

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AMAZON.COM, INC., AMAZON.COM SERVICES LLC,

Petitioners,

v.

NOKIA TECHNOLOGIES OY,

Patent Owner.

Case No. IPR2024-00921

U.S. Patent 8,077,991

Declaration of Charles D. Creusere

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I, Charles D. Creusere declare as follows:

1. My name is Charles D. Creusere. I am a Full Professor in the Klipsch School of Electrical & Computer Engineering at New Mexico State University. I have prepared this declaration as an expert witness retained by Amazon.com, Inc. and Amazon.com Services LLC. In this declaration, I give my opinions as to whether certain claims of U.S. Patent No. 8,077,991 (“the ’991 patent”) are invalid and provide technical bases for these opinions as appropriate.

2. This declaration contains statements of my opinions formed to date and the bases and reasons for those opinions. I may offer additional opinions based on further review of materials in this case, including opinions and/or testimony of other expert witnesses. I make this declaration based upon my own personal knowledge and, if called upon to testify, would testify competently to the matters contained herein.

I. Overview of the Technology

A. Video Codecs

3. Video encoders and decoders (together, “codecs”) are built upon technologies dating back several decades. Research in digital image and video coding goes back at least to the 1970s (*see, e.g.*, Ex-1004, [56] (citing a 1977 academic publication)), when the invention of the integrated circuit began making previously unimaginable levels of computational power widely available that could facilitate digital image processing. Digitization of video involved sampling, e.g.,

measuring the color and brightness of, regularly spaced points across the space occupied by a video frame (an image). Displaying all of these point samples in the same relative positions in space, called pixels (short for picture element), would show the image, similar to the way that a picture in a magazine is printed using many small dots. However, there was a problem in saving the raw information “spatially,” i.e. as sampled for each position in the image: the data rates far surpassed the storage and communication systems of the day. Thus, a need for video compression was born. *See* Ex-1005, ¶¶0003-0004.

4. The fundamental goal of all image and video compression algorithms was and is to compress input data as much as possible while preserving a sufficient level of perceptual quality in the displayed images or video. *See, e.g.,* Ex-1004, 1:8-14; Ex-1006, ¶¶0005, ¶0019, ¶0014. Such compression, going back to the 1980s, typically involves: (1) omitting information about pixels that can otherwise be deduced and (2) omitting information that will make little to no difference to what the viewer perceives.

5. Over the years, various approaches have been proposed and were known in 2007 for still image compression, including “predicting” parts of an image based on other parts for which you already have the information available (e.g., figuring out if a pixel is part of an object and what color it should be from the other pixels that make up the object), using mathematical equations to “transform”

the pixel values into a more concise representation (e.g., defining the area of the object with a few equations), and “quantizing” information, whether spatial or transformed, to reduce the precision (e.g., reducing the number of shades into fewer representative colors), as opposed to directly saving the sampled information for each pixel in its location in space. This includes spatial predictive compression, adopted in, e.g., the JPEG-LS lossless image compression standard, and transform coding, adopted in, e.g., the JPEG standard, which uses discrete cosine transform (DCT), and the JPEG-2000 standard. These approaches have been adapted to compress video, leading to approaches combining prediction with transform coding and quantization of sampled pixels (e.g., Ex-1004; Ex-1006; Ex-1005).

6. Such approaches—often called hybrid DPCM¹-transform coding or just hybrid video coding—now dominate the video coding field. The idea, as originally proposed by Jain,² was to exploit temporal redundancy in a video (i.e., image sequence) using a predictive coder (e.g., by predicting the value of a pixel in a given video frame based on values of pixels in preceding or subsequent frames), and spatial redundancy in individual video frames using DCT-based transform

¹ DPCM stands for differential pulse code modulation. The idea of storing a sample or value as the differential over another one was first patented by Bell Telephone Laboratories (AT&T) in the 1950s. *See* U.S. Patent No. 2,605,361.

² Jain & Jain, “Displacement Measurement and Its Application in Interframe Image Coding”, IEEE Trans. On Communications, Vol. COM-29, No. 9, Dec. 1981

coders (e.g., by transforming the spatial relationship among a large number of pixels such that it can be represented using a few mathematical (cosine) functions) instead of transmitting all the individual pixels. Ex-1004, 2:3-21 (summarizing Jain). Jain proposed analyzing the motion in the video to find “displacement vectors” (or “motion vectors”) and using them to shift around pixel blocks in the previously-transmitted frame to form a prediction for the current frame. Because the prediction is essentially a sophisticated guess, the prediction of the frame is subtracted from the actual data representing the current frame to form a prediction error —“residual” values of the original image that were not reflected in the prediction. Ex-1005, ¶0121. Because it is calculated by simple subtraction for each pixel, simply adding the residual pixel values to the prediction results in the correct image. In addition, the prediction error is then DCT transformed and quantized to reduce its size.

7. The different coded parts, e.g., motion vectors, transform coefficients, and other information, are then each encoded with a lossless compression algorithm, usually referred to as entropy coding; packaged together; stored or transmitted for viewing.

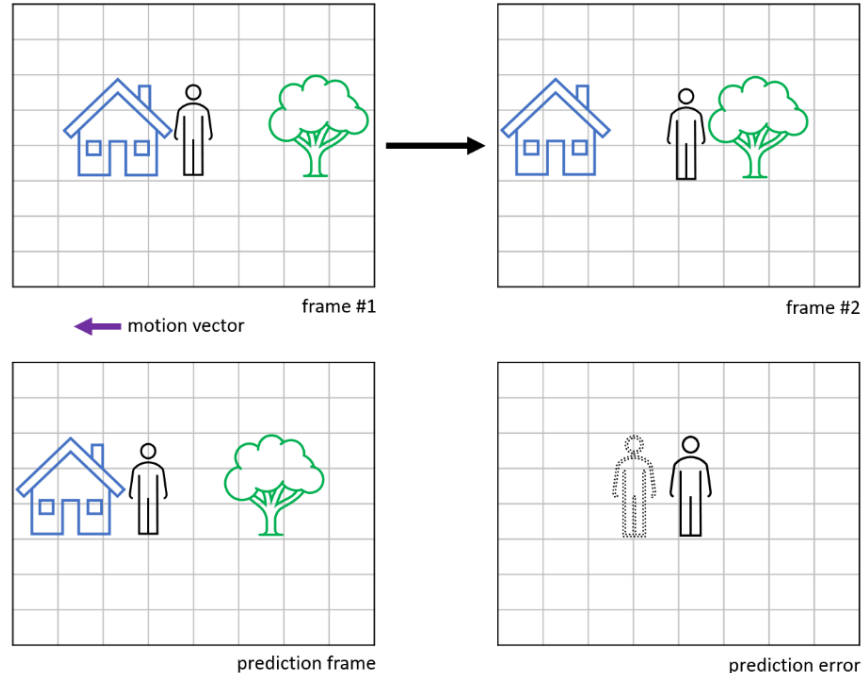
8. The hybrid DPCM-transform paradigm is central to every major video compression algorithm standardized by April 2007, including MPEG-1, MPEG-2, ATSC, H.261, H.263, H.264 (MPEG4/AVC); as well their subsequent versions

and newly adopted standards, e.g., H.265 (HEVC). *See, e.g.*, Ex-1006, ¶0002. A myriad of patents and research publications are directed to or discuss hybrid video coding. *E.g.*, Ex-1004, 2:8-9; Ex-1006, ¶0005, ¶0009; Ex-1005, Figs. 3-4. The standards define supportive techniques and data formats, such as transmitting various “side information” (e.g., as a flag) to provide to the decoder information does not directly encode the image (such as motion vectors, various profiles, encoding modes, quantization parameters, or optional settings). *See, e.g.*, Ex-1005, ¶0062, ¶0070; Ex-1006, Tables 2-3 (showing H.264/AVC syntax: “slice_header,” “Macroblock_layer,” “residual_block_cabac”).

B. Predictive Coding

9. Predictive coding is motivated by the fact that it is unnecessary to transmit or store any information the decoder can predict based on data it has already received. The most common approach is for the encoder to contain a captive decoder whose output is synchronized with the output of the remote decoder and feed this output into a “predictor” to predict the next sample. To adjust for errors in prediction, the resulting prediction is subtracted from the current input sample to create a prediction error signal. By applying the same principle used in AT&T’s DPCM patent (*see supra* n.1), the original sample is then reproduced at the remote decoder by adding the prediction error signal to the predicted sample. Below is a diagram illustrating the relationship between the

predicted image based on the motion vector and the error compared to the actual frame #2. The two images in the top row visualize consecutive frames, the previous frame #1 and the current frame #2. A camera panning across the scene to the right would send the whole scene to the left, as indicated by the purple arrow showing the predicted motion. The image to the bottom left shows the predicted frame based on the motion vector indicated with a purple arrow. However, as seen in the actual frame #2, the person in the middle has walked to the right while the rest of the scene has shifted left due to the camera's panning. The bottom right image shows the difference (the prediction error), between the predicted frame and the original image in frame #2.



Assuming that the frame consists of 8×8 pixels and that the walking person covers only 6 pixels in the block, 52 of the pixels in the prediction error will be near zero

(because the motion was accurately predicted). On the other hand, 12 pixels will have large values (because 6 pixels for the person are missing at the predicted location shown as a dotted figure, and 6 pixels must be added for the person at the actual location shown in bold) as seen in the bottom right image.

10. Such predictive coding is applied (combined with a transform) to perform intra-frame coding in modern video standards like H.264, H.265, and WMV8. Ex-1005, ¶¶0005-0006. Intra-frame coding is typically carried out directly on pixel values in the spatial domain—that is, the values correspond to samples organized to correspond to spatial locations. *See, e.g.*, Ex-1005, Figs. 1-2. Alternatively, such coding can be applied to the same information, but after the information has been, e.g., DCT transformed. *E.g.*, Ex-1005, ¶¶0007-0012, Fig. 1. When using predictive coding for motion-compensated video compression (for *inter*-frame coding where temporal redundancy is exploited), a motion estimation algorithm analyzes the movement of pixel blocks in the current video frame (*e.g.*, Ex-1005, ¶¶0013-0014) and attempts to motion-compensate a previously transmitted and reconstructed frame to match up as closely as possible with the current frame to form the predicted frame. The predicted frame is then subtracted from the current frame to form the prediction error (a.k.a. prediction residual or residual error). Ex-1005, ¶0014, ¶¶0018-0020; Ex-1006, ¶0002.

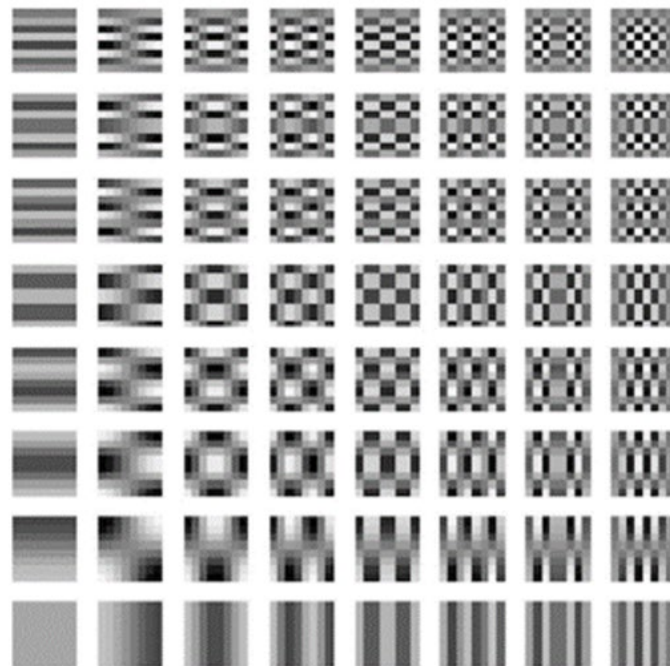
11. The prediction error signal usually contains some spatial redundancy, so it is then typically orthogonally transformed (Ex-1005, ¶0015; Ex-1006, ¶0026) into corresponding values that allow the spatial redundancy to be more easily removed. Employing orthogonal transforms reduces computational redundancy and make it easy to identify coefficients and corresponding basis functions.

C. Transform Coding

12. Hybrid coding typically includes transform coding, which applies a mathematical operation to input data blocks to represent the data in a “transformed” space. *E.g.*, Ex-1006, ¶¶0002-0004 (referring to transformed space as “frequency domain”); Ex-1005, ¶0072 (“frequency domain (i.e., spectral data”). To illustrate how this works, if a number of samples are distributed along a diagonal line, the orthogonal transform would rotate the coordinate axes so that all of those samples are now on (or very close to) one of the new axes. This has the effect of compacting most of the signal energy for multiple sample values into a single transform coefficient (i.e., the one corresponding to the axis aligned with the samples) such that the transform coefficients corresponding to the other coordinate axis can be set to zero without significantly affecting the accuracy of the inverse transformed samples. The transformed data in the transformed space is called “transform coefficients,” and the process is invertible so the decoder can convert

transform coefficients back into the original data space, e.g., a two-dimensional image surface (a.k.a. the spatial domain).

13. For the DCT, the transform coefficients are labeled as “DC” (direct current) or “AC” (alternating current) where the single DC coefficient contains the mean value of the sample block that was transformed while each of the AC coefficients quantify wave patterns of increasing frequency. Ex-1012, 000006 (Fig. 2, DCT basis functions):



The data input to the encoder are samples for spatial locations, i.e. pixels, and thus, the data output by the decoder must also be spatial samples. Associated with each transform coefficient are basis functions (basis vectors); specifically, the transform coefficient’s value determines how much of its associated basis function is “mixed in” to (i.e., weights) the decoder’s reconstruction of the spatial samples. See Ex-

1012, 000008 (“[T]he components of the DCT output indicate the magnitude of image components at various 2D spatial frequencies.”). Similar to DCT, the coefficients of a Hadamard transform weight the basis vectors (called Walsh functions)—one difference being that the basis functions are square waves rather than sinusoidal waves.

14. Orthogonal transforms are often preferred in compression applications because they are energy-preserving. The DCT is a common orthogonal transform, as are the discrete Fourier/Haar/Hadamard/discrete wavelet transforms (the DCT has been used for JPEG, MPEG-1/2/4, H.261, H.262, H.263, H.264/AVC, and H.265/HEVC). The DCT’s popularity in compression applications is largely because its ability to concentrate a data block’s energy from a large number of correlated pixel samples into as few transform coefficients as possible, allowing most coefficients corresponding to a pixel block to be set to zero without adversely affecting decoded image quality. Because many coefficients are zeroed out, fewer bits are required to transmit the set, resulting in a higher compression ratio. Ex-1006, ¶0009 (“[T]he coding gain for the frequency domain is mainly based on the phenomenon that the low frequency components have larger magnitudes, and most of the high frequency coefficients are zero....”).

15. A DCT processes $M \times M$ sized blocks with an identically-sized $M \times M$ DCT matrix, which results in an identically sized $M \times M$ matrix of coefficients.

See, e.g., Ex-1012, 000005-9. Typical block sizes used in video coding were square blocks of 4×4 or 8×8 pixels, resulting in equivalently sized sets of transform coefficients. Ex-1014, ¶0004; Ex-1012, 000005-12; Ex-1005, ¶0015, ¶0007, Fig. 1.

16. The DCT performs poorly when the energy is already compacted, i.e., the non-zero samples are distributed across a small number of pixels. Ex-1006, ¶0002; Ex-1004, 2:3-37. Applying DCT here has the opposite effect: it spreads the energy out amongst more coefficients, which requires more bits to code. This happens, e.g., when motion compensated prediction is very good over most of the block but very bad for a few spatial samples. It was known to encode the small number of non-zero samples of the prediction error as-is, in the spatial domain. Ex-1006, ¶¶0002-0005. This can be considered “spatial coding” (e.g. coding in the spatial domain) although this use of the term is different from the conventional use of the term as I mention. *Supra* §I.B, *infra* ¶27, §V.B.

17. After DCT transformation, the energy contained in those large spatial values (e.g., outliers) will be spread amongst a large number of lower amplitude transform coefficients. If encoding of the transform coefficients is bit-constrained, as it often is for video compression algorithms requiring a constant or average bitrate, some of the transform coefficients will end up being discarded, causing a

noticeable deterioration in the quality of the spatial pixels reconstructed by the decoder.

D. Filtering Outliers

18. Statistical techniques were commonly employed in video encoding to increase the performance of the coding process. *E.g.*, Ex-1016, 2:35-60 (“Filtering of motion regions is carried out using local statistics...”); Ex-1006, ¶¶0040 (discussing the use of statistics to generate probability models for arithmetic coding), ¶¶0006-0007 (discussing the use of Lagrange functions, a statistical tool, to calculate rate distortion costs). One such technique (known as “Winsorization” in statistics) involved having samples “which are regarded as excessively outlying [to be] moved to a prefixed position near the central observations.” Ex-1019, 000009-000010. Applied to video/image compression, the approach was to replace spatial samples that statistically deviated significantly from other samples in the block with approximate values in line with neighboring samples, *e.g.* by taking the average value of a neighboring set of pixels. The mean, median, and mode are the three ways to compute a statistical average (a statistical summary or representative value of a set of values that measures the central tendency of the set). Ex-1020, 000004-000006. Commonly employed in video applications was calculating the median or mean value of neighboring pixels within a window. *E.g.*, Ex-1005, ¶¶0120-0125; Ex-1016, 7:12-32. For example, extreme values of a pixel in the

center of the window could be replaced with the median or mean of the 8-9 pixels immediately surrounding that pixel (a 3×3 pixel window), or adjacent pixel values could be interpolated to calculate an approximated intermediate value. In either case, the outlying value would be replaced with similar values to those in its vicinity, increasing the compressibility of the sample set. Median filtering used the median average and was popular (e.g., Ex-1016, 2:35-60) for image processing purposes because it performs well in reducing isolated extreme values (e.g., salt and pepper noise), while preserving image features such as edges. Ex-1005, ¶0122. Moving average filtering was another well-known technique, that replaced the outlier values with the mean average of the pixels in a window. *See, e.g.*, Ex-1016, 7:12-32. Other methods to adjust sample values to increase “subsequent compression of the residuals [(prediction error)] using Discrete Cosine Transform” were also known in the art. *E.g.*, Ex-1017, 000004, 000010-000011.

E. Quantization

19. Quantization is a lossy-compression method that intentionally introduces noise or distortion into the data in a controlled manner by selectively removing bits. For example, if the original data samples had values ranging from 0 to 255, those data samples could be represented in the computer using 8-bits/sample. If one wanted to quantize these samples to 4-bits each, one could do so by dividing each sample by 16 and then rounding to the nearest integer.

Consider an input sample in this scenario with a value of 61. Quantized to 4-bits, the quantized sample value would become 4. To reverse the quantization step, the decoder would multiply the quantized sample value received from the encoder by whatever integer had been divided out (in this example, 16). Therefore, the 61 that was originally input to the encoder's quantizer will be reconstructed by the decoder's dequantizer as $16 \times 4 = 64$. The 50% reduction in size comes at a small price—obviously, a small level of error has been introduced; the reconstructed value is off by 3 from the original input of 61. The relationship between quantization bin size (a.k.a. step size) and the decoder's reconstruction accuracy is also affected by the dynamic range of the sample data. For example, even when quantized down to 4 bits, data originally sampled at 8 bits/sample would result in a bin size of 16, while data sampled at 12 bits/sample would result in a bin size of 256.

20. Clearly, the bin size (or, equivalently, the compressed bit rate) and the dynamic range of the input samples jointly determine the quality of the decoder's reconstructed samples after dequantization. Within the context of image and video compression, the transform coefficients of a block of spatial pixels will have a considerably different (and generally lower) dynamic range than that of the original pixels. Thus, even if the same bit rate was assigned to identically-sized blocks of transform coefficients and pixels, the bin sizes of these two quantizers

would be different because the same number of bins would have to cover differing dynamic ranges (as illustrated in the example above in the preceding paragraph).

21. Another important feature of a quantizer is its dead zone. The dead zone of a quantizer corresponds to the range of input values that are mapped to an output value of 0. With a bipolar signal represented by 8-bits (i.e., in the range of $[-127, 127]$), the dead zone using a quantization step size of 16 will be (depending on how the rounding is performed) approximately $[-8, 8]$). For example, input values of -5, 1, -7, 3, etc. would all be quantized to 0. Thus, the dead zone size of a conventional scalar quantizer—the type contemplated here and in the example above (¶19)—is entirely determined by the quantizer step size. By the 2007-2008 timeframe, it was known that superior performance (in terms of the perceptual quality to compression ratio) can often be achieved by making the dead zone larger than it would otherwise be for conventional scalar compression. This is especially true for transform-based image and video compression since large reductions in the bit rate can be achieved if a few more higher-frequency transform coefficients are zeroed out with only a modest impact on the perceived visual quality. Furthermore, spatially adapting the size of the dead zone based on the contents of blocks of image pixels can provide even higher reductions in the compressed bit rate while maintaining the perceptual quality of the image reconstructed by the decoder.

F. Lossless Compression

22. Lossless compression, typically variable-length or other entropy coding, is universally applied to all elements of the video data stream as a final step. In particular, arithmetic coding (e.g., context-adaptive binary arithmetic coding or CABAC in H.264) has been part of virtually every image and video compression algorithm standardized since the year 2000. Ex-1006, ¶¶0002. Other well-known algorithms include Huffman codes, Golomb-Rice codes, Tunstall Codes, dictionary codes (e.g., LZ-77, LZ-78, LZW), and CAVLC (context-adaptive variable-length coding).

G. Implementation of Codecs

23. Video codecs in the 1970-80s were generally implemented using custom circuitry, because central processing units (CPUs) were not yet powerful and graphics processing units (GPUs) had not yet been invented. These custom circuits were, of course, “processors” since they were accepting input data (raw/compressed video) and outputting processed data (compressed/raw video). As processing power grew, more video compression/decompression was being performed using general purpose computers. By the 2007-2008 timeframe, general purpose processors in the form of CPUs—and, to a lesser degree, GPUs—as well as computers built around such processors were being used widely for video/image compression. *E.g.*, Ex-1005, ¶¶0051-0060. Software programs and codec

packages such as Microsoft's Windows Media Video and Apple Quicktime, supported various proprietary and industry standards for video coding/compression and were available and widely used.

24. Regardless, implementing video encoders/decoders on general purpose processors requires that software programs be written, stored, and executed. It was common for general purpose computers to store computer program code on optical and magnetic media and different flavors of ROM were also commonly used for computer code that did not change frequently, while RAM was typically used to store program code being executed/processed.

II. The '991 Patent

A. Overview

25. The '991 patent provides a "system and method for improving prediction error coding performance of various video compression algorithms." Ex-1001, Abstract. The alleged "invention relates to prediction error coding in both frequency and spatial domains." Ex-1001, 1:7-9. The '991 patent does not purport to invent "[t]ypical hybrid video codecs" that encode video information using "motion compensation mechanisms" and "spatial mechanisms," and then "coding the prediction error, i.e. the difference between the predicted block of pixels and the original block of pixels...using a specified transform (e.g., a Discrete Cosine Transform (DCT) or a variant thereof)." Ex-1001, 1:28-48.

Rather, the '991 patent discusses a typical hybrid video “decoder” in its “Background of the Invention” and acknowledges that it was known to apply these admittedly prior art techniques: “[a]fter applying prediction and prediction error decoding processes, the decoder sums up the prediction and prediction error signals (i.e., the pixel values) to form the output video frame.” Ex-1001, 1:49-63.

26. The '991 patent states that transform coding of the prediction error signal may exhibit “suboptimal performance.” Ex-1001, 2:25-38. This is attributed to the fact that known video encoding methods provided “good quality predictions for the image blocks to be coded,” resulting from “minimizing and decorrelating the prediction error signal,” and therefore “the [transform] coding performance deteriorates when the prediction error to be transformed becomes less correlated.” *Id.* (describing typical transform coding).

27. The '991 patent states that “[t]o address some of the above issues, a number of hybrid video coding schemes have been developed” that reduce temporal redundancies using a combination of inter-picture motion prediction and spatial redundancies using intra-picture spatial prediction. Ex-1001, 2:39-54. In the art, these techniques are respectively known as “inter-frame compression”/“motion estimation” and “intra-frame compression”/“spatial coding.” *Supra* §I.B. The '991 patent explains that transform coding is “typically”

applied to a “residual/error signal” following prediction “in order to reduce spatial redundancies.” Ex-1001, 2:39-54.

28. The ’991 patent purports to “improve the compression efficiency of modern video and image codecs” (Ex-1001, 3:35-43) by encoding “the prediction error signal for a single image block...using both transform basis functions and spatial samples (i.e., pixel values), thereby combining the desired features of both the transform and spatial coding approaches discussed previously.” Ex-1001, 2:58-3:12. The ’991 patent highlights that transform coding “can efficiently pack energy of the prediction error signal [] under certain statistics.” Ex-1001, 2:25-38. However, the ’991 patent does not discuss any desirable features of spatial coding in its technical background section (Ex-1001, 1:11-2:54) or elsewhere, apart from the purported advantages provided by its proposed combination of transform and spatial coding (Ex-1001, 3:35-49).

29. The ’991 patent takes these admittedly known techniques and further proposes a “system and method for representing the prediction error signal as a weighted sum of different basis functions of a *selected* transform and quantized spatial samples.” Ex-1001, 2:58-3:12 (emphasis added). This is accomplished by identifying “outlier values” in the prediction error signal (interchangeably referred to as the difference signal), substituting the outlier values with “interpolated representations of those values, e.g., by averaging the neighboring prediction error

values” for transform coding, and applying “spatial coding...(involving quantization and entropy coding without transform) to the difference between the original outlier values and the transform decoded outlier values.” Ex-1001, 5:24-50, Fig. 4 (highlighted):

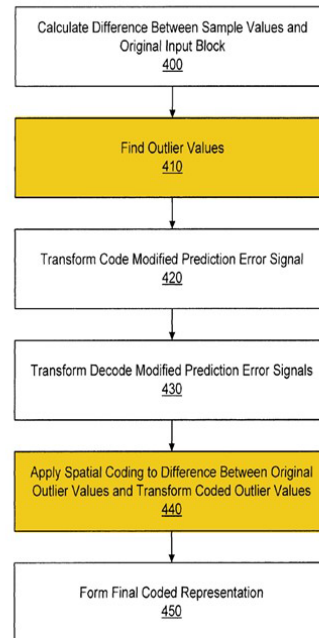


FIG. 4

According to the '991 patent:

This allows for the utilization of those selected transform basis functions that give good overall representation of the image block with minimal amount of transform coefficients (representing the component of prediction error signal that is well correlated with the basis functions). Additionally, various embodiments of the present invention allow for the efficient spatial representation of those components of the prediction

error signal of the same image block that are not well correlated with the basis functions of the applied transform (such as certain types of sensor noise, high frequency texture and edge information).

Ex-1001, 3:2-12.

