Mitigating Artifacts of JPG Compression in Digital Images

Far too often, people use a high compression setting on their digital cameras and flatbed scanners or in the software they use to make images smaller (in size) so they can either store more images on their memory cards or so they can download or email their images faster. Unfortunately, what far too many people don't realize is that JPG (also known as JPEG, which is short for "Joint Photographic Experts Group") compression discards real pixel values. Depending upon the level of JPG compression used, the images can be damaged significantly and the details within the image can lost and the image can become noticeably "blocky" as well as can appear pixilated.

Most JPG compression algorithms are consider to be "lossy" because actual details within the image can be lost. JPG algorithms that lose less detail are "less lossy." Today there are some algorithms that are considered to be "lossless" meaning that no details are lost in the compression process, but color values can be changed within the image, which can affect the image enhancement process.

Lossless compression allows the exact original data to be reconstructed from the compressed data whereas lossy compression only allows replacement of the missing data using the sampled data values saved in the compression process.

Lossless compression is used in many applications, such as email or ZIP files or other applications where deviations from the original source data could be catastrophic, such as executable computer program files, text documents, spreadsheets, etc.

In digital imaging, JPG-LS or JPG 2000 algorithms provide near-lossless compression. JPG 200 and JPG XR are argued to be provided a lossless compression method. The bad news is that JPG-LS, JPG 2000 and JPG XR are not used by camera manufacturers, who have developed their own proprietary compression algorithms. These algorithms are said to be optimized for the quantization of data unique to the imaging sensor in the specific camera. These algorithms also include an automatic noise reduction process as well as an automatic sharpening process.

The picture below was captured using a 10 megapixel (MP) digital camera and the image was compressed using the highest quality image setting, which has the least amount of compression. When stored on the memory card in the camera or when saved on the computer, the size of the file on disk is 3,645,440 bytes or 3.47 megabytes (MB). When the file is decompressed and displayed on the screen, the image size is 28.6 MB.

When the image is zoomed out (reduced) so the entire picture can be displayed on a computer screen. On a 27 inch monitor with a screen resolution of 1920 pixels by 1200 pixels, the image, which contains 3648 pixels wide by 2736 pixels high, is resampled to 38.5% or approximately a ratio of 2.6 pixels values resampled to provide 1 pixel on the display. The image detail has also been further resampled by inserting the image onto this page, where the width and height of the image is 6.51 inches by 4.87 inches, which is significantly less than half the size that it was displayed on a 27 inch monitor. When displayed on the 27 inch monitor, the image measures 15 inches wide by 11.25 inches high.

And, of course, there is also a significant resampling of pixel values when the image is printed, but we're not going to talk about that here because of all of the variables involved in that process, such what type of printer is used (i.e., ink jet printer, laser printer, or dye sublimation printer), what type of paper is used (i.e.,

plain, matte finish, luster, glossy, etc.), what are the technical specifications of the printer (i.e., 1.5, 2.0, 3.5, 4.0, 6.0 or 9.0 picoliter droplets or toner), so on and so forth. In other words, the printing process can hide a significant number of flaws in poor quality, low resolution jpg images … and there are a lot of people "banking" on the fact that you can't easily see the loss of detail when the image is printed. Unfortunate for them, the loss can be enormously apparent when the image is viewed on a computer monitor.

I know that all of these numbers of pixels, percentages, inches and droplet sizes sound painful and may provide more than enough stimulation required for the onset of a migraine headache, so let's just simply suffice it to say that the loss of detail may not be noticeable when the entire image is printed or reduced for display on a monitor, but it can (will be) significantly noticeable when the image is zoomed (enlarged), especially during image processing, analysis and comparison.

In the event that you would need to zoom in on the image to conduct analysis of the details in the image, the loss of detail may become significantly noticeable. In fact, it may prevent meaningful analysis of the details within the image and render it useless for analysis. This is particularly true when dealing with images used for forensic analysis.

For example, in the picture above, what do you think the orange, yellow and white blips are in the lower left corner of the image? (There are actually a series of orange, yellow and white blips just to the left and above the tree tops in the lower portion of the image.) Believe it or not, those are actually people who were walking from a parking area off the left side of the picture to the aerial tram. Notice the relative size of the people, when viewed from above – albeit at an angle, compared to the size of the white truck at the road

junction to the right of the blue tarp. And, depending upon whether you are reading this in a printed form or if you are reading it in an electronic form on a computer monitor, you may or may not even be able to see all of the people blips.

JPG Artifacts

Most, if not all JPG algorithms are based on a standard 8 pixel by 8 pixel block in which a Fourier-related transform is used. Depending upon the frequency components of the values in that block, several types of artifacts can appear including, but not limited to:

- Ringing (artifacts caused when there are sharp transitions within the block, which is particularly visible around text in pictures)

- Posterizing (artifacts caused when portions of the original image with a gradual transition are replaced by abrupt changes in shading and gradation from one area of tone to another)

- Staircase noise (aliasing) along curving edges

- Blockiness (also called checkerboarding)

