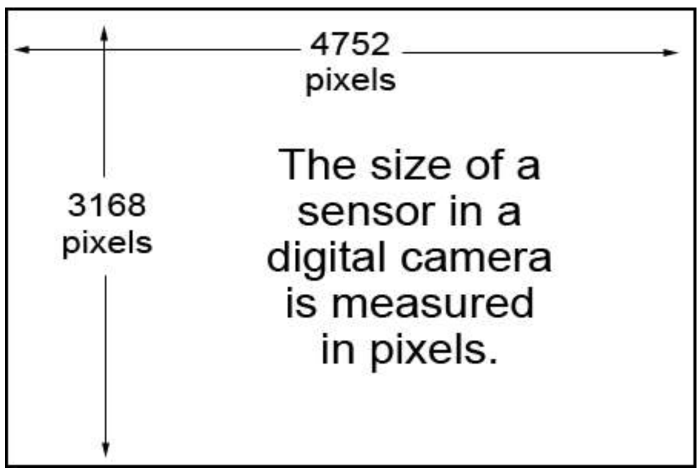
Digital imaging resolution is an issue many photographers find difficult to grasp. This article will hopefully help to bring some clarity to the situation. It is actually a simple concept, but with some unnecessarily confusing aspects. Once the simplicity of the concept of a two-dimensional array is resolved in your mind, the translation of the information into the third item – *resolution* – should be more easily understood.

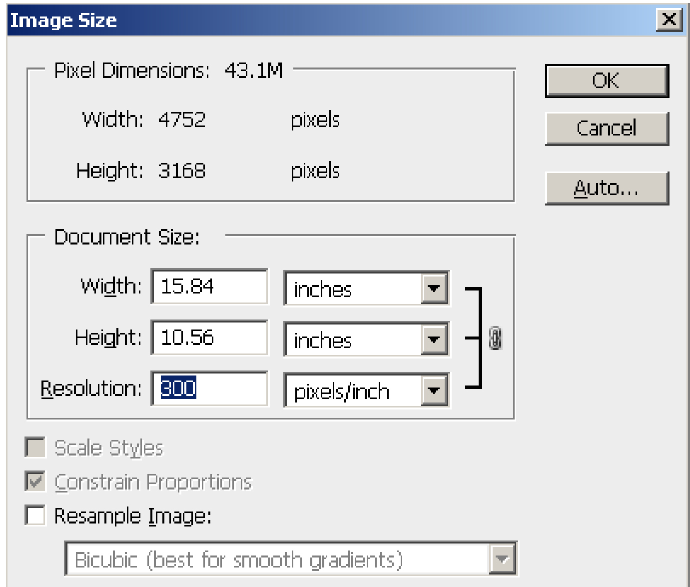
The specifications for a digital camera include the size of the array of pixels that capture the image. An array is simply the horizontal and vertical dimensions of the sensor, describing the number of pixels in each dimension. By multiplying the two dimensions, they describe the size of the array as used by camera manufacturers to define their cameras



In this example we see the 4752 x 3168 pixel dimensions of a popular 15 mega-pixel (Mp) camera. Notice that there are only two numbers, and that they indicate the width and height of the array. Understanding digital resolution starts with that realization. Adding a third number describes how those dimensions will be translated (resolved) to the device on which the image is either displayed or printed. Until and unless that translation (*resolution*) is made, only the two pixel array dimensions are relevant. It is, therefore, possible to discuss the size of an image in pixel dimensions alone if no specific output device is known or assumed. Even if the *resolution* of the image is known, it is still accurate to describe any image in terms of the width and height of the pixel s as those dimensions do not change with *resolution*. Only the resulting output size changes depending on the third number in the equation, which is referred to as the *resolution* of the image.

The resolution of an image is only important if the person receiving the image has an output device in mind that you need to match. If that person understood resolution completely, they could just as easily give you the pixel dimensions (1200x 1800) instead of a three number description such as 4x6 inches at 300 ppi (pixels per inch). Fortunately, the difference between the two is simple math.

Digital imaging programs have an image size dialog that can help you understand how resolution affects the output size of a pixel array, and get a better understanding of the importance (or relevance) of the third number.