30. However, as explained above, encoding data, and more specifically, digital video, using a combination of transform functions and spatial coding to improve compression efficiency was already known in the art as was also interpolating or averaging outlier values. *See supra* §§I.A, I.D; *infra* §II.B.2 (admission during prosecution of Canadian counterpart).

B. Prosecution History

1. The '991 Patent

31. The '991 patent issued December 13, 2011 from Application No. 12/101,019 (“the '019 application”). It was allowed after one non-final office action rejecting the claims under 35 U.S.C. §101 as being directed to non-statutory subject matter. Ex-1002, 000154-000155. The office action did not include any rejections based on prior art under 35 U.S.C. §§102 or 103. *See* Ex-1002, 000152-000194.

32. To overcome the §101 rejection, Applicant amended the claims to add trivial features, including requiring that each method step is performed “by a processor” (claims 1, 22, and 39), specifying that computer-readable medium is

“non-transitory” (claims 12 and 30), and adding a transmitting or storing step (claim 1). Ex-1002, 000203-000213.

33. Applicant further amended claim 1 to specify that the “joining” step is “to form a coded prediction error signal,” thus transplanting this limitation from the preamble where it had been recited in the claims as originally filed. Ex-1002, 000204:

1. (Currently Amended) A method ~~of encoding a prediction error signal for a block of data~~, comprising:

calculating, by a processor, a difference signal representing differences between sample values of a predicted block of data and values for an original input block;

performing, by a processor, transform coding to the difference signal, thereby creating a first representation of a first component of the difference signal;

performing, by a processor, spatial coding to the difference signal, thereby creating a second representation of a first component of the difference signal;

joining, by a processor, the first and second representations to form a coded prediction error signal; and

at least one of transmitting or storing the coded prediction error signal.

34. Applicant made corresponding amendments to claims 22 and 39, including removing “of [encoding/decoding] a prediction error signal for a block of data” from their preambles. Ex-1002, 000207, 000209. However, similar language was not inserted elsewhere as a replacement as it was done for claim 1. *Id.*

35. The Notice of Allowance pointed out three features that the Examiner believed “the prior art taken either singly or in combination does not teach.” Ex-1002, 000243. These features come from each of the independent claims and all require a combination of both transform and spatial encoding/decoding. *Id.*

The present invention provides a new method and system for coding and decoding digital video material, so as to allow for the utilization of selected transform basis functions that give good overall representation of the image block with minimum amount of transform coefficients (specification, page 4, paragraph [0011]).

Particularly, the new method and system comprise the following features, which the prior art taken either singly or in combination does not teach:

- joining, by a processor, the first and second representations to form a coded prediction error signal (see independent claims 1 and 13);

- adding, by a processor, the decoded transform information, ... of the block of data (see independent claims 22 and 31);

- joining, by a processor, the transform coded data and the spatial coded data to form a coded prediction error signal (see independent claim 39).

2. Foreign Counterparts

36. Patent Owner filed International Patent Application No. PCT/IB2008/051351 on April 9, 2008, with an identical specification and claims to those originally filed with the '019 application. This application entered the European phase on November 12, 2009, and was assigned European Application No. EP08737779.2 (Ex-1008, 000104), and entered the national phase in Canada on October 9, 2009, which led to Canadian Application No. 2,684,110 (Ex-1009, 000050, 000058).

37. During the prosecution of both the European and the Canadian applications, Applicant clarified the meaning of the term “spatial coding” by amending it to “spatial domain coding.” Ex-1008, 000128; Ex-1009, 000061, 000066-70.

38. During the prosecution of the Canadian application, after the '991 patent issued (Ex-1002, 000258), Applicant amended the claims which were identical to those originally filed for the '991 patent, in an attempt to overcome

another prior art reference, Santiago. Ex-1009, 000060-000062. Applicant added the limitation of “*creating a modified prediction error signal by substituting outlier values* in the difference signal with non-outlier values” to the independent claims. *Id.*, 000061 (emphasis added). This limitation is found in claims 2 and 14 (Ex-1001, 8:61-64, 9:23-25). In fact, Applicant conceded that “[Santiago] discloses an image coding technique, in which pixel and frequency domain information is combined in order to improve image quality over standard transform coding at given bit rates.” Ex-1009, 000061. The Canadian Intellectual Property Office also rejected dependent claims 2 and 14 that recite the outlier substitution limitations in view of Santiago in combination with another prior art reference Segall. *Id.*, 000058-000059. These references were disclosed during prosecution of the ’991 patent’s application, but was not otherwise discussed. Ex-1002, 000065. After the rejection and amendment, Applicant abandoned the application by failing to pay maintenance fees. Ex-1021, 000002-000003. While Applicant disclosed other foreign office actions to the USPTO based on these references for the same reasons (Ex-1002, 000110-000119 (international search report), 000138-000146 (Korean Intellectual Property Office rejection), 000198-000200 (Mexican Industrial Property Institute office action requesting a Spanish translation of the references)), there was no discussion by the Examiner of Santiago or Segall in any notice or

office action. *See* Ex-1002, 000050-000051, 000125, 000152-000194, 000237-000252, 000258.

C. Priority Date

39. The '019 application that issued as the '991 patent was filed on April 12, 2008, claiming priority to U.S. Provisional Patent Application No. 60/911,480 (“the '480 provisional application”), filed on April 12, 2007. I have been asked to assume that the '991 patent is entitled to its claimed priority date of April 12, 2007.

D. Challenged Claims

40. I understand that Petitioners are challenging the validity of claims 1-3, 5-15, 17-21, 39 (the “Challenged Claims”) of the '991 patent in the Petition for *Inter Partes* Review to which this declaration will be attached. Those claims are reproduced in Appendix 3. While this Petition and declaration are directed to the Challenged Claims, I have considered all claims (1-39) of the '991 patent, as well as portions of the '991 patent prosecution history and the prosecution history of related patent applications in forming my opinions.

III. Summary of the Prior Art

41. I have reviewed and considered the prior art discussed in this section, along with materials listed in Appendix 2.

A. Invalidity Grounds

42. Based on my review and analysis of the materials cited herein, my understanding of a POSITA in 2007-2008, and my training and experience, it is my opinion that the Challenged Claims are invalid based on the following grounds:

Grounds	Claims	Statutory Basis	Prior Art
1	1, 5-6, 8-13, 17-21	§103	Koga
2	1-3, 5-15, 17-21, 39	§103	Koga in view of Lin
3	1, 5-6, 8-13, 17-21	§103	Koga in view of Narroschke
4	1-3, 5-15, 17-21, 39	§103	Koga in view of Lin, further in view of Narroschke

43. I understand that none of the above-referenced art was cited or considered during prosecution of the '991 patent because none of these references or any related patents are listed on the face of the '991 patent, and I did not see the references discussed in any office action or elsewhere in the prosecution history.

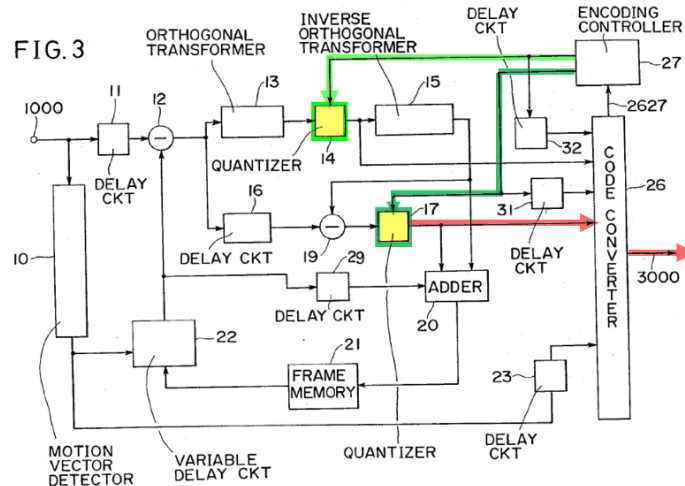
B. U.S. Patent No. 4,723,161 ("Koga") (Exhibit 1004)

44. Koga is a patent that issued on February 2, 1988. I understand that Koga is prior art under pre-AIA §102(a) because it was patented before the invention of the '991 patent (which claims priority to a provisional application filed April 12, 2007) and under §102(b) because it was patented more than one year before the earliest filing date of the '991 patent.

45. Koga is directed to a “method and arrangement of coding digital image signals utilizing interframe correlation.” Ex-1004, [54] (title). Koga recognized that using an orthogonal transformation to encode a prediction error reduces data redundancy in some scenarios but is less effective in other scenarios. Ex-1004, 2:22-37. Specifically, when “intraframe correlation of the prediction error signals is very low,” orthogonal transformation is less effective. *Id.*

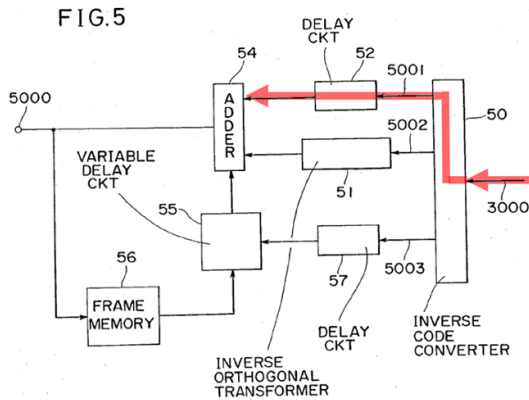
46. Koga addresses this problem by encoding the prediction error signal in the conventional manner with an “orthogonally transformed” version of the prediction error resulting from “motion compensated interframe prediction,” and additionally including a spatially coded residual of the prediction error, which is the “difference between the inversely orthogonally transformationed error signal [(e.g., the prediction error reconstructed from the transformed version)] and the original prediction error signal.” Ex-1004, 3:67-4:10. In addition, Koga proposes addressing this problem by adaptively controlling how much of either encoding technique is used by separately controlling the characteristics (e.g., level or amount) of the quantization applied to each output. *Id.* I have annotated Koga’s encoder shown in Figure 3 to highlight these two additions to the standard hybrid encoder setup that Koga follows, which is the basic setup for video coding to this day. The red line follows the flow of data to encode the spatial residual samples, created by the subtraction of the quantized and reconstructed transform coefficients

from the prediction error, while the green line follows the blocks involved in controlling the quantization:

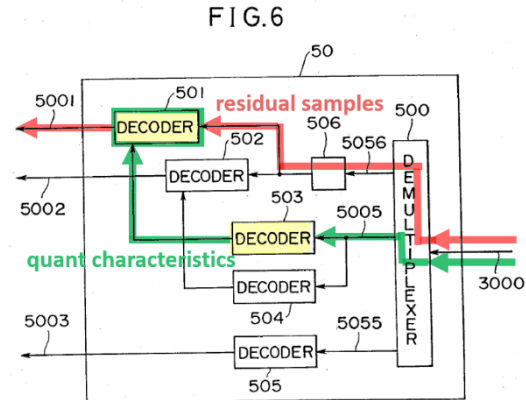


Ex-1004, Fig. 3 (annotated).

47. Koga's decoder is shown in Figure 5 and the Inverse Code Converter 50 is shown in further detail in Figure 6. I have annotated Figures 5 and 6 below to follow the respective processing paths for decoding the spatial residual samples (red) and decoding the quantization control signal (dark green), which is used to control dequantization of the residual:



Ex-1004, Fig. 5 (annotated).



Ex-1004, Fig. 6 (annotated).

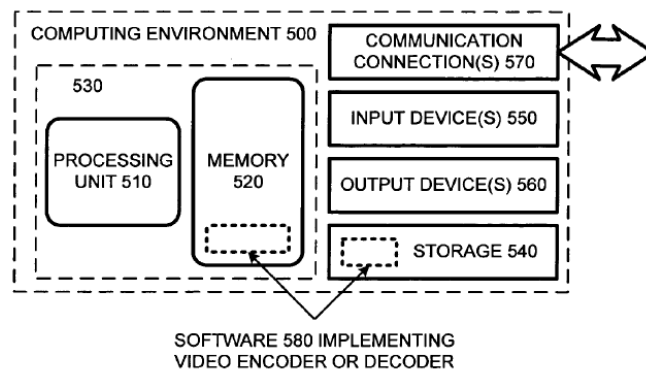
48. Koga is analogous art because it is in the same field of endeavor as the '991 patent, which is video and image processing/coding. *Infra* §IV. Koga states one of its objectives “is to provide a method of *encoding digitized images signals* using correlation between conse[c]utive frames for data compression or redundancy reduction.” Ex-1004, 2:45-54 (emphasis added). Koga provides circuit diagrams for corresponding encoders and decoders in Figures 3-6. Ex-1004, Figs. 3-6. Koga is reasonably pertinent to the problem addressed by the '991 patent's inventor, because it attempts to address the same issue of suboptimal performance of transform coding in hybrid video coding.

C. U.S. Patent Application Publication No. 2006/0268990A1 (“Lin”) (Exhibit 1005)

priority to a provisional application filed April 12, 2007, and §102(e) because it was published on an application with an effective filing date before the invention of the '991 patent.

50. Lin is directed to “adaptive video encoding using a perceptual model.” Ex-1005, (54) (title). Lin describes a video encoder/decoder implemented in a “computing environment.” Ex-1005, ¶¶0050-0060, Fig. 5:

FIG. 5



51. Lin’s computing environment includes “at least one processing unit 510” that “executes computer-executable instructions” and “non-volatile memory” “stor[ing] software 580 implementing a video encoder.” *Id.*, ¶0052. Lin builds upon video compression techniques that are used in, e.g., known “Standards for Video Compression and Decompression.” *Id.*, ¶0020-0021.

52. Lin teaches various adaptive coding techniques that enhance the performance of hybrid video encoders. One such technique involves “determin[ing] intensity variance” between pixel values (*id.*, ¶¶0099-0105) and

calculating a median value for the pixels in a block or “a subset thereof” (*id.*, ¶0115). Filtering is applied to samples using the calculated median to “remov[e] isolated noise values” and therefore, increase compressibility. *Id.*, ¶0122.

53. Lin is analogous art because it is in the same field of endeavor as the ’991 patent, which is video and image processing/coding. *Infra* §IV. Lin “describe[s] technology relat[ing] to video compression.” Ex-1005, ¶0001. Its techniques are “incorporated into or used by embodiments of a video encoder and decoder (together, ‘codec’).” *Id.*, ¶0050. Therefore, Lin is reasonably pertinent to the problem addressed by the ’991 patent’s inventor, because its techniques improve on a similar hybrid video coding scheme. Additionally, Lin is classified under the art class 375/240 which was identified as relevant by the Examiner and included in the search field during prosecution of the ’991 patent. *Id.*, (52); Ex-1001, (58).

D. U.S. Patent Application Publication No. 2011/0038410A1 (“Narroschke”) (Exhibit 1006)

54. Narroschke was published February 17, 2011 from Application No. 12/160,418, and claims priority from provisional application No. 60/766,300, which was filed January 9, 2006. Therefore, I understand that Narroschke is prior art under at least pre-AIA §102(e) because its effective filing date is before the earliest possible filing date for the ’991 patent, i.e., the provisional application filing date of April 12, 2007.

55. I have been informed that a reference is entitled to claim the benefit of its provisional application filing date if the disclosure of the provisional application provides support for the claims and the relied upon teachings in the reference, and have been asked to determine whether this is true for Narroschke. I have compared the contents of Narroschke with the provisional to which it claims priority. Their figures are identical, apart from the order of the figures and labeling using numerals rather than text for figures 1-2 in Narroschke. The two specifications disclose the same subject matter, although there are differences in organization and embellishments providing further detail in the U.S. patent application. There are no other substantive differences between the specifications. Although Narroschke's provisional included only 5 very broad claims, each of the claims in Narroschke are fully supported by the disclosures in the provisional as outlined in the table below. In any event, the teachings of Narroschke that I rely on herein are also found in the provisional.

Narroschke publication claims (Ex-1006)	Written support in Narroschke's provisional (Ex-1007)
23. A Method for coding a video signal using hybrid coding, comprising:	¶7, Claim 1, Title, Abstract, Fig. 2

reducing temporal redundancy by block based motion compensated prediction in order to establish a prediction error signal,	¶1
deciding whether to transform the prediction error signal into the frequency domain, or to maintain the prediction error signal in the spatial domain for encoding.	¶¶5-6, Abstract, Claim 2, Fig. 2
30. The method for coding a video signal using a hybrid coding, wherein the temporal redundancy is reduced by block based motion compensation prediction, the method comprising:	¶1, ¶7, Claim 1, Title, Abstract, Figs. 2, 6
providing the samples of the prediction error signal in a prediction error block in the spatial domain,	¶7
scanning the samples in the prediction error block to provide an array of samples in a specific order, wherein the scanning scheme is derived from a prediction error image or a prediction image.	¶7, ¶2, Figs. 1-2, 4
34. A Data signal representing a coded video signal, comprising coded information of a prediction error signal being partially coded in the spatial domain and partially coded in the frequency domain.	¶1, Claim 1, Fig. 2
37. A Method for decoding a video signal using hybrid coding, comprising: decoding coded video data effectively in the frequency or the spatial domain, in accordance with the coding mechanism used for coding the video signal data.	¶15, Claim 1, Fig. 6
39. A Coder for coding a video signal using hybrid coding, comprising:	¶7, Claim 1, Title, Abstract, Figs. 2

means for reducing the temporal redundancy by block based motion compensated prediction in order to establish a prediction error signal, and	¶1
adaptive control means for deciding whether to transform the prediction error signal into the frequency domain, or to maintain the prediction error signal in the spatial domain.	¶¶5-6, Abstract, Claim 2, Fig. 2
40. A Decoder for decoding a video signal being coded by use of hybrid coding, comprising adaptive control means (201) for adaptively deciding whether an input stream of a coded video signal represents the prediction error signal of the coded video signal in the spatial domain or in the frequency domain.	¶15, Claims 1-2, Fig. 6

56. Even if Narroschke is not entitled to the filing date of its provisional, I understand that it would still be prior art under §102(e) because it was filed December 22, 2006, which is before the '991 patent's provisional application filing date of April 12, 2007.

57. Narroschke is directed to “coding a video signal...based on hybrid coding.” Ex-1006, ¶0004, Figs. 1, 2. Narroschke discusses techniques for “coding of the prediction error” following frame prediction using motion estimation. Ex-1006, ¶¶0001-0002. These include “coding mechanisms...for the frequency domain” as well as those “adapted especially to the needs of the samples in the spatial domain.” Ex-1006, ¶0005.

58. In particular, Narroschke proposes adaptively “optimised quantiser[s]” for “frequency related coefficients” (Ex-1006, ¶0026, ¶0036) and for “samples in the spatial domain” (Ex-1006, ¶0014). In order to convey side information regarding the quantization parameters used, Narroschke sets flags conveying this side information to the decoder. Ex-1006, ¶¶0018-0019. Narroschke also describes the use of CABAC and CAVLC for entropy coding and describes a technique to apply them to spatial domain samples. Ex-1006, ¶0002, ¶0009, ¶0040.

59. Narroschke is analogous art because it is in the same field of endeavor as the ’991 patent, which is video and image processing/coding. *Infra* §IV. Narroschke sets out “to provide a coding and decoding method, respective coders and decoders, data signals as well as corresponding systems and semantics for coding and decoding video signals.” Ex-1006, ¶0003. Narroschke is reasonably pertinent to the problem addressed by the ’991 patent’s inventor, because it relates to coding the prediction error signal either transformed or maintained in the spatial domain. Additionally, Narroschke is classified under the art class 375/240 which was identified as relevant by the Examiner and included in the search field during prosecution of the ’991 patent. Ex-1006, (52); Ex-1001, (58).

IV. Level of Ordinary Skill in the Art

60. I have analyzed the '991 patent and determined that the field of the patent is video and image processing/coding. The specification explains that “[t]he present invention relates to the coding and decoding of digital video material.” Ex-1001, 1:6-9. And in particular, “to prediction error coding in both frequency and spatial domains.” *Id.* The '991 patent focuses on techniques for “improving prediction error coding performance of various video compression algorithms.” Ex-1001, Abstract. The '991 patent goes on to propose a “system and method for representing the prediction error signal as a weighted sum of different basis functions of a selected transform and quantized spatial samples.” Ex-1001, 2:58-3:12.

61. In determining the characteristics of a hypothetical person of ordinary skill in the art (“POSITA”) in the field of the '991 patent at the time of the claimed alleged invention, I considered several things, including various prior art techniques relating to the video and image processing/coding, the type of problems that such techniques gave rise to, and the rapidity with which innovations were made. I also considered the sophistication of the technologies involved, and the educational background and experience of those actively working in the field at the time. I also considered the level of education that would be necessary to understand the '991 patent. Finally, I placed myself back in the relevant period of

time and considered the engineers and programmers that I have worked with and managed in the field of video and image processing/coding.

62. As a result, I came to the conclusion that a person of ordinary skill in the field of art of the '991 patent would have been a person with a (1) Bachelor's degree in electrical engineering, computer engineering, computer science, or a comparable field of study, and (2) approximately two to three years of practical experience with video and/or image processing or coding. Additional experience can substitute for the level of education, and vice-versa.

63. I at least qualify under the above definition of a POSITA because I have a B.S./M.S/PhD in Electrical and Computer Engineering and have more than 30 years of experience with data compression/decompression/storage, including video data. *See infra* §VII.

64. In the 2007-2008 timeframe, a POSITA would have known and had the skills necessary to:

- Design and implement video and image codecs using circuits and processors, including integrated circuits (ICs);
- Design and implement video and image codecs using software running on general-purpose and special-purpose computers;
- Understand video coding and processing in accordance with standards such as MPEG-1/2/4, WMVx, VC-1, ATSC and other DTV standards, H.120 and H.26x;
- Understand image coding and processing in accordance with standards such as JPEG, JPEG-LS, JPEG2000, and TIFF;

- Understand general data coding and compression algorithms, the underlying concepts and mathematical properties, and their application to video and image coding. For example such algorithms include:
 - Entropy coding (e.g., arithmetic coding, dictionary coding, predictive coding, variable-length encoding, Golomb coding, Rice coding, Huffman coding, run-length encoding, Tunstall coding, Lempel-Ziv coding)
 - Transforms (e.g., linear, Fourier, sine/cosine, discrete, Hadamard, Haar, wavelet transforms)
 - Pulse-code modulation (e.g., PCM, DPCM)
 - Perceptual Coding; and
 - Quantization
- ; and
- Implement known techniques for processing video and image signals and blocks in hardware and software.

V. Claim Construction

65. For purposes of this inter partes review, I have considered the claim language, specification, and portions of the prosecution history, to determine the meaning of the claim language as it would have been understood by a person of ordinary skill in the art at the time of the invention. The “plain and ordinary meaning” or Phillips standard has traditionally been applied in district court litigation, where a claim term is given its plain and ordinary meaning in view of the specification from the viewpoint of a POSITA.

66. I have applied the Phillips standard in my analysis. Unless otherwise stated, I have applied the plain and ordinary meaning to claim terms.

A. “spatial samples”

67. Based on my review of the claims and specification of the '991 patent, it is my opinion that a POSITA would have understood that “spatial samples” means “pixel values.”

68. For example, the '991 patent defines “spatial samples” as “pixel values,” explaining that “the prediction error signal for a single image block is constructed using both transform basis functions and *spatial samples (i.e., pixel values)*, thereby combining the desired features of both the transform and spatial coding approaches....” Ex-1001, 2:64-3:2 (emphasis added).

69. This is confirmed by the language of the claims and the specification describing the operation of preferred embodiments. In the '991 patent, spatial samples are calculated as a difference between a prediction error signal and a reconstituted prediction error signal, and these are then quantized, and entropy coded, “without transform.” *Id.*, 5:37-47, 5:6-23, Fig. 4. Spatial samples directly correspond to values of pixels in the spatial domain, in contrast to transform coefficients that have been transformed, e.g., into the frequency domain in the case of DCT. That is why claim 22 recites “adding, by a processor, the *decoded* transform information, the decoded spatial information, and a *reconstructed*

prediction of the block of data, thereby forming a decoded representation of the block of data.” (emphasis added). The decoded spatial information is already in the spatial domain, and the claims call for decoding the transform information and predicting the image block by reverting both back to the spatial domain. This is because, to reconstitute an approximation of the original image’s pixel value—which was in the spatial domain before encoding—by adding together the decoded transform information, decoded spatial information, and reconstructed prediction, each of these components also have to be in the spatial domain. *Id.*, 6:47-55, Fig. 5. If the three components were all in different domains, adding them would result in incomprehensible distortions; using only simple subtraction and addition to split and reconstitute the original value for a given pixel relies on the fact that any particular component represents the exact same pixel (i.e., at the same spatial location) in the exact same terms (e.g., intensity, hue, chroma, etc.).

70. I further note there is no such term of art in the field for the way that the specification uses “spatial samples.” Based on the plain language of the term, however, a POSITA would have understood it to mean what it says—a sample relating to something occupying a space. In the context of image data, the corresponding concept is the sample value of a pixel, which mirrors the ’991 patent’s specification. This is consistent with the use of the term “spatial domain” in the prior art, which refers to pixel values that have not been transformed, or have

been transformed and then inverse transformed back, as being “maintained in the spatial domain.” *Compare* Ex-1006, ¶0004; Ex-1005, ¶0072, *with* Ex-1001, 5:42-43. The prosecution of foreign counterparts to the ’991 patent confirms the relevance of this usage, as Applicant clarified the meaning of the related term “spatial coding,” which is used to encode spatial samples in the ’991 patent (Ex-1001, 5:43-47, 9:6-7), as “spatial domain coding.” *Supra* §II.B.2.

71. I have also reviewed the Joint Statement Regarding Claim Construction filed in the related International Trade Commission investigation, where Amazon and Nokia agreed that “spatial samples” means “pixel values” in the context of the ’991 patent. Ex-1010, 000001.

B. “spatial coding”

72. Based on my review of the claims and specification of the ’991 patent, it is my opinion that a POSITA would have understood that “spatial coding” means “coding in the spatial domain.”

73. The ’991 patent discloses that spatial coding is used to encode spatial samples. Ex-1001, 5:43-47, 9:6-7. Instead of limiting the algorithm or encoding technique for spatial coding, the ’991 patent describes this spatial coding as the coding (e.g., quantizing and entropy coding) of pixel values in the spatial domain “without transform.” *Id.*, 5:37-47, Fig. 4. The ’991 patent’s use of the term departs from the conventional meaning in the literature and video standards such as

H.263, MPEG-4 and their successors. *Supra* §II.A. “Spatial coding,” when used, often refers to intra-frame prediction that encodes information using spatial redundancies. *See supra* §I.B. In contrast, the ’991 patent’s use of the term is consistent with the Applicant’s amendments during prosecution of foreign counterparts that amended and clarified “spatial coding” to “spatial domain coding.” *Supra* §II.B.2.

C. “difference signal” (Claims 1 and 39)

74. Based on my review of the claims and specification of the ’991 patent, it is my opinion that a POSITA would have understood that “difference signal” means “prediction error signal.”

