

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.

IPR2024-00921

U.S. Patent No. 8,077,991

PETITION FOR *INTER PARTES* REVIEW

OF U.S. PATENT NO. 8,077,991

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EXHIBIT LIST

Exhibit No.	Description
1001	US8,077,991 to Lainema ('991 patent)
1002	File History of U.S. Application 12/101,019
1003	Declaration of Charles D. Creusere
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

Hybrid video coding is a well-known way to compress digital video that combines motion prediction coding and spatial coding techniques. The '991 patent does not purport to invent hybrid video coding; rather it is directed to an alleged “system and method for *improving* prediction error coding performance of various video compression algorithms.” Ex-1001, Abs. The '991 patent was erroneously allowed because the Examiner incorrectly believed encoding a prediction error using a combination of transform coding and spatial coding was novel.

Amazon’s First Petition challenges non-overlapping claims directed to decoding video. This Petition challenges different claims that are directed to encoding video, including claims that require filtering outlier values during encoding. In addition, the Challenged Claims here suffer from several drafting errors that warrant claim construction.

I. BACKGROUND

A. Video Codecs

Video encoders and decoders (together, “codecs”) are built-upon technologies going back to the 1970s. Digital video involves sampling (e.g., measuring color and brightness) 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), reproduces the image, similar to the way that a picture in a magazine is printed using many small

dots. Such “spatially” sampled image information was too large to store and transmit, and led to the development of video compression techniques. Ex-1005, ¶¶0003-0004. Typical video compression techniques going back to the 1980s sought to compress input data while preserving perceptual quality by: (1) omitting information about pixels that could be deduced and (2) omitting information that had little impact on what the viewer perceives. Creusere (Ex-1003), ¶¶3-4.

Before 2007, well-known approaches for still image compression included “predicting” parts of an image using other parts of the image, “transforming” pixel values into another representation using mathematical operations, and “quantizing” information to reduce precision (e.g., reducing the number of shades into one or more representative colors). Adapting these approaches to video produced the dominant hybrid DPCM¹-transform coding method (hybrid video-coding), which combines prediction with transform coding and quantization. *E.g.*, Ex-1004; Ex-1006; Ex-1005. Instead of storing/transmitting all pixels, DPCM methods exploit temporal redundancy in an image sequence of a video by using a predictive coder (e.g., to predict pixel values based on the estimated motion of pixels in preceding

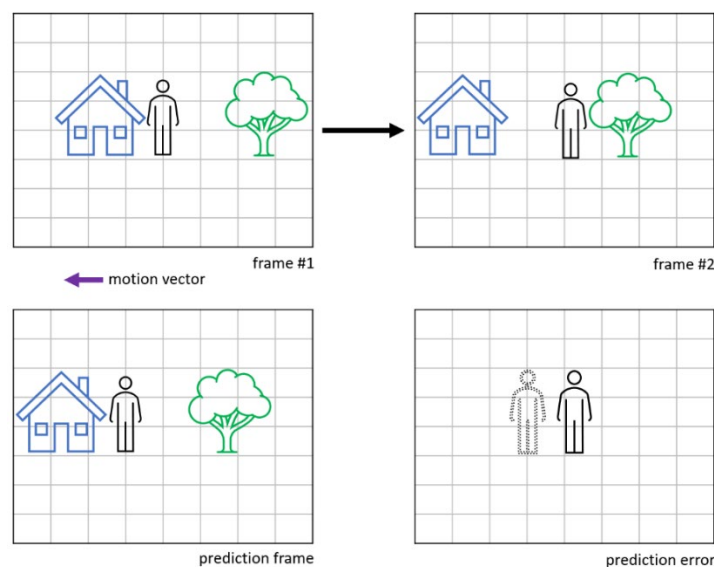
¹ DPCM stands for differential pulse code modulation. The idea of storing a sample or value as the differential over another dates back to the 1950s. *See* U.S. Patent No. 2,605,361.

or subsequent frames), and exploit spatial redundancy by using discrete cosine transform (DCT)-based transform coders (e.g., transforming the spatial relationship among a large number of pixels into mathematical (cosine) functions). Ex-1004, 2:3-21. However, the prediction is essentially a sophisticated guess, so the prediction of the frame is subtracted from the original data to generate a prediction error (“residual” values of the original that were not reflected in the prediction). Adding the residual pixel values to the prediction reconstructs the original image. The prediction error is also transformed and quantized to reduce its size. The different coded parts of the video are then each encoded with a lossless compression algorithm (entropy coding), packaged together, and stored or transmitted for viewing. Creusere, ¶¶5-7.