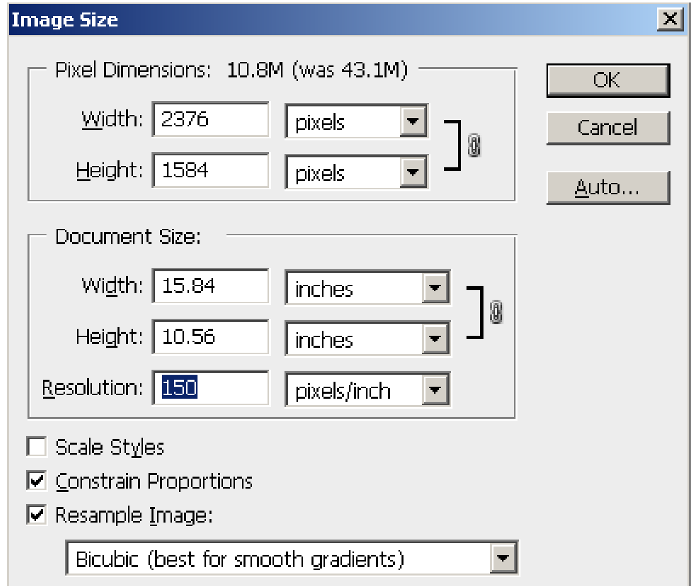
In this copy of the *Photoshop Image Size* dialog we see the 4752 x 3168 size of our array in the top section called *Pixel Dimensions*. This is precisely the terminology we want to use as it accurately describes the size of the image in pixels. Also notice that the number immediately next to the *Pixel Dimensions:* is 43.1M (megabytes) and this represents the size that the image will be as interpreted into three channels to create a color image. It is about three times the size of the original pixel array. Remember that a megabyte is not 1000 pixels, but 1024 pixels, accounting for the difference between 43.1 Mb and 45 Mb. The image is three times the size, as the original pixel array is used three times to produce the RGB channels needed to represent the colors in the image.

Below the *Pixel Dimensions* is the box that describes the *Document Size* or the *resolved image* size with the *resolution* number in consideration. The *resolution* here is 300 ppi and the resulting image at that density is 15.84 x 10.56 inches. The box is actually doing simple math by dividing the *Pixel Dimensions* by the desired resolution and telling you what the resulting image will be in inches. The braces on the right of the three boxes for width, height and resolution have a *chain* icon next to them indicating that these dimensions are locked together – changing any one of them will change the other two to reflect a different *Document Size*. The *Pixel Dimensions* will not change no matter what we do to the numbers in the *Document Size* boxes.

Notice that the box called *Resample Image* is not checked in the first dialogue box above, indicating that we do not want to interpolate (change) the size of the image, only resolve it according to a desired ppi resolution. Putting a check mark in that box will change the appearance of the entire dialog box as seen in the next example.

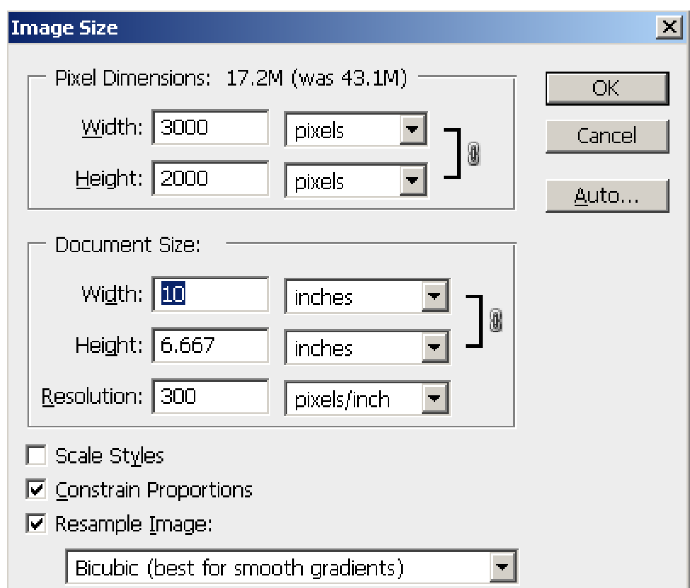
By checking the *Resample Image* box we are telling the program that we do want to modify the *Pixel Dimensions* of the image. This will change the file size, and the *Document Size* of the image will either change in width *and* height or in resolution.