75. Claims 1 and 39 each recite “a difference signal representing differences between sample values of a predicted block of data and values for an original input block.” A POSITA would have understood this refers to a prediction error signal, which was a well-known concept in the art. The specification reflects this meaning, which defines a prediction error: “The second phase involves coding the prediction error, i.e. the difference between the predicted block of pixels and the original block of pixels.” Ex-1001, 1:37-40. Dependent claims 2 and 14 confirm this meaning: “substituting outlier values in the difference signal with non-outlier values to create a modified prediction error signal.” *Id.*, 8:61-64, 9:38-42. Finally, modifying “the difference signal” by substituting outlier values results in a

modified difference signal, which the '991 patent calls “a modified prediction error signal.” *Id.*, 5:24-50; *see id.*, 5:51-65, Fig. 4.

D. “the difference signal” (Claims 13 and 14)

76. Claims 13 and 14 each recite “the difference signal,” without reciting or otherwise defining “a difference signal.” This is a clear error in claim drafting.

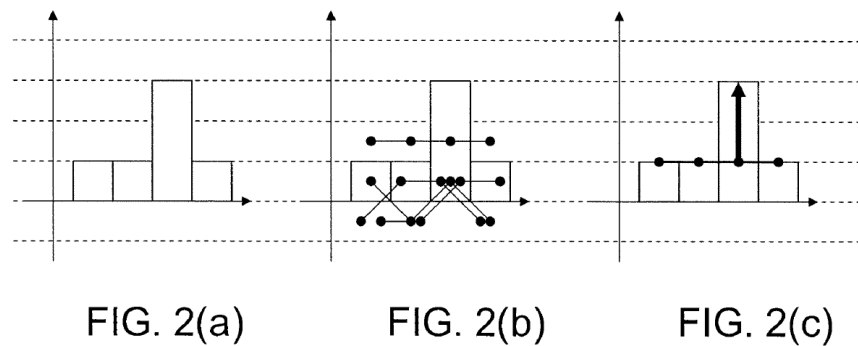
77. To the extent it can be understood, it is my opinion that a POSITA would have understood “the difference signal” to mean “a difference signal representing differences between sample values of a predicted block of data and values for an original input block” as recited in claim 1. Claim 13 is the corresponding apparatus to the method of claim 1, and claims identical limitations except for missing a corresponding limitation to [1a]. *Infra* §VI.A.2. The specification supports this understanding; it likewise discloses a difference signal which is the prediction error signal. *Supra* §V.C.

E. “outlier values”

78. Based on my review of the claims and specification of the '991 patent, it is my opinion that a POSITA would have understood “outlier values” means “values for pixels that significantly differ from those for neighboring pixels.”

79. The '991 patent places its use of the terms “values” and “outlier values” as referring to “the difference between sample values of a predicted block and an original input block.” Ex-1001, 5:28-50; Claims 2 and 14 (“outlier values

in the difference signal”). While the specification does not provide a succinct definition for outlier values, the ’991 patent provides an example where [3] is the outlier among the four values [1, 1, 3, 1]. *Id.*, 5:51-65, Figs. 2(a)-2(c):



80. The specification also provides an example of non-outlier values as being “interpolated representations of those values, e.g., by averaging the neighboring prediction error values.” *Id.*, 5:37-42, Claims 7 and 19. For the example of Figure 2, the ’991 patent explains [3] is substituted “with an average of the second and fourth samples, making the signal [1 1 1 1].” *Id.*, 5:55-57.

81. From these example and the claims, a POSITA would have understood an outlier value to be a value that significantly differs from neighboring values. The specification clarifies that the threshold of the difference is not absolute, but rather that it can be smaller or larger depending on the bitrate and desired quality. *Id.*, 5:28-50 (“[T]he amplitude [of the difference to count as an outlier] depends on the expected accuracy of the coded representation....”). This use of “outlier value” in the ’991 patent is consistent with the meaning of the term

in the field of statistics, where an outlier is a value that lies outside most of the values in a set of data and is therefore “unrepresentative” or “inconsistent”. Ex-1018, 000007, 000010-000011.

F. Second Recitations of “a first component”

82. Independent claims 1 and 13 each recite “a first component” twice. Ex-1001, 8:47-61, 9:26-37. For example, claim 1 recites “performing...transform coding to the difference signal, thereby creating a first representation of a first component of the difference signal,” and later recites “performing...spatial coding to the difference signal, thereby creating a second representation of *a first component* of the difference signal.” This is an error of claim drafting because the second recitation of “a first component” uses the indefinite article “a” instead of the definite article “the.” In view of the claim language and the specification, a POSITA would have understood that the second recitation of “a first component” was intended to be “a second component.”

83. The specification makes clear that “the present invention” is directed to representing a prediction error signal using two components: (1) “a weighted-sum of different basis functions of a selected transform,” e.g., a transform-coded component, and (2) “quantized spatial samples,” e.g., a spatially-coded component. *Id.*, 4:18-37, 2:58-3:12, Abstract. The specification refers to “first” and “second” representations in one passage: “Transform coding and spatial coding are both

performed to the difference signal, thereby creating a first and second representations of first and second components of the difference signal. The first and second representations are then combined to provide the prediction error signal.” *Id.*, 3:18-22. A POSITA would have understood from this disclosure that the specification describes creating two different representations: a representation of the transform component, and a representation of the spatial component. *See also id.*, 5:24-50. Notably, the specification does not disclose creating a first representation and a second representation of one, same component of a difference signal.

84. This interpretation is further supported by the dependent claims. For example, dependent claims 3 and 4 claim the different possible permutations of the order in which the two components could be coded: (1) claim 3 requires transform coding followed by spatial coding, and alternatively (2) claim 4 requires spatial coding followed by transform coding. *Id.*, 8:65-9:3.

G. “the non-outlier values used to replace the outlier values” (Claim 19)

85. Claim 19 recites terms that lack antecedent basis. Dependent claim 19 recites “the non-outlier values used to replace the outlier values.” Ex-1001, 9:53-55. However neither does claim 19, nor claim 13 from which it depends, ever recite any “non-outlier values,” “outlier values,” or that non-outlier values have been “used to replace” outlier values. *Id.*, 9:26-37, 9:53-55.

86. To the extent these limitations can be understood, it is my opinion that a POSITA would have understood claim 19 to depend from claim 14, instead of claim 13 as recited. The terms lacking antecedent basis are recited in Claim 14 (“substituting outlier values in the difference signal with non-outlier values to create a modified prediction error signal”). *Id.*, 9:38-42. Moreover, claim 19 mirrors claim 7 which claims a method reciting identical language. *Id.*, 9:53-55, 9:8-10. Claim 7 depends from claim 2, and claim 14 mirrors the limitations of claim 2. *Id.*, 9:38-42, 8:61-64. This reading of claim 19 would be consistent with the ’991 patent’s disclosures.

VI. Invalidity

87. Based on my review and analysis of the materials cited herein, my understanding of a POSITA in the 2007-2008 timeframe, and my training and experience, it is my opinion that the Challenged Claims are rendered obvious by the Grounds raised. *Supra* §III.A. The reasons for my conclusions are explained more fully below.

A. Grounds 1-2: Obviousness over Koga and the Combination of Koga and Lin

88. Koga teaches all limitations of claims 1, 5-6, 8-13, and 17-21, including the recited processors and memory including computer code as a computer program product. To the extent Nokia argues that the ’991 patent requires a general-purpose processor, e.g., a central processing unit, and Koga does

not teach it or any other limitations , Lin further teaches such limitations. A POSITA would have found those limitations and claims as well as claims 2-3, 7, 14-15, and 39, to be obvious based on the combination of Koga and Lin.

1. Independent Claim 1 is rendered obvious by Koga.

89. It is my opinion that a POSITA would have found claim 1 rendered obvious by Koga.

[1pre] A method, comprising:

90. I understand that a preamble generally does not limit a claim. If the preamble is limiting, it is my opinion that Koga teaches the claimed “method.”

91. Koga teaches a **method** and arrangement of circuits and circuit elements for encoding/decoding digital video/image signals. Koga is entitled “*Method and arrangement* of coding digital image signals utilizing interframe correlation.” Ex-1004, [54] (emphasis added). Koga explains its “invention relates to a *method and arrangement* for prediction coding..., and more specifically to such a *method and arrangement* which feature high reproduction quality ranging from still pictures to very rapidly moving ones.” *Id.*, 1:8-23 (emphasis added). Therefore, Koga teaches a **method**, which includes the encoding of digital image signals as explained for limitations [1a]-[1e].

[1a] calculating, by a processor, a difference signal representing differences between sample values of a predicted block of data and values for an original input block;

92. It is my opinion that Koga teaches this limitation.

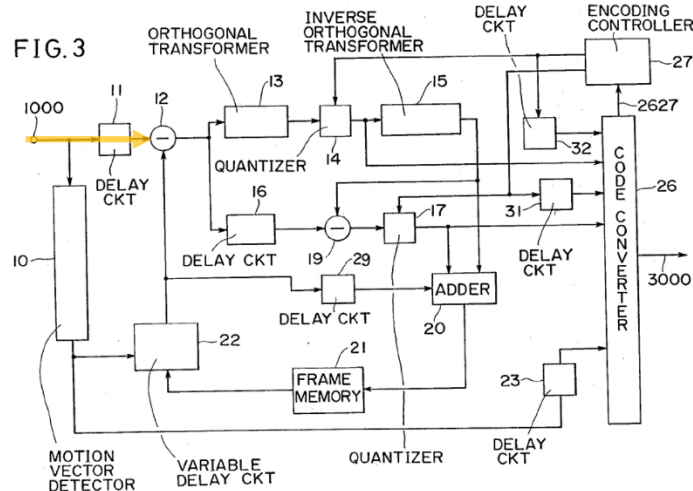
93. Koga teaches an encoder that **calculat[es]...a difference signal representing differences between sample values of a predicted block of data and values for an original input block.** A POSITA would have known that, in hybrid video coding, prediction error refers to the difference between an original frame of video (or a subunit of a frame of video, such as a block) and the corresponding predicted frame of video (or a predicted block). *Supra* §§I.A-B. A hybrid video encoder detects motion in the original frame and produces a set of motion vectors that describe the movement of groups of pixels (blocks) relative to a previously-encoded reference frame. Applying motion vectors to the reference frame produces the predicted frame for the current video frame being encoded. This process is known as motion compensation or motion prediction coding. The '991 patent shares this same understanding of hybrid video coding. Ex-1001, 1:28-37.

94. Because motion compensation does not perfectly encode the movement of all pixels in a frame/block, there are typically differences between the original image and corresponding predicted image for a frame/block. The difference between the original image and the predicted image is called the

prediction error. The '991 patent uses this term in the same way, interchangeably referring to the “difference signal” and the “prediction error.” *Supra* §V.C.

95. A POSITA would have understood that Koga's encoder determines a prediction error as the output of subtracter 12 in Figure 3 because the subtracter is subtracting the original image signal from a predicted image signal.

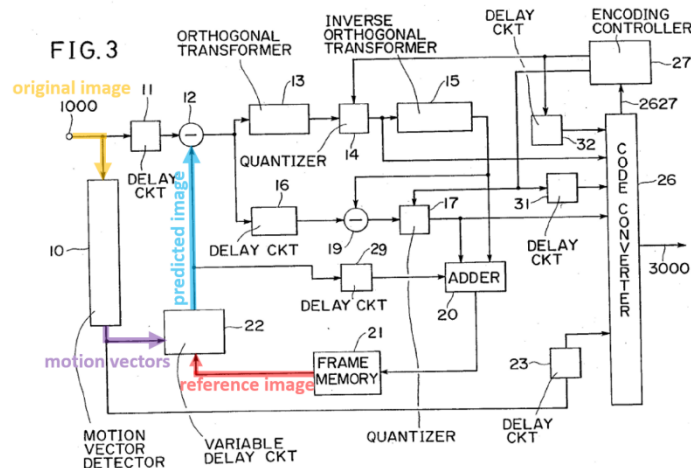
96. The first input to subtracter 12 is the original image signal because Figure 3 shows input signal 1000 passes through delay circuit 11 to subtracter 12:



Ex-1004, Fig. 3 (annotated). This is also confirmed by accompanying text: “delay circuit 11 provides incoming motion picture signal with a delay corresponding to the time period required to detect the motion vector at the detector 10, and applies the output thereof to the subtracter 12.” *Id.*, 4:57-61.

97. The second input to subtracter 12 is the predicted image, shown as the arrow coming from variable delay circuit 22. A POSITA would have understood from Figure 3 that this input is the predicted image signal because the original

image signal 1000 is supplied to motion vector detector 10 and Figure 3 further shows the motion vectors produced by the detector are applied at variable delay circuit 22 to an image signal from frame memory 21. Ex-1004, Fig. 3 (annotated):



98. A POSITA would have known from Figure 3 that the frame memory contains the latest decoded frame because the local decoding loop (20-22) is the same as the decoder in Figure 5 (54-56). This is further confirmed by accompanying text explaining that the output of delay circuit 22 to subtracter 12 is a prediction signal:

Motion picture signals are applied, via an input terminal 1000, to the motion vector detector 10 and the delay circuit 11. The detector 10 is adapted to detect the magnitude of velocity and direction (viz., motion vector) of an object on a block by block basis, wherein each block is an N-line $\times$ M-pixel size (for example), and thence applies the motion vectors detected to the variable delay circuit 22 and the delay circuit 23. *The variable*

delay circuit 22 is supplied with a locally decoded signal from the frame memory 21, and provides same with a delay according to the motion vector received, and then applies the output thereof (viz., prediction signal) to the subtracter 12 and the delay circuit 29.

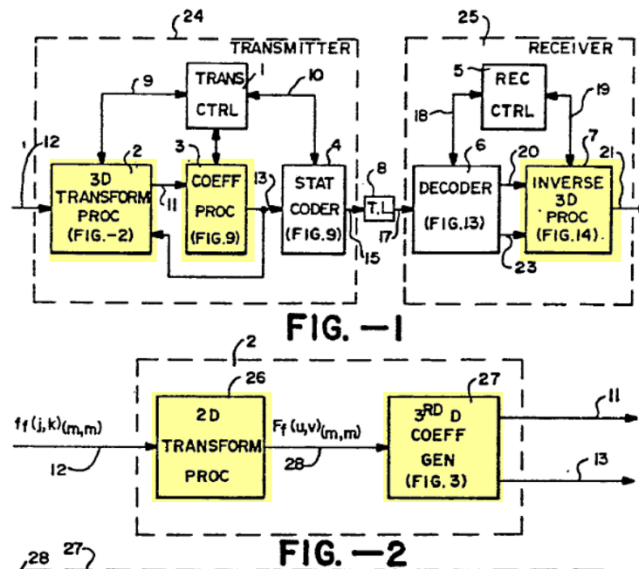
Ex-1004, 4:42-54 (emphasis added).

99. The output of subtracter 12 is a prediction error because it is the difference between the original input (first input) and the predicted image (second input). The accompanying text confirms this: “*subtracter 12 determines the difference between the two signals applied thereto, and outputs prediction error signals....*” *Id.*, 4:61-64 (emphasis added).

100. Koga teaches the calculation is carried out **by a processor**. For example, Koga describes the foregoing blocks and arrangements as including “circuits,” “circuit elements,” and “circuit arrangements.” Ex-1004, 3:7-14; 3:35-38, Figs. 5-6. Specifically, Koga’s encoder includes processors that process video signals, such as “an inverse code converter 50,... an inverse orthogonal transformer 51, an adder 54, a variable delay circuit 55, and a frame memory 56....” *Id.*, 6:27-33. A POSITA would have understood that such blocks, circuits, elements, and arrangements comprise a claimed “processor.” They are processors at least because they process data to generate a defined output as a result of the processing, and in particular processing digital image data. *Id.*, 4:42-5:24

(describing, e.g., “data processing,” “process the incoming prediction error signal,” “process the incoming signals and to generate the outputs”).

101. A POSITA would have understood circuitry that implements an encoder/decoder like Koga to be a processor. The prior art confirms this; for example, Chen illustrates how a POSITA would have referred to various processing blocks in a video encoder/decoder as processors. Ex-1011, 3:60-61, 5:19-23, Figs. 1-2 (highlighted):



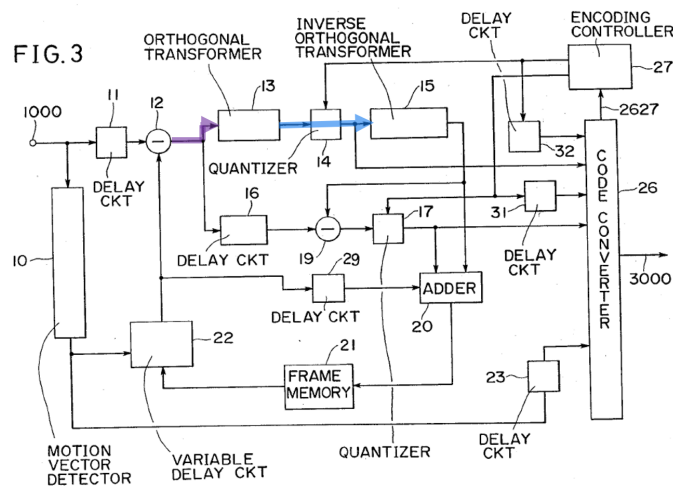
102. This is consistent with the '991 patent's explanation that its alleged invention may be implemented in a device including “codec circuitry 54.” Ex-1001, 7:58-8:3, Fig. 9.

[1b] performing, by a processor, transform coding to the difference signal, thereby creating a first representation of a first component of the difference signal;

103. It is my opinion that Koga teaches this limitation.

104. Koga teaches **performing...transform coding to the difference signal**. For example, Figures 3 and 4 disclose that the prediction error signal is orthogonally transformed at orthogonal transformer 13, quantized at quantizer 14, and then entropy coded by the code converter 26. The '991 patent acknowledges that, in hybrid video codecs, “coding the prediction error...is typically accomplished by transforming the difference in pixel values using a specified transform (e.g., a Discrete Cosine Transform (DCT) or a variant thereof), quantizing the coefficients, and entropy coding the quantized coefficients.” Ex-1001, 1:37-44.

105. A POSITA would have understood that Koga teaches coding the prediction error signal in the typical way. Figure 3 shows that the prediction error signal (output from subtracter 12) is the input to orthogonal transformer 13, and that the output of the transformer is then input to quantizer 14. Ex-1004, Fig. 3 (annotated):



The accompanying text confirms that the prediction error signal is orthogonally transformed using a Hadamard³ or discrete cosine transform and then quantized:

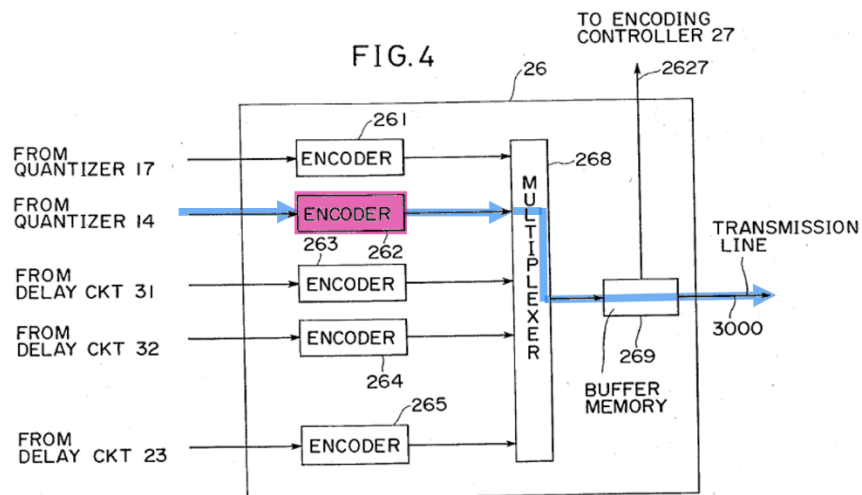
The output of the subtracter 12 undergoes orthogonal transformation (Adamal [sic, Hadamard⁴] transformation, discrete cosine transformation, etc.) at the orthogonal transformer 13 on a block by block basis.... The output of the orthogonal transformer 13 is then quantized at the quantizer 14, and thereafter fed to the inverse orthogonal transformer 15 and the code converter 26.

Ex-1004, 4:64-5:7.

106. Koga teaches that the quantized transform coefficients are further entropy coded at code converter 26, shown in further detail by Figure 4. *Id.*, 5:4-8, 3:18-19 (linking Fig. 3 with Fig. 4). Figure 4 shows that the transform coefficients from quantizer 14 are encoded by encoder 262 and then multiplexed (268) into output signal 3000:

³ The '991 patent's exemplary embodiment uses "a Hadamard transform" like Koga. Ex-1001, 3:53-54, 4:38-58, 5:66-6:4.

⁴ By Adamal transformation, Koga refers to a Hadamard transform. The typographical error appears to be an artifact of translation that attempted to phonetically transcribe the pronunciation of the French mathematician Jacques Hadamard's name after whom the transform is named. I have reviewed a machine translation of Koga's Japanese parent that renders the corresponding discussion as "Hadamard transformation." Ex-1015, 000007-8. I also note that there is no recognized meaning of the term "Adamal transform" in the field of video/image processing/coding—there is no such orthogonal transform.



Id., Fig. 4 (annotated).

107. Koga teaches the transform coding **thereby creat[es] a first representation of a first component of the difference signal**. A POSITA would have understood Koga’s transform coding to produce transform coefficients as a representation of a component (e.g., the corresponding block) of the difference signal (e.g., prediction error signal) in the transformed space (frequency domain). Koga states that the orthogonal transform is applied “on a block by block basis, wherein the block size is preferably selected equal to that of the block processed in the motion vector detector 10 and is preferably set $M=N=2^n$ (wherein n is a whole positive integer). . . .” Ex-1004, 4:64-5:4. The transform coefficients represent the values in the prediction error, and can be inverse-transformed to reproduce the values as confirmed by Koga’s teachings of inverse orthogonal transforming the coefficients both at the encoder and at the decoder. *Id.*, 4:64-5:7, 7:20-43. To the extent this limitation requires a “first” representation in relation to another

representation, this is a first representation because Koga teaches a second representation as I explain below for limitation [1c].

108. Koga teaches the performing is carried out **by a processor**. As discussed above for limitation [1a], Koga discloses circuitry for carrying out the processing of Koga's video encoding method, including transform coding. *Supra* §VI.A.1.[1a]; Ex-1004, 4:64-5:8, Figs. 3-4.

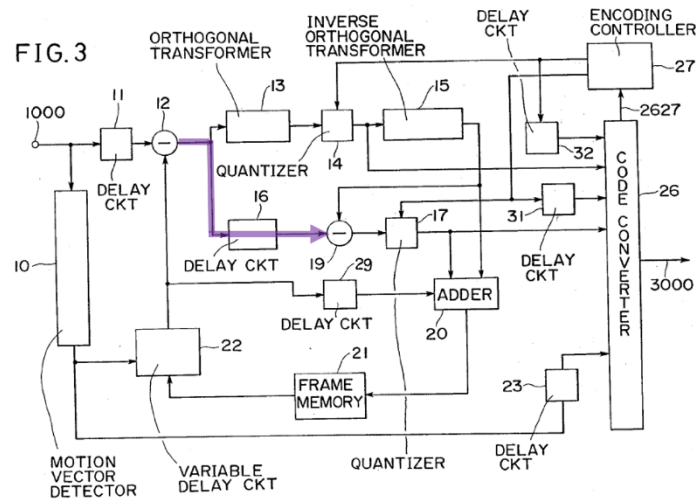
[1c] performing, by a processor, spatial coding to the difference signal, thereby creating a second representation of a first component of the difference signal;

109. It is my opinion that Koga teaches this limitation. As I explained above, to the extent this limitation can be understood, a POSITA would have understood “a first component” to mean “a second component.” *Supra* §V.F. Therefore, I analyze this limitation under that understanding.

110. Koga teaches **performing...spatial coding to the difference signal**. For example, Figure 3 discloses the spatial coding of spatial samples produced from the difference signal at subtracter 19, by quantizing at quantizer 17 and then entropy coding at the code converter 26. As I explained above, a POSITA would have understood “spatial coding” to mean “coding in the spatial domain.” *Supra* §V.B. A POSITA would have understood that Koga performs spatial coding on the residual of the prediction error because “spatial samples” in this context refers to “pixel values” (*supra* §V (claim construction)) and the residual is not

transformed to another domain, but coded (quantized and entropy coded) as-is in the spatial domain. *See supra* §I.C.

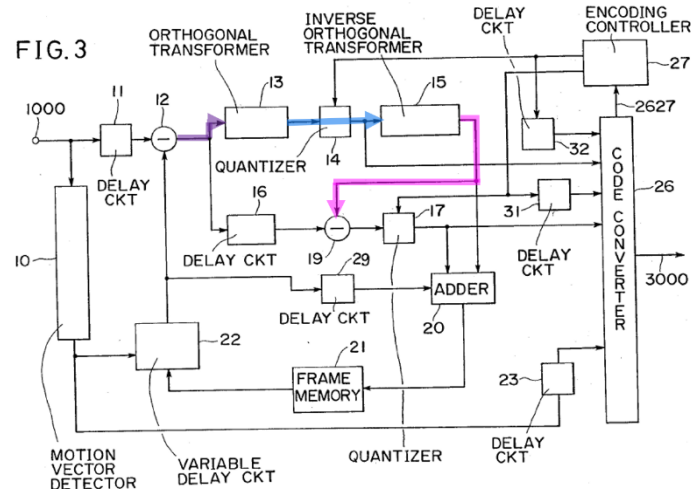
111. The first input to subtracter 19 is the prediction error signal determined by subtracter 12 (as explained above) that is delayed by delay circuit 16 to align its timing with the second input:



Ex-1004, Fig. 3 (annotated).