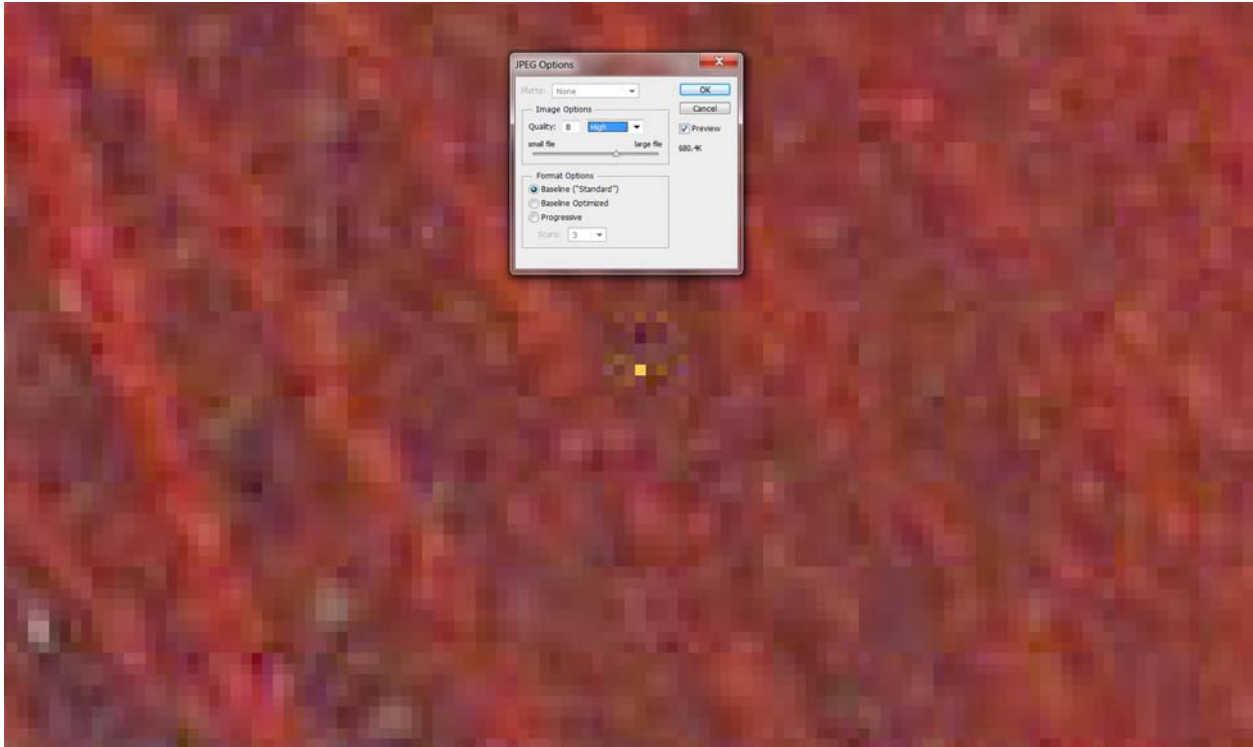All of these artifacts appear in the image below.
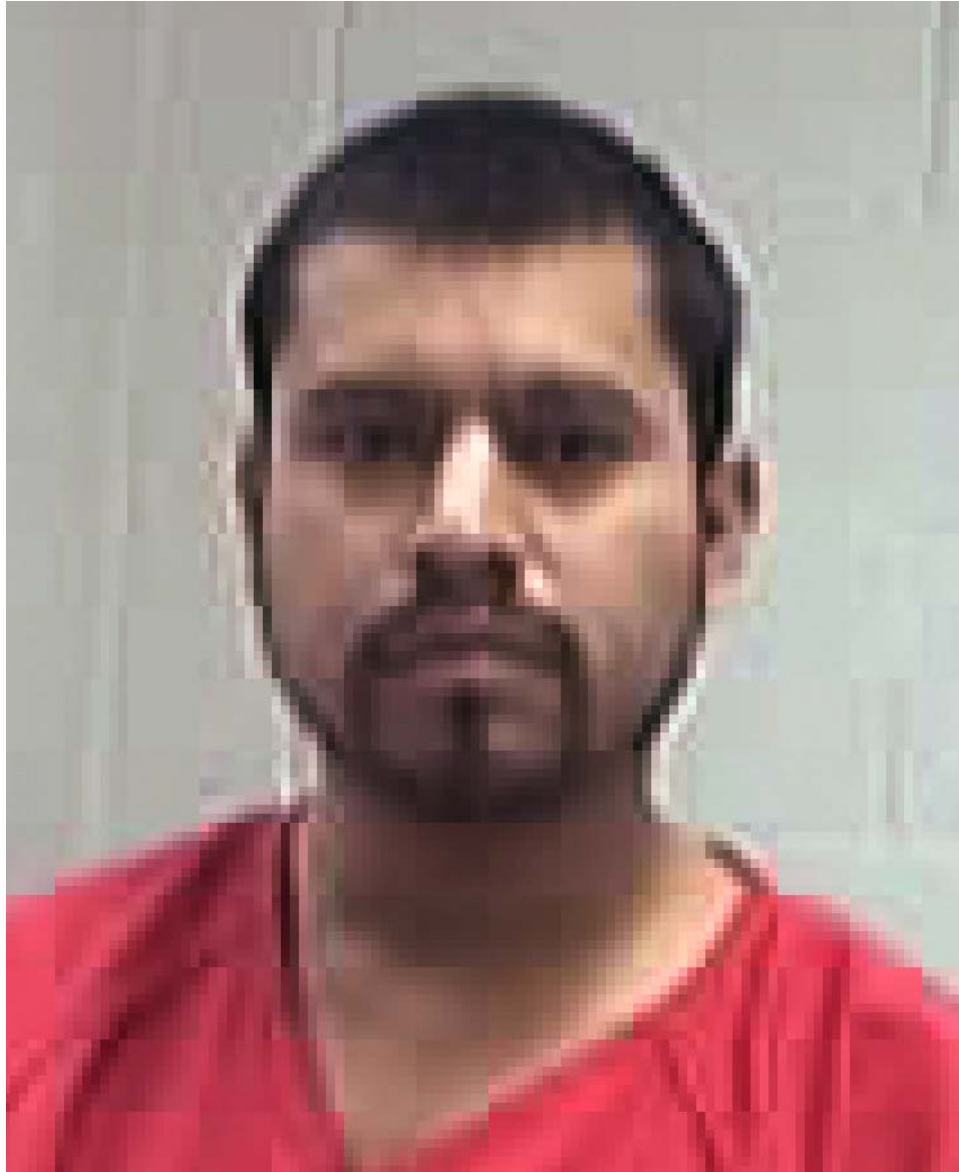
The following images illustrate the damage done to a latent fingerprint with a single yellow pixel in the image.