Hybrid video-coding is central to every major compression standard (including MPEG-1/2, ATSC, H.261-264) and discussed in countless prior art. *E.g.*, Ex-1004, 2:8-9; Ex-1006, ¶¶0002, 0005, 0009; Ex-1005, Figs. 3-4. The standards also describe supportive techniques and data formats, such as transmitting “side information” (e.g., a flag) to provide information related to the encoding such as motion vectors, various profiles, encoding modes, quantization parameters, or optional settings. Creusere, ¶8.

B. Predictive Coding

Predictive coding reduces redundant information by encoding just the differences the decoder can predict based on data it already has. The encoder itself contains an internal decoder to simulate decoding. This feedback loop ensures predictions at the encoder match the predictions at the viewer-side decoder, and allows the encoder to calculate a prediction error signal that helps to correct for differences between what is predicted and what was in the original image. To adjust for such errors, the resulting prediction is subtracted from the current input sample to create a prediction error signal. The original sample is reproduced by adding the prediction error to the predicted sample. The following diagram illustrates the relationship between the predicted image, motion vector, and the prediction error compared to the actual frame #2. Dr. Creusere provides a detailed explanation of the diagram in his declaration. Creusere, ¶9.



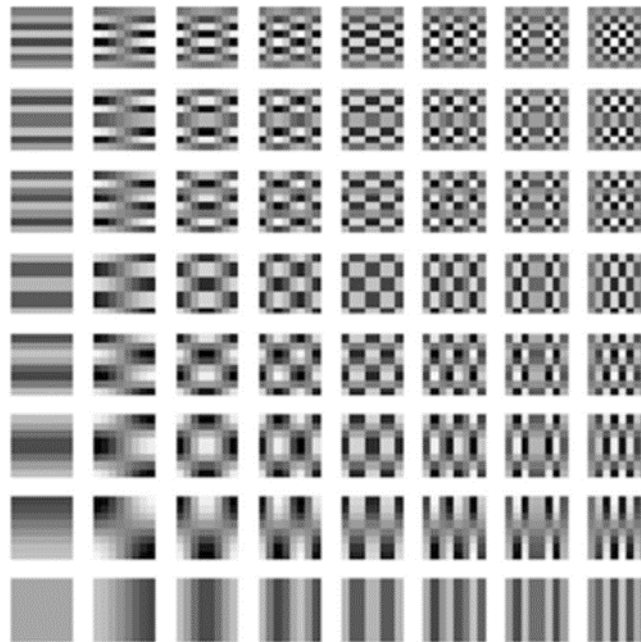
Predictive coding is also used for intra-frame coding in modern video standards. Ex-1005, ¶¶0005-0006. Intra-frame coding is typically applied directly to pixel values in the spatial domain (*see, e.g.*, Ex-1005, Figs. 1-2), and can also be applied to transformed information (*e.g.*, Ex-1005, ¶¶0007-0012, Fig. 1). For *inter*-frame coding (motion-compensated video compression), a motion estimation algorithm analyzes the movement of pixel blocks in the current video frame (*e.g.*, Ex-1005, ¶¶0013-0014) and attempts to describe the motion as vectors. The predicted frame generated with the motion vectors is then subtracted from the current frame to form the prediction error. Ex-1005, ¶0014, ¶¶0018-0020; Ex-1006, ¶0002. The prediction error is typically orthogonally transformed to reduce any spatial redundancy (Ex-1005, ¶0015; Ex-1006, ¶0026). Creusere, ¶¶10-11. The details of orthogonal transform coding is explained in the following section.