112. The second input to subtracter 19 is a reconstructed approximation of the prediction error derived from the first representation of the first component referenced for limitation [1b] above. As explained above, Figure 3 shows the prediction error (from subtracter 12) is orthogonally transformed (at 13) and then quantized (at 14). A POSITA would have understood that the output of quantizer 14 is quantized transform coefficients resulting from transforming the prediction error signal from the spatial domain to a transform domain (e.g., the frequency domain by applying the discrete cosine transformation). This was well-known, as

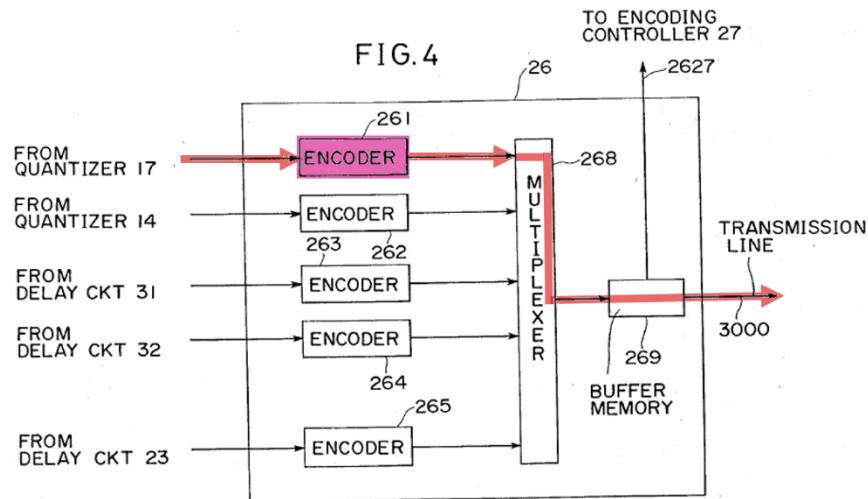
confirmed by Lin. Ex-1005, ¶0072 (“A frequency transformer 660 converts the spatial domain video information into frequency domain (i.e., spectral) data. For block-based video frames, the frequency transformer 660 applies a discrete cosine transform [‘DCT’] or variant of DCT to blocks of the pixel data or prediction residual data, producing blocks of DCT coefficients.”) (brackets in original).



producing pixel data or prediction residual data for key frames or predicted frames, respectively.”) (brackets in original).

114. The subtracter 19 determines the difference between the prediction error signal (first input) and the reconstructed prediction error signal (second input). Ex-1004, FIG. 4, 5:4-16 (“The subtracter 19 derives the difference between the outputs of the delay circuit 16 and the inverse orthogonal transformer 15.”). This is a residual of the prediction error.

115. Koga teaches that the residual of the prediction error (the output of subtracter 19) is quantized (at 17) and sent to code converter 26. *Id.*, 5:16-19 (“The output of the subtracter 19 is quantized at the quantizer 17 which applies its output to the code converter 26...”). Figure 4 and its accompanying text discloses that the quantized residual of the prediction error is entropy coded (by encoder 261) and multiplexed into signal 3000. *Id.*, 6:4-9 (“The output of quantizer 17 is variable-word-length encoded at the encoder 261, utilizing Huffman codes (for example), and are converted into compressed image data...”), 6:15-22 (disclosing that output of encoder 261 is combined by the multiplexer), Fig. 4 (annotated):



116. Koga teaches the spatial coding of the residual **thereby creat[es] a first representation of a second⁵ component of the difference signal.** A POSITA would have understood that the encoded residual of the prediction error is the difference between the prediction error signal from subtracter 12 and the reconstructed prediction error signal from inverse orthogonal transformer 15, as I explained above. *Supra* ¶114. Thus, it represents the component of the prediction error signal that was lost during transform coding—a second component that is not the first component transform coded as I explained above for limitation [1b]. In like manner to the '991 patent's example of spatial coding the components “not well correlated with the basis functions of the applied transform” (Ex-1001, 2:58-3:12), this component of the prediction error comprises the samples that were

^{5 5} *Supra* §V.F.

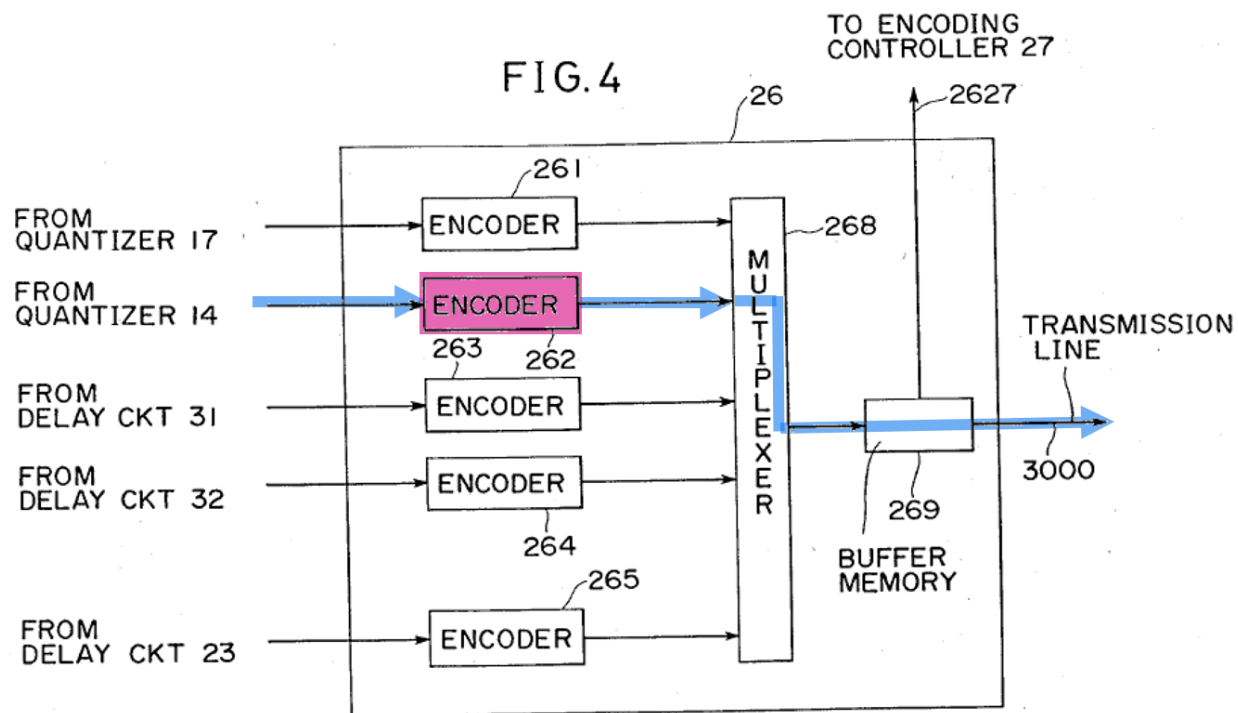
discarded for not being efficiently transform coded; they were not well correlated with the basis functions of the orthogonal transform.

117. Koga teaches the performing is carried out **by a processor**. As discussed above for limitation [1a], Koga discloses circuitry for carrying out the processing of Koga's video encoding method, including spatial coding. *Supra* §VI.A.1.[1a]; Ex-1004, 5:14-19, Figs. 3-4.

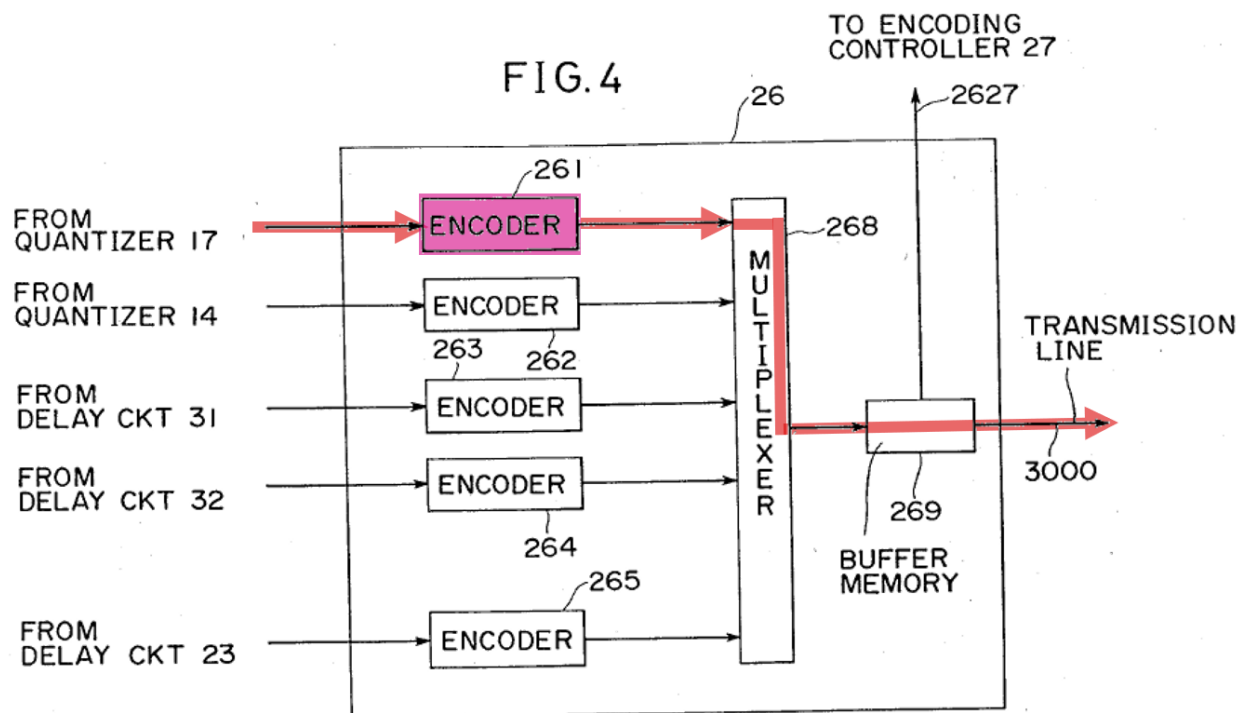
[1d] joining, by a processor, the first and second representations to form a coded prediction error signal; and

118. It is my opinion that Koga teaches this limitation.

119. Koga teaches **joining...the first and second representations to form a coded prediction error signal**. For example, the quantized and encoded transform coefficients and residual spatial samples are joined (e.g., multiplexed) into signal 3000 by code converter 26, shown in further detail by Figure 4. Ex-1004, 5:4-8, 3:18-19 (linking Fig. 3 with Fig. 4). Figure 4 shows that the transform coefficients from quantizer 14 (entropy coded by encoder 262) are multiplexed (268) into output signal 3000. *Id.*, Fig. 4 (annotated):



Likewise, the residual samples from quantizer 17 (entropy coded by encoder 261) are multiplexed into signal 3000. *Id.*, Fig. 4 (annotated):



120. The accompanying text also discloses that the encoded, quantized transform coefficients and the encoded, quantized residual samples are joined with the other components of Koga's encoded signal:

The outputs of the encoders 261, 262, 263, 264 and 265 are combined at the multiplexer 268 into a predetermined order, and thereafter successively applied to the buffer memory 269. This memory 269 is provided to temporarily store the coded information applied from the multiplexer 268 and to feed same into the transmission line 300[0] (or a suitable storage medium) at a defined rate.

Id., 6:15-22.

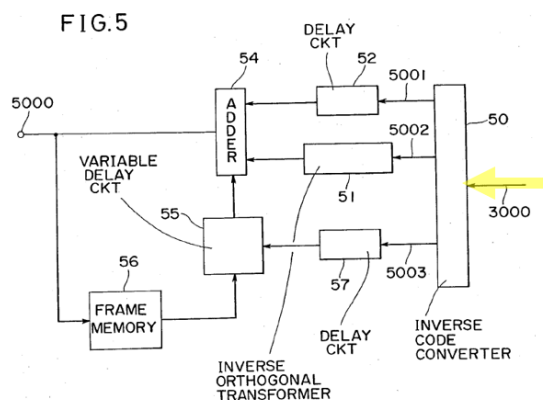
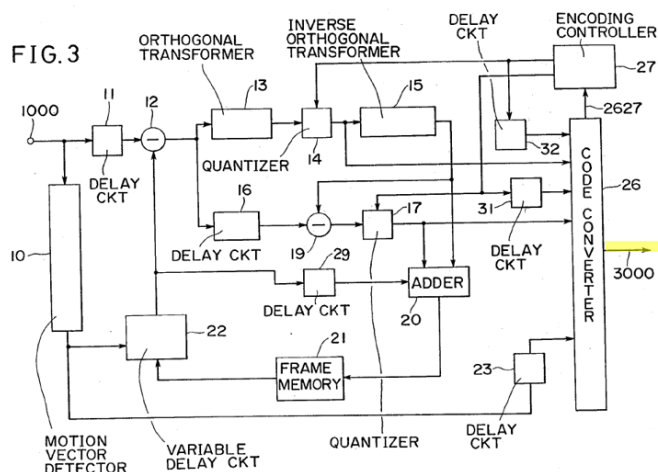
121. A POSITA would have understood the two coded representations of the prediction error signal, are joined in a "predetermined order," **to form a coded prediction error signal**, that is included in video signal 3000. This is because it is the encoded output that together comprises the full prediction error signal, as I explained above for limitation [1c]. *Supra* §VI.A.1.[1c].

122. Koga teaches the joining is carried out **by a processor**. As discussed above for limitation [1a], Koga discloses circuitry for carrying out the processing of Koga's video encoding method, including joining. *Supra* §VI.A.1.[1a]; Ex-1004, 5:25-29, Fig. 3.

[1e]	at least one of transmitting or storing the coded prediction error signal.
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123. It is my opinion that Koga teaches **at least one of transmitting or storing the coded prediction error signal**, because it teaches both of them.

124. Koga teaches **transmitting...the coded prediction error signal**. For example, Figures 3 and 5 teaches the encoded prediction error signal I have described above for limitations [1a]-[1d] is transmitted over “transmission line 3000” from the encoder to the decoder:



Ex-1004, Figs. 3, 5 (annotated), 6:15-26 (“This memory 269 is provided to temporarily store the coded information applied from the multiplexer 268 and to feed same into the transmission line 300....”); 3:6-12 (explaining that “like blocks, circuits, or circuit elements are denoted by like reference numerals”), 3:18-19 (Figures 3 and 5 are the only encoder and decoder depicting Koga’s arrangement for coding and reproduction).

125. Koga also teaches **storing the coded prediction error signal**. For example, Koga teaches “feed[ing the coded signal 3000] into...a suitable storage medium.” *Id.*, 6:15-26.

2. Independent Claims 1 and 13 are rendered obvious by Koga combined with Lin.

126. Claim 1 is directed to a method where certain steps are performed by a processor. Claim 13 is directed to an apparatus that contains a processor and a memory that contains computer code for performing claim 1’s method steps.

127. The following chart shows that the claims are substantially the same, except that claim 13 further requires “a memory unit communicatively connected to the processor” and “including computer code for” performing the same method limitations of claim 1. While limitations [1b]-[1d] each individually recite the method is performed “by a processor,” claim 13 recites “a processor” in limitation [13a] that carries out operations corresponding to those recited in claim 1. The material differences between the two claims is bolded and colored green:

[1pre] A method , comprising:	[13pre] An apparatus , comprising:
	[13a] a processor; and a memory unit communicatively connected to a controller and comprising:
[1a] calculating, by a processor, a difference signal representing differences between sample values of a predicted block of data and values for an original input block;	
[1b] performing, by a processor, transform coding to the difference signal, thereby creating a first representation of a first component of the difference signal;	[13b] computer code for performing transform coding to the difference signal, thereby creating a first representation of a first component of the difference signal;
[1c] performing, by a processor, spatial coding to the difference signal, thereby creating a second representation of a first component of the difference signal;	[13c] computer code for performing spatial coding to the difference signal, thereby creating a second representation of a first component of the difference signal; and
[1d] joining, by a processor, the first and second representations to form a coded prediction error signal; and	[13d] computer code for joining the first and second representations.
[1e] at least one of transmitting or storing the coded prediction error signal.	

128. As explained above, Koga teaches a hardware-based encoder that performs claim 1's method of encoding video. However, Koga does not expressly disclose an apparatus comprising a processor and a memory unit containing computer code for performing its decoding method. A POSITA would have found it obvious to implement Koga's decoding method in such an apparatus based upon Lin. Lin teaches a computing environment, including a processor, controller, and interconnected memory/storage, that implements a video encoder/decoder in the form of computer-executable instructions/software stored in the computing environment's memory/storage. Ex-1005, ¶¶0050-0053, Fig. 5.

[13pre] An apparatus, comprising:

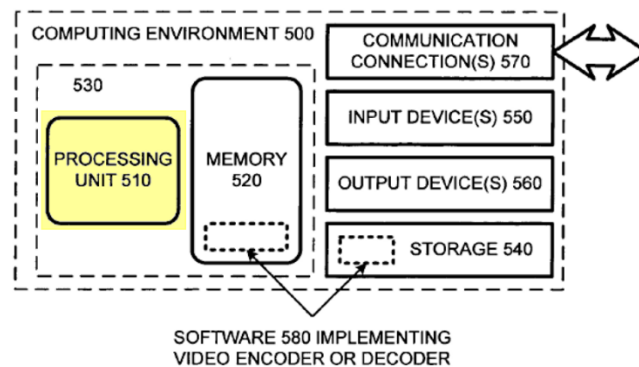
[13a] a processor; and a memory unit communicatively connected to a controller and comprising:

129. It is my opinion that the combination of Koga and Lin teaches the preamble (to the extent it is limiting) and limitation [13a] based on Lin's teachings. Lin teaches a computing environment including processors and memory units communicatively connected to controllers, and further includes computer code stored in memory.

130. Lin teaches **a processor; and a memory unit connected to a controller**. For example, Lin discloses its computing environment includes a "processing unit 510," and "memory 520" and "storage 540" that each "stores

instructions for the software 580 implementing the video encoder or decoder.” Ex-1005, ¶¶0051-0055, Fig. 5 (highlighted):

FIG. 5



Lin explains processing unit 510 “may be a real or a virtual processor.” Ex-1005, ¶¶0052, ¶¶0058. The computing environment may also consist of “a multi-processing system, [with] multiple processing units,” which can either be “local or distributed.” *Id.*, ¶¶0052, ¶¶0059. The computing environment further includes “communication connections 570” and “[a]n interconnection mechanism (not shown) such as a bus, *controller*, or network interconnects the components of the computing environment 500.” *Id.*, ¶¶0053 (emphasis added). This was a customary composition of computing devices because communication is necessary for the components to pass data to each other for processing and to “coordinate[] activities of the components.” *Id.*, ¶¶0053. Thus, a POSITA would have understood Lin’s memory and storage to be communicatively connected to an “interconnection mechanism” such as a controller.

131. As I explained above (*supra* §VI.A.1), Koga teaches all substantive limitations of claims 1 and 13 (Ground 1). As I explained above (*supra* §I.G), it was customary by the 2007-2008 timeframe to implement video codecs using computers, including processors and memory including computer code to process image data being encoded/decoded, and a POSITA would have found it obvious to do the same with Koga's codec.

132. To the extent Nokia argues that Koga does not teach any limitations of the Challenged Claims, Lin further teaches such limitations and claims (*infra* §§VI.A.2-11). A POSITA would have found those limitations and claims obvious based on the combination of Koga and Lin (Ground 2), and a POSITA would have been motivated to implement Koga's codec using a processor with memory communicatively connected to a controller, and further including computer code for processing video data, as taught by Lin for several reasons that I explain below.

Motivation to Combine

133. *First*, the references themselves provide express teachings and motivation to combine their teachings in the manner I describe. For example, Lin suggests combining its teachings with other video coding methods, because “the innovations described herein can be implemented independently or in combination in the context of other digital signal compression systems, and implementations may provide adaptive video encoding...in compliance with any of various video

codec standards.” Ex-1005, ¶¶0050, ¶¶0152-0153. Lin states the well-known fact that video encoders/decoders “shown in software may be implemented in hardware and vice versa.” *Id.*, ¶¶0152, ¶¶0050 (“various combinations of software and/or in dedicated or programmable digital signal processing hardware in other digital signal processing devices.”). Indeed, Koga teaches a video codec that could be combined and implemented on Lin’s teachings of a computing environment with a general-purpose processor and memory/storage communicatively coupled to a controller and including computer code (*Id.*, ¶¶0050-0060) to process video using Koga’s encoding/decoding methods. Likewise, Koga presents its invention as improvements on and additions to similar, known video encoders/decoders that utilize the hybrid coding scheme, which includes, for example Lin. *See* Ex-1004, 1:6-2:42; Ex-1005, Figs. 1-4, 6-7. Therefore, a POSITA would have been motivated to combine the two references.

134. *Second*, such a combination of prior art elements according to known methods yields predictable results. Koga teaches (1) a method/apparatus for encoding/decoding video; (2) encoding/decoding the prediction error in two signals (transform coefficients and a spatial residual), where the transform coefficients are generated using transform coding and the residual is encoded without using transform coding (i.e., encoded spatially, plain “**spatial coding**”); and (3) controlling these signals’ quantization characteristics. Ex-1004, 3:67-4:10, 5:41-

6:26, 7:3-7:19. Lin teaches a computing environment for encoding/decoding video that includes memory embodying computer-executable instructions coupled in communication with controllers and processors executing such instructions. Ex-1005, ¶¶0050-0060. The combination yields the predictable results of implementing Koga's codec teachings using Lin's computing environment teachings.

135. *Third*, Koga and Lin are analogous art at least because they share a similar purpose and architecture. A POSITA would have looked to Lin's teachings to implement a codec according to Koga's teachings and to make improvements to the same. Both references teach similar video encoding/decoding methods that follow the well-known hybrid video coding framework that combines motion prediction with prediction error transform coding (*supra* §I.A): Koga and Lin each teach block-based interframe coding in which pixels are grouped into and coded together as "blocks" and in which redundancies between successive video frames are exploited to reduce the amount of bits required to represent that video signal being encoded. Ex-1004, 1:35-49, 4:42-5:24, Figs. 1, 3, and 5; Ex-1005, ¶¶0013-0014, ¶¶0019-0020, Figs. 6, 7. And both teach correcting errors resulting from the prediction of a block within a given video frame or in a neighboring frame, by calculating, encoding, and transmitting a prediction error signal. Ex-1004, 2:55-3:4, 4:42-5:24; Ex-1005, ¶¶0120-0122, ¶¶0015-0020. Moreover, both references

employ adaptive coding techniques that exploit features of human visual perception and video/image data to increase image compression while maintaining a sufficient level of perceived visual quality. Ex-1004, 2:3-42, 3:67-4:33; Ex-1005, ¶¶0089-0090, ¶¶0140-0141.

136. *Fourth*, applying Lin’s computing-environment teachings to Koga’s codec teachings, would have involved applying a known technique (video coding with processors etc.) to a known device/method (hybrid codec that executes video coding processes) ready for improvement to yield predictable results (see immediately above). For example, Koga teaches “processing” data to encode/decode images (including video) (Ex-1004, 4:42-5:24, 7:65-10:10) and Lin teaches a computing environment to implement similar processes. Ex-1005, ¶¶0051-0060. It was customary to implement video codecs using computers comprising processors. *Supra* §I.G. Lin’s computing environment was a known arrangement for processing video/image data, and Koga was ready for improvement because it taught the processing for encoding/decoding video.

137. A POSITA would have realized that Koga’s method and apparatus were ready for improvement because Koga contemplated implementing its arrangement using hardware available at Koga’s time, 20 years before the 2007-2008 timeframe, when general processors were less capable. Ex-1004, [22]. Koga teaches a coding method of “high quality [for] still to very rapidly moving content”

(*id.*, 2:45-54) that would benefit from the advances made by 2007 in processing power. Implementing Koga's method as software, written in computer code, to execute on newer, more powerful processor(s) would have been straight-forward, because software code was known to be written with computer-executable instructions that described methods/algorithms and it was well-known to store and execute software in this manner, as Lin teaches. Ex-1005, ¶0058; *supra* §I.G.

138. *Fifth*, using Lin's computing environment to implement Koga's codec would have had several known advantages. For example, Lin's computing environment provides a flexible solution, e.g., rewritable computer instructions, that allows for easy modification and testing, allowing for integrating new coding techniques to improve performance. A POSITA would have appreciated the ability to easily integrate new video coding techniques into Koga's decoder by writing software code that would run on a general- or special-purpose processor. This would provide time and cost savings in terms of developing, implementing, and updating the codec using this arrangement. For example, it would avoid the need to go through even more complicated design and manufacturing processes, such as developing and producing specialized ICs using semiconductors or putting together physical circuits using electrical components.

139. The widespread availability of standardized computer environments such as Lin's would have also spurred development of Koga as a software codec,

eliminating the need to develop and distribute custom hardware. Instead, the codec would be distributed as software—computer programs that would have been cheaply replicated. Thus, market forces would drive the combination because it would have allowed for increased market penetration and higher profit margins. A POSITA would have been aware of these many benefits and motivated to implement Koga's decoder using Lin's computing environment.

140. Combining Koga's and Lin's teachings would not have changed either reference's principle of operation because it simply uses teachings from each according to their known principles, in the manner taught by each reference. Koga's encoder/decoder, quantization control, and entropy coding teachings, when combined with Lin's related teachings would have still been applied in the manner taught by Koga, just with straightforward changes or additional details disclosed by Lin. Similarly, Lin's teachings would have been applied to Koga in the manner taught by Lin, to implement a codec in a computing environment. Applying Koga's coding teachings and implementing Koga using Lin's computing environment would have been a simple matter of substituting and remapping known techniques, which are fundamentally mathematical algorithms that process data, and as such, can be implemented as computer software programs running on a computer, dedicated hardware processing units, or a combination of the two.

141. A POSITA would have had a reasonable expectation of success when combining Koga's and Lin's teachings in the manner I describe because they are combined in a conventional manner that does not change any principle of operation but instead simply involves tweaks or the addition of implementation details. The combination is based on compatible devices and techniques in video and image processing/coding, the compatible devices themselves being based on the same hybrid coding scheme as I explained above. Koga's and Lin's teachings, when combined, would each have been used for their known purposes in the conventional manner taught by each reference. A POSITA would have been more than capable of combining the two references because the combination would encode and decode video using a hybrid coding scheme, adaptively quantize and entropy code the prediction error signal in transformed and non-transformed parts, and transmit the corresponding information to be decoded in like manner; all of these were well-known in the art.

142. A POSITA would have been fully capable of combining Koga's and Lin's teachings, including making necessary modifications that, as explained above, would have involved straightforward processing of information using mathematically defined algorithms and implementing processes with straightforward programming. Hybrid coding, predictive coding, transform coding, entropy coding, and quantization were all known in the prior art as I

explained above. *Supra* §§I.A-E. The combination is directed to the simpler aspects of combining such known techniques, integrating and interfacing their inputs and outputs, and programming a general-purpose computer to practice the techniques as taught.

143. Based on my education and experience in the field of video and image processing/coding (*infra* §VII), including as a graduate student, overseeing graduate students, and working with researchers in the field, it is my opinion that developing software and hardware for video coding was a common task for artisans in the field; and such development routinely involved combining and modifying different coding techniques and technologies. Thus, it is my view that a POSITA would have been able to combine and would have combined the features of Koga and Lin in the manner I describe herein. *See also supra* §IV.

- [13b] computer code for performing transform coding to the difference signal, thereby creating a first representation of a first component of the difference signal;**
- [13c] computer code for performing spatial coding to the difference signal, thereby creating a second representation of a first component of the difference signal; and**
- [13d] computer code for joining the first and second representations.**

144. It is my opinion that the combination of Koga with Lin teaches these limitations. As explained for the preamble and limitation [13a], a POSITA would have found it obvious to implement Koga's decoding method on an apparatus

according to Lin's teachings. *Supra* §VI.A.2.[13pre]/[13a]. In particular, instead of implementing Koga's decoding method in the form of circuitry, a POSITA would have instead implemented Koga's decoding method as software, which is computer code that is stored in Lin's memory/storage.

