

Resolution and Stuff Like That

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Resolution Of The Eye

- Resolution is a measure of the ability to discern fine details.
- Optical instruments, including the eye, “see” fine detail in angle space.
- The human eye’s resolution limit is 1 arc minute (1/60 of a degree) (1 part in 3000)
- That limit applies to the case of infinite contrast.

Pixel Density in a Photograph

- To apply this to a photograph, we must specify a viewing distance to convert the angle to a distance. We will use 10 inches for maximum acuity.
- The distance between two white dots on a black photograph must be greater than $10/3000$ inches to be resolved by the eye. This corresponds to 300 pixels per inch.

What Pixel Density Should I Use?

- Tom Peterson uses 150 ppi.
- Photoshop suggests 180 or 220 ppi.
- The “rule of thumb” states: 200 ppi for prints, 72 ppi for the Internet.
- Many experts suggest 300 ppi.
- The variety persists because there is no reason to prefer any of the above!

The Cost of Image Files

- A 1 TB auxiliary hard drive costs \$100
- One dollar will buy 10 GB
- The JPEG file from a 10 megapixel digital camera is about 5 MB
- You can store 2,000 pictures for \$1
- Moore's Law is still in effect. In 18 months you will be able to store 4,000 pictures for 1\$.

Digital Cameras, Computers and Monitors Do Not “See” Pixel Density.

- The cameras, etc. “see” a file with a number of pixels. There are no length measures.
- The file in Photoshop has no length measures.
- The display on the monitor is sized to fit the screen, regardless of the number of pixels in the file.

Monitors

- The pixel density on a monitor is fixed when manufactured.
- High-end monitors are 1080p. They have 1080 rows of 1920 pixels each.
- If the image file being displayed has other than 1920 pixels per line, the monitor (video card) converts it to that number.

Printers

- Printer nozzles are fixed at manufacture; 1200 per inch for HP, 1440 for Epson.
- If the pixel density is other than 1200 ppi, the printer will convert it to that value.
- The printer's nozzle density is high enough that it will not degrade the image.

35mm Slide Scanners

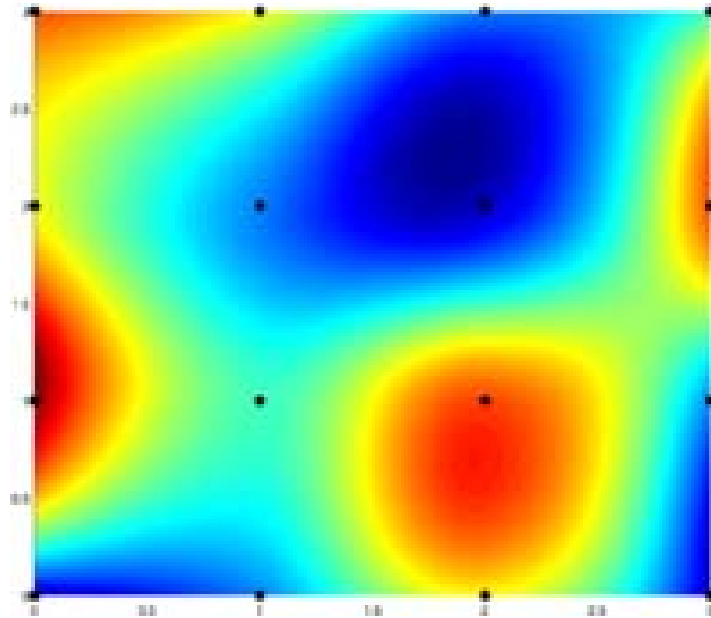
- My Nikon Coolscan 5000 35mm slide scanner has a fixed sensor density of 4000 pixels per inch.
- It is designed to extract all of the information in the slide.
- This produces a file that is 5800 X 3800 pixels.
- Saved as a JPEG, that's a 5 MB file.

Flat Bed Scanners

- My flat bed scanner (HP Officejet 8500) has an optical resolution (sensor density) of 4500 ppi.
- I scan my prints at 400 ppi, so I can crop and enlarge without going below 150 ppi.
- The scanner sends image size data to the computer.

Up Sampling/Down Sampling

- In addition to the video card and the printer, Photoshop does pixel number conversions.
- Most use a bi-cubic spline to interpolate from the original number to the new number.



Sizing A Picture For The Web

- Size the picture for the intended use.
- For screen viewing at 1080p, the image should be 1920 X 1080 (2 megapixels) or better.
- For printing an 8X10 @160 ppi (2 megapixels), the picture should be 1600 X 1280.
- A 2 megapixel image (JPEG about 1 MB) will download in 10 seconds with DSL. Cable is twice as fast.