C. Transform Coding

Transform coding applies a mathematical operation to input data blocks to represent the data in a “transformed” space. *E.g.*, Ex-1006, ¶¶0002-0004; Ex-1005, ¶0072. For example, a number of samples distributed along a diagonal line are compounded into a single coefficient representing the line; they are thus transformed from two-dimensional space to the transformed space of a one-dimensional line. This transformed data is called “transform coefficients.” Creusere, ¶12.

Orthogonal transforms, such as DCT or Hadamard transform, are popular in compression because they can concentrate a data block's energy from a large number of correlated pixel samples into as few transform coefficients as possible, allowing most coefficients of a block to be set to zero. When many coefficients are zeroed out, fewer bits can represent all the pixels in the block, achieving a higher compression ratio. Ex-1006, ¶0009; Creusere, ¶14.

For DCT, the transform coefficients are labeled as “DC” (direct current, representing the mean of the whole block) or “AC” (alternating current), which quantify basis functions that are wave patterns of increasing frequency. Ex-1012, 000006 (Fig. 2, DCT basis functions):



While the input and output of an encoder/decoder pair are samples that represent the amount of perceived light at spatial locations (e.g. pixels), the

transform coefficients represent the amount of basis functions (basis vectors) in the image: how much an associated basis function is “mixed in” to (e.g., weights) the decoder’s reconstruction of the samples in space. Similar to DCT, the coefficients of a Hadamard transform weight the basis vectors. Creusere, ¶13.

A DCT processes $M \times M$ sized blocks with an identically-sized $M \times M$ DCT matrix, which results in a $M \times M$ matrix of coefficients. *See, e.g.*, Ex-1012, 000005-9. Square blocks of 4×4 or 8×8 pixels are typically used, resulting in identically-sized transform coefficients. Ex-1014, ¶0004; Ex-1012, 000005-12; Ex-1005, ¶0015, ¶0007, Fig. 1; Creusere, ¶15.

DCT performs poorly when the energy is already compacted (e.g., the non-zero samples are distributed across a small number of pixels), for example, when motion is accurately predicted for most of the frame, but does not match a few spatial samples. Ex-1006, ¶0002; Ex-1004, 2:3-37. Here, DCT spreads the energy out among more coefficients, which requires coding a larger number of bits. If the encoding is bit-constrained, some of those transform coefficients will be discarded, causing deterioration of image quality. So, it was known to encode the small number of non-zero samples of the prediction error as-is in the spatial domain (“spatial coding” per the ’991 patent), instead of transforming them. Ex-1006, ¶¶0002-0005; Creusere, ¶¶16-17.

D. Filtering Outliers

Statistical techniques were commonly employed in video coding, for example to modify the prediction error to enhance transform coding. *E.g.*, Ex-1017, 000004, 000010-000011. One such technique (“Winsorization”) involved moving outlying values in line with central observations (e.g., statistical average). Common methods used in video/image compression filtered the outliers by replacing them with the statistical average (mean or median) value of neighboring pixels. *E.g.*, Ex-1005, ¶¶0120-0125; Ex-1016, 2:35-60, 7:12-32. Median filtering was popular because it performs well in reducing isolated extreme values (e.g., salt and pepper noise), while preserving image features such as edges. *E.g.*, Ex-1016, 2:35-60. Creusere, ¶18.

E. Quantization

Quantization is a form of lossy-compression because it selectively removes bits and introduces distortion. For example, data with values ranging from 0 to 255 can be represented using 8-bits/sample. Quantizing these samples to 4-bits each would reduce the size by half, but lump values together in bunches of 16 (called bins or steps). For example, an original sample of 61 would be quantized to 4, then dequantized to 64—introducing an error of 3. The dynamic range (the range that values are distributed) of the sampled data also affects the relationship between quantization bin size and the decoder’s reconstruction accuracy. For

example, when identically quantized down to 4-bits, data originally sampled at 12-bits/sample would result in a bin size of 256 (i.e., larger potential error) in comparison to the example given above. Creusere, ¶19.

