Disclosure of Application No. 08/411,369 (Ex. 1016)	**Disclosure of US Patent No. 5,850,484 (Ex. 1007)**
"Text and Image Sharpening of JPEG Compressed Images in the Frequency Domain." Ex. 1016, p. 4, lines 5–6.	"Text and Image Sharpening of JPEG Compressed Images in the Frequency Domain." Ex. 1007, at Title.
"Figure 1 shows a block diagram of a typical implementation of the JPEG compression standard. The block diagram will be referred to as a compression engine. The compression engine 10 operates on source image data, which represents a source image in a given color space such as CIELAB. The source image data has a certain resolution, which is determined by how the image was captured. Each individual datum of the source image data represents an image pixel. The pixel further has a depth which is determined by the number of bits used to represent the image pixel. The source image data is typically formatted as a raster stream of data. The compression technique, however, requires the data to be represented in blocks. These blocks represent a two-dimensional portion of the source image data. The JPEG standard uses 8x8 blocks of data. Therefore, a raster-to-block translation unit 12 translates the raster source image data into 8x8 blocks of source image data. The source image data is also shifted from unsigned integers to signed integers to put them into the proper format for the next stage in the compression process. These 8x8 blocks are then forwarded to a discrete cosine transformer 16 via bus 14.	"FIG. 1 shows a block diagram of a typical implementation of the JPEG compression standard. The block diagram will be referred to as a compression engine. The compression engine 10 operates on source image data, which represents a source image in a given color space such as CIELAB. The source image data has a certain resolution, which is determined by how the image was captured. Each individual datum of the source image data represents an image pixel. The pixel further has a depth which is determined by the number of bits used to represent the image pixel. The source image data is typically formatted as a raster stream of data. The compression technique, however, requires the data to be represented in blocks. These blocks represent a two-dimensional portion of the source image data. The JPEG standard uses 8x8 blocks of data. Therefore, a raster-to-block translation unit 12 translates the raster source image data into 8x8 blocks of source image data. The source image data is also shifted from unsigned integers to signed integers to put them into the proper format for the next stage in the compression process. These 8x8 blocks are then forwarded to a discrete cosine transformer 16 via bus 14.

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The discrete cosine transformer 16 converts the source image data into transformed image data using the discrete cosine transform (DCT). The DCT, as is known in the art of image processing, decomposes the 8x8 block of source image data into 64 DCT elements or coefficients, each of which corresponds to a respective DCT basis vector. These basis vectors are unique 2-dimensional (2D) 'spatial waveforms,' which are the fundamental units in the DCT space. These basis vectors can be intuitively thought to represent unique images, wherein any source image can be decomposed into a weighted sum of these unique images. The discrete cosine transformer uses the forward discrete cosine (FDCT) function as shown below, hence the name. $Y[k,l] = \frac{1}{4} C(k) \bullet C(l) \left[\sum_{x=0}^{7} \sum_{y=0}^{7} S(x,y) \bullet \cos \frac{(2x+1)k\pi}{16} \cos \frac{(2y+1)l\pi}{16} \right]$ where: $C(k), C(l) = 1/\sqrt{2}$ for $k,l = 0$; and $C(k), C(l) = 1$ otherwise The output transformer 16 is an 8x8 block of DCT elements or coefficients, corresponding to the DCT basis vectors. This block of transformed image data is then forwarded to a quantizer 20 over a bus 18. The quantizer 20 quantizes the 64 DCT elements using a 64-element quantization table 24, which must be	The discrete cosine transformer 16 converts the source image data into transformed image data using the discrete cosine transform (DCT). The DCT, as is known in the art of image processing, decomposes the 8x8 block of source image data into 64 DCT elements or coefficients, each of which corresponds to a respective DCT basis vector. These basis vectors are unique 2-dimensional (2D) 'spatial waveforms,' which are the fundamental units in the DCT space. These basis vectors can be intuitively thought to represent unique images, wherein any source image can be 5 decomposed into a weighted sum of these unique images. The discrete cosine transformer uses the forward discrete cosine (FDCT) function as shown below, hence the name. $Y[k,l] = \frac{1}{4} C(k) \cdot C(l) \left[\sum_{x=0}^{7} \sum_{y=0}^{7} S(x,y) \cdot \cos \frac{(2x+1)k\pi}{16} \cos \frac{(2y+1)l\pi}{16} \right]$ where: $C(k), C(l)=1/\sqrt{2}$ for $k,l=0$; and $C(k), C(l)=1$ otherwise The output of the transformer 16 is an 8x8 block of DCT elements or coefficients, corresponding to the DCT basis vectors. This block of transformed image data is then forwarded to a quantizer 20 over a bus 18. The quantizer 20 quantizes the 64 DCT elements using a 64-element quantization table 24, which must be