The original image:

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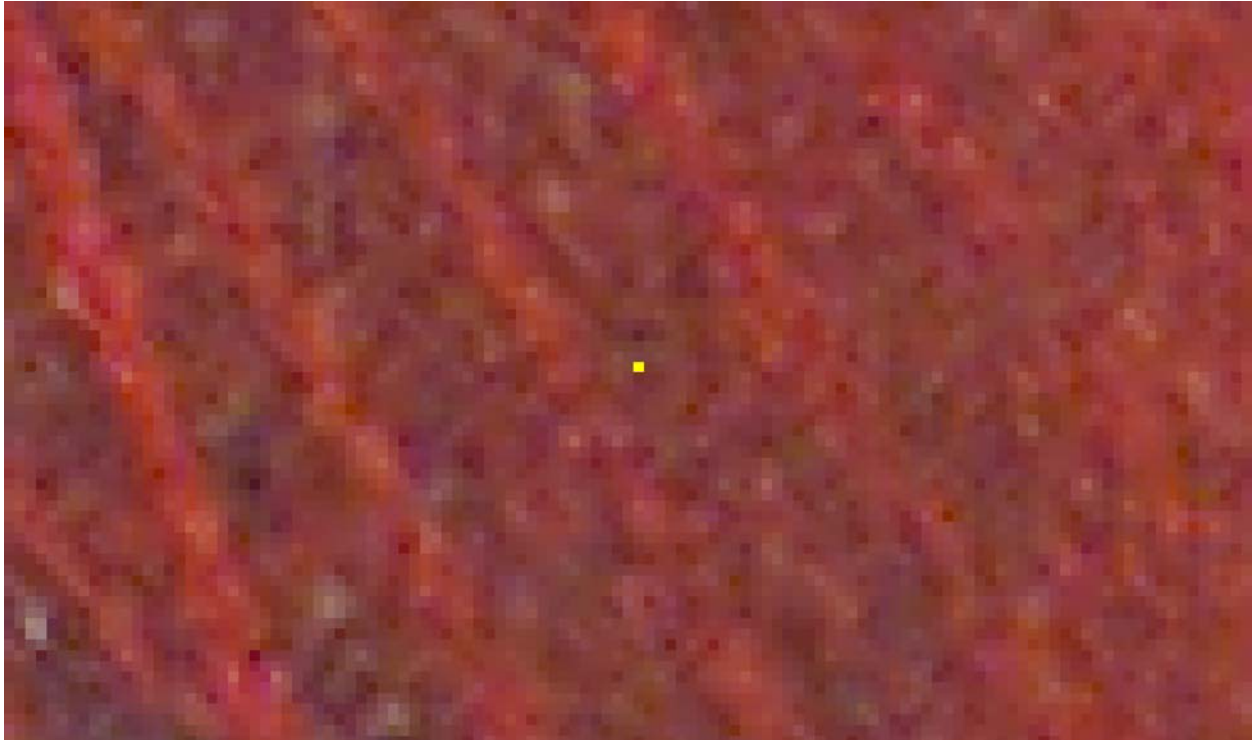
The image compressed using a "High" image quality setting. The posterizing artifacts as well as the "checkerboarding" artifacts are becoming more visible.

