Image Resolution

By Bryan A. Thompson / Last Updated 01/15/2013

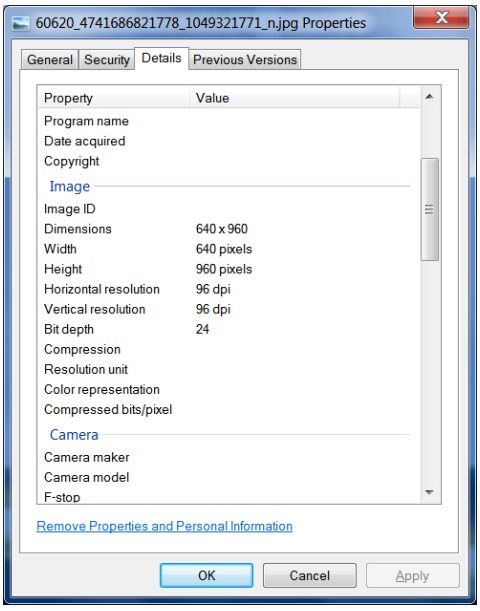
Resolution and Megapixels

Image resolution describes the detail an image holds. The higher the resolution, the higher the detail in the image.

Camera and monitor manufacturers commonly express the image resolution in a couple of different ways:

- Number of pixels along the horizontal side of the image sensor or monitor, multiplied by the number of pixels along the vertical side. My camera's sensor is 5616 x 3745 pixels, or 21.3 Megapixels. My monitor's native resolution is 1920 x 1080 pixels, or about 2.07 Megapixels. This specifies both the pixel count of the sensor / display panel, as well as the aspect ratio.
- Megapixel Count. This is the number of photosites on the image sensor, typically measured in millions of pixels, or Megapixels. This specifies the count of pixels, but not the aspect ratio of the sensor.

To see the resolution of an image, right-click the image and choose "Properties," then select the Details tab.



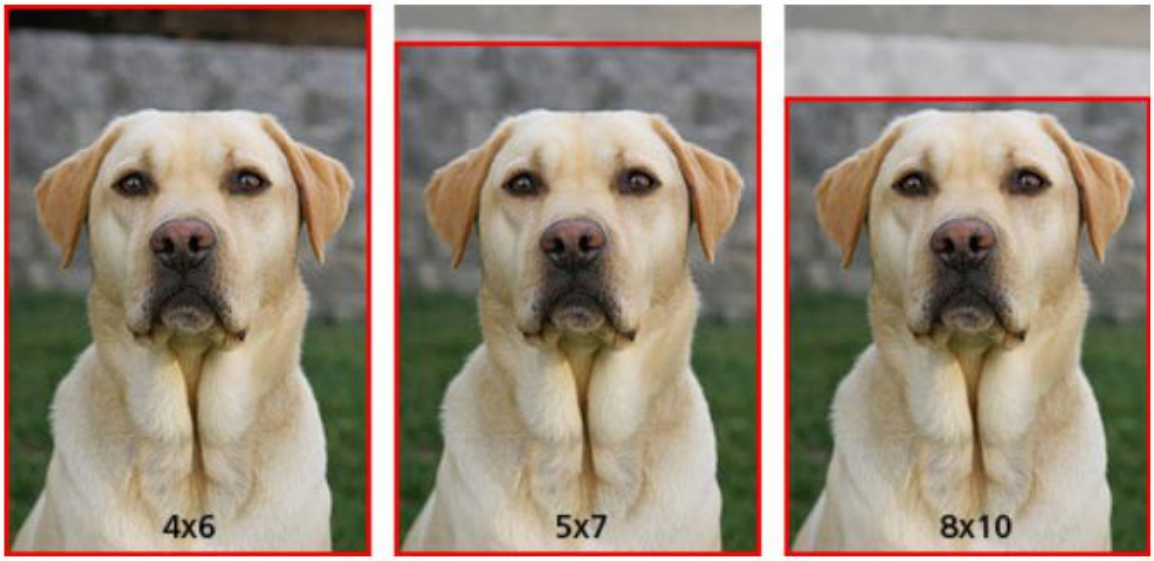
Because the size of the image is usually larger than can be displayed on a monitor, when editing in Photoshop, it helps to zoom in to full size (one monitor pixel represents one pixel in the output image) to see the actual effect the edits you're making have on the image.

Aspect Ratio

The aspect ratio is the ratio of the width to the height (or vice versa). This determines the "shape" of the image. To calculate the aspect ratio of an image, take the length of the long side of the image and divide it by the length of the short side of the image. This works for inches or for the number of pixels in that length.

Regardless of their sensor size or Megapixel count, DSLR cameras have an aspect ratio of 3:2. Older CRT monitors had an aspect ratio of 4:3. Widescreen monitors typically have an aspect ratio of 16:9 or 16:10. HDTV has an aspect ratio of 16:9. 4x6, 8x12, 12x18, 20x30 and 24x36 prints all have an aspect ratio of 3:2, and it is possible to make prints from DSLR images in these sizes without cropping. 4x5 and 8x10 and 11x14 prints have an aspect ratio of 5:4, and 5x7 prints have an aspect ratio of 7:5, which means it will always be necessary to crop DSLR images to print them in these sizes.