145. Claim 13 has no antecedent basis for "the difference signal." *Supra* §V.D. However, given the parallelism with claim 1, a POSITA would have understood "the difference signal" to refer to "a difference signal representing differences between sample values of a predicted block of data and values for an original input block" as recited in limitation [1a]. *Id.* I explained above for claim 1, how Koga alone, and in combination with Lin, each teach the substantive limitations of [1a], and [1b]-[1d] that share common language with limitations [13b]-[13d]. Because Grounds 1 and 2 satisfy limitations [1a]-[1d], those same teachings also teach the same elements of limitations [13b]-[13d] and that analysis is incorporated here by reference. *Supra* §§VI.A.1.[1a]-[1d].

146. As I explained above, it is my opinion that Koga alone teaches claim 1, including method steps [1b]-[1d] that must be performed **by a processor**. If Nokia contends that the construction of "a processor" requires more than hardware circuitry that processes a video signal, it is my opinion that claim 1 would still be rendered obvious by the combination of Koga and Lin as described herein because Lin teaches that the computing environment may consist of "general-purpose or

special-purpose computing environments” using general or special purpose processors. Ex-1005, ¶0051. For example, Lin’s computing environment can comprise various types of processing units, such as “a real or a virtual processor;” or consist of “multiple processing units,” which can be “local or distributed.” *Id.*, ¶0052, ¶0058, ¶0059. A POSITA would have understood Lin’s discussion of real or virtual processors to refer to general processing units, such as CPUs, that could themselves be actual hardware or simulated on another general-purpose processor, and multiple processing units to refer to multiprocessor systems or multi-cored processors, which were common by the 2007-2008 timeframe. Thus, a POSITA would have understood that Lin’s apparatus modified to implement Koga’s decoding method would have satisfied claim 1.

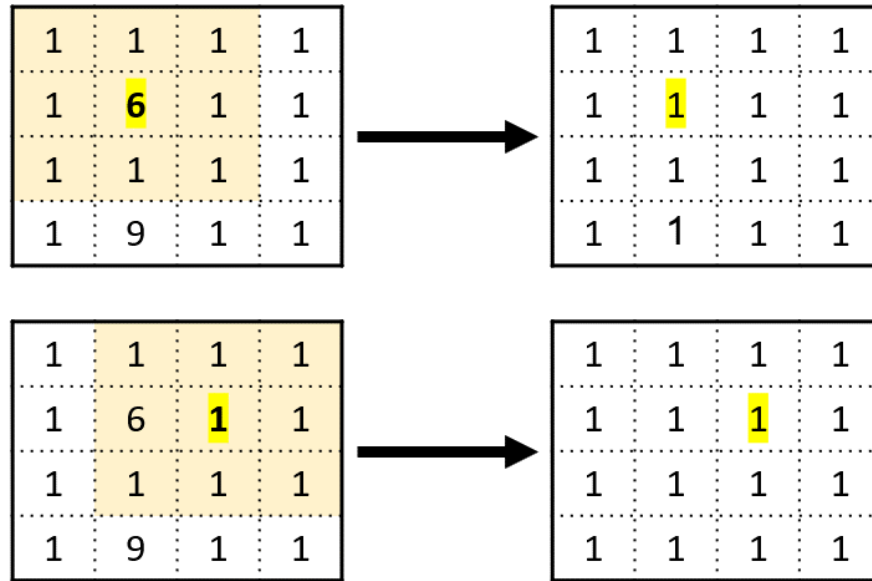
3. Dependent Claims 2 and 14 are rendered obvious by Koga combined with Lin.

- 2. The method of claim 1, further comprising, before performing transform coding and spatial coding, substituting outlier values in the difference signal with non-outlier values to create a modified prediction error signal.**
- 14. The apparatus of claim 13, wherein the memory unit further comprises computer code for, before performing....**

147. Claims 2 and 14 depend from claims 1 and 13, respectively, and are otherwise identical. As I explained above, Koga alone, and Koga in combination with Lin, each teach claims 1 and 13. *Supra* §§VI.A.1-2 (incorporated here by reference). It is my opinion that the combination of Koga and Lin further teaches

the remaining limitations of these claims. For example, Lin teaches applying a median filter to smooth out values to enhance compressibility before performing a frequency transformation (DCT). Ex-1005, ¶¶0120-0125. A POSITA would have been motivated to use Lin's median filter in Koga's encoder to modify the prediction error calculated at subtracter 12 before transform coding it and spatial coding its residual, for several reasons that I explain further below.

148. Lin's median filtering method teaches **substituting outlier values in the difference signal with non-outlier values to create a modified prediction error signal**. As was known in the art, median filtering refers to the replacement of values with the median value of a surrounding set of values. *Supra* §I.D. As was known in the art, a median filter scans through a set of values. At the position under consideration, the median filter replaces the position's current value with the median value for the filter's window. The effect is that values that exceed or fall short of the median value (outliers) are substituted with the median value (non-outlier value) of each window. I have prepared an exemplary diagram to illustrate how this works:



149. For example, using a median filter with a 3×3 pixel window on the position with pixel value 6 (second row from top, second column from left), where the surrounding samples are all 1 (peach shadowed pixels), results in the 6 being replaced with the window’s median value of 1. For the position to the right of the 6 (second row from top, third column from left) with a value of 1, the position’s value remains 1 after filtering because 1 is the median value of the 9 samples in the window. Applying this filter to a prediction error signal would result in a modified prediction error signal, because the values in it have been changed.

150. Lin confirms its median filtering substitutes the outlier values (e.g., “isolated, ‘salt and pepper noise’ values”) in the prediction error that creates a modified (e.g., smoothed out) version of the prediction error. Ex-1005, ¶0122:

Even when motion compensation succeeds for a block,
there may be information content in the prediction

residual^[6] for the block. The information content appears as isolated, “salt and pepper noise” values among areas with zero residual values for motion-compensated prediction has mostly succeeded, or the information content may appear as edges where a new part of an object has been exposed that was not in a reference frame. A median filter tends to smooth residual information (removing isolated noise values) while at the same time preserving useful detail (such as edges) in the residual information. The smoothing adds redundancy, which makes subsequent lossless compression more efficient. To control how much the video information is filtered, the video encoder changes the median filter kernel applied to the residual information based upon the block characterizations.

A POSITA would have understood that Lin’s isolated noise values are outlier values that stand out from neighboring values—values for pixels that significantly differ from those for neighboring pixels. *Supra* §V.E. The noise values significantly differ from the median of the prediction error values of neighboring pixels in Lin’s filter window. Therefore, they significantly differ from the neighboring values to the point where Lin’s filter will substitute them with the median value to create a modified prediction error signal. This is consistent with

⁶ Lin interchangeably refers to the prediction error as prediction residual. E.g., Ex-1005, ¶0121-0123.

the '991 patent's example that explains a value with an amplitude of 3 out of a group of 4 values, with the other three being 1, is an outlier (and replacing it with the value 1). Ex-1001, 5:51-65, Figs. 1, 2(a)-2(c).

151. The '991 patent does not provide any particular manner to determine whether a value is sufficiently different enough to be an outlier. Instead, it explains the determination of an outlier can be of “smaller” or “high[er] amplitude” differences depending on target bitrates or image quality. Ex-1001, 5:24-50. Lin teaches using median filters with various kernel sizes and shapes, for example “ 5×5 ” “ 3×1 ” or “ 3×3 ” pixels, depending on the amount of smoothing to apply. Ex-1005, ¶0071. Lin's teaching of using different filter sizes similarly shows how the degree of difference used as a threshold can be varied. Typically, the filter will smooth more aggressively when using a large window that averages over a larger number of samples, while the filter will preserve the spatial pixels more accurately if a smaller window is used.

152. The combination teaches that the median filtering is applied **before performing transform coding and spatial coding**. A POSITA would have found it obvious to apply Lin's median filter to Koga's prediction error (output from subtracter 12) to create a modified prediction error signal before performing the transform coding at transformer 13, and before the spatial coding of the residual of the prediction error at quantizer 17 (which occurs after the orthogonal transform,

etc.). A POSITA would have been motivated to combine Koga and Lin in this manner for a number of advantages that I explain below.

Motivation to Combine

153. *First*, as I explained above for claim 13, Lin suggests combining its teachings with other video coding methods. Ex-1005, ¶0050, ¶¶0152-0153; *supra* §VI.A.2 (motivation to combine). Koga teaches a hybrid-video codec that could utilize Lin’s median filter. Applying Lin’s median filter teachings to the prediction error in Koga’s codec teachings, would have involved applying a known technique (replacing values with median values) to a known device/method (hybrid codec) ready for improvement to yield predictable results (encoding with increased compression). Lin teaches that “smoothing adds redundancy, which makes subsequent lossless compression more efficient” when applied to the prediction residual. Ex-1005, ¶0122. A POSITA would have understood that applying Lin’s median filtering to Koga’s prediction error would likewise increase redundancy (e.g., correlation between the pixel values). It would thus provide similar benefits in making orthogonal transforms, such as DCT or Hadamard, more efficient. Therefore, a POSITA would have been motivated to combine the two references.

154. *Second*, Koga and Lin are analogous art at least because they share a similar purpose and architecture. A POSITA would have looked to Lin’s teachings to improve the efficiency of Koga’s encoding teachings. As I explained above,

both references teach similar video coding methods based on the hybrid video coding model. Ex-1004, 1:35-49, 2:55-3:4, 4:42-5:24, Figs. 1, 3, and 5; Ex-1005, ¶¶0013-0014, ¶¶0015-0020, ¶¶0120-0122, Figs. 6 and 7; *supra* §VI.A.2.[13pre]/[13a] (motivation to combine). Both references aim to increase image compression while retaining reconstruction quality, and the combination would contribute to this goal. Ex-1004, 2:3-42, 3:67-4:33; Ex-1005, ¶¶0089-0090, ¶¶0140-0141.

155. A POSITA would have realized that Koga's method and apparatus were ready for improvement because Koga's codec was based on algorithms of the time, 20 years before the 2007-2008 timeframe. Ex-1004, [22]. A POSITA would have found it obvious and been motivated to apply various improvements, such as Lin's teaching of median filtering of prediction errors, to improve the performance of Koga's encoder. No changes to Koga's decoder would be required to benefit from Lin's median filtering: it would work equally well for the encoder modified per the combination as it did for the original one. Furthermore, when modified as proposed, the decoder would be able to reconstruct video frames without errors in the absence of encoder quantization. This desirable property is sometimes called asymptotic perfect reconstruction and it tells us that as more and more bits are allocated to encoding the video (i.e., the quantization becomes progressively less severe), the quality of the decoded video will become close and closer to being

perfect. The fact that the combination of Koga and Lin achieves asymptotic perfect reconstruction would further motivate a POSITA.

156. The combination of Koga's and Lin's teachings would not have changed either reference's principle of operation because it uses teachings from each according to their known principles, in the manner taught by each reference. Applying Lin's median filter to Koga's encoder would not require significant changes to Koga's functions. It would have been a simple matter of remapping known techniques, which are fundamentally mathematical algorithms that process data.

157. For the same reasons, a POSITA would have had a reasonable expectation of success when combining Koga's encoder teachings and Lin's median filtering teachings. A POSITA would have found it simple because it would have been a simple matter of mapping additional known techniques to Koga's flow of processing video data.

158. As I explained above, a POSITA would have been fully capable of combining Koga's and Lin's teachings, including making necessary modifications that would have involved straightforward processing of information using mathematically defined algorithms and implementing processes with straightforward programming. *Supra* §VI.A.2.[13pre]/[13a] (discussing reasonable expectation of success); *supra* §IV (skills and knowledge of a POSITA).

4. Dependent Claims 3 and 15 are rendered obvious by Koga combined with Lin.

- 5. The method of claim 2, wherein transform coding is applied to the modified prediction error signal and spatial coding is applied to a residual thereof.**
- 15. The apparatus of claim 14, wherein transform coding is....**

159. Claims 3 and 15 depend from claims 2 and 14, respectively, and are otherwise identical. As I explained above, the combination of Koga and Lin teaches claims 2 and 14. *Supra* §VI.A.3 (incorporated here by reference). The combination teaches the remaining limitation. It is my opinion that the combination of Koga and Lin further teaches the remaining limitations of these claims. For example, Koga teaches orthogonal transforming a prediction error and spatial coding the residual of the prediction error. Ex-1004, Figs. 3 and 4.

160. As I explained above for claims 2 and 14, applying Lin's median filter to Koga's prediction error from subtracter 12 would create a modified prediction error signal. The combination would provide the modified prediction error signal to orthogonal transformer 13 per Koga's usual coding path, where **transform coding is applied to the modified prediction error signal** instead of the original prediction error signal. *Supra* §VI.A.1.[1b] (incorporated here by reference). Consequently, the orthogonal transform would transform a different set of values to produce different transform coefficients.

161. I explained above how **spatial coding is applied to a residual thereof**, by Koga's calculating the residual from a reconstructed prediction error and encoding the residual in the spatial domain. Ex-1004, Figs. 3 and 4; *Supra* §VI.A.1.[1c] (incorporated here by reference). The difference here is that the reconstructed output from inverse orthogonal transformer 15 would be that of the modified prediction error, instead of the original prediction error. When subtracted from the original prediction error, the calculated residual would reflect the difference introduced by substituting certain values with median values. This residual of the modified prediction error would be spatial coded in the usual manner (quantized and entropy coded) as taught by Koga.

162. I explained how and why a POSITA would have been motivated to combine Lin's median filtering teachings to Koga's codec above for claims 2 and 14. The same reasons and analysis apply here, and are incorporated by reference. *Supra* §VI.A.3 (motivation to combine). The effects and advantages of applying Lin's median filtering teachings to Koga's prediction error result from the combination of the median value substitution with the transform and/or spatial coding, to improve compression efficiency.

5. Dependent Claims 5 and 17 are rendered obvious by Koga.

- | |
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| <p>5. The method of claim 1, wherein, for transform coding, at least one transform coefficient is set to zero.</p> <p>17. The apparatus of claim 13, wherein, for transform coding....</p> |
|--|

163. Claims 5 and 17 depend from claims 1 and 13, respectively, and are otherwise identical. As I explained above, Koga alone, and Koga in combination with Lin, each teach claims 1 and 13. *Supra* §§VI.A.1-2 (incorporated here by reference). It is my opinion that Koga further teaches the remaining limitations of these claims. For example, Koga generates “quantization characteristic control signals” that control the quantizer 14 to set all, including at least one, of the transform coefficients to zero, “if the motion vector is zero or close to zero.” Ex-1004, 7:44-64.

164. For example, Koga’s quantization control signal indicates “[w]hether or not the orthogonal transformation is utilized” in relation to the motion vector for that block/frame. Ex-1004, 4:21-33. Koga controls quantizer 14 with the control signal. *Id.*, 2:27-39; 5:41-5:59 (“The coding controller 27 outputs two quantization characteristics control signals which are respectively supplied to the quantizers 14 and 17 in order to control the quantization characteristics of the quantizers 14 and 17.”). When “the motion vector is zero or close to zero”—i.e., when there is little or no movement from frame to frame— “quantizer 14 is controlled to generate a signal with zero value.” *Id.*, 7:44-64.

165. Koga optimizes the allocation of bits for its prediction error signal between transform coefficients and the spatial residual, “[b]y selecting the quantization characteristics,” which controls “the influence or contribution of the orthogonal transformation” because adjusting the quantization level will impact the amount of data (number of bits) preserved or discarded. *Id.*, 3:67-4:10. Koga explains that “the reproduced picture quality is impaired to a considerable extent” by the transform if correlation is low. *Id.*, 2:27-39. So, Koga adjusts the quantization amount to take advantage of the property of orthogonal transforms, such as DCT, that show high compression for images with highly correlated pixels (e.g., a smooth image). *Supra* §I.C.

166. When “the motion vector is zero or close to zero,” a still or slowly moving image exhibits highly localized and easily noticed regions of prediction error, as seen for example in Koga’s Figure 2. Ex-1004, 7:44-64, Fig. 2. Because orthogonal transforms such as DCT either smooth fine detail excessively or require a fine level of quantization (that requires more bits to encode) to adequately represent such fine detail, in such cases Koga proposes “generat[ing] a signal with zero value” for the quantized results of the orthogonal transform, effectively providing none of the transform coefficients for encoding. Instead, the bits can be allocated to the residual of the spatial prediction error, which is more suitable for encoding highly uncorrelated pixels.

167. Koga confirms the provided and received control signal indicates that the “the orthogonal transform is [not] to be decoded,” because the transform coefficients have been set to zero, “the decoder[...502 outputs zero.” *Id.*, 7:3-19. A POSITA would have recognized Koga’s technique of adjusting quantization to set a range of values to zero to be what was later referred to as dead-zoning in the art, as described, e.g., by Lin. Ex-1005, ¶0130 (“A dead-zone is the region within which zero output is generated for some transform coefficient[s] during quantization”).

6. Dependent Claims 6 and 18 are rendered obvious by Koga.

- 6. The method of claim 1, wherein, for spatial coding, at least one spatial sample is set to zero.**
- 18. The apparatus of claim 13, wherein, for spatial coding....**

168. Claims 6 and 18 depend from claims 1 and 13, respectively, and are otherwise identical. As I explained above, Koga alone, and Koga in combination with Lin, each teach claims 1 and 13. *Supra* §§VI.A.1-2 (incorporated here by reference). It is my opinion that Koga further teaches the remaining limitations. For example, Koga teaches generating and transmitting “quantization characteristic control signals” that control quantizer 17 to set to zero all of the spatial samples in the residual of the prediction, which occurs “if the motion vector reaches around the motion compensation limit.” Ex-1004, 7:44-64.

169. After being used to adjust quantization at quantizer 17, Figure 4 shows the quantization characteristic control signal is sent to code converter 26 via block 31 and entropy coded at encoder 263. *Id.*, 5:60-6:3, Figs. 3, 4. I explained above for claims 5 and 17 how the quantization characteristic control signals are applied to the quantizers and encoded at code converter 26, the same teachings and analysis apply to the quantization control signal here, that differs only in that controls quantizer 17 and goes through delay circuit 31 and encoder 263. *Id.*, 6:4-26; *Supra* §VI.A.5 (incorporated here by reference).

170. As I explained above for claims 5 and 17, Koga's quantization control signal controlling quantizer 14 indicates "[w]hether or not the orthogonal transformation is utilized" in relation to the motion vector for that block/frame. Ex-1004, 4:21-33. Koga teaches that Koga's controller 27 generates a second quantization control signal fed to quantizer 17, that is in an inverse relation with the control signal for the transform coefficients. It sets all samples in the residual to zero in the opposite scenario: when interframe correlation is low (i.e., intraframe correlation of the prediction error signal is high). *Id.*, 5:41-5:59 ("The coding controller 27 outputs two quantization characteristics control signals...to control the quantization characteristics of the quantizers 14 and 17."). Therefore, this control signal controls whether or not the residual is utilized, which Koga confirms is not used when "the motion vector reaches around the [upper] motion

compensation limit.” *Id.*, 7:44-64. That is, the spatial samples are foregone in favor of the transform coefficients because “orthogonal transformation contributes to effective data redundancy reduction if applied to encoding of pictures wherein the image is moving very rapidly. This stems from the fact that the correlation [of the prediction error] between consecutive frames is very high” (*id.*, 2:22-26).

171. Koga skips preserving the residual of the prediction error for rapidly moving scenes because that signal comprises highly uncorrelated samples which are used to provide fine detail. *Id.*, 7:44-64 (“[I]f the motion vector reaches around the motion compensation limit, then the quantizer 17 is controlled to output zero....”). For a rapidly moving image with large motion vectors, the image is blurred over consecutive frames resulting in widespread prediction error across the frame which leads to high correlation between the samples in the frame being encoded. Thus, “the orthogonal transformation contributes to effective data redundancy reduction if applied to encoding of pictures wherein the image is moving very rapidly” because it can be encoded at a low bit rate with a coarse level of quantization that “cut[s] off or discard[s] the coefficients corresponding to sophisticated patterns” without affecting perceived quality. *Id.*, 2:3-26. In other words, because the image is blurry to begin with, a viewer is unlikely to notice artifacts or errors introduced by the orthogonal transform, while at the same time being unlikely to perceive the extra detail provided by the spatial residual. *Id.*, 2:3-

21 (“This however, causes no significant problem concerning visual sensation in that the viewer is not particularly sensitive to the obscurity of a very rapidly moving image.”).

7. Dependent Claim 7 is rendered obvious by Koga combined with Lin.

- 7. The method of claim 2, wherein the non-outlier values used to replace the outlier values comprise an average of neighboring prediction error values.**
- 19. The apparatus of claim 13, wherein the non-outlier values....**

172. Claim 7 depends from claim 2. As I explained above, Koga in combination with Lin teaches claim 2. *Supra* §§VI.A.3 (incorporated here by reference). It is my opinion that Lin further teaches the remaining limitations. For example, Lin teaches replacing outlier values with median values calculated by a median filter. Ex-1005, ¶¶0071, 0120-0125.

173. Lin teaches **wherein the non-outlier values used to replace the outlier values comprise an average of neighboring prediction error values.** For example, Lin’s median replacement value is a statistical average of neighboring values. *Supra* §I.D. Lin teaches using configurations of “5×5,” “3×1,” or “3×3” pixel-sized windows, where the median average of values for 25, 3, and 9 neighboring pixels will each be taken, respectively. Ex-1005, ¶0071. As was known in the art, a median is a type of statistical average; statistical methods and techniques were commonly used in video compression applications. *Supra*

§I.D. Similar to Lin that replaces the isolated noise values with average (e.g., median) values of neighboring pixels in the window, the '991 patent discloses an embodiment where the outlier values are “substituted by interpolated representations of those values, e.g., by averaging the neighboring prediction error values.” Ex-1001, 5:24-65.

174. To the extent Nokia argues that the '991 patent requires replacing the outlier values with the mean, it would have been obvious to a POSITA to use other average calculating methods, such as the mean. Calculating the mean by interpolating nearby pixel values was known in the art. Like Lin's median filter, it was also common to use for smoothing purposes moving-average filters that replaced a pixel value with the mean average of pixels in a surrounding window. *Supra* §I.D. The three commonly known mathematical ways of quantifying the center (i.e., the statistical average) of a group of samples are the mean, median, and mode. Ex-1020, 000004-000006. A POSITA would have been motivated to try out the mean average among this limited set of options, and apply the filter that provides superior performance in terms of video quality or compression performance. Indeed, Lin suggests that “[f]urther variations in median filters are contemplated.” Ex-1005, ¶0125.

8. Dependent Claim 10 is rendered obvious by Koga.

10. The method of claim 1, wherein for the transform coding, a transform coefficient is formed, the transform coefficient comprising a weighting coefficient of a discrete transform basis vector.
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175. Claim 10 depends from claim 1. As I explained above, Koga alone, and Koga in combination with Lin, each teach claim 1. *Supra* §§VI.A.1-2 (incorporated here by reference). It is my opinion that Koga further teaches the remaining limitations of these claims. For example, Koga teaches orthogonal transforming with DCT or Hadamard transforms. Ex-1004, 4:61-5:4.

176. Koga teaches **wherein for the transform coding, a transform coefficient is formed**. As I explained above for claim 1, Koga's encoder orthogonally transforms the prediction error from subtracter 12 to form "transformation coefficient signals." *Id.*, 8:36-39, Fig. 3; *supra* §VI.A.1.[1b] (incorporated here by reference).

177. Koga teaches **the transform coefficient comprising a weighting coefficient of a discrete transform basis vector**. For example, Koga teaches orthogonal transforming with DCT or Hadamard transforms. Ex-1004, 4:61-5:4. A POSITA would have understood each of Koga's DCT transform coefficients to be weighting coefficients for a discrete transform basis vector, because DCT is defined by a number of basis vector functions and each transform coefficient weights the contribution of one of these basis vectors to the spatial reconstruction of the block when inverse transformed. The 2-dimensional DCT calculates the

transform coefficients by carrying out a 2-dimensional inner product between the block of input pixels and each of the basis vectors (Ex-1012, Fig. 2). *Id.*, 000007. The transform coefficients are restored to the spatial domain by carrying out the inverse, a 2-dimensional inner product between the transform coefficients and the inverse basis vectors. This was a well-known property of DCT. *See* Ex-1012, 000007-000008; *supra* §I.C. Similarly, it was known that the transform coefficients resulting from a Hadamard transform weights the discrete Walsh functions used as basis vectors for the Hadamard transform. *Supra* §I.C.

9. Dependent Claim 11 is rendered obvious by Koga.

11. The method of claim 10, wherein the discrete transform comprises a discrete orthogonal transform.

178. Claim 11 depends from claim 10. As I explained above, Koga alone, and Koga in combination with Lin, each teach claim 10. *Supra* §§VI.A.8 (incorporated here by reference). It is my opinion that Koga further teaches the remaining limitations of these claims. For example, Koga teaches orthogonal transforming with DCT or Hadamard transforms. Ex-1004, 4:61-5:4.

179. Koga teaches **wherein the discrete transform comprises a discrete orthogonal transform**. For example, Koga teaches orthogonal transforming with DCT or Hadamard transforms. *Id.*, 4:61-5:4. As was known in the art, both DCT and Hadamard transforms were commonly used discrete orthogonal transforms. *Supra* §I.C.

10. Dependent Claim 12 is rendered obvious by Koga.

12. A computer program product, embodied in a non-transitory computer-readable medium, comprising computer code configured to perform the method of claim 1.
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180. Claim 12 depends from claim 1 and recites additional language that is substantively similar to claim 13 (“comprising computer code configured to perform the method of claim 1”). *See also* §VI.A.2 (explaining shared limitations between claims 1 and 13). Because the substantive limitations of claims 12, 13, and 1 are the same, I have addressed only the differences below for claim 12. It is my opinion that Koga alone, and in combination with Lin, each render obvious claim 12.

Koga teaches claim 12.

181. Koga teaches and suggests **a computer program product, embodied in a non-transitory computer-readable medium**. A POSITA would have further found it obvious for Koga’s arrangement to include a **computer program product** because computer code was customarily packaged as computer program products for sale or distribution. *E.g.*, Ex-1014, ¶0003; Ex-1005, ¶0006.