The bin size (or the compressed bit rate) and the dynamic range of the input jointly determine dequantized quality. Transform coefficients will generally have a lower dynamic range that is considerably different than that of the original pixels. Thus, the bin sizes of quantizers for transform coefficients and pixel values would be different even with the same number of bins—they would have to cover differing dynamic ranges. Creusere, ¶20.

The dead zone of a quantizer corresponds to the range of input values that are mapped to zero. For example, quantizing 8-bits for the range of $[-127, 127]$ to 4-bits, the dead zone will be approximately $[-8, 8]$. Input values between -8 and 8 are quantized to 0. It was known (in 2007-2008) that improved performance in terms of the perceptual quality to compression ratio could often be achieved by enlarging the dead zone. For example, large bit-rate reductions can be achieved by zeroing out additional higher-frequency transform coefficients with only a modest impact on quality. Adapting the dead-zone size based on the contents of blocks can provide even higher bit-rate reductions while maintaining quality. Creusere, ¶21.

F. Lossless Compression

Entropy coding can, and typically is, applied to most elements of the video data stream to further compress the data without losing any information. Huffman codes, arithmetic codes, Golomb-Rice codes, and dictionary codes were well-known examples. Creusere, ¶22.

G. Implementation of Codecs

Video codecs in the 1970-80s were generally implemented using custom circuitry, which were “processors” because they took input data (raw/compressed video) and outputted processed data (compressed/raw video). By 2007, general purpose processors (e.g., CPUs) in computers were used for video/image compression. *E.g.*, Ex-1005, ¶¶0051-0060. Codecs implemented as software were widely available and used (e.g., Microsoft Window’s Media Video, Apple QuickTime). Computer program code was commonly stored on various types of computer-readable media and memory. Creusere, ¶¶23-24.

II. THE ’991 PATENT

A. Admitted Art

The ’991 patent discloses a “system and method for improving prediction error coding performance” (Ex-1001, Abs.) that “relates to prediction error coding in both frequency and spatial domains” (*id.*, 1:7-9). The patent does not purport to invent “[t]ypical hybrid video codecs,” which encode video using “motion compensation mechanisms” and “spatial mechanisms,” and then code the

prediction error using a transformation such as DCT. *Id.*, 1:28-48. The patent also admits a typical hybrid video “encoder”/“decoder” was known that applies these 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.” *Id.*, 1:49-63; Creusere, ¶25.

The patent further acknowledges the well-known fact that transform coding may exhibit “suboptimal performance” when “good quality [motion] predictions” result in “minimizing and decorrelating the prediction error signal.” Ex-1001, 2:25-38. The patent also admits that “hybrid video coding schemes have been developed” to use a combination of inter-frame motion prediction and intra-frame spatial prediction. *Id.*, 2:39-54. The 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; Creusere, ¶¶26-27.

B. Alleged Invention

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).” Ex-1001, 2:58-3:12. While highlighting the known advantage of transform coding (“efficiently pack energy of the prediction error signal [] under certain statistics” (Ex-1001, 2:25-38)), the patent is silent as to

advantages of spatial coding, other than the purported advantage of combining it with transform coding. *Id.*, 3:35-49; *see also id.*, 1:11-2:54 (technical background); Creusere, ¶28.

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). It proposes substituting “outlier values” in the prediction error signal (interchangeably referred to as the difference signal) with “interpolated” or “averag[ed]” values for transform coding, and applying “spatial coding...(without transform) to the difference between the original outlier values and the transform decoded outlier values” (the residual). *Id.*, 5:24-50, Fig. 4 (highlighted):

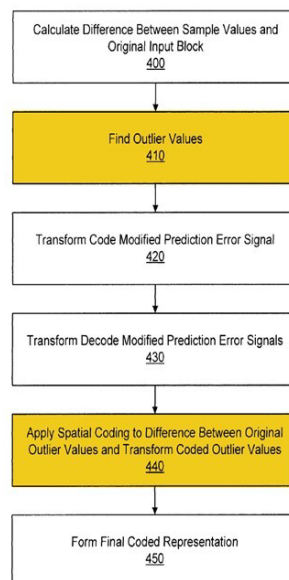


FIG. 4

The patent's proposed substitution of outlier values "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" and "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." *Id.*, 3:2-12; Creusere, ¶29.