File Types And File Sizes

File Types

- Bitmap (.bmp)
- Photoshop (.psd)
- Tagged Image (.tif)
- Raw (.raw)
- JPEG (.jpg)
- Graphic Image (.gif)
- Portable Network Graphic (.png)

Bitmap, Photoshop and TIFF

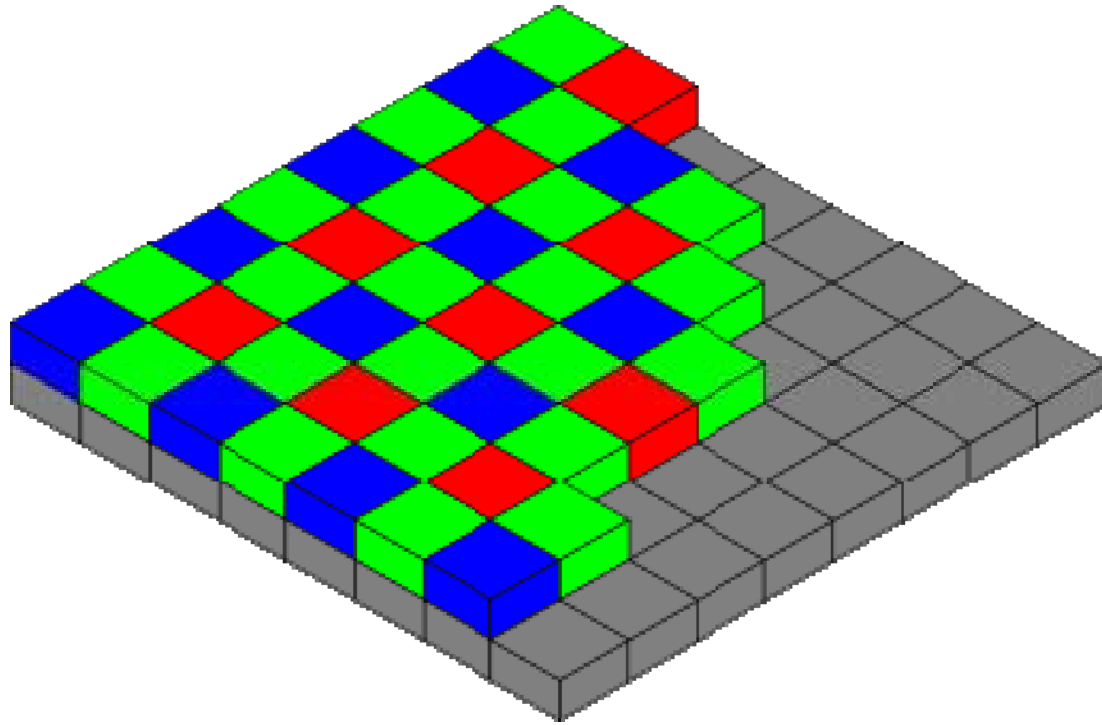
- Bitmap is a pixel by pixel description of each pixel in the image. A better name might be “pixel map”. Bitmaps are 3 Bytes per pixel.
- Photoshop is a bitmap file, with extra features to accommodate layers, history, etc. Photoshop files are 3+ Bytes per pixel.
- TIFF is a bitmap file, packaged more efficiently. TIFF files are ~ 2 Bytes per pixel.
- All three are “lossless”.

RAW

- Raw is the “raw” image in a digital camera, before the camera does any processing.
- It allows Photoshop to substitute for the camera’s processor.
- A RAW file is 1 Byte per pixel. (Color has not yet been computed.)

Mosaic and De-mosaic

- Most digital cameras use a Bayer mosaic to compute color.



JPEG

- The JPEG process divides the picture into 8 X 8 pixel squares.
- It analyzes the array in terms of luminance and chrominance. (Brightness and color)
- The eye is not sensitive to small changes in color, so most of that information is discarded.
- It uses run-length coding. The quality factor determines when a new run is required.
- Compressions of 10 to 1 do not degrade appearance.
- JPEG files are about 0.5 Bytes per pixel.

GIF and PNG

- GIF is an old format developed by CompuServe. It used 4 bits of color.
- It is still used in Sunday Comics.
- Recently someone noticed that it uses a patented compression algorithm.
- PNG was developed to avoid legal problems.
- It is not used in normal image files.

Considerations In Scanning Large Quantities Of Old Slides And Prints

Plan Ahead

- Think about your ultimate use, and select pictures that fit. Get rid of the majority of your pictures.
- Name your files so that a stranger can identify the people. Proper names, left to right.
- Make notes about the scene, the location, the occasion, the people, etc.; and tie the notes to the picture. (Organizer> Date View> Window> Properties> Notes)

Scanning 35 mm Slides

- Use a high resolution scanner – 4,000 ppi
- This extracts all of the information in the slide.
- The 20 Megapixel file JPEGs to 5 MB. (I use Quality 10)
- The scanner will also scan 35 mm negative strips.

Post Processing Slides

- Crop
- Adjust brightness and contrast, using Levels.
(Editor> Enhance> Adjust Lighting> Levels)
- If the color appears “off”, remove a color cast.
(Editor> Enhance> Adjust Color> Remove Color Cast)
- Clean up dirt and scratches. Spot Healing Tool for small blemishes; Clone Stamp for larger.
- Save to file, naming the people.
- Add a note.

Scanning Photographic Prints

- Use a flat bed scanner
- I scan at 400 ppi
- A 3 X 3 Polaroid is 1200 X 1200
- That JPEGs to 450 KB
- Post-processing is the same as a slide.