To avoid black-barring and disproportionate stretching of the image, the image should be cropped to an aspect ratio which matches the aspect ratio of the print or monitor. This can be easily done in Photoshop (we saw how to do it in a previous lesson).



Spatial Resolution (DPI / PPI)

DPI, or Dots Per Inch, is a unit of spatial resolution commonly used to measure printer resolution. PPI, or Pixels Per Inch, is a unit of spatial resolution commonly used to measure camera and monitor resolution. It tells us how large each dot or pixel is. If there are 300 dots per inch, then each dot is 1/300" in size. A 55" HD television (1920 x 1080) has a spatial resolution of 53dpi, but a 20" HD monitor of the same resolution has a spatial resolution of 160dpi.

To calculate the PPI / DPI required for a quality print or viewing experience on a monitor, divide 3438 by the viewing distance. A 4x6 print viewed at 11" should have a DPI of 312 or higher. A bulletin board might only need a 10-20 dpi image.

Lenses also have a maximum spatial resolution, measured in Lines Per MilliMeter (LPMM). The size and resolution of the sensor in your camera determine the resolution of the lens needed. Smaller sensors and sensors with higher pixel count require better lenses with higher spatial resolution than larger and lower pixel count sensor cameras require.

Image Size

The resolution specifies how many pixels the image contains, and the aspect ratio determines the shape of the image. If we add information about the spatial resolution, we can determine the physical size of the image. If an image is 8" x 12" in size, and has a resolution of 2400 x 3600 pixels, it has a spatial resolution (DPI) of 300DPI.

Viewing Distance

An appropriate viewing distance for prints is about 1.5 times the diagonal of the print. A 4x6" print has a diagonal of 7.21", so an appropriate viewing distance is about 11".

Examples

Here's a table that summarizes the info above for standard print sizes:

Print Size	Diagonal	Viewing Distance	PPI Required	Resolution Required
4 x 6	7.21"	11"	313	1252 x 1878
5 x 7	8.60"	13"	264	1320 x 1848
8 x 10	12.81"	19"	181	1448 x 1810
8 x 12	14.42"	22"	156	1248 x 1872
11 x 14	17.80"	27"	127	1397 x 1778
16 x 20	25.61"	38"	90	1440 x 1800
16 x 24	28.84"	43"	80	1280 x 1920
20 x 30	36.06"	54"	64	1280 x 1920
24 x 36	43.20"	64"	53	1272 x 1908
40 x 60	72.11"	108"	32	1280 x 1920

From the data, we can conclude:

- When it comes to obtaining quality prints, it's a combination of resolution and viewing distance that matters, not the DPI.
- High DPI is only really important in smaller prints. This means it's a good idea to print your smaller prints at a Pro lab that uses higher resolution technology.
- The required resolution is close to the same, regardless of the size of print being made.

Example 1

What is the maximum camera resolution required to make a print in any size available? We see that the maximum horizontal resolution required is 1920 pixels, and the maximum vertical resolution is 1448 pixels. So the maximum size camera required is 2.76 Megapixels – if the print is viewed from an appropriate viewing distance. The only time that more Megapixels is better is if the print is to be viewed more closely than the recommended viewing distance, or if the original image is cropped.

Example 2

We have an image with a resolution of 3600 x 2400 pixels. This also tells us the aspect ratio is 3:2, so without cropping, we can print as a 4x6, 8x12, 12x18, 20x30 or 24x36, all of which also have aspect ratios of 3:2. Since this is larger than the file sizes required for any of the prints listed in the table, we can print it as any size we desire.

Example 3

I found an awesome image on Facebook that I want to print. I don't have the original file, but I was smart enough to show the image full-screen before I saved the pic, so I have a 2048 x 1366 pixel image.

I need to determine how large I can print the image. Again, from the data in the table, that image can be printed in almost any size desired.

Example 4

I took a photo at a wedding. I was in a hurry and didn't properly frame the subject, so I was forced to crop the image. I'm left with an image that's only 2000 x 1340 pixels, but the client loves the image, and wants to make a 60" print (and I'll make a LOT of money on that print). We see from the table above that a 40 x 60 print should be viewed at a distance of at least 9ft, and can be printed with files of the size we have available. Additional pixels would help the image appear sharper when viewed from a distance closer than 9ft, but aren't necessary to get a print that looks great when viewed from the optimal viewing distance.

Example 5

My images are all 3:2 aspect ratio, but the client wants an 8x10 to fit her favorite frame. Again, we have to compromise.

- We can select to crop the image, but that means we lose 16.7% of the image somewhere along the long side.
- We have other options, like white/black-barring the print. This means creating an 8x10 image, with black or white bars at the top and bottom of the image.
- We can use a matt, which means that a much smaller print like a 4x6 or 6x9 is used in conjunction with a matt to fit the size of the frame.
- My preference is to print the image as 8x12, and let the user decide which part of my masterpiece to discard. We can also take that 8x12, add a 2" matt, and

You can purchase replacement viewfinder screens with markings for 8x10 cropping, so that you can create images in-camera which lend themselves to 8x10 cropping. If you shoot a lot of stuff which gets printed as 8x10, like school or sports photos, that might be a good investment.