However, encoding digital video using a combination of transform functions and spatial coding to improve compression efficiency was already known in the art; as was interpolating or averaging outlier values. *See supra* §§I.A, I.D; *infra* §II.C; Creusere, ¶¶30, 17, 4-8, 38.

C. Prosecution History

The '991 patent issued December 13, 2011, after one non-final office action. Ex-1002, 154-155. The office action did not include any prior art rejections. *See* Ex-1002, 000152-000194; Creusere, ¶31.

To address a §101 rejection, the claims were amended to recite trivial features, including each step being performed "by a processor," the computer-readable medium being "non-transitory," and adding a transmitting or storing step. Ex-1002, 000203-000213. Applicant removed "[encoding/decoding] a prediction error signal for a block of data" from preambles of the independent claims. Ex-

1002, 000204, 000207, 000209. This limitation was moved to the joining step in claim 1, but not in other claims. *Id.*; Ex-1002, 000204; Creusere, ¶¶32-34.

The Notice of Allowance noted three features that the Examiner believed were not taught by the prior art, all related to coding the prediction error as a combination of transform coding and spatial coding. Ex-1002, 000243; Creusere, ¶35.

After the '991 patent issued, Applicant conceded to the Canadian Intellectual Property Office that the cited prior art Santago discloses this very feature: 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. As a final attempt to overcome the CIPO’s rejection before abandoning the Canadian application, the claims were amended to include the outlier value substitution limitations found in dependent claims 2 and 14. *Id.* However, dependent claims 2 and 14 already stood rejected by Santago in combination with another prior art reference. *Id.*, 000059. While waiting for the CIPO to consider the amendment and arguments, Applicant abandoned the application. Ex-1021, 000002-000003. Applicant disclosed Santago and other foreign office actions citing Santago during prosecution of the '991 patent’s application before USPTO, but the Examiner did not discuss or otherwise use Santago. Creusere, ¶38.

D. Priority Date

The '991 patent claims priority to a provisional application filed on April 12, 2007. Creusere, ¶39. This Petition shows the Challenged Claims were invalid as of April 12, 2007.²

III. IDENTIFICATION OF CHALLENGE

A. Statutory Grounds

Petitioners request *inter partes* review and cancelation of the challenged claims 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 and Lin
3	1, 5-6, 8-13, 17-21	§103	Koga and Narroschke
4	1-3, 5-15, 17-21, 39	§103	Koga, Lin, and Narroschke

Grounds 1-4 render the challenged claims obvious because any differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to POSITA to which the subject matter pertains. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007); Creusere, ¶¶40, 42, 87.

² Petitioners reserve the right to challenge the '991 patent's priority date in this or other proceedings.

B. Relied-Upon Prior Art³

1. Koga (Ex-1004)

Koga is prior art under pre-AIA §§102(a) and (b) because it was patented (February 2, 1988) before the alleged invention and more than one year before the earliest filing date (April 12, 2007). Koga was not cited during prosecution.

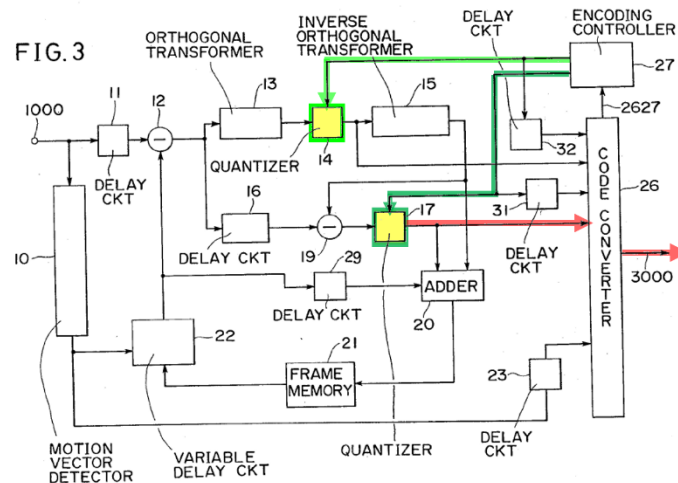
Creusere, ¶¶43-44.