182. Koga teaches using **non-transitory computer-readable media**, e.g., storing video data in “a suitable storage medium.” Ex-1004, 6:15-26; *see also* Ex-1004, 5:41-6:3, 4:34-41 (discussing buffer memory). To be “suitable,” Koga’s “storage medium” clearly must be non-transitory, and preferably non-volatile—

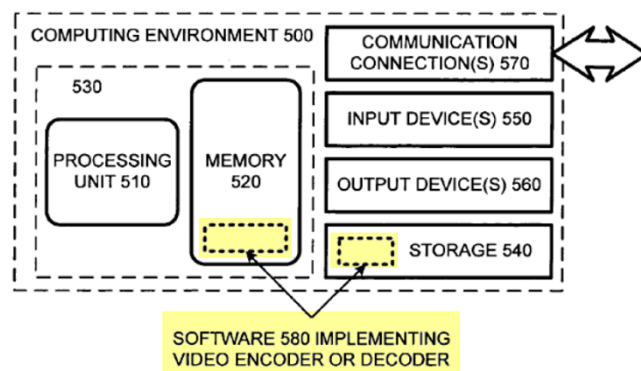
otherwise the computational effort spent to encode the video for future use would be wasted. This would teach and suggest the obvious to a POSITA—embodying the instructions in non-transitory computer-readable media so as to be used repeatedly throughout the lifetime of the equipment, which was customary by the 2007-2008 timeframe. *See supra* §I.G. Hence, a POSITA would have considered, and likewise been motivated to store the “computer program product” using non-transitory storage medium.

Lin further teaches claim 12.

183. To the extent Nokia argues that Koga does not teach this limitation, Lin reinforces Koga’s teachings with additional teachings of computer program products embodied in non-transitory computer readable media.

184. Lin further teaches **a computer program product**, e.g., “software 580 implementing a video encoder...or decoder.” Ex-1005, ¶0052, ¶0050, Fig. 5 (annotated):

FIG. 5



Typically, such software is developed and marketed as a program product for use on an operating system in a computing environment in the same manner as taught by Lin. *Id.*, ¶0053. The “computer-executable instructions” are “included in *program* modules.” *Id.*, ¶0058 (emphasis added). Lin provides an example of a commercialized computer program product for encoding/decoding video. *Id.*, ¶0006 (“Microsoft Corporation's Windows Media Video, Version 8 [‘WMV8’]”) (brackets in original).

185. Lin further teaches the software codec is **embodied in a non-transitory computer-readable medium**. For example, Lin teaches the software codec is stored in “memory 520[, which] may be volatile memory (e.g., registers, cache, RAM), *non-volatile memory* (e.g., ROM, EEPROM, flash memory, etc.), or some combination of the two.” *Id.*, ¶0052 (emphasis added), Fig. 5. As known in the art, non-volatile memory refers to durable non-transitory storage medium that preserves stored data in the absence of power for prolonged periods of time.

186. Lin additionally teaches storing the software in “storage 540[, which]...includes magnetic disks, magnetic tapes or cassettes, CD-ROMs, DVDs, or any other medium which can be used to store information” and therefore is non-transitory. *Id.*, ¶0054. Lin explains the medium “can be accessed within the computing environment 500,” meaning it is **computer-readable**. *Id.* Lin’s teaching is consistent with the state of the art and POSITA knowledge that I

explained above. I explained above how a POSITA would have been motivated to combine Koga's teachings with Lin's computing environment for claims 1 and 13, the same analysis applies here and is incorporated by reference. *Supra* §VI.A.2.[13pre]/[13a].

11. Dependent Claim 19 is rendered obvious by Koga combined with Lin.

19. The apparatus of claim 13, wherein the non-outlier values used to replace the outlier values comprise an average of neighboring prediction error values.
--

187. Claim 19 depends from claim 13. Claim 19 appears to be written in error because it lacks antecedent basis for "the non-outlier values" and "the outlier values." *Supra* §V.G. Because the limitations of claim 19 have the same scope as claim 7, the combination of Koga and Lin renders obvious claim 19 for the same reasons including Lin's teachings of median filtering and the obviousness of using a mean average filter. Ex-1005, ¶¶0120-0125; *supra* §VI.A.7 (incorporated here by reference).

12. Independent Claim 39 is rendered obvious by Koga combined with Lin.

188. Claim 39 is directed to a method that recites language substantively similar to a combination of claims 1, 2, 3, and 4. The following chart shows that the claims are substantially the same, except that claim 39 combines claims 3 and 4 and their respective ordering of transform coding and spatial coding as alternatives;

and explicitly recites the intermediate step of reconstructing the prediction error from the first of the transform or spatial coded prediction error. The material differences between the two claims is bolded and colored green:

Claim 39	Claims 1, 2, 3, and 4	
[39pre] A method, comprising:	[1pre] A method, comprising:	
[39a] calculating, by a processor, a difference signal representing differences between sample values of a predicted block of data and values for an original input block;	[1a] calculating, by a processor, a difference signal representing differences between sample values of a predicted block of data and values for an original input block;	
[39b] substituting, by a processor, outlier values in the difference signal with non-outlier values to create a modified prediction error signal;	2. The method of claim 1, further comprising, before performing transform coding and spatial coding, substituting outlier values in the difference signal with non-outlier values to create a modified prediction error signal.	
[39c] performing, by a processor, one of transform coding and spatial coding to the modified prediction error signal, creating one of a transform coded data and spatial coded data;	3. The method of claim 2, wherein transform coding is applied to the modified prediction error signal and spatial coding is applied	4. The method of claim 2, wherein spatial coding is applied to the modified prediction error signal and transform coding
[39c] performing, by a processor, an inverse of the one of transform coding and spatial coding;		

[39d] applying, by a processor, the other of transform coding and spatial coding to a residual from the inverse transform or spatial decoding, creating the other of transform coded data and spatial coded data ;	to a residual thereof.	is applied to a residual thereof.
[39e] joining, by a processor, the transform coded data and the spatial coded data to form a coded prediction error signal; and	[1d] joining, by a processor, the first and second representations to form a coded prediction error signal; and	
[39f] at least one of transmitting or storing the coded prediction error signal.	[1e] at least one of transmitting or storing the coded prediction error signal.	

189. Because the substantive limitations of claims 1, 2, 3, and 39 are the same, I have addressed only the differences below for claim 39. It is my opinion that Koga alone, and in combination with Lin, each render obvious claim 39.

[39pre] A method, comprising:	
[39a] calculating, by a processor, a difference signal representing differences between sample values of a predicted block of data and values for an original input block;	
[39b] substituting, by a processor, outlier values in the difference signal with non-outlier values to create a modified prediction error signal;	

190. It is my opinion that the combination of Koga with Lin teaches these limitations. I explained above for claim 1 how Koga alone, and in combination with Lin, each teach the substantive limitations of [1pre]-[1a] that share common

language with limitations [39pre]-[39a]. Because Grounds 1 and 2 satisfy limitations [1pre]-[1a], those same teachings also teach the same elements of limitations [39pre]-[39a] and that analysis is incorporated here by reference. *Supra* §§VI.A.1.[1pre]-[1a], VI.A.2.[13pre]/[13a].

191. I further explained above for claim 2, how Koga in combination with Lin, teach the substantive limitations of claim 2 that share common language with limitation [39b]. Because claim 2 is narrower than limitation [39b] and Ground 2 satisfies claim 2, those same teachings teach the common elements of limitation [39b] and that analysis is incorporated here by reference. *Supra* §VI.A.3.

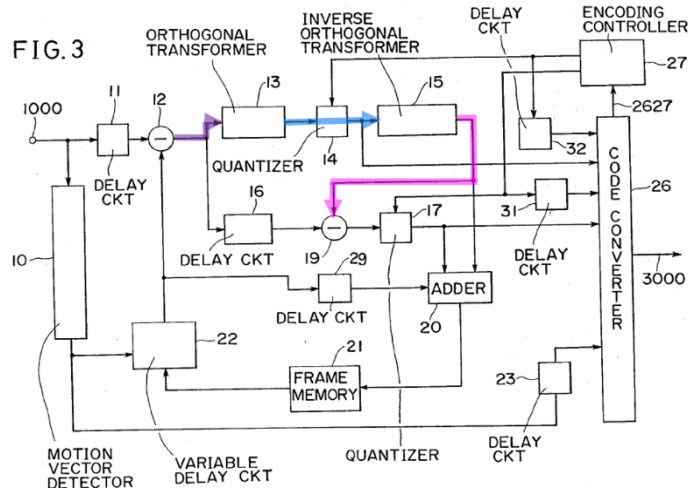
- [39c] performing, by a processor, one of transform coding and spatial coding to the modified prediction error signal, creating one of a transform coded data and spatial coded data**
- [39d] performing, by a processor, an inverse of the one of transform coding and spatial coding:**
- [39e] applying, by a processor, the other of transform coding and spatial coding to a residual from the inverse transform or spatial decoding, creating the other of transform coded data and spatial coded data;**

192. It is my opinion that the combination of Koga with Lin teaches these limitations. Together, limitations [39c], [39d], and [39e] call for either (1) transform coding the modified prediction error signal, decoding the transformed modified prediction error signal (which can be used to calculate a residual), and spatial coding the residual; or (2) doing the same in the opposite order by spatial

coding the modified prediction error signal first and transform coding the residual. The first case corresponds to claim 3, while the second corresponds to claim 4.

193. The combination of Koga and Lin satisfies at least the first case, because the combination satisfies claim 3 as I explained above. Those same teachings apply here to limitations [39c] and [39e] and that analysis is incorporated here by reference. *Supra* §VI.A.4; *see also* §§VI.A.3 (discussing Lin’s teaching of median filtering outlier values to create a modified prediction error signal), VI.A.1.[1b]-[1c] (discussing Koga’s teachings of orthogonal transforming a prediction error to create transform coefficients and encoding the residual in the spatial domain to create encoded residual samples). In addition to applying transform and coding methods to the respective signals, limitations [39c] and [39e] recite “performing, by a processor” the respective coding steps. I explained above how Koga alone, and in combination with Lin, each teach performing the video coding method by a processor. *Supra* §§VI.A.1.[1a], VI.A.2.

194. In connection with coding the prediction error, Koga further teaches **performing, by a processor, an inverse of the one of transform coding and spatial coding** as recited by limitation [39d]. For example, Koga teaches inverse orthogonal transforming the transform coefficients that were quantized at quantizer 14. Ex-1004, 5:4-7. Figure 3 shows that the quantized transform coefficients (at 14) are applied to inverse orthogonal transformer 15. Ex-1004, Fig. 3 (annotated):



195. A POSITA would have understood the inverse orthogonal transform to **perform...an inverse of...the transform coding**, because the inverse operation transforms the quantized transform coefficients back to the spatial domain to reconstruct the prediction error signal before the transform. I explained this above for limitation [1c], and how Koga teaches calculating the residual by subtracting the reconstructed prediction error from the originally prediction error signal. Ex-1004, FIG. 4, 5:4-16; *supra* §VI.A.1.[1c].

[39f] joining, by a processor, the transform coded data and the spatial coded data to form a coded prediction error signal; and

[39g] at least one of transmitting or storing the coded prediction error signal.

196. It is my opinion that the combination of Koga with Lin teaches these limitations. I explained above for claim 1 how Koga alone, and in combination with Lin, each teach the substantive limitations of [1d]-[1e] that share common language with limitations [39f]-[39g]. Because Grounds 1 and 2 satisfy limitations

[1d]-[1e], those same teachings also teach the same elements of limitations [39f]-[39g] and that analysis is incorporated here by reference. *Supra* §§VI.A.1. [1d]-[1e].

B. Grounds 3-4: Obviousness over the Combination of Narroschke with Koga and with Koga and Lin

197. Grounds 3 and 4 each combine Ground 1 (Koga alone) and Ground 2 (Koga and Lin) with Narroschke's teachings of using a flag to indicate coding of a block in the frequency/spatial domain. It is my opinion that a POSITA would have found the Challenged Claims obvious based on the teachings of these combinations. I have explained how Koga alone, and in combination with Lin teach the Challenged Claims for Grounds 1 and 2. *Supra* §VI.A. Grounds 3 and 4 likewise teach the Challenged Claims for the same reasons. In the following sections, I will explain how Narroschke further teaches one or more of the Challenged Claims.

1. Dependent Claims 8 and 20 are rendered obvious by Koga, and Koga and Lin, each further in view of Narroschke.

- | | |
|------------|--|
| 8. | The method of claim 1, further comprising providing an indication that no transform coefficients exist in the block of data if appropriate. |
| 20. | The apparatus of claim 13, further comprising.... |

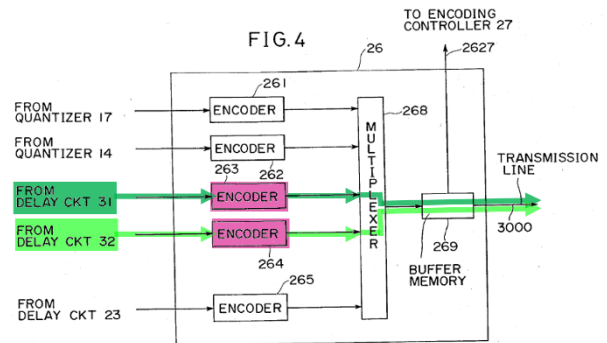
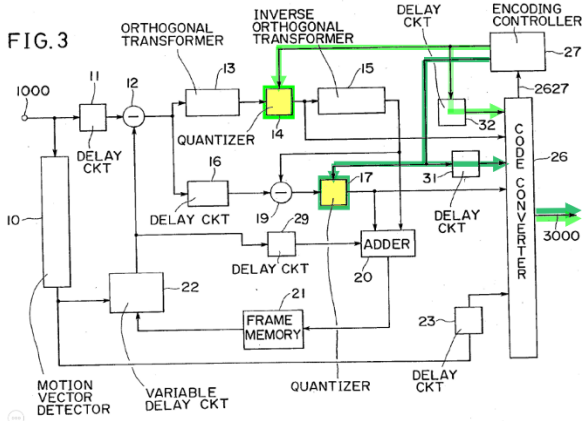
198. Claims 8 and 20 depend from claims 1 and 13, respectively, and are otherwise identical. As I explained above, Koga alone, and Koga in combination with Lin, each teach claims 1 and 13. *Supra* §§VI.A.1-2 (incorporated here by

reference). It is my opinion that the respective combinations with Narroschke each further render obvious the remaining limitations.

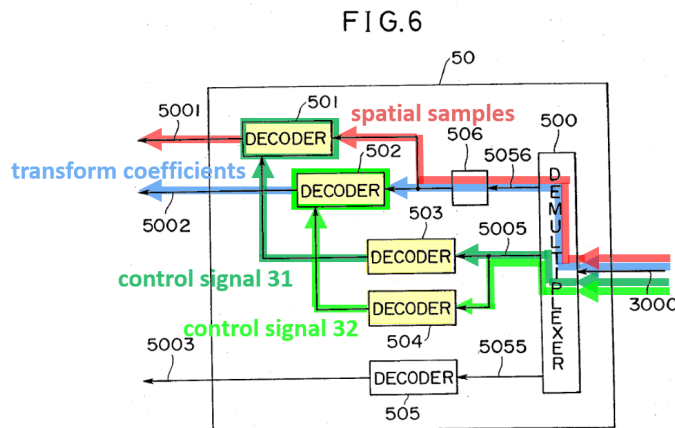
Koga teaches claims 8 and 20.

199. For example, as I also explained above for claims 5 and 17, Koga teaches generating and transmitting “quantization characteristic control signals” that indicate whether the transform coefficients are set to zero at quantizer 14, which occurs “if the motion vector is zero or close to zero.” Ex-1004, 7:44-64; *Supra* §VI.A.5.

200. Koga teaches **further comprising providing an indication**. For example, Koga encodes and transmits a quantization control signal for the transform coefficients. Ex-1004, 6:4-26 (“...the qua[n]tization characteristics control signals, applied from the delay circuits 31 and 32, are also coded...”). Figure 4 shows the quantization control signal is sent to code converter 26 via block 32 and entropy coded at encoder 264. *Id.*, 5:60-6:3 (“...three encoders 263, 264 and 265 which are respectively coupled to the delay circuits 31, 32 and 23....”), Figs. 3-4 (annotated):



201. In like manner with the transform coefficients and spatial residual samples as I explained above for claim 1, Figure 4 shows the encoded quantization control signal is then “combined at the multiplexer 268,” and provided, e.g., “fe[]d [] into the transmission line 300[0],” to the decoder. *Id.*, 6:4-26; *supra* §VI.A.1.[1d]-[1e] (explaining how Koga’s encoder joins the video components and transmits the encoded signal to a decoder; incorporated here by reference). Figure 6 shows the control signals are demodulated/demultiplexed by block 500, and then “decoded at the decoders 503 and 504.” *Id.*, 6:34-58, Fig. 6 (annotated):



202. Koga teaches the control signal is **an indication that no transform coefficients exist in the block of data if appropriate**. Koga teaches encoding the prediction error using both an orthogonal transform and direct spatial domain coding. *Supra* §VI.A.1.[1b]-[1c]. Koga teaches adjusting bit allocation between the two techniques “[b]y selecting the quantization characteristics,” which controls “the influence or contribution of the orthogonal transformation” and of the non-transformed residual. Ex-1004, 3:67-4:10. For example, Koga teaches “the orthogonal transformation is strongly suppressed” or “allowed to prevail” depending on the amount of motion in the scene to provide “picture quality which changes continuously or smoothly.” *Id.*, 4:11-20.

203. Koga teaches using quantization characteristic control signals to achieve this bit allocation. Koga generates two control signals that each respectively control the quantizer 14 for the transform coefficients and the quantizer 17 for the spatial residual. *Id.*, 5:41-5:59 (“The coding controller 27 outputs two quantization characteristics control signals which are respectively supplied to the quantizers 14 and 17 in order to control the quantization characteristics of the quantizers 14 and 17.”). At the decoder, the control signal from decoder 504 is then used to control the dequantization while decoding the entropy coded transform coefficients at decoder 502, and the control signal from decoder 503 is used to control the dequantization while decoding the spatial

residual samples at decoder 501. *Id.*, 6:51-7:19 (“The decoders 501 and 502 [de]codes the output of the delay circuit 506 using the quantization characteristics signals applied from 503 and 504, respectively.”).

204. Koga provides an example of how the quantization can be controlled. *Id.*, 7:44-64:

For example, in the case where the motion vector is used to control the quantizers 14 and 17 with respect to the quantization characteristics thereof, the delay circuit 23 is modified to have a tap coupled to the encoding controller 27, wherein the delay at the tap is made equal to the total delay at the delay circuits 11 and 16. **In this case, if the motion vector reaches around the motion compensation limit, then the quantizer 17 is controlled to output zero**, while, *if the motion vector is zero or close to zero, the quantizer 14 is controlled to generate a signal with zero value*, by way of example. On the other hand, in the case that the motion vector is in an intermediate range, the quantizers 14 and 17 are controlled, by moderate quantization characteristics, to realize a medium picture quality as compared to the case where the quantizers 14 and 17 is utilized independently.

205. In the latter portion I italicized and highlighted yellow in the passage above, Koga proposes quantizing the transform coefficients to zero when the image is still or moving slowly. A slow or still image exhibits highly localized and easily noticed regions of prediction error, as Koga demonstrates with Figure 2. *Id.*, Fig. 2. Koga suggests using spatial coding in this case, because orthogonal

transforms such as DCT either smooth fine detail excessively or require a fine level of quantization (that requires more bits to encode) to adequately represent such fine detail. Conversely, in the first portion I bolded and highlighted green in the passage above, Koga proposes quantizing the spatial residual to zero when the image is moving rapidly. Koga instead suggests encoding the prediction error by orthogonal transforming only. For a rapidly moving image, the image is blurred over consecutive frames resulting in widespread prediction error across the frame which is highly correlated between the samples in the current frame. In this case, transform coding is more suitable than spatial coding of the residual. As Koga notes, “orthogonal transformation contributes to effective data redundancy reduction if applied to encoding of pictures wherein the image is moving very rapidly[because]...the correlation [of the prediction error] between consecutive frames is very high.” *Id.*, 2:22-26. Because the image is blurry to begin with, a viewer is unlikely to notice artifacts or errors introduced by the orthogonal transform, or to benefit from the extra detail provided by the residual. *Id.*, 2:3-21 (“This however, causes no significant problem concerning visual sensation in that the viewer is not particularly sensitive to the obscurity of a very rapidly moving image.”).

206. A POSITA would have understood that setting all coefficients to zero is effectively the same as having no transform coefficients for the purpose of

decoding. A POSITA would have known the inverse orthogonal transform of an all zero matrix, also known as a null matrix, would likewise result in a null matrix and that adding the zero values at adder 54 would not alter the output signal. There would be no need to transmit the entire block of zeros, or process the non-extant transform coefficients. One of Koga's aims is "redundancy reduction of information to be transmitted" (*Id.*, 1:8-23) and a POSITA would have appreciated that providing an indication that no transform coefficients exist in lieu of transmitting all the information would increase compression by reducing the non-extant transform coefficient information.

207. Koga confirms that the provided and received control signal indicates that the "the orthogonal transform is [not] to be decoded," because the transform coefficients have been set to zero, "the decoder[...]502 outputs zero." *Id.*, 7:3-19. A POSITA would have recognized Koga's technique of adjusting quantization to set a range of values to zero to be what was later referred to as dead-zoning in the art, as described, e.g., by Lin. Ex-1005, ¶0130 ("A dead-zone is the region within which zero output is generated for some transform coefficient[s] during quantization"). It was customary for the parameters of quantization, e.g., "quantizer selection information" and "step size information" to "be provided to the decoder...as side information" (*id.*, ¶0138, ¶0062); a POSITA would have

understood Koga's control signal to provide similar information to indicate the absence of non-zero transform coefficients.

208. Additionally, Koga teaches its "motion vectors," which are similarly provided to the decoder, can also be used to indicate "[w]hether or not the orthogonal transformation is utilized," and therefore teach **providing an indication that no transform coefficients exist in the block of data if appropriate.** *Id.*, 4:21-33 ("Whether or not the orthogonal transformation is utilized, is determined with ease by checking whether a detected motion vector exceeds a predetermined range of motion compensation.'). This is because the scenarios where Koga uses its orthogonal transformation or not are directly correlated with the motion vectors. *Compare id.*, 4:21-33, *with id.*, 7:44-64. Koga teaches that they can be used for this purpose in place of the quantization characteristics. *Id.*, 4:21-33.

Narroschke further teaches claims 8 and 20.

209. To the extent Nokia argues that Koga does not teach the claimed **indication....**, the respective combinations with Narroschke each teach these claims. Narroschke reinforces Koga's teachings with additional teachings of setting a flag that indicates whether an entire slice/macroblock is coded in the spatial domain, or in the frequency (transformed) domain. Ex-1005, ¶0019, ¶0041. A POSITA would have been motivated to use Narroschke's flag in each

combination's codec to indicate whether the transform coefficients have all been set to zero for several reasons, as I explain further below.

210. Narroschke teaches **further comprising providing an indication that no transform coefficients exist in the block of data if appropriate**. For example, Narroschke teaches indicating with a flag whether a block, e.g., a macroblock or whole slice, includes only spatial information, or only transform coefficients. Ex-1006, ¶0019 (emphasis added):

Further, this aspect of the invention takes also account of the possibility that a whole macroblock or a whole slice may be coded *only in one of the two domains*. So, if for example an entire macroblock is coded in the spatial domain, this may be indicated by a single flag or the like. Further, even a whole slice may be coded only in the frequency or in the spatial domain, and a corresponding indicator could be included for the whole slice into the data stream. This results in a decreased data rate and a more efficient coding mechanism for the side information.

When Narroschke's flag indicates that "an entire macroblock is coded in the spatial domain" (*id.*), this would indicate that no transform coefficients exist in the block of data. Transform coefficients result from transform coding, which transforms the pixel values in the spatial domain into the corresponding domain of the transform function. In the case of DCT, that would be in the frequency domain. The thus

transformed values would no longer be in the spatial domain. Conversely, when the pixel values are coded only in the spatial domain and are not transform coded, there are no transform coefficients.

211. In one example, Narroschke's flag provides the indication "by a specific bit in the coded video data signal." Ex-1006, ¶0041. In the case of providing the indication for a slice, Narroschke aptly names the flag the "Slice_FD_SD_coding_flag", where FD stands for frequency domain and SD stands for spatial domain. *Id.* Narroschke proposes doing this for different sizes and levels of blocks, including macroblocks and slices as just discussed, as well as "blocks of a macroblock, which may all be coded in each of the two domains, or only in one domain." *Id.*

Motivation to Combine

212. *First*, Narroschke suggests "[a] similar scheme may be applied in other video coding algorithms for the prediction error coding." *Id.*, ¶0042. Like Narroschke, Koga teaches a hybrid video codec that carries out prediction error coding. Ex-1004, 2:55-3:4, 1:35-49, 4:42-5:24, Figs. 1-2, 3, 5; Ex-1006, ¶0026, ¶0029, ¶¶0002-0005, Figs. 1-2. It would have been obvious to combine Narroschke's flag with Koga's prediction error coding because Narroschke and Koga essentially teach the same thing (a way to indicate to the decoder whether a block includes only transform coefficients in the frequency domain, or only non-

transformed samples in the spatial domain) for the same purpose, and a POSITA would have recognized that Narroschke provides a simple but elegant implementation method for Koga's teachings. Koga's quantization characteristics control how respective prediction error signals in the frequency/spatial domains are quantized/dequantized, and are provided as side information to the decoder. Ex-1004, 5:41-59, 6:59-7:19. Narroschke's flag similarly controls how the prediction error signals are quantized/dequantized; it indicates whether signals are in the frequency/spatial domain and therefore whether to use quantizer parameters optimized for either domain. Ex-1006, ¶¶0018-0019, ¶¶0040-0041.

213. A POSITA would have been motivated to apply Narroschke's flag teachings to Koga because they provide clear benefits, including a simple and efficient way to encode this information—e.g., as a single “specific bit in the coded video data signal.” Ex-1006, ¶¶0041. In comparison to passing on the whole quantization characteristic control signal as disclosed in Koga, which a POSITA would have understood to include, e.g., quantizer step sizes and intervals, this would have provided an even more concise representation for this side information. As Narroschke puts it, “[t]his results in a decreased data rate and a more efficient coding mechanism for the side information.” *Id.*, ¶¶0019. Thus, the combination involves using a known technique to improve similar devices/methods in the same way.

214. *Second*, it was common in the art, including in the various, known video compression standards, to define and set flags to indicate the use of various profiles, coding modes, or options used for encoding, therefore requiring the use of a corresponding decoding method. *See supra* §I.A. Narroschke builds on and repurposes the use of flags in existing standards, presenting “exemplary syntax and semantics allowing the incorporation of the [flags] into the H.264/AVC coding scheme.” Ex-1006, ¶0042, Claims 35-36, Tables 2-4. For example, Narroschke teaches the “Slice_FD_SD coding flag may be introduced in the slice header,” while the “MB_FD_SD coding flag may be sent in each macroblock layer” and using “FD_or_SD flag” in the “residual_block_cabac” element of the macroblock element. *Id.*, ¶0042. A POSITA would have been motivated to incorporate into Koga the advanced techniques taught by Narroschke, which reflected years of improvement in video encoding/decoding techniques made after Koga and that had been standardized by 2007-2008.