In this dialog I have changed the resolution of the image from the 300 ppi in the original box to a lower resolution of 150 ppi. The result is an image of the same size in inches, but as printed at a lower resolution, therefore, requiring fewer pixels to make up the image. The *Pixel Dimensions* have changed to reflect this modification, and the file size has lowered as a result. We have *interpolated* the image, changing the original pixels, in this case to a new *resolution.* You should be aware that you are now throwing away pixel information, and you should save this altered image with a new name rather than overwriting the original file as the information cannot be recovered.



Let's look at the same box with some different numbers to help understand this well. In the next example we return to the 300 ppi resolution, but want to resize the image to fit on a 10-inch wide print. The *Constrain Proportions* checkbox is checked to make sure that the aspect ratio or relative size of width to height remains the same as the original. Otherwise, we would distort the image. This is also why the *Width* and *Height* in the *Pixel Dimensions* and *Document Size* boxes both have the locked braces next to them. Plugging the desired 10 inches into the *Width* box modifies the *Height*, and also modifies the *Pixel Dimensions* to accommodate the desired change in the *Document Size.* So, we have again *interpolated* the image, in this case to a new size, but at the same *resolution.*

Again, this is simple math, as 300 ppi times 10 inches requires 3000 pixels, which is exactly what we see in the *Width* box of the *Pixel Dimensions* area. The *Height* changes to 2000 pixels to maintain the aspect ratio.



The *Height* in the *Document Size* box has changed to 6.667 inches, the proper size relationship to 10 inches as the original width and height dimensions of the image.

With the *resample* box unchecked, you are simply redefining the image *resolution* or *document size* but not changing the original pixels in the image. With the *resample* box checked, you are *interpolating* the image to a new *document size* at the same *resolution,* or a new *resolution* at the same *document size*, or possibly both. In any case, with *resample* checked you will modify the original pixels in the image. The *Pixel Dimensions* of the image determine the *Image Size* and the *Document Size* is simply the mathematical interpretation of the *Pixel Dimensions* to inches based on the desired *resolution.*

I encourage you to experiment with the *Image Size* dialog in your imaging program, changing various parameters, modifying inches to pixels and other units of measure, and locking and unlocking relationships in order to help you understand what happens with each change. Doing so with the same image, something that will easily show when distortions occur, like a box or an architectural subject, can be a visual aid to comprehending the changes.

Another part of *resolution* that is often missed is pixel size. If you print at a lower resolution, the pixels are larger in size. Pixels are not a fixed size, but vary according to the resolution you assign to them. That is obvious if you simply consider that at 300 ppi it takes 300 pixels to make an image one inch wide, and at 150 ppi it only takes 150 pixels. Obviously, the 300 ppi pixels must be smaller to occupy the same space as the larger 150 ppi pixels. We do not have to be concerned with pixel size, as it is a function of the *resolution* and is resolved for us. In other words, a pixel is a unit, not an absolute, and the unit size changes based on the required *resolution*.

Another place you can see this pixel size difference is on your monitor. At 100 percent image size on your monitor you are viewing the pixels at the size of the *monitor resolution*. Once a monitor resolution is set, the pixels cannot change size as they can on a print, so the image changes size instead. Monitor resolution is another area where a lot of confusion is possible. For a discussion on monitor resolution see the article on that subject on my web site —www.brysonleidich.com – and click on the Learning Center link at the bottom of the page.

A final point is on the common misunderstanding about monitors and the internet being 72 ppi. Web pages are designed according to the desired *width and height* the page should be displayed, such as 600x800 or 1024x768, which are typical monitor resolutions. Notice that there is no third *resolution* number. The internet actually has no resolution. A web page displays relative to the resolution of your monitor as the monitor is the output device and, therefore, determines the *Document Size* of the page or the images on it. However, if the page dimensions are larger than your screen resolution is set at, you will have to scroll to see it all as the size of a web page does not change when you display it on a monitor. It simply occupies more or less space than the actual, physical size of your screen. Most images intended for screen display, such as web images or PowerPoint presentations, are set to 72 ppi as a matter of convention, but the important numbers remain the width and height of the image in pixels. Get that right and the rest takes care of itself.