The image compressed using a "Medium" image quality setting. The yellow pixel is no longer visible (posterizing and ringing) and the checkerboarding artifacts are becoming significantly more visible.
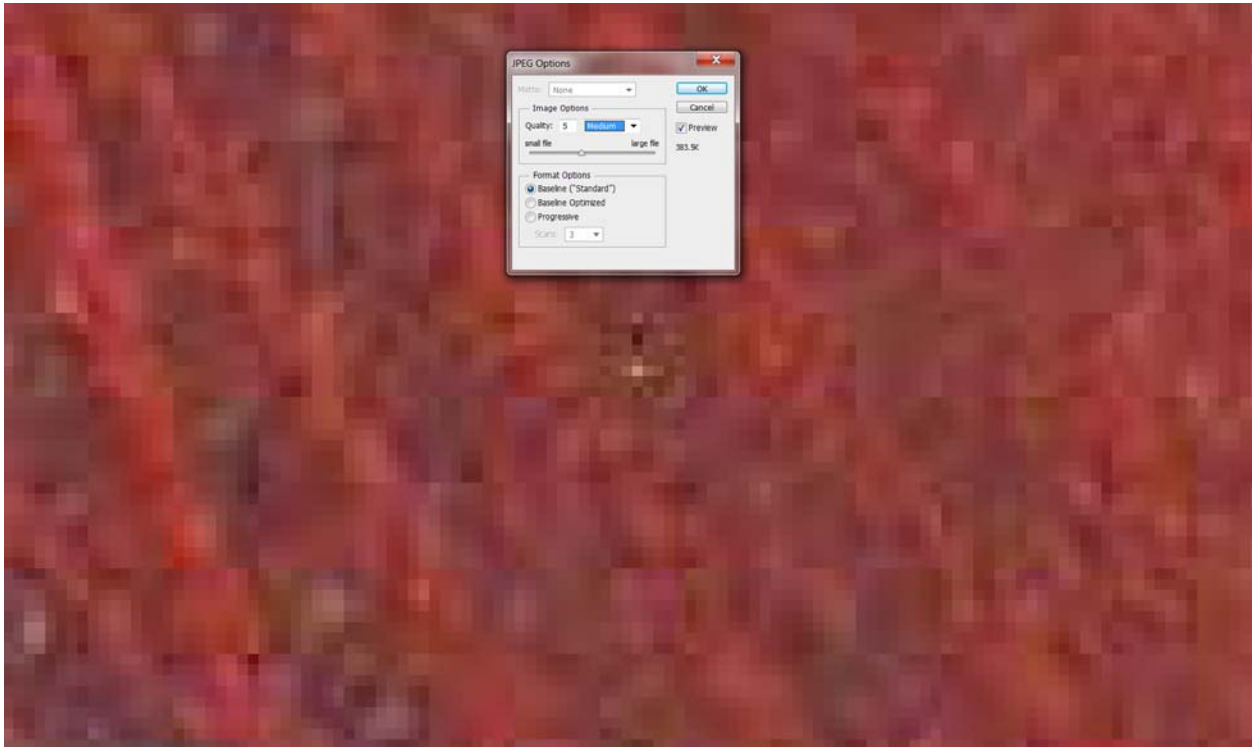
The image compressed using a "Low" image quality setting. The yellow pixel is no longer visible at all, nor is there even a reference where the yellow pixel existed, and the checkerboarding artifacts have become impossible to ignore. Plus the loss of image detail is definitely noticeable.
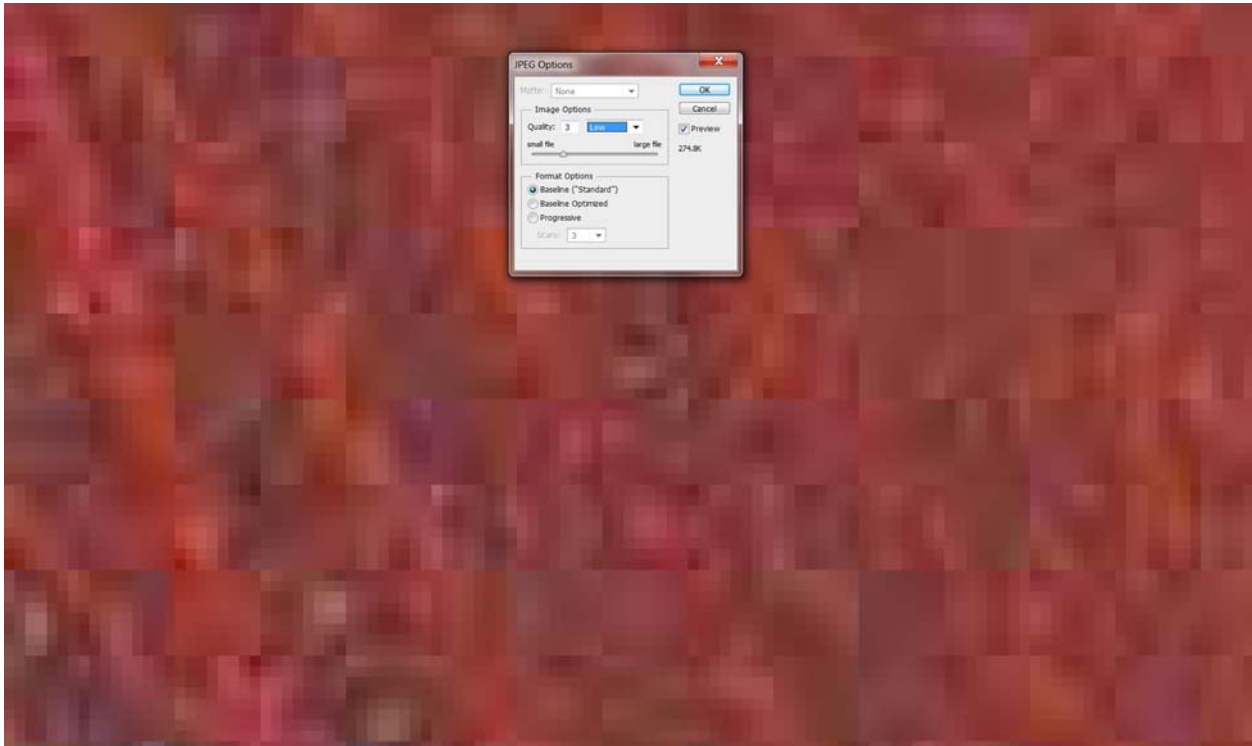
Argumentatively, some people will still use a compressed image for latent print, footwear, tire tread or Questioned Document analysis because they can still see enough detail when the image is zoomed out (and visible detail within the image is reduced) even though there are portions of the image that are unusable and certain characteristics within the image cannot be determined. (Is it an ending ridge or is it a bifurcation? Only the original image detail knows.) Admittedly in some "simple" (non-complex) images, you may be able to get by using a high-quality JPG image.

