| | | | | |
|---|---|---|---|---|
| **12mp**<br>4288x2848 | **excellent**<br>356 dpi | **good**<br>259 dpi | **good**<br>225 dpi | **poor**<br>119 dpi |
| **16mp**<br>4992x3328 | **excellent**<br>416 dpi | **excellent**<br>302 dpi | **good**<br>262 dpi | **poor**<br>138 dpi |
| **18mp**<br>5232x3516 | **excellent**<br>439 dpi | **excellent**<br>320 dpi | **good+**<br>275 dpi | **poor**<br>145 dpi |
| **21mp**<br>5616x3744 | **excellent**<br>468 dpi | **excellent**<br>340 dpi | **excellent**<br>295 dpi | **poor**<br>156 dpi |

*Typical maximum image size vs. nominal Pixel Count. See below for comments on dpi and print size*

## Digital Zoom and Optical Zoom

Most cameras have both optical zoom and digital zoom. Optical zoom works just like a zoom lens on a film camera. The lens changes focal length and magnification as it is zoomed. Image quality stays high throughout the zoom range. Digital zoom simply crops the image to a smaller size, then enlarges the cropped portion to fill the frame again. Digital zoom results in a significant loss of quality as is clear from the examples below. It's pretty much a last resort, and if you don't have it in camera, you can do a similar job using almost any image editing program.




*Comparison of optical zoom and digital zoom*

## Memory

There are quite a few different (and incompatible) memory cards used in digital cameras.

- Compact Flash (CF) - The original memory card. 42mm x 36mm x 3mm. Somewhat larger than the others, but used on all high end DSLRs. Available in capacities up to 2GB. There are also miniature hard drives (Microdrives) with almost the same form factor as CF cards (CF type II, 5mm thick)) which are available in capacities from 340MB to 4GB. Microdrives used to be cheaper than solid state CF cards, though there is not a big difference today up to about 1GB. The 4GB Microdrives are actually cheaper than the 2GB CF cards though. Of course prices change pretty fast these days! Overall CF cards tend to be cheaper than any of the other forms of solid state memory - though this too could change. CF cards and microdrives contain their own disk controller, so that makes the camera electronics simpler.


- Secure Digital (SD) - Very small - about 24mm x 32mm and 2mm thick. They have a built in write protect switch to prevent accidental erasure and certain encryption capabilities of little interest to digital camera owners.


- Multimedia - Same size as SD but with less features and no encryption capability. There are some that can be used in some SD cameras but they aren't 100% compatible with SD cards in all applications. They also don't have the "lock" feature that the SD cards have, and they are likely to become obsolete.



- Smart Media - Thinner than CF cards, but lacking an on-card memory controller. They can still be bought, but they are well on their way to becoming obsolete.

- Memory Stick - Introduced by Sony and used only by Sony. If you own Sony, you will have to use memory sticks since Sony has chosen not to support the SD or CF formats. This can be quite inconvenient since you cannot share cards between Sony and non-Sony products. Memory sticks are available in high capacities but are larger than SD cards. Newer versions of the stick have the PRO designation.



- Mini Secure Digital (miniSD):
  Sixty per cent smaller than an SD card, the MiniSD was designed to go into

various ultra-portable devices such as cameras, cell phones and MP3 players. These cards can be used in devices that support regular SD but require an adaptor to do so.

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Is there any real difference in performance? No, not really. The CF cards are the cheapest per megabyte and are available in higher capacity models than the other (of course that may change with time). Most high end DSLRs use them. The smaller cards tend to be used in the smaller consumer digicams. There's really no reason to pick a camera with one type over another unless you have multiple cameras or other devices (MP3 players, phones, for example) which also use memory cards - then it's convenient if they can share cards. It may also be difficult (and/or expensive) to find really high capacity cards (1GB and up) in formats other than CF, but that's probably not a concern for most digicam users.

The following table gives the approximate number of shots you can expect to get using low JPEG compression using various pixel count cameras in conjunction with various sized memory cards at the lowest ISO speed settings of a typical camera. The exact numbers depend on how much compression the camera applies and the ISO speed used. Higher ISO settings result in more noise and noise is hard to compress and so leads to larger files and less images per card. If you're shooting in a RAW or NEF format you can divide these numbers by 3. If you're shooting TIFF files you'd have to divide these numbers by 8.

***Approximate number of shots per memory card for various digital camera pixel counts using high quality JPEGs for storage***

| Memory Card Photo Capacity | | | | | | |
|---|---|---|---|---|---|---|
| Memory Cards | Photos | | | | | |
| Storage Capacity | 2 MP | 3 MP | 4 MP | 5 MP | 6MP | 8 MP |
| 128 MB | 149 | 113 | 95 | 74 | 60 | 40 |
| 256 MB | 298 | 226 | 180 | 149 | 119 | 79 |
| 512 MB | 595 | 452 | 381 | 298 | 238 | 159 |
| 1 GB | 1190 | 905 | 762 | 595 | 476 | 317 |
| 2 GB | 2379 | 1808 | 11524 | 1190 | 952 | 635 |
| 4 GB | 4758 | 3619 | 3046 | 2381 | 1905 | 1270 |
| 8 GB | 9516 | 7238 | 6092 | 4762 | 3812 | 2540 |

MP=Megapixels: MB=Megabytes, GB = Gigabytes)
1 Megabyte (MB) = 1,000,000 bytes; 1 Gigabyte (GB) = 1,000,000,000 bytes

* Some of the listed capacity is used for formatting and other functions and is not available for data storage.
**Approximate number of standard JPEG pictures. JPEG file sizes vary based upon camera model and default settings, as well as user-selected resolution and compression mode settings. Some host devices may not support all of the Flash storage capacities listed.

CAUTION To prevent memory card corruption, keep batteries charged and don't delete. Wait for lights to stop flashing then turn camera off before removing memory. For card readers, double click Safely Remove Hardware. Select, then click Stop and OK.