215. A POSITA would have realized Koga’s method and apparatus were ready for improvement because Koga contemplated implementing its arrangement using prediction error coding techniques known at Koga’s time, 20 years before the 2007-2008 timeframe, when less research had been carried out in the field. Ex-1004, [22] (“Filed: Mar. 19, 1986”), [45] (“Date of Patent: Feb. 2, 1988”). Applying Narroschke’s newer methods to Koga’s codec would have been straight-

forward, because Narroschke provides specific details/examples of how to implement its techniques in other video compression standards, e.g., H.264/AVC. Ex-1006, ¶¶0036-0041, Tables 1-4.

216. *Third*, such a combination of prior art elements according to known methods would yield predictable results. Grounds 3 and 4 each add Narroschke's teachings of signaling the absence of transform coefficients or spatial samples with a flag to Koga's video codec. Koga teaches (1) a method/apparatus for encoding/decoding video; (2) encoding/decoding the prediction error in two signals (transform coefficients and a residual), one using transform coding and one without using transform coding (i.e., "**spatial coding**"); and (3) controlling the quantization characteristics for each of these signals. Ex-1004, 3:67-4:10, 5:41-6:26, 7:3-7:19. For Ground 4, Lin facilitates the combination by teaching a modern computing environment comprising a general processor communicatively coupled with memory/storage that includes a computer program code with instructions to encode/decode video. *See supra* §§VI.A.2.[13pre]-[13d], VI.A.11. The combined result is, e.g., a video codec operating as taught by Koga, with improvements to coding and transmitting quantization side information as taught by Narroschke. For Ground 4, the codec of Ground 3 is simply implemented in Lin's computing environment. None of these combinations would require significant changes to Koga's functions, Narroschke's techniques, or Lin's

computing environment. Koga's, Narroschke's, and Lin's respective teachings would have been used in a conventional manner, as explained below.

217. *Fourth*, Koga, Lin, and Narroschke share a similar purpose and architecture. I discussed above how Koga and Narroschke teach block-based hybrid coding with prediction error coding (*supra* ¶212), and Lin is no different. Ex-1005, ¶¶0013-0014, ¶¶0120-0122, ¶¶0015-0020, Figs. 6-7. Moreover, all three references seek to improve video compression by making it more efficient, e.g., providing better perceived quality at a lower bit rate. Ex-1006, ¶0005, ¶0007, ¶0019; Ex-1004, 1:8-14; Ex-1005, ¶0039, ¶0089, ¶¶0022-0025. Therefore, a POSITA reviewing any of the references would have been motivated to look to the others and given the similarities and combine their teachings because it would improve similar video coding methods and devices in the same way.

218. Combining Koga's, Lin's, and Narroschke's teachings would not have changed the references' principles of operation because it simply uses teachings from each according to their known principles, in the manner taught by each reference. Koga's encoder/decoder, quantization control, and entropy coding teachings, when combined with Narroschke's and/or Lin's related teachings would have still been applied in the manner taught by Koga, just with mundane changes or additional details from Narroschke/Lin. Similarly, Narroschke's teachings would have been applied to Koga and/or Lin in the manner taught by Narroschke,

to provide a flag related to quantization parameters. Lin's teachings would likewise have been applied to Koga and Narroschke in the manner taught by Lin, to implement a codec in a computing environment, including a general processor communicatively coupled with memory/storage embodying a computer program product with instructions to carry out the combined video coding method. Moreover, the references' similarities (discussed above) reinforce the fact that the combination would not change the principles of operation. Indeed, the combination would have been a simple matter of using known techniques, mapping the inputs and outputs of different blocks or components, and coding the techniques, which are mathematical algorithms, as software.

219. A POSITA would have had a reasonable expectation of success when combining the teachings of Koga and Narroschke, and further with Lin, because the teachings complement each other and are combined in a conventional manner that does not change any principle of operation but instead simply involves tweaks or the addition of implementation details. Indeed, the combination is based on compatible devices and techniques in video and image processing/coding based on the same, well-known hybrid coding scheme described above. The teachings of Koga, Narroschke, and Lin would each have been used for their known purposes in the conventional manner taught by each reference. A POSITA would have been more than capable of combining the teachings because the combination would

encode/decode video using a hybrid coding scheme, adaptively quantize and entropy code the prediction error signal in transformed and non-transformed parts, provide side information about the quantization, and implement these functions on a computer; all of these were well-known in the art.

220. A POSITA would have been fully capable of combining these references, including making routine modifications that, as explained above, would have involved straightforward processing of information using mathematically defined algorithms and implementing processes with routine programming. Hybrid video coding, predictive coding, transform coding, entropy coding, and quantization were all known in the prior art as I explained above. *Supra* §I.A-E. The combination is directed to the simpler aspects of combining such known techniques, integrating and interfacing their inputs and outputs, and programming a general-purpose computer to practice the techniques as taught.

221. As I discussed above for the Ground 2 combination, developing software and hardware for video coding was a common task, routinely involving combining and modifying different coding techniques and technologies. Thus, it is my view that a POSITA would have been able to combine the features of Koga, Narroschke, and Lin in the manner I describe herein, as, among other things, such combination would have been straightforward. *Supra* §§VI.A.2.[13pre]/[13a] (discussing reasonable expectation of success), IV.

2. Dependent Claims 9 and 21 are rendered obvious by Koga, and Koga and Lin, each further in view of Narroschke.

9. The method of claim 1, further comprising providing an indication that no spatial samples exist in the block of data if appropriate.

21. The apparatus of claim 13, further comprising....

222. Claims 9 and 21 depend from claims 1 and 13, respectively, and are otherwise identical. As I explained above, Koga alone, and Koga in combination with Lin, each teach claims 1 and 13. *Supra* §§VI.A.1-2 (incorporated here by reference). It is my opinion that Koga further teaches the remaining limitations of these claims.

Koga teaches claims 9 and 21.

223. As I explained above for claims 6 and 18, Koga teaches generating and transmitting “quantization characteristic control signals” that indicate whether the residual of the prediction error is set to zero at quantizer 17, i.e., all spatial samples are set to zero, which occurs “if the motion vector reaches around the motion compensation limit.” Ex-1004, 7:44-64; *Supra* §VI.A.6. Koga teaches **further comprising providing an indication**. For example, Koga encodes and transmits the quantization characteristic control signal for the residual of the prediction error. After being used to adjust quantization at quantizer 17, Figure 4 shows the quantization characteristic control signal is sent to code converter 26 via block 31 and entropy coded at encoder 263. Ex-1004, 5:60-6:3, Figs. 3, 4. I

explained above for claims 8 and 20 how the quantization characteristic control signals are applied to the quantizers and encoded at code converter 26, the same teachings and analysis apply to the quantization control signal that differs only in that controls quantizer 17 and goes through delay circuit 31 and encoder 263. Ex-1004, 6:4-26; *Supra* §VI.B.1 (incorporated here by reference).

224. I also explained above for claims 8 and 20 how the control signals are provided to the decoder in signal 3000 and decoded, the same analysis applies here and is incorporated by reference. Ex-1004, 6:34-58, Fig. 6; *Supra* §§ VI.B.1 (discussing extracting and decoding the control signal; incorporated here by reference).

225. The corresponding control signal from decoder 503 is used to decode the spatial samples from the encoded residual at decoder 501. Ex-1004, 6:51-7:2, 7:3-19. Koga confirms the control signal has been provided, by using it to determine whether to set “the decoder[]...501 [to] output[] zero” because there are effectively no spatial samples to decode. *Id.*, 7:3-19.

226. Koga teaches the control signal is an **indication that no spatial samples exist in the block of data if appropriate**. As I explained above for claims 5 and 17, Koga’s quantization control signal controlling quantizer 14 indicates “[w]hether or not the orthogonal transformation is utilized” in relation to the motion vector for that block/frame. *Id.*, 4:21-33. Koga teaches that Koga’s

controller 27 generates a second quantization control signal fed to quantizer 17, that is in an inverse relation with the control signal for the transform coefficients. It sets all samples in the residual to zero in the opposite scenario: when interframe correlation is low (i.e., intraframe correlation of the prediction error signal is high). *Id.*, 5:41-5:59 (“The coding controller 27 outputs two quantization characteristics control signals...to control the quantization characteristics of the quantizers 14 and 17.”). Therefore, this control signal controls whether or not the residual is utilized, which Koga confirms is not used when “the motion vector reaches around the [upper] motion compensation limit.” *Id.*, 7:44-64. That is, the spatial samples are foregone in favor of the transform coefficients because “orthogonal transformation contributes to effective data redundancy reduction if applied to encoding of pictures wherein the image is moving very rapidly. This stems from the fact that the correlation [of the prediction error] between consecutive frames is very high” (*id.*, 2:22-26).

227. As I explained above for claims 8/20, Koga teaches not encoding the spatial residual portion of the prediction error for rapidly moving scenes. *Id.*, 7:44-64; *supra* ¶¶204-205. In the same manner as for the transform coefficients, a POSITA would have understood that setting all samples to zero is effectively the same as having no samples for the purpose of decoding. A POSITA would have known that adding the zero values at adder 54 would not alter the output signal.

There would likewise be no need to transmit the entire block of zeros. One of Koga's aims is "redundancy reduction of information to be transmitted" (Ex-1004, 1:8-23) and a POSITA would have appreciated that providing an indication that no spatial samples exist in lieu of transmitting all the information would increase compression by reducing the non-existent transform coefficient information.

228. Additionally, Koga's "motion vectors" teach **providing an indication that no spatial samples exist in the block of data if appropriate.** *Id.*, 4:21-33 ("Whether or not the orthogonal transformation is utilized, is determined with ease by checking whether a detected motion vector exceeds a predetermined range of motion compensation."). Koga's disclosure of using the motion vectors to determine "[w]hether or not [the transformed prediction error signal] is utilized" teaches and suggests this limitation, because the scenario described in Koga to set the residual to zero is the opposite of, i.e., inversely correlated with, the situation to set the transformed prediction error to zero, which in turn are correlated with the motion vectors. *Compare id.*, 4:21-33, *with id.*, 7:44-64.

Narroschke further teaches claims 9 and 21.

229. To the extent Nokia argues that Koga does not teach the claimed **indication...**, the respective combinations with Narroschke each teach these claims. As I explained above for claims 5 and 17, Narroschke reinforces Koga's teachings with additional teachings of setting a flag that indicates whether the

prediction error for a slice or an entire macroblock is coded in the spatial domain, or in the frequency (transformed) domain. Just as a flag signaling that only spatial coding is being used indicates that there are no transform coefficients, if the flag signals that only transform coding is being used, this indicates there are no spatial samples. *Supra* §VI.B.1 (explaining how Narroschke teaches flags to indicate the absence of transform coefficients or spatial samples; incorporated here by reference). A POSITA would have been motivated to use Narroschke's flag in Koga's codec for the same reasons I explained above; that analysis is incorporated here by reference. *Supra* §VI.B.1 (explaining why Narroschke's flag would have been applied to Koga's method).

VII. Background and Qualifications

230. This section contains a summary of my educational background, career history, publications, and other relevant qualifications. My full curriculum vitae is attached as Appendix 1 to this declaration.

231. I received a Bachelor of Science degree in Electrical and Computer Engineering from the University of California at Davis in 1985. I received a Master's of Science degree in Electrical and Computer Engineering from the University of California at Santa Barbara in 1990, and I received my PhD in Electrical and Computer Engineering, also from the University of California at Santa Barbara in 1993.

232. I have more than 30 years of experience with data compression, decompression, and data storage.

233. I am currently a Full Professor in the Klipsch School of Electrical & Computer Engineering at New Mexico State University. I was an Assistant Professor at New Mexico State from January 2000 until I became an Associate Professor in 2004. I have been a Full Professor since August 2010. My research and coursework at New Mexico State have focused on digital signal and image and video processing. Much of the research I have done over the course of my career is in the area of image and video compression.

234. My first exposure to the field of signal compression came in the fall of 1989, when I took a course entitled Vector Quantization and Signal Compression at UCSB from Prof. Allen Gersho—an internationally renowned researcher in the area of speech compression. As my Ph.D. research progressed, I began to focus on transform-based compression as my main application area. My first paper dealing with image compression was published in 1991. I have since written 24 other journal and conference papers directly related to compression, and I am the named inventor on two issued United States patents related to compression.

235. Since joining the faculty of New Mexico State University in 2000, I have taught numerous classes at both the graduate and undergraduate levels. At the graduate level, I have taught the following courses: Signal Compression

(EE573), Image Processing (EE596), Digital Signal Processing (EE545), Pattern Recognition (EE565), Advanced Linear Systems (EE555), Telemetry Systems (EE585), Information Theory (EE586), Adaptive Signal Processing (EE594), Multirate Signal Processing and Wavelets (EE595), and Neural Signal Processing (EE590). At the undergraduate level, I have taught the following courses: Linear Algebra & Probability (EE200), Signals and Systems I (EE312), Image Processing (EE446), Introduction to Digital Signal Processing (EE395), and Digital Communications (EE497).

236. From 1993 through 1999, I was a Researcher and Team Leader, at the Naval Air Warfare Center, China Lake. At China Lake, my research efforts focused on high speed image and video compression technologies including embedded wavelet video compression. I also developed a real-time video streaming system that efficiently operated over TCP/IP networks while retaining the highest possible fidelity.

237. From 1990 through 1993, I worked as a Research Assistant in the Department of Electrical and Computer Engineering at the University of California, Santa Barbara. In this position, I worked on subband coding (compression) and multirate filter bank theory. I also implemented real-time filter banks on a digital signal processor. In the summer of 1992, I worked at AT&T

Bell labs where I developed and simulated new methods of extremely low bit rate video coding for video telephone applications.

238. From 1985 through 1989, I worked as a Design Engineer at the Naval Weapons Center, China Lake. In this role, I built and tested the guidance electronics for various laser guided munitions. This project included mixed analog and digital circuit design as well as the programming of an embedded digital signal processor. I also developed software for an advanced video processor and studied ground target tracking.

239. A full listing of my publications is found in my curriculum vitae. See Appendix 1.

240. I have published 17 peer-reviewed journal articles and 94 conference papers, including 9 journal articles and 30 conference papers directly related to data compression; the following are representative:

- C.D. Creusere, "A new method of robust image compression based on the embedded zerotree wavelet algorithm," IEEE Trans. on Image Processing, Vol 6, No. 10, Oct. 1997, pp. 1436-1442.
- C.D. Creusere, "Fast embedded compression for video," IEEE Trans. on Image Processing, Vol. 8, No. 12, pp. 1811-16, December 1999.

- C.D. Creusere, "Motion compensated video compression with reduced complexity encoding for remote transmission," Signal Processing: Image Communications, Vol. 16, pp. 627-42, April 2000.

241. I am a named co-inventor on two issued patents, both relating specifically to image and video compression. I am the listed inventor on U.S. Patent No. 6,148,111 entitled "Parallel digital image compression system which exploits zerotree redundancies in wavelet coefficients" and U.S. Patent No. 6,466,698 entitled "Efficient embedded image and video compression using lifted wavelets."

242. In addition to the experience and publications listed above, I have also received the following awards and distinctions that are relevant to the subject matter of this declaration. I am currently deputy Editor-in-Chief for IEEE Transactions on Image Processing as well as an Area Editor for IEEE Open Journal on Signal Processing. I have previously served as an Associate Editor for IEEE Transactions on Image Processing from 2010 through 2014. I have also served in this capacity from 2002 through 2005. From 2008-2013, I served as an Associate Editor for IEEE Transactions on Multimedia. I also served as a Senior Area Editor for IEEE Transactions on Image Processing from 2016-2022.

243. In 2004, I served as the co-general chair for the IEEE Digital Signal Processing Workshop in Taos, New Mexico. In 2012 and 2014, I served as the co-

technical chair for the Southwest Symposium on Image Analysis and Interpretation held in Santa Fe, New Mexico and San Diego, CA, respectively. In addition, I served as the technical chair for the 2015 and 2021 International Telemetering Conference held in Las Vegas, NV in October. I am also a member of the technical program committees for the IEEE Data Compression Conference, IEEE International Conference on Image Processing and the IEEE Acoustics, Speech, and Signal Processing Conference.

A. Compensation

244. For my efforts in connection with the preparation of this declaration I have been compensated at my standard rate for this type of consulting activity. My compensation is in no way contingent on the results of these or any other proceedings relating to the above-captioned patent.

B. Materials and Other Information Considered

245. I have considered information from various sources in forming my opinions. I have reviewed and considered each of the exhibits listed in the attached Appendix 2 (Materials Considered in the Preparation of This Declaration) in forming my opinions.

VIII. Understanding of the Law

246. I am not an attorney. In forming my opinions in this Declaration, I applied the relevant legal principles provided to me by counsel, which are summarized in Appendix 4.

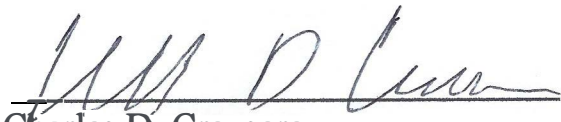
IX. Reservation of Rights

247. My opinions are based upon the information that I have considered to date. I am unaware of any evidence of secondary considerations with respect to the '991 Patent that would render any of the challenged claims non-obvious. I reserve the right, however, to supplement my opinions in the future to respond to any arguments raised by the owner of the '991 Patent and to take into account new information that becomes available to me.

248. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed on July 1, 2024.

By:



Charles D. Creusere

Appendix 1: Curriculum Vitae of Charles D. Creusere

VITA

CHARLES D. CREUSERE

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Article I. DISSERTATION TITLE

"Perfect Reconstruction Modulated Polyphase Filter Banks Using Reverse-Time Subfilters."

Article II. ACADEMIC TRAINING

1980-1985: University of California at Davis, B.S. in Electrical and Computer Engineering.

1989-1990: University of California at Santa Barbara, M.S. in Electrical and Computer Engineering.

1990-1993: University of California at Santa Barbara, Ph.D. in Electrical and Computer Engineering.

Article III. PROFESSIONAL EXPERIENCE

2010-Present Holder of the Frank Carden Endowed Chair in Telemetry & Telecommunications and Full Professor. Current research interests include compressive sensing/sparse reconstruction for LIDAR and streaming sensor data as well as EEG brain analysis for audiovisual perceptual quality assessment and modeling.

October 2008 Selected for the International Foundation for Telemetry Endowed Professorship.

Jan. 2000-2008 Assistant/Associate professor in the Klipsch School of Electrical & Computer Engineering. My teaching areas include digital signal processing, image processing, pattern classification, and source coding (signal compression). I have done past research in areas of image, video, and audio compression as well as feature vector extraction for pattern classification. Currently, my research interests include distributed compression, polarimetric image processing for scene analysis, and nonstationary signal denoising.

1993-1999: Researcher & Team Leader, Naval Air Warfare Center, China Lake. My research efforts have focused on high speed image and video compression technologies which offer unique capabilities such as robustness to transmission errors and regional localization. My team (2 other people) and I have implemented a real-time (3 to 15 frames/second with 240x512 frames)

320C80-based system which uses a wavelet transform along with embedded coding techniques to compress a video input and stream it through the Internet via TCP/IP protocols. Our recent research focus has been to add more intelligence to the encoder so that the space-frequency information in the image that is most useful for image analysis is received with the highest fidelity. While most of my recent research has been in the area of embedded compression, I am still very much interested in other applications of time/space-frequency decompositions and of multirate digital signal processing concepts in general.

1999, Spring Quarter: Instructor at the University of California at Santa Barbara. Taught graduate class in Multirate Digital Signal Processing, ECE 258B.

1990-1993: Research Assistant, Department of Electrical and Computer Engineering, University of California, Santa Barbara. Worked under Prof. S.K. Mitra on subband coding and multirate filter bank theory. Also implemented real-time filter banks on a Motorola 56001 digital signal processor.

1992: Summer Employee, AT&T Bell labs, Murray Hill, NJ. Developed and simulated new methods of extremely low bit rate video coding for video telephone applications.

1985-1989: Design Engineer, Naval Weapons Center, China Lake. Designed, built, and tested the guidance electronics for the Laser Guided Training Round. This project included mixed analog and digital circuit design as well as the programming of an embedded DSP. Also developed software for an advanced video processor and studied ground target tracking.

FUNDED RESEARCH

- (2000) Office of Naval Research, *Compression of Digital Elevation Maps Using Non-linear Wavelets*, 2000-2003, \$94K
- (2001) Sandia National Labs, *Intelligent Compression for Remote Sensing*, 2001-2003, \$70K.
- (2002) National Science Foundation (Early Career Grant), *Efficient Audio Compression with Perceptually Embedded Scalability*, 2002-2007, \$350K.
- (2004) National Geospatial-Intelligence Agency, *Passive Polarimetric Imagery Classification Study*, 2004-2006, \$160K (joint with Dr. David Voelz).
- (2005) Los Alamos National Laboratories, *Signal Detection via Adapted Filter Banks and Geometric Dimensionality Reduction*, 2005-2006, \$15K (unburdened).
- (2006) Los Alamos National Laboratories, *Signal Detection via Adapted Filter Banks and Geometric Dimensionality Reduction*, 2006-2007, \$50K (unburdened).
- (2006) National Geospatial-Intelligence Agency, *Exploiting Polarization in Imaging Systems*, 2006-2009, \$304K (joint with Dr. David Voelz).
- (2006) Army Research Office, *Distributed Source Coding Using Bitstream-based Detection and Classification*, 2006-2009, \$326K.
- (2006) DARPA (Subcontract from LANL), *ADAM Project*, 2006-2007, \$104K (joint with Dr. Joe Lakey and Dr. Jaime Ramirez)

- (2009) NMSU IRG, *Perceptual audio quality evaluation by direct measurement of human brain responses*, 2009-2010, \$39K (joint with Dr. Jim Kroger, Psychology)
- (2011) National Science Foundation, *CIF:Medium:Assessment and modeling of temporal variation in perceived audio and video quality using direct brainwave measurement*, 2011-2015, \$917K (lead PI with Dr. Jim Kroger and Dr. Joerg Kliewer as co-PIs)
- (2011) NASA EPSCOR, *Proximity Operations for Near Earth Asteroid Exploration*, 2011-2014, \$750K (co-PI, with Dr. Eric Butcher (lead), others)
- (2012) National Geospatial Intelligence Agency (NGA), *Pulse Complexity Based LIDAR Scene Modeling for Sparse Reconstruction and Super-Resolution*, 2012-2013 (plus 3 1 year options), \$150K (\$75K/option year), co-PI Dr. David Voelz.
- (2018) Airforce Research Lab (AFRL), *Software Radio Design in LabView FPGA*, 2018-2019, \$140K.

Article IV. PATENTS

- Patent titled "Parallel digital image compression system which exploits zerotree redundancies in wavelet coefficients," Patent Number 6,148,111.
- Patent titled "Efficient embedded image and video compression using lifted wavelets," Number: 6,466,698, granted October 15, 2002.

Article V. OTHER DISTINCTIONS

- Awarded the International Foundation for Telemetering Professorship, October 2008.
- Received an educational fellowship from the Department of Defense, 1989-1992.
- Certificate of Merit for the outstanding technical paper awarded at the AIAA Missile Sciences Conference for the paper "Automatic target recognition directed image compression," Nov. 1998.
- Patent (classified) "Notice of Allowability" titled, "Microcontroller-Based Laser Pulse Decoder," granted October 7, 1991.
- Associate editor for IEEE Trans. on Image Processing, 2002-2005, 2010-2014
- Associate editor for IEEE Trans. on Multimedia , 2008-2013.
- Guest Editor, "Issue on Advances in Hyperspectral Data Processing and Analysis", IEEE Journal of Selected Topics in Signal Processing, Vol. 5, Numbers: 5 & 6, August-September 2015,
- Co-general chair, IEEE Digital Signal Processing Workshop, August 2004, Taos, NM.
- Co-technical chair for the 2012 and 2014 Southwest Symposium on Image Analysis and Interpretation.
- Student Paper Contest Chair, 40th Asilomar Conf. on Signals, Systems, and Computers, October 2006.

- Organized special session entitled "Applications of Multirate DSP" at the 40th Asilomar Conf. on Signals, Systems, and Computers, October 2006.
- Member of technical program committees for the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), the IEEE International Conference on Image Processing (ICIP), and the IEEE Data Compression Conference (DCC).
- Senior Area Editor, IEEE Transactions on Image Processing, March 2016 to May 2022.
- Area Editor for IEEE Access, June 2022-Present.
- Deputy Editor-in-Chief, IEEE Transactions on Image processing, May 2023-present.

Article VI. CONSULTING ACTIVITIES

- Video compression systems (technology consultant), Abba Tech, Albuquerque, NM, 2000.
- Expert witness in laser rangefinding technology, Asia Optical Inc. (through NY law firm of Osterlenk, Faber, Gerb & Soffen), Case: LTI versus Nikon/AOI, July 2001-2003. Case went to trial/testified in court.
- Technical expert for defense; Case: Real-Time v. AT&T (byte.mobile), 2011-2012, case settled June 2012.
- Technical expert for defense; Case: Princeton Digital v. Dell, 2014-2015, case dismissed June 2015.
- Technical expert for defense; Noninfringement & IPR (6,597,812), Real-time v. SAP, 1/2016-6/2016.
- Technical expert for defense; IPRs (7,378,992 & 8,643,513), Real-time v. Riverbed, et al., 2/2016-2017
- Technical expert for defense; IPRs (7,415,530, 9,116,908, 7,161,506, & 9,054,728), Real-time v. Dell, et al., 2/2016-2017
- Technical expert for defense; Noninfringement, Real-time v. HP Enterprises, 4/2016-2018.
- Technical expert for defense; IPR (7,358,867, 7,161,506, & 9,054,728), Real-time v. Teradata 11/2016-2017
- Technical expert for defense; IPRs (7,415,530, 8,643,513 & 7,378,992), Real-time v. Veritas 12/2016-2017.
- Technical expert for defense; IPRs (7,075,917 & 6,304,612), UNILOC v. Apple 9/2018-2019.
- Technical expert for defense; IPR (7,558,730), Advanced Voice Recognition Systems v. Apple 7/2019-2020.
- Technical expert for defense; District Court; Noninfringement, Realtime Adaptive Systems v. YouTube/Google, 2018-2020.
- Technical expert for defense; ITC case; Nokia v. Lenovo, Oct. 2020-2021.
- Technical expert for defense; IPR (10,176,848), Maxell v. Apple, 2019-2021.

- Technical expert for plaintiff (rebutting invalidity); East Texas District Court; USAA v. PNC Bank, 2021-present. Deposed in Case 1 and Case 2; Attended trial in May 2022 for Case 1 and September 2022 for Case 2 but was not called to testify (USAA won on all counts, patents upheld as valid); I have also opined as an expert in 3 related IPRs (deposed in one of those cases, so far).
- Technical expert for defense; District Court; Gesture Tech Partners v. Apple/Lenovo&Motorola, 2021.