Koga is directed to a method and arrangement of coding digital image signals. Ex-1004, [54]. Koga explains the same characteristic of orthogonal transformation as the '991 patent: it reduces data redundancy while encoding a prediction error in some scenarios, but is less effective in others (e.g., when “intraframe correlation of the prediction error signals is very low”). Ex-1004, 2:22-37; Creusere, ¶¶45, 26.

Koga addresses this problem by encoding the prediction error signal in the conventional hybrid-coding 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 and the original prediction error signal.” Ex-1004, 3:67-4:10; Creusere, ¶46.

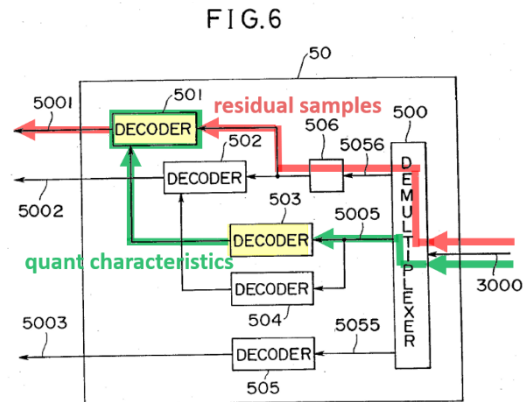
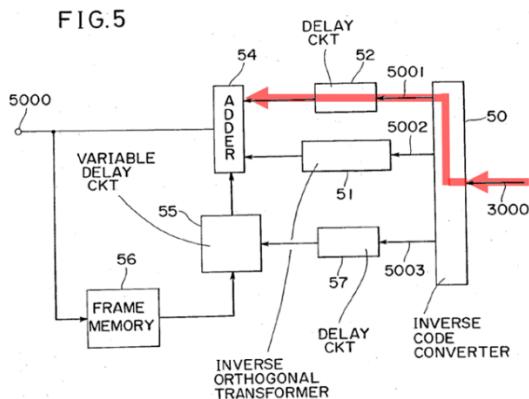
³ Pre-AIA 35 U.S.C. §102 applies. MPEP §2159.02.

Koga further proposes adaptively controlling how much of either technique is used by separately controlling the quantization characteristics of each output. *Id.* Figure 3 highlights Koga's two additions to a standard hybrid encoder (red for spatially encoded residual samples; green for quantization control signals that control the yellow quantizers):



Ex-1004, Fig. 3 (annotated). Creusere, ¶46.

The respective use of these signals for decoding the compressed video are shown below in Koga's Figures 5 and 6, which each depict the overall decoder and Inverse Code Converter 50, respectively, using like colors:



Ex-1004, Fig. 5 (annotated), Fig. 6 (annotated); Creusere, ¶47.

Koga is analogous prior art because it is in the same field of endeavor: video and image processing/coding. *Infra* §IV. Koga “provide[s] a method of encoding digitized images signals...for data compression or redundancy reduction,” and diagrams for corresponding encoders/decoders. Ex-1004, 2:45-54, Figs. 3-6. Koga is reasonably pertinent to the problem addressed by the ’991 patent because it attempts to address the same issue of suboptimal performance of transform coding in hybrid video coding. Creusere, ¶48.

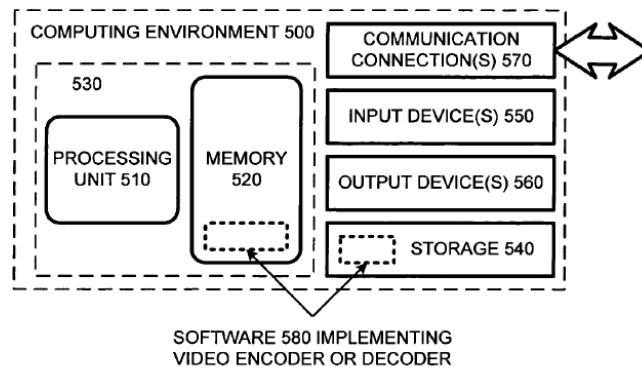
2. Lin (Ex-1005)

Lin is prior art under pre-AIA §§102(a) and (e) because it was published (November 30, 2006) from an application filed (May 25, 2005) before the alleged invention of the '991 patent. Creusere, ¶49. Lin was not cited during prosecution. Creusere, ¶43.