Artifact Reduction

Over the years, various techniques and processes have been suggested to reduce the effects of image compression so that people (in our case the law enforcement agencies) retain the benefits of compression (such as lower transmission requirements and reduced storage costs). To date, there has been no "post-processing" technique that has been demonstrated to improve image quality in all images. As a result, none of the techniques or processes has gained wide acceptance in law enforcement, particularly in the forensic science community.

The following image illustrates a latent print that was developed on a check using ninhydrin processing. The image was scanned using a flatbed scanner at 1200 pixels per inch (PPI) and then was saved using a JPG format with a "medium" image quality setting and a Baseline ("Standard") format option. Due to the artifacts created in this image, it was impossible to successfully remove all of the background noise and clearly visualize all of the ridge detail in the image.

Unfortunately, the damage to the image was not discovered until a suspect was named. Once the damage to the image was discovered, they tried to rescan the original evidence. However, the fingerprint detail developed by the ninhydrin process had faded to the point that rescanning was no longer an option.
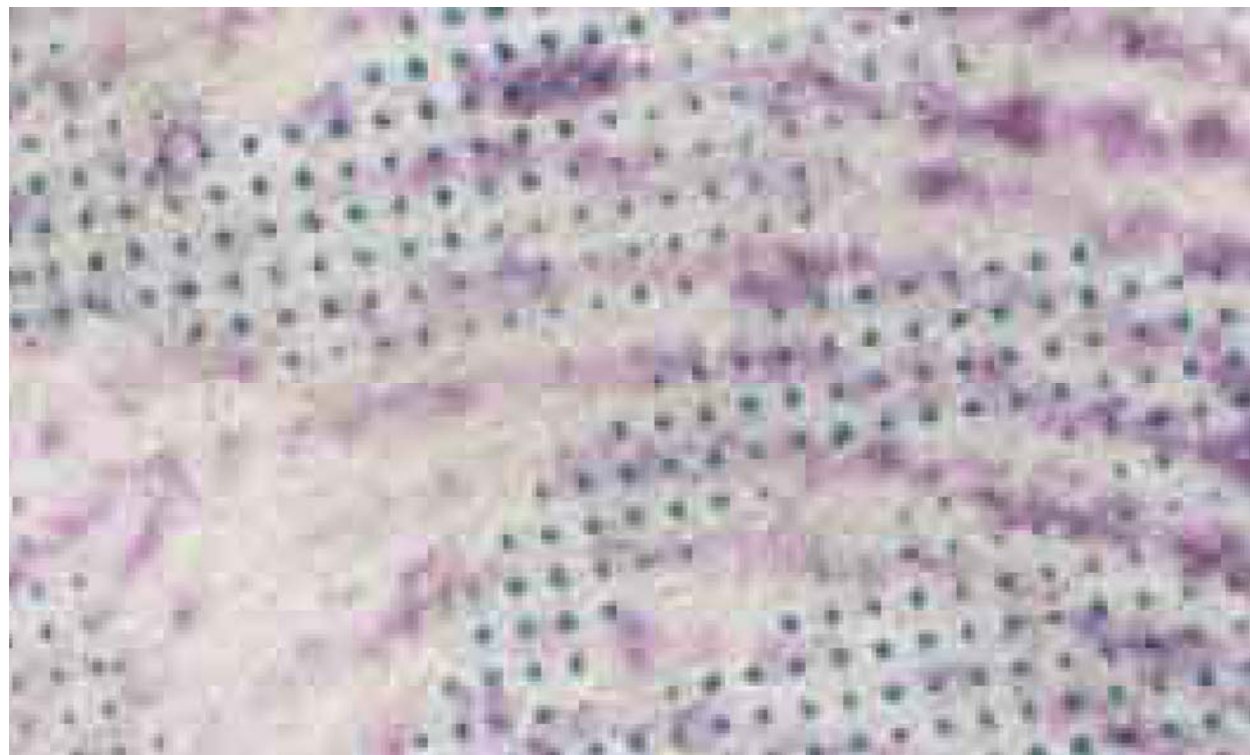
The bottom line is that digital images that are to be used for analysis and comparison should be stored using a lossless file format, such as a TIF (Tagged Image File) format.

Commonly Used JPG Artifact Reduction

While it is impossible to repair the damage done to the image during the compression process, you can – at least – make the damage appear less distracting and make the image appear more like a regular picture. And, as stated above, there have been a number of techniques and processes that have been suggested to reduce the effects of image compression. One technique that is commonly used to mitigate some of damage caused by JPG compression is described below.