Article VII. JOURNAL PUBLICATIONS

1. **C.D. Creusere and S.K. Mitra**, "A simple method for designing high-quality prototype filters for M-band pseudo-QMF banks," *IEEE Trans. on Signal Processing*, Vol. 43, No. 4, April 1995, pp. 1005-1007.
2. **C.D. Creusere and S.K. Mitra**, "Efficient audio coding using perfect reconstruction noncausal IIR filter banks," *IEEE Trans. on Speech and Audio Processing*, Vol. 4, No. 2, March 1996, pp. 115-123.
3. **C.D. Creusere and S.K. Mitra**, "Image coding using wavelets based on perfect reconstruction IIR filter banks," *IEEE Trans. on Circuits and Systems for Video Technology*, Vol. 6, No. 5, Oct. 1996, pp. 447-458.
4. **C.D. Creusere**, "A new method of robust image compression based on the embedded zerotree wavelet algorithm," *IEEE Trans. on Image Processing*, Vol 6, No. 10, Oct. 1997, pp. 1436-1442.
5. **C.D. Creusere and A. Van Nevel**, "ATR-directed image and video compression," *Journal of Aircraft*, Vol. 36, No. 4, pp. 626-31, July-August 1999.
6. **C.D. Creusere**, "Fast embedded compression for video," *IEEE Trans. on Image Processing*, Vol. 8, No. 12, pp. 1811-16, December 1999.
7. **C.D. Creusere**, "Motion compensated video compression with reduced complexity encoding for remote transmission," *Signal Processing: Image Communications*, Vol. 16, pp. 627-42, April 2000.
8. **C.D. Creusere**, "Understanding perceptual distortion in MPEG scalable audio coding," *IEEE Trans. on Speech and Audio Processing*, Vol. 13, No. 3, pp. 422-431, May 2005.
9. **L. E. Boucheron and C.D. Creusere**, "Lossless wavelet-based compression of digital elevation maps for fast and efficient search and retrieval," *IEEE Trans. on Geoscience and Remote Sensing*, Vol. 43, No. 5, pp. 1210-1214, May 2005.
10. **V. Thilak, D. Voelz, and C.D. Creusere**, "Polarization-based index of refraction and reflection angle estimation for remote sensing applications," *Applied Optics*, Vol. 46, Bo. 30, pp. 7427-7536, Oct. 2007.
11. **C.D. Creusere, K. Kallakuri, and R. Vanam**, "An Objective Metric of Human Subjective Audio Quality Optimized for a Wide Range of Audio Fidelities," *Audio, Speech, and Language Processing, IEEE Transactions on [see also Speech and Audio Processing, IEEE Transactions on]*, vol.16, no.1, pp.129-136, Jan. 2008
12. **S. Kandadai and C.D. Creusere**, "Scalable Audio Compression at Low Bitrates," *Audio, Speech, and Language Processing, IEEE Transactions on [see also Speech and Audio Processing, IEEE Transactions on]*, vol.16, no.5, pp.969-979, July 2008
13. **S. Kandadai and C.D. Creusere**, "Reverse engineering and repartitioning vector quantizers using training set synthesis," *Signal Processing*, August 2008.
14. **V. Thilak, C.D. Creusere, and D. Voelz**, "Passive Polarimetric Imagery-Based Material Classification Robust to Illumination Source Position and Viewpoint," *Image Processing, IEEE Transactions on*, vol.20, no.1, pp.288-292, Jan. 2011.
15. **C.D. Creusere and J. Hardin**, "Assessing the Quality of Audio Containing Temporally Varying Distortions," *Audio, Speech, and Language Processing, IEEE Transactions on*, vol.19, no.4, pp.711-720, May 2011.

16. **Castorena, J.; Creusere, C.D.**, "The Restricted Isometry Property for Banded Random Matrices," *Signal Processing, IEEE Transactions on* , vol.62, no.19, pp.5073-5084, Oct.1, 2014
doi: 10.1109/TSP.2014.2345350.
17. **Castorena, J.; Creusere, C.D.**, "Sampling of Time-Resolved Full-Waveform LIDAR Signals at Sub-Nyquist Rates," *Geoscience and Remote Sensing, IEEE Transactions on* , vol.53, no.7, pp.3791-3802, July 2015. doi: 10.1109/TGRS.2014.2383839.

Article VIII. REFEREED CONFERENCE PUBLICATIONS

1. **H. Babic, S.K. Mitra, C.D. Creusere, and A. Das**, "Perfect reconstruction recursive QMF banks for image subband coding," *Proc. Asilomar Conf. Signals, Systems, and Computers*, Pacific Grove, CA, Nov. 1991, pp. 746-750.
2. **S.K. Mitra, C.D. Creusere, and H. Babic**, "A novel implementation of perfect reconstruction QMF banks using IIR filters," *Proc. IEEE Int. Symposium on Circuits and Systems*, San Diego, CA, May 1992, pp. 2312-2315.
3. **S.K. Mitra, C.D. Creusere, and H. Babic**, "Design of transmultiplexers using IIR filter banks," *Signal Processing VI: Theories and Applications*, Elsevier Science Publishers, 1992, pp. 223-226.
4. **C.D. Creusere and S.K. Mitra**, "Efficient image scrambling using polyphase filter banks," *Proc. International Conference on Image Processing*, Austin, TX, Nov. 1994, pp. 81-85.
5. **C.D. Creusere and G. Hewer**, "Wavelet-based nearest neighbor pattern classification using scale sequential matching," *Proc. Asilomar Conf. Signals, Systems and Computers*, Pacific Grove, CA, Nov. 1994, pp. 1123-1127.
6. **C.D. Creusere**, "Embedded zerotree image coding using low complexity IIR filter banks," *Proc. Int. Conf. on Acoustics, Speech, and Signal Processing*, Detroit, MI, May 1995, pp. 2213-16.
7. **C.D. Creusere and Gary Hewer**, "Digital video compression for weapons control and bomb damage indication," *AGARD Conference Proceedings 576*, Chapter 16, Sept. 1995.
8. **C.D. Creusere**, "Image coding using parallel implementations of the embedded zerotree wavelet algorithm," *Proc. of the Digital Video Compression Conference (Algorithms and Technologies 1996)*, San Jose, CA, Jan. 28-Feb. 2, 1996, pp. 82-93.
9. **C.D. Creusere**, "A family of image compression algorithms which are robust to transmission errors," *Proceedings of the SPIE*, Vol. 2825, Denver, CO, August, 1996, pp. 890-900.
10. **C.D. Creusere**, "Perfect reconstruction time-varying IIR filter banks," *Conf. Rec. Asilomar Conf. Signals, Systems, and Computers*, Pacific Grove, CA, Nov. 1996, pp. 1319-23.
11. **C.D. Creusere**, "Out-of-loop motion compensation for reduced complexity video encoding," *Proc. of the Data Compression Conf.* (pp. 428) & *Data Compression Industry Workshop* (pp.28-37), March 1997, Snowbird, UT.
12. **C.D. Creusere**, "Periodic pan compensation for reduced complexity video compression," *Proc. Int. Conf. on Acoustics, Speech, and Signal Processing*, Vol IV, pp. 2889-92, April 1997, Munich, Germany.
13. **C.D. Creusere**, "A new approach to global motion compensation which reduces video encoding complexity," *Proc. Int. Conf. on Image Processing*, Vol. III, pp. 634-7, October 1997, Santa Barbara, CA.
14. **C.D. Creusere**, "Spatially partitioned lossless image compression in an embedded framework," *Conf. Rec. 31st Asilomar Conf. on Signals, Systems, and Computers*, Nov. 1997, Pacific Grove, CA.
15. **C.D. Creusere**, "Adaptive embedding for reduced complexity image and video compression," *Proc.*

of the SPIE, Vol 3309 (Visual Communications and Image Processing), pp. 48-57, Jan. 1998, San Jose, CA.

16. **C.D. Creusere**, "Successive coefficient refinement for embedded lossless image compression," *Proc. of the Data Compression Conf.*, pp. 539, March 1998, Snowbird, UT.
17. **C.D. Creusere**, "Subband coding of speech and audio," *Proc. of the European Signal Processing Conf.* (invited paper), Sept. 1998, Isle of Rhodes, Greece.
18. **C.D. Creusere**, "Fast embedded video compression using cache-based processing," *Proc. of the European Signal Processing Conf.*, Sept. 1998, Isle of Rhodes, Greece.
19. **C.D. Creusere**, "Successive coefficient refinement for embedded lossless image compression," *Proc. Int. Conf. on Image Processing*, Oct. 1998, Chicago, IL.
20. **C.D. Creusere** and A. Van Nevel, "Autonomous target recognition directed image compression," *Proc. of the AIAA*, Nov. 1998.
21. **C.D. Creusere**, "Improved successive refinement for wavelet-based embedded image compression," *Proc. of the SPIE*, Denver, CO, July 1999.
22. A. Van Nevel and **C.D. Creusere**, "Intelligent Bandwidth Compression," *Proc. of the SPIE*, Denver, CO, July 1999.
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92. **Sergio Lara, Charles D. Creusere**, "LabView for Software Defined Radio Development," *International Telemetering Conference Proceedings*, October 2021.
93. **Ayatollah Elsayed, Charles D. Creusere**, "The Feedback Dynamics of Brain-Computer Interfaces in a Distributed Processing Environment," *Proceedings of HICSS-55*, January 2022; <http://hdl.handle.net/10125/79821>.
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Article IX. PRESENTATIONS & OTHER PUBLICATIONS

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2. **C.D. Creusere**, "Robust image coding using the embedded zerotree wavelet algorithm," presented at the Digital Compression Conference, Snowbird, UT, April 1996.
3. **C.D. Creusere**, "Creating a compressed and embedded image representation which is robust to transmission errors," presented at the Office of Naval Research Workshop on Error Resilient Compression, San Diego, CA, February, 1996.
4. **C.D. Creusere**, "Data Compression Project Final Report," NAWCWD Technical Paper, TP 8442.
5. **C.D. Creusere**: "Applications of multirate digital signal processing to communications systems," NATO/RTA lecture series 216 on *Applications of Mathematical Signal Processing Techniques to Mission Systems*, presented in Paris, France; Cologne, Germany; and Monterey, CA, November 1999.
6. **C.D. Creusere**, "Object detection and recognition in compressed video," invited presentation

and white paper for the Motion Imagery Workshop, sponsored by the National Imagery and Mapping Agency (NIMA) and the National Science Foundation (NSF).

7. **C.D. Creusere**, "Application specific compression: digital elevation map browsing, video surveillance, and scalable audio," invited seminar at the University of Arizona, Tucson, AZ, March 2003.

8. **C.D. Creusere**, "Compressing Digital Elevation Maps for Efficient Search and Retrieval," presented at the Office of Naval Research Workshop on Image Processing, Minneapolis, MN, May 2003.

Appendix 2: Materials Considered in the Preparation of this Declaration

Exhibit No.	Description
1001	US8,077,991 to Lainema ('991 patent)
1002	File History of U.S. Application 12/101,019
1004	US4,723,161 to Koga (Koga)
1005	US2006/0268990A1 to Lin (Lin)
1006	US2011/0038410A1 to Narroschke (Narroschke)
1007	US60/766300 (Narroschke provisional)
1008	File History of EP08737779
1009	File History of CA2,684,110
1010	Joint Claim Construction Statement in ITC INV-337-TA-1380
1011	EP0123456B1 to Chen (Chen)
1012	Watson, "Image Compression Using DCT" (Watson)
1013	Sayood, "Introduction to Data Compression" (excerpts) (Sayood)
1014	US2008/0225947A1 to Narroschke (Narroschke '947)
1015	JPA1986-214885 (EPO Machine Translation)
1016	US8,149,336 to Mohanty (Mohanty)
1017	WO99/07154A1 to Martens (Martens)
1018	Barnett & Lewis, "Outliers in Statistical Data" 2nd Ed. (excerpts) (Barnett).
1019	Hawkins, "Identification of Outliers" (excerpts) (Hawkins).
1020	Burr, "Applied Statistical Methods" (excerpts) (Burr)
1021	Administrative Status Summary of CA2,684,110

Appendix 3: Challenged Claims

[1pre] A method, comprising:

[1a] calculating, by a processor, a difference signal representing differences between sample values of a predicted block of data and values for an original input block;

[1b] performing, by a processor, transform coding to the difference signal, thereby creating a first representation of a first component of the difference signal;

[1c] performing, by a processor, spatial coding to the difference signal, thereby creating a second representation of a first component of the difference signal;

[1d] joining, by a processor, the first and second representations to form a coded prediction error signal; and

[1e] at least one of transmitting or storing the coded prediction error signal.

2. The method of claim 1, further comprising, before performing transform coding and spatial coding, Substituting outlier values in the difference signal with non-outlier values to create a modified prediction error signal.

3. The method of claim 2, wherein transform coding is applied to the modified prediction error signal and spatial coding is applied to a residual thereof.

5. The method of claim 1, wherein, for transform coding, at least one transform coefficient is set to zero.

6. The method of claim 1, wherein, for spatial coding, at least one spatial sample is set to zero.

7. The method of claim 2, wherein the non-outlier values used to replace the outlier values comprise an average of neighboring prediction error values.

8. The method of claim 1, further comprising providing an indication that no transform coefficients exist in the block of data if appropriate.

9. The method of claim 1, further comprising providing an indication that no spatial samples exist in the block of data if appropriate.

10. The method of claim 1, wherein for the transform coding, a transform coefficient is formed, the transform coefficient comprising a weighting coefficient of a discrete transform basis vector.

11. The method of claim 10, wherein the discrete transform comprises a discrete orthogonal transform.

12. A computer program product, embodied in a non-transitory computer-readable medium, comprising computer code configured to perform the method of claim 1.

[13pre] An apparatus, comprising:

[13a] a processor; and a memory unit communicatively connected to a controller and comprising:

[13b] computer code for performing transform coding to the difference signal, thereby creating a first representation of a first component of the difference signal;

[13c] computer code for performing spatial coding to the difference signal, thereby creating a second representation of a first component of the difference signal; and

[13d] computer code for joining the first and second representations.

14. The apparatus of claim 13, wherein the memory unit further comprises computer code for, before performing transform coding and spatial coding, Substituting outlier values in the difference signal with non-outlier values to create a modified prediction error signal.

15. The apparatus of claim 14, wherein transform coding is applied to the modified prediction error signal and spatial coding is applied to a residual thereof.

17. The apparatus of claim 13, wherein, for transform coding, at least one transform coefficient is set to zero.

18. The apparatus of claim 13, wherein, for spatial coding, at least one spatial sample is set to zero.

19. The apparatus of claim 13, wherein the non-outlier values used to replace the outlier values comprise an average of neighboring prediction error values.

20. The apparatus of claim 13, further comprising providing an indication that no transform coefficients exist in the block of data if appropriate.

21. The apparatus of claim 13, further comprising providing an indication that no spatial samples exist in the block of data if appropriate.

[39pre] A method, comprising:

[39a] calculating, by a processor, a difference signal representing differences between sample values of a predicted block of data and values for an original input block;

[39b] Substituting, by a processor, outlier values in the difference signal with non-outlier values to create a modified prediction error signal;

[39c] performing, by a processor, one of transform coding and spatial coding to the modified prediction error signal, creating one of a transform coded data and spatial coded data

[39d] performing, by a processor, an inverse of the one of transform coding and spatial coding:

[39e] applying, by a processor, the other of transform coding and spatial coding to a residual from the inverse transform or spatial decoding, creating the other of transform coded data and spatial coded data;

[39f] joining, by a processor, the transform coded data and the spatial coded data to form a coded prediction error signal; and

[39g] at least one of transmitting or storing the coded prediction error signal.

Appendix 4: Understanding of the Law

I have applied the following legal principles provided to me by counsel in arriving at the opinions set forth in this report.

Legal Standard for Prior Art

I am not an attorney. I have been informed by attorneys of the relevant legal principles and have applied them to arrive at the opinions set forth in this declaration.

I understand that the petitioner for inter partes review may request the cancelation of one or more claims of a patent based on grounds available under 35 U.S.C. § 102 and 35 U.S.C. § 103 using prior art that consists of patents and printed publications.

Anticipation and Prior Art

I understand that § 102 specifies when a challenged claim is invalid for lacking novelty over the prior art, and that this concept is also known as “anticipation.” I understand that a prior art reference anticipates a challenged claim, and thus renders it invalid by anticipation, if all elements of the challenged claim are disclosed in the prior art reference. I understand the disclosure in the prior art reference can be either explicit or inherent, meaning it is necessarily present or implied. I understand that the prior art reference does not have to use the same words as the challenged claim, but all of the requirements of the claim

must be disclosed so that a person of ordinary skill in the art could make and use the claimed subject-matter.

In addition, I understand that § 102 also defines what is available for use as a prior art reference to a challenged claim.

Under § 102(a), a challenged claim is anticipated if it was patented or described in a printed publication in the United States or a foreign country before the challenged claim's date of invention.

Under § 102(b), a challenged claim is anticipated if it was patented or described in a printed publication in the United States or a foreign country more than one year prior to the challenged patent's filing date.

Under § 102(e), a challenged claim is anticipated if it was described in a published patent application that was filed by another in the United States before the challenged claim's date of invention, or was described in a patent granted to another that was filed in the United States before the challenged claim's date of invention.

I understand that a challenged claim's date of invention is presumed to be the challenged patent's filing date. I also understand that the patent owner may establish an earlier invention date and "swear behind" prior art defined by § 102(a) or § 102(e) by proving (with corroborated evidence) the actual date on which the

named inventors conceived of the subject matter of the challenged claim and proving that the inventors were diligent in reducing the subject matter to practice.

I understand that the filing date of a patent is generally the filing date of the application filed in the United States that issued as the patent. However, I understand that a patent may be granted an earlier effective filing date if the patent owner properly claimed priority to an earlier patent application.

I understand that when a challenged claim covers several structures, either generically or as alternatives, the claim is deemed anticipated if any of the structures within the scope of the claim is found in the prior art reference.

I understand that when a challenged claim requires selection of an element from a list of alternatives, the prior art teaches the element if one of the alternatives is taught by the prior art.

Legal Standard for Obviousness

I understand that even if a challenged claim is not anticipated, it is still invalid if the differences between the claimed subject matter and the prior art are such that the claimed subject matter would have been obvious to a person of ordinary skill in the pertinent art at the time the alleged invention.

I understand that obviousness must be determined with respect to the challenged claim as a whole.

I understand that one cannot rely on hindsight in deciding whether a claim is obvious.

I also understand that an obviousness analysis includes the consideration of factors such as (1) the scope and content of the prior art, (2) the differences between the prior art and the challenged claim, (3) the level of ordinary skill in the pertinent art, and (4) “secondary” or “objective” evidence of non-obviousness.

Secondary or objective evidence of non-obviousness includes evidence of: (1) a long felt but unmet need in the prior art that was satisfied by the claimed invention; (2) commercial success or the lack of commercial success of the claimed invention; (3) unexpected results achieved by the claimed invention; (4) praise of the claimed invention by others skilled in the art; (5) taking of licenses under the patent by others; (6) deliberate copying of the claimed invention; and (7) contemporaneous and independent invention by others. However, I understand that there must be a relationship between any secondary evidence of non-obviousness and the claimed invention.

I understand that a challenged claim can be invalid for obviousness over a combination of prior art references if a reason existed (at the time of the alleged invention) that would have prompted a person of ordinary skill in the art to combine elements of the prior art in the manner required by the challenged claim. I understand that this requirement is also referred to as a “motivation to combine,”

“suggestion to combine,” or “reason to combine,” and that there are several rationales that meet this requirement.

I understand that the prior art references themselves may provide a motivation to combine, but other times simple common sense can link two or more prior art references. I further understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may come from market forces.

I understand obviousness to include, for instance, scenarios where known techniques are simply applied to other devices, systems, or processes to improve them in an expected or known way. I also understand that practical and common-sense considerations should be applied in a proper obviousness analysis. For instance, familiar items may have obvious uses beyond their primary purposes.

I understand that the combination of familiar elements according to known methods is obvious when it yields predictable results. For instance, obviousness bars patentability of a predictable variation of a technique even if the technique originated in another field of endeavor. This is because design incentives and other market forces can prompt variations of it, and predictable variations are not the product of innovation, but rather ordinary skill and common sense.

I understand that a particular combination may be obvious if it was obvious to try the combination. For example, when there is a design need or market

pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. This would result in something obvious because the result is the product not of innovation but of ordinary skill and common sense. However, I understand that it may not be obvious to try a combination when it involves unpredictable technologies.

It is further my understanding that a proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill in the art, not just the patentee. Accordingly, I understand that any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

It is my understanding that the Manual of Patent Examining Procedure §2143 sets forth the following as exemplary rationales that support a conclusion of obviousness:

- Combining prior art elements according to known methods to yield predictable results;
- Simple substitution of one known element for another to obtain predictable results;
- Use of known technique to improve similar devices (methods, or products) in the same way;

- Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- Choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art;
- Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

A person of ordinary skill in the art looking to overcome a problem will often use the teachings of multiple publications together like pieces of a puzzle, even though the prior art does not necessarily fit perfectly together. Therefore, I understand that references for obviousness need not fit perfectly together like puzzle pieces. Instead, I understand that obviousness analysis takes into account inferences, creative steps, common sense, and practical logic and applications that a person of ordinary skill in the art would employ under the circumstances.

I understand that a claim can be obvious in light of a single reference, if the elements of the challenged claim that are not explicitly or inherently disclosed in the reference can be supplied by the common sense of one of skill in the art.

I understand that obviousness also bars the patentability of applying known or obvious design choices to the prior art. One cannot patent merely substituting one prior art element for another if the substitution can be made with predictable results. Likewise, combining prior art techniques that are interoperable with respect to one another is generally obvious and not patentable.

In order for a claim to be found invalid based upon a modification or combination of the prior art, there must be reasonable expectation that a person of ordinary skill would have successfully modified or combined the prior art to arrive at the claimed arrangement. This does not mean that it must be certain that a person of ordinary skill would have been successful – the law only requires that the person of ordinary skill in the art would have perceived a reasonable expectation of success in modifying or combining the prior art to arrive at the claimed invention.

In sum, my understanding is that obviousness invalidates claims that merely recite combinations of, or obvious variations of, prior art teachings using understanding and knowledge of one of skill in the art at the time and motivated by the general problem facing the inventor at the time. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor

at the time of the invention, can provide a reason for combining the elements of or attempting obvious variations on prior art references in the claimed manner.

Legal Standard for Claim Construction

I understand that before any invalidity analysis can be properly performed, the scope and meaning of the challenged claims must be determined by claim construction.

I understand that a patent may include two types of claims, independent claims and dependent claims. I understand that an independent claim stands alone and includes only the limitations it recites. I understand that a dependent claim depends from an independent claim or another dependent claim. I understand that a dependent claim includes all the limitations that it recites in addition to the limitations recited in the claim (or claims) from which it depends.

In comparing the challenged claims to the prior art, I have carefully considered the patent and its file history in light of the understanding of a person of skill at the time of the alleged invention.

I understand that to determine how a person of ordinary skill would have understood a claim term, one should look to sources available at the time of the alleged invention that show what a person of skill in the art would have understood disputed claim language to mean. It is my understanding that this may include what is called “intrinsic” evidence as well as “extrinsic” evidence.

I understand that, in construing a claim term, one should primarily rely on intrinsic patent evidence, which includes the words of the claims themselves, the remainder of the patent specification, and the prosecution history. I understand that extrinsic evidence, which is evidence external to the patent and the prosecution history, may also be useful in interpreting patent claims when the intrinsic evidence itself is insufficient. I understand that extrinsic evidence may include principles, concepts, terms, and other resources available to those of skill in the art at the time of the invention.

I understand that words or terms should be given their ordinary and accepted meaning unless it appears that the inventors were using them to mean something else or something more specific. I understand that to determine whether a term has special meaning, the claims, the patent specification, and the prosecution history are particularly important, and may show that the inventor gave a term a particular definition or intentionally disclaimed, disavowed, or surrendered claim scope.

I understand that the claims of a patent define the scope of the rights conferred by the patent. I understand that because the claims point out and distinctly claim the subject matter which the inventors regard as their invention, claim construction analysis must begin with and is focused on the claim language itself. I understand that the context of the term within the claim as well as other claims of the patent can inform the meaning of a claim term. For example, because

claim terms are normally used consistently throughout the patent, how a term is used in one claim can often inform the meaning of the same term in other claims. Differences among claims or claim terms can also be a useful guide in understanding the meaning of particular claim terms.

I understand that a claim term should be construed not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the entire specification. I understand that because the specification is a primary basis for construing the claims, a correct construction must align with the specification.

I understand that the prosecution history of the patent as well as art incorporated by reference or otherwise cited during the prosecution history are also highly relevant in construing claim terms. For instance, art cited by or incorporated by reference may indicate how the inventor and others of skill in the art at the time of the invention understood certain terms and concepts. Additionally, the prosecution history may show that the inventors disclaimed or disavowed claim scope, or further explained the meaning of a claim term.

With regard to extrinsic evidence, I understand that all evidence external to the patent and prosecution history, including expert and inventor testimony, dictionaries, and learned treatises, can also be considered. For example, technical dictionaries may indicate how one of skill in the art used or understood the claim

terms. However, I understand that extrinsic evidence is considered to be less reliable than intrinsic evidence, and for that reason is generally given less weight than intrinsic evidence.

I understand that in general, a term or phrase found in the introductory words or preamble of the claim, should be construed as a limitation if it recites essential structure or steps, or is necessary to give meaning to the claim. For instance, I understand preamble language may limit claim scope: (i) if dependence on a preamble phrase for antecedent basis indicates a reliance on both the preamble and claim body to define the claimed invention; (ii) if reference to the preamble is necessary to understand limitations or terms in the claim body; or (iii) if the preamble recites additional structure or steps that the specification identifies as important.

On the other hand, I understand that a preamble term or phrase is not limiting where a challenged claim defines a structurally complete invention in the claim body and uses the preamble only to state a purpose or intended use for the invention. I understand that to make this determination, one should review the entire patent to gain an understanding of what the inventors claim they invented and intended to encompass in the claims.

I understand that 35 U.S.C. § 112 ¶ 6 created an exception to the general rule of claim construction called a “means plus function” limitation. These types of

terms and limitations should be interpreted to cover only the corresponding structure described in the specification, and equivalents thereof. I also understand that a limitation is presumed to be a means plus function limitation if (a) the claim limitation uses the phrase “means for”; (b) the “means for” is modified by functional language; and (c) the phrase “means for” is not modified by sufficient structure for achieving the specified function.

I understand that a structure is considered structurally equivalent to the corresponding structure identified in the specification only if the differences between them are insubstantial. For instance, if the structure performs the same function in substantially the same way to achieve substantially the same result. I further understand that a structural equivalent must have been available at the time of the issuance of the claim.