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specified as an input to the compression engine 10. Each element of the quantization table is an integer value from one to 255, which specifies the stepsize of the quantizer for the corresponding DCT coefficient. The purpose of quantization is to achieve the maximum amount of compression by representing DCT coefficients with no greater precision than is necessary to achieve the desired image quality. Quantization is a many-to-one mapping and, therefore, is fundamentally lossy. As mentioned above, quantization tables have been designed which limit the lossiness to imperceptible aspects of the image so that the reproduced image is not perceptually different from the source image. The quantizer 20 performs a simple division operation between each DCT coefficient and the corresponding quantization table element. The lossiness occurs because the quantizer 20 disregards any fractional remainder. Thus, the quanitzation function can be represented as shown in Equation 2 below. $Y_Q[k,l] = \text{Integer Round}\left(\frac{Y[k,l]}{Q[k,l]}\right)$ where Y(k,l) represents the (k,l)-th DCT element and Q(k,l) represents the corresponding quantization table element.	specified as an input to the compression engine 10. Each element of the quantization table is an integer value from one to 255, which specifies the stepsize of the quantizer for the corresponding DCT coefficient. The purpose of quantization is to achieve the maximum amount of compression by representing DCT coefficients with no greater precision than is necessary to achieve the desired image quality. Quantization is a many-to-one mapping and, therefore, is fundamentally lossy. As mentioned above, quantization tables have been designed which limit the lossiness to imperceptible aspects of the image so that the reproduced image is not perceptually different from the source image. The quantizer 20 performs a simple division operation between each DCT coefficient and the corresponding quantization table element. The lossiness occurs because the quantizer 20 disregards any fractional remainder. Thus, the quantization function can be represented as shown in Equation 2 below. $Y_Q[k,l] = \text{Integer Round}\left(\frac{Y[k,l]}{Q[k,l]}\right)$ where Y(k,l) represents the (k,l)-th DCT element and Q(k,l) represents the corresponding quantization table element.

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To reconstruct the source image, this step is reversed, with the quantization table element being multiplied by the corresponding quantized DCT coefficient. The inverse quantization step can be represented by the following expression: $Y'[k, l] = Y_Q[k, l]\ Q_E[k, l].$ As should be apparent, the fractional part discarded during the quantization step is not restored. Thus, this information is lost forever. Because of the potential impact on the image quality of the quantization step, considerable effort has gone into designing the quantization tables. These efforts are described further below following a discussion of the final step in the JPEG compression technique." Ex. 1016, at p. 4 , line 32 – p. 7, line 15.	To reconstruct the source image, this step is reversed, with the quantization table element being multiplied by the corresponding quantized DCT coefficient. The inverse quantization step can be represented by the following expression: $Y'[k,l]=Y_Q[k,l]\ Q_E[k,l].$ As should be apparent, the fractional part discarded during the quantization step is not restored. Thus, this information is lost forever. Because of the potential impact on the image quality of the quantization step, considerable effort has gone into designing the quantization tables. These efforts are described further below following a discussion of the final step in the JPEG compression technique." Ex. 1007, at 1:40-2:60.
"These limitations significantly degrade text in color images because sharp edges are very important for reading efficiency." Ex. 1016, p. 10, lines 28-29.	"These limitations significantly degrade text in color images because sharp edges are very important for reading efficiency." Ex. 1007, at 4:44-46.
"Accordingly, the need remains for a computationally efficient method for improving the visual quality of images, and in particular text, in scanned images." Ex. 1016, p. 11, lines 16-18.	"Accordingly, the need remains for a computationally efficient method for improving the visual quality of images, and in particular text, in scanned images." Ex. 1007, at 4:65-67.

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"For edge sharpening in the frequency domain, the full image is first transformed into the frequency domain using the Fast Fourier Transform (FFT) or the Discrete Fourier Transform (DFT), low frequency components are dropped, and then the image is transformed back into the time domain." Ex. 1016, p. 11, lines 9–14.	"For edge sharpening in the frequency domain, the full image is first transformed into the frequency domain using the Fast Fourier Transform (FFT) or the Discrete Fourier Transform (DFT), low frequency components are dropped, and then the image is transformed back into the time domain." Ex. 1007, at 4:56–61.
"In general, compression and decompression are performed in conformance with the JPEG standard." Ex. 1016, p. 11, lines 24–25.	"In general, compression and decompression are performed in conformance with the JPEG standard." Ex. 1007, 5:5–7.
"By using the scaling matrix S, the high-frequency components of the DCT elements can be 'enhanced' without any additional computational requirements." Ex. 1016, p. 12, lines 9–11.	"By using the scaling matrix S, the high-frequency components of the DCT elements can be 'enhanced' without any additional computational requirements." Ex. 1007, 5:20–22.
"The scanned image, although it can be any image, in the preferred embodiment is a printed version of the reference image. Thus, the variance of the scanned image represents the energy or frequency composition of the reference image but which is compromised by the inherent limitations of the scanner. The scaling matrix, therefore, boosts the frequency components that are compromised by the scanning process. A preferred embodiment of the invention is described herein in the context of a color facsimile (fax) machine. The color fax machine includes a scanner for rendering a color image into color source image data that represents the color image, a	"The scanned image, although it can be any image, in the preferred embodiment is a printed version of the reference image. Thus, the variance of the scanned image represents the energy or frequency composition of the reference image but which is compromised by the inherent limitations of the scanner. The scaling matrix, therefore, boosts the frequency components that are compromised by the scanning process. A preferred embodiment of the invention is described herein in the context of a color facsimile (fax) machine. The color fax machine includes a scanner for rendering a color image into color source image data that represents the color image, a

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