Example 6

I want to print an image that I know will be viewed at a distance less than the minimum recommended viewing distance. I plan to print an 8 x 12 print at the maximum resolution of the printer, 300 DPI. How closely will I be able to view the image and still have it appear normally?

We see that an image resolution of 2400 x 3600 will be required to print the image. From the table, we see that 300DPI images are best viewed at a distance of 11 inches. This holds even though the print is larger than 4x6, however our print will only be viewable from that distance if the file we submit is at least 3600 x 2400.

Optimal Resolution for Various Media

Printing

Inkjet

Low quality labs such as Walmart, Walgreens and Snapfish use (surprise) low-quality inkjet technology. Snapfish has a minimum image size of 90 pixels per inch. This means that for a 4x6 print, you need to send them at least a 360 x 540 pixel image. Since 90dpi is the effective resolution of their printers, the output images will have a resolution of less than 1/3 that of a light jet printer.

Some photographers use high-quality inkjet printers (the Epson Stylus 4900 is one such printer) to reduce costs and to achieve more control of the final output than is possible with a lab print.

Lightjet Photo Printers

These are the printers used by Pro Photo Labs such as Diversified in St Louis (divlab.com). They use a laser to paint the image onto color print film at very high resolution, then develop the print like a normal photograph. For optimal results, Diversified expects Level 10 compression JPG files at 304.8dpi. This means for a 4x6 image, you need to send them a file that's at least 1200 x 1800 pixels in size, and for an 8x12 image, you need to send them a file that's 2400 x 3600 pixels in size. We intentionally use a larger image than is shown in the resolution table so that the images look great even when viewed more closely than the optimal viewing distance. If you're making large prints (ones that would require a higher pixel count than your camera can provide), pro labs will use software to increase the resolution of the image so that it has enough pixels to print large images at 304.8dpi.

Facebook

Profile Pic

The profile pic is displayed as 160 x 160 pixels, but the uploaded image must be at least 180x180 pixels. It's possible to click the profile pic to see a larger version, so you might want it to be larger than 180 pixels (like 960 or 2048 pixels on the longest dimension).

Wall Photos

The wall photo is displayed as 403 pixels wide, but the uploaded image must be at least 480 x 480 pixels, and 960 pixels wide is ideal.

Photo Viewer

If you click on a wall photo or album, the photo will be opened in Photo Viewer. The image will be displayed with a maximum of 960 pixels on the longest side. The maximum size for Photo Viewer images is 2048 x 2048 pixels. If you attempt to upload a larger image, it will be resized by Facebook. If you save the image while in Photo Viewer, you'll get the 960 x 640 version.

Photo Viewer (Full Screen)

While in Photo Viewer, if you click the Full Screen option, the image will be displayed in the maximum resolution (2048 pixels on the longest side). If you save the image at this point, you'll get the 2048 x 1366 pixel image. With this size image, it is possible to make decent looking prints of ANY size, so watermarking images posted in full-resolution is a good idea.

Cover Image

The cover image is displayed behind the Profile pic, at the top of the timeline. It is 851 x 315 pixels in size. The profile pic partially overlaps the cover image – be careful not to cover up anything important.

Web

It is much easier to control the quality of your photo products as prints than it is when they're presented on the web. The problem is that because we don't know what device the user is going to use to display our image, we don't know what size image is required. Older CRT monitors had the ability to display spatial resolutions of 72dpi (ish), and the typical resolution was 1024 x 768 pixels. Modern (cheap) LCD displays are capable of displaying a resolution of 1920x1080, with spatial resolutions of around 100-160dpi. Notice how close this is to the optimal resolution for prints of any size? Newer devices such as iPhone, iPad, and MacBook Pro, have displays with extremely high spatial resolutions of 260-326dpi (called Retina displays), which Apple claims is high enough that the human eye isn't capable of resolving individual pixels at a typical viewing distance.

So how large should the image be, for typical web viewing? Our goal is to maximize the experience of the viewer on the other end. We need to balance the quality of the image we display vs the time it takes to download. Since we also don't know the speed of the end-user's Internet connection, we are forced to make at least three guesses. My approach is to show the user an image which is at most 800 – 1000 pixels wide (so that even users with older monitors won't have to scroll), and which is at most 300k in size, to allow for reasonably quick downloads. I also want to have enough spatial resolution (DPI) so that the image doesn't appear pixelated. Testing on my monitor reveals that I can see pixels at a resolution of less than 125DPI. So I want to limit the amount of the screen the image is displayed on, so that it has a Spatial Resolution which is around 150 DPI. I also give the user the ability to click the image to see a full-resolution image.

Modern website design allows the web server to determine the specs of the device on the other end (including mobile devices), so that it can tailor the image specifically to fit on the monitor on the other end, and at a spatial resolution specified by the web author.