Lin demonstrates the obviousness of implementing known video compression techniques using a general purpose processor as of 2007. Ex-1005,

¶0020-0021; Creusere, ¶51. Lin describes a “computing environment” for video encoders/decoders. Ex-1005, ¶¶0050-0060, Fig. 5:

FIG. 5



Creusere, ¶50.

Lin’s computing environment includes “processing unit[s],” “computer-executable instructions,” and “non-volatile memory” “stor[ing] software.” Ex-1005, ¶0052; Creusere, ¶51.

Lin teaches a technique to enhance the compressibility of sample values using transform or entropy coding. Median filtering is used to “remov[e] isolated noise values” and replace them with the median of neighboring pixel values. Ex-1005, ¶0122; Creusere, ¶52.

Lin is analogous art because it is in the same field of endeavor as the ’991 patent. *Infra* §IV. Lin “describe[s] technology relat[ing] to video compression,” and techniques that are “incorporated into or used by embodiments of a video encoder and decoder....” Ex-1005, ¶¶0001, 0050. Lin is reasonably pertinent to

the problem addressed by the '991 patent because it improves on a similar hybrid video coding scheme and is classified in art class 375/240 found relevant by the Examiner. *Compare id.*, (52), with Ex-1001, (58); Creusere, ¶53.

3. Narroschke (Ex-1006)

Narroschke is prior art under pre-AIA §102(e) because it was published from an application filed December 22, 2006, which claims priority to a January 9, 2006 provisional, and both dates are before the earliest possible filing date for the '991 patent (April 12, 2007). Creusere, ¶¶54, 56. Narroschke was not cited during prosecution. Creusere, ¶43.

Narroschke is entitled to its provisional filing date under *Dynamic Drinkware* because (1) at least one claim of the reference is supported by the provisional, and (2) the specific subject matter relied upon in this Petition is supported by the provisional. The figures of Narroschke and its provisional are identical, and the two specifications disclose the same subject matter. *E.g., compare* Ex-1006, Figs. 1-6, *with* Ex-1007, (Figs. 1-6). All independent claims of Narroschke are supported by the provisional, as explained by Dr. Creusere. Creusere, ¶55 (analyzing and comparing Ex-1006, Claims 23, 30, 34, 37, 39, 40 with Ex-1007 (provisional application), ¶¶1, 5-7, Claim 1, Title, Abs., Figs. 1-2, 4, 6)).

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,” (*id.*, ¶¶0001-0002), including optimized “coding mechanisms...for the frequency domain” (*id.*, ¶0026) and those for “samples in the spatial domain.” (*id.*, ¶0005). To convey side information about the quantization, Narroschke sets and transmits flags to the decoder. *Id.*, ¶¶0018-0019. Narroschke also describes using entropy coding methods CABAC and CAVLC, and applying them to spatial domain samples. *Id.*, ¶0002, ¶0009, ¶0040; Creusere, ¶¶57-58.

Narroschke is analogous art because it is in the same field of endeavor as the '991 patent. *Infra* §IV. Narroschke “provide[s] a coding and decoding method, respective coders and decoders, data signals...[,] 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 because it relates to coding the prediction error signal in transform/spatial domains and is classified in art class 375/240 found relevant by the Examiner. *Compare* Ex-1006, (52), with Ex-1001, (58); Creusere, ¶59.

IV. LEVEL OF ORDINARY SKILL IN THE ART

The field of the '991 patent is video and image processing/coding. A hypothetical person of ordinary skill in the art (“POSITA”) in the field of the '991 patent would have had (1) a 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. Creusere, ¶¶60-63.