But before we begin describing the technique, let's show you the before and after images of a low resolution JPG image that has been processed.

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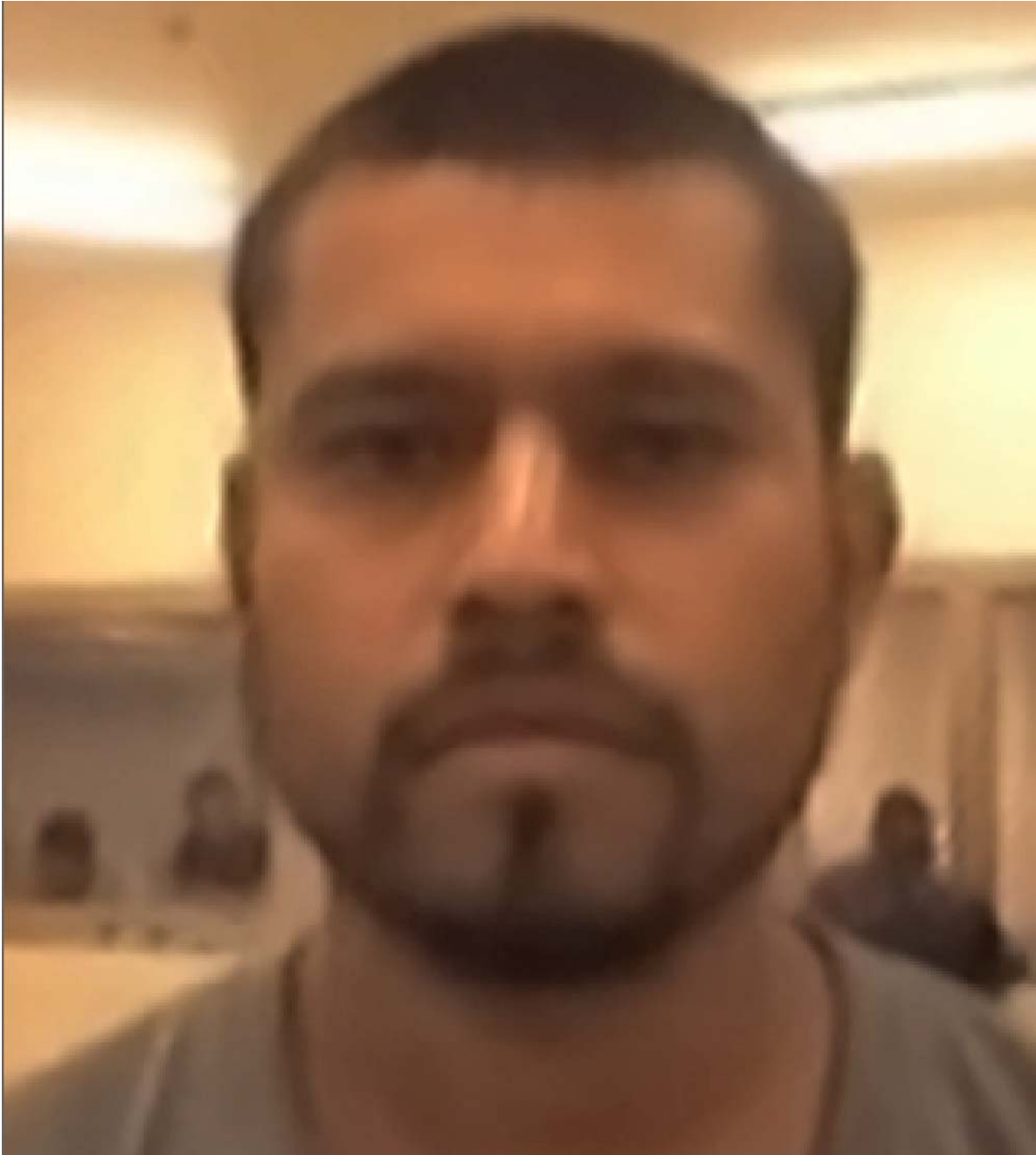
1. Using Adobe Photoshop CS4, CS5 or CS6, open the image file.

2. Zoom in on the image (press and hold the Control key and press the plus (+) key several times to zoom into the image) so that you can observe the adjustments carefully – and in detail – as you make them.

3. From the Filter menu, choose Noise and then select Reduce Noise …. (The Reduce Noise function is used to eliminate random color pixel values that do not appear to be part of the image detail.) The Reduce Noise dialog box will be displayed as shown below.
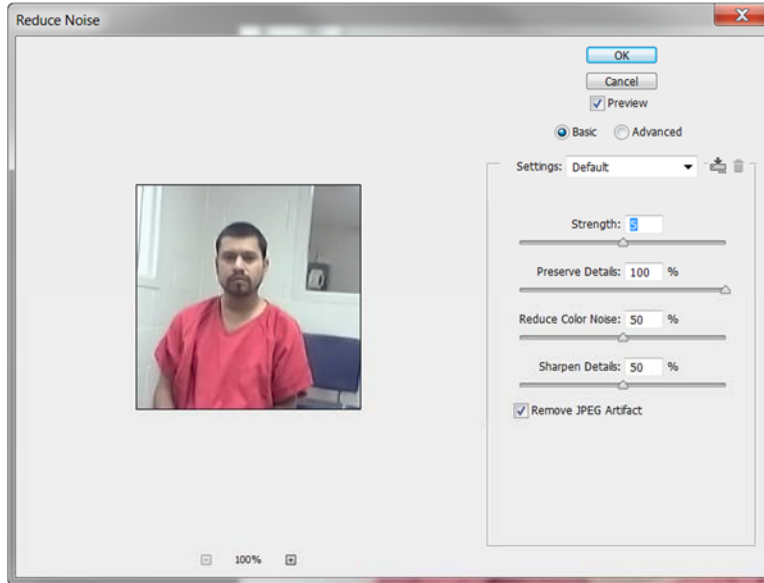
4. Using the "Basic" options (a dot appears in the circle immediately to the left of the word Basic below and slightly to the left of the OK and Cancel buttons):

   a. Set Strength (the amount of luminance or to be applied to the color channels) to 5 (Medium)

   b. Preserve Details should be set to 100% -- or adjust the Strength and Preserve Details settings to fine tune the amount of noise reduction.

   c. Set the Reduce Color Noise option to approximately 50% -- this value adjusts how many "random" color pixels are removed, where a high value removes more color noise.

   d. Sharpen Details should be set to approximately 50% … or you can use Unsharp Mask or Smart Sharpen to provide clarity within the image.

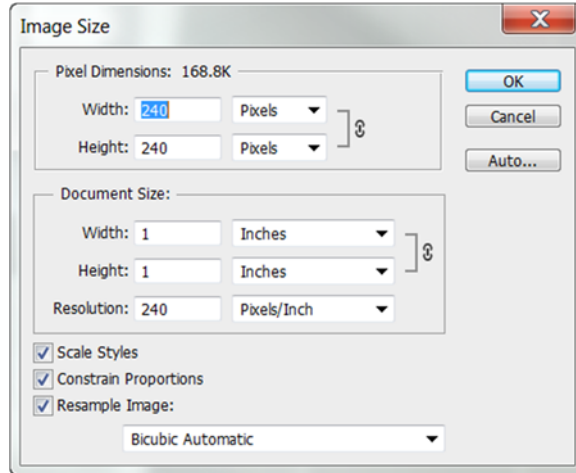   e. Ensure that a checkmark appears in the checkbox to the left of the Remove JPEG Artifact option.

   NOTE: Depending upon the color values of image it may be necessary to select the Advanced Option, where you can adjust the amount of luminance (noise reduction) for a select channel as shown below. When using the Advanced option, I recommend that Strength be set to 4, 5, or 6. The Preserve Details option will typically be somewhere between 10% and 25%. And depending upon the colors within the image, it may be necessary to adjust these values for one, two or all three color channels (Red, Green and Blue).
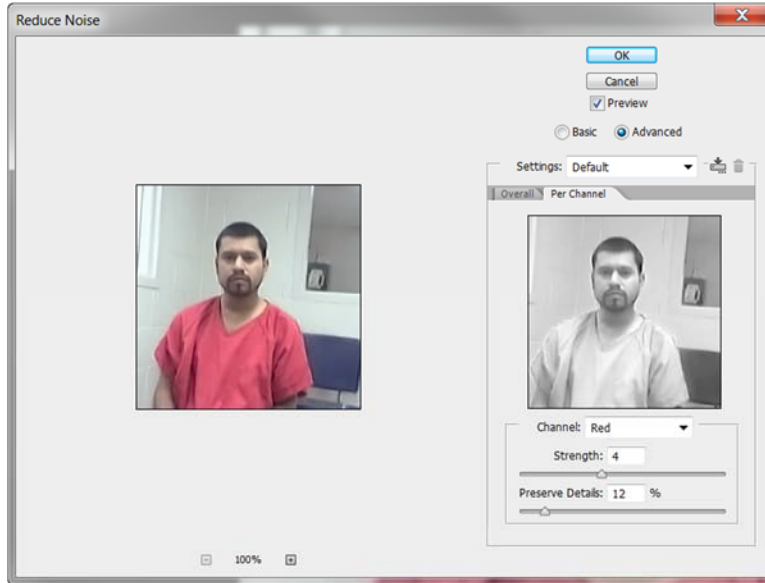
f. Click the OK button in the upper right corner of the Reduce Noise dialog box to close the dialog box and apply the changes to the image.

5. From the Filter menu, choose Noise and then select Dust and Scratches …. (The Dust and Scratches function is used to blur the aliasing and ringing artifacts by eliminate random pixel values that do not appear to be part of the image detail.) The Dust & Scratches dialog box will appear on your screen.

   a. The Radius should be set to 1 Pixel and the Threshold can range between 0 and 10, where 0 is the most commonly used value.)
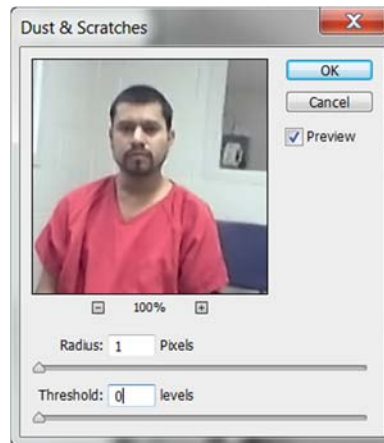
   b. Click the OK button in the upper right corner of the Dust & Scratches dialog box to close the dialog box and apply the changes to the image.

6. From the Image menu, choose Image Size…. (The Image Size function is used to reduce the appearance of pixilation within the image.) The Image Size dialog box will be displayed.

a. First, ensure that a checkmark appears in the option box immediately to the left of both Constrain Proportions and Resample Image checkboxes at the bottom of the window. (It makes no difference whether or not a checkmark is in the checkbox to the left of Scale Styles as there are no styles in an original digital image.)

b. Under the Resample Image option, choose Bicubic Smoother.

c. Adjust the Width or Height setting to the desired output size (the desired size that the image will be when it is printed.)

d. Highlight whatever value appears in Resolution, add 300 to that value, and then type the new value into the Resolution text box. (For example, using the Image Size dialog box shown above, you would highlight the Resolution value 240 and replace it – by typing over it – with the value 540.)

e. Click the OK button in the upper right corner of the Image Size dialog box to close the dialog box and apply the changes to the image.

7. From the Image menu, choose Apply Image…. (The Apply Image function is used to adjust the contrast within the image.) The Apply Image dialog box will be displayed.
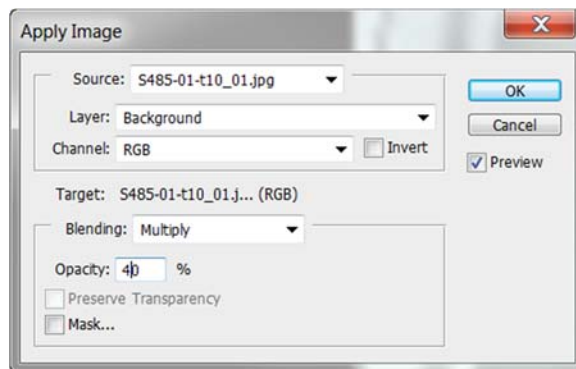

8. Typically, the Blending option of Multiply works the best, and the Opacity should be set to somewhere between 25 and 50, depending upon the contrast within the image.

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9. OPTIONAL: Rotate the image as necessary or appropriate. The recommended technique for rotating an image (such as a mug shot), is to select the Ruler Tool from the Toolbox as shown below.
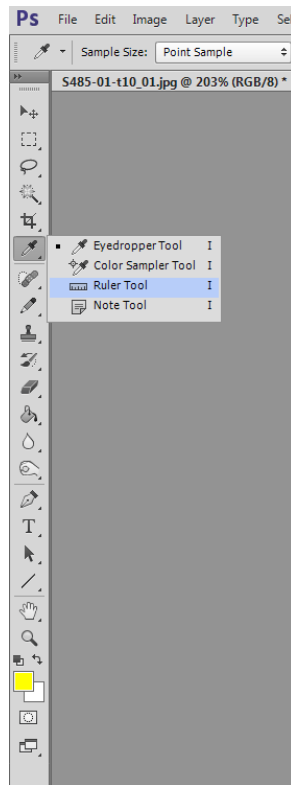
a. Then move the cursor onto the image and position the cursor over the pupil of the left eye, then click and hold the left mouse button and move the cursor over the pupil of the right eye, and then release the mouse button. A line will appear connecting the two pupils (center of pupil to center of pupil).

b. From the Image menu, choose Image Rotation, and then select Arbitrary…. The Rotate Canvas dialog box will appear on the screen, and the Angle will be filled automatically using the angle of the line created using the Ruler Tool.
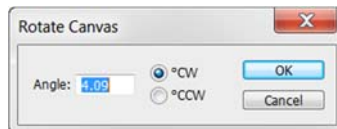
c. Click OK to rotate the image so that the face (and body) appears to have the appropriate (portrait style) orientation.

10. OPTIONAL: Select the Crop tool and crop the image, as appropriate, to eliminate any unnecessary background (i.e., so that the picture contains just the face, neck and shoulder area).

Below are the before and after images. As you can see, there is a significant improvement in the visualization of the image once the distracting compression artifacts are minimized.

Once again, I would like to remind you that this is not an optimal solution as having a high-resolution, high-quality image will always provide the best picture. However, the still images produced as a result of the video image capture process are often low resolution (such as 720 pixels x 576 pixels, where the overscanned pictures are reduced to 480 pixels high, or 680 pixels x 550 pixels, where the overscanned pictures are reduced to 450 pixels high. In addition, these images are then compressed by the software when the image frames are saves from the video stream. The bottom line is that most video images suffer from low-resolution capture as well as degradation from compression to store video streams for an extended time on the memory device.

The goal is produce an image that appears more realistic and life-like without the distortion – and distraction – caused by the compression process. This is particularly true with facial images obtained from video cameras, etc.

While this process does not provide an optimum solution for images that will be used for analysis and comparison, it "may" provide sufficient clarity to identify a possible suspect or eliminate a possible suspect using level 1 detail (fingerprint pattern) and level 2 detail (ending ridge and bifurcation characteristics). Level 3 (pores, creases, incipient ridges, etc.) may be distorted beyond the point where that level of detail will most likely not be clear enough for purposes of identification.