A POSITA in 2007-2008, would have known and had the skills necessary to:

- Design and implement video and image codecs using hardware, and software running on general-purpose and special-purpose computers;
- Understand video/image coding and processing in accordance with known video/image standards (e.g., MPEG-1/2/4, WMVx, H.26x, JPEG, JPEG-LS, JPEG2000);
- Understand coding and compression algorithms (e.g., entropy coding (arithmetic coding, variable-length encoding, Huffman coding, etc.), transforms (discrete cosine, Hadamard, etc.), pulse-code modulation (PCM, DPCM), perceptual coding, and quantization), the underlying concepts and mathematical properties, and their application to video and image coding; and
- Implement known techniques for processing video and image signals and blocks in hardware and software.

Creusere, ¶64.

V. CLAIM CONSTRUCTION

A. “spatial samples”

Amazon and Nokia agreed in an International Trade Commission investigation that “spatial samples” means “pixel values” in the context of the ’991 patent (Ex-1010, 000001; Creusere, ¶¶71), which is consistent with how the ’991 patent itself defines “spatial samples.” Ex-1001, 2:64-3:2 (“spatial samples (i.e., pixel values)”); Creusere, ¶¶67-68.

The claims and the specification confirm this. “Spatial samples” are calculated as a difference between a prediction error signal and a reconstituted prediction error signal, directly corresponding to values of pixels in the spatial domain, in contrast to transform coefficients in a transform domain (e.g., frequency domain). Ex-1006, 5:6-45, Fig. 4. Claim 22 confirms this by reciting the adding of the decoded spatial samples with other elements that are in the spatial domain, which would only be meaningful if the spatial samples are also in the spatial domain. Ex-1001, 6:47-55, Fig. 5; Creusere, ¶¶69.

The plain language of “spatial samples” supports the meaning as a sample value of a pixel. This is consistent with the prior art, which refers to pixel values “maintained in the spatial domain.” *Compare* Ex-1006, ¶¶0004; Ex-1005, ¶¶0072, *with* Ex-1001, 5:42-43; Creusere, ¶¶70.

B. “spatial coding”

“Spatial coding” means “coding in the spatial domain.” The ’991 patent departs from the conventional use of “spatial coding” as intra-frame coding. *See supra* §§I.B, I.C. Instead, the specification describes spatial coding as the coding (e.g., quantizing and entropy coding) of pixel values in the spatial domain “without transform,” but without limiting it to a particular algorithm or technique. Ex-1001, 5:6-23, Fig. 4. This is consistent with the prosecution of foreign counterparts where Applicant amended and clarified “spatial coding” (*id.*, 5:43-47, 9:6-7) to “spatial domain coding.” Creusere, ¶¶72-73, §II.B.2.

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

“Difference signal” means “prediction error signal.” Claims 1 and 39 define a “difference signal” as “representing differences between sample values of a predicted block of data and values for an original input block.” This corresponds to the well-known concept of a prediction error signal, which is confirmed by the specification. Ex-1001, 1:37-40 (“The second phase involves coding the prediction error, i.e. the difference between the predicted block of pixels and the original block of pixels.”). The specification and dependent claims 2 and 14 further confirm this: substituting outlier values in the difference signal results in “a modified prediction error signal.” *Id.*, 5:24-65, Fig. 4; Creusere, ¶¶74-75.

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

Claims 13 and 14 contain a drafting error that recites “the difference signal,” without antecedent basis. A POSITA would have understood “the difference signal” in these claims 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 limitation [1a] of claim 1, because Claim 13 is the corresponding apparatus claim and the specification supports this understanding. *Supra* §V.C; Creusere, ¶¶76-77.

E. “outlier values”

For the '991 patent, “outlier values” means “values for pixels that significantly differ from those for neighboring pixels.” The '991 patent states that “outlier values” refer to “the difference between sample values of a predicted block and an original input block.” Ex-1001, 5:28-50; Claims 2 and 14. From the example of outlier and non-outlier values in the specification and claims, a POSITA would have understood an outlier value to be a value that significantly differs from neighboring values. *See id.*, 5:51-65, Figs. 2(a)-2(c), 5:37-42, Claims 7 and 19. This is consistent with the term’s use in statistics. Creusere, ¶¶78-81.

F. Second Recitations of “a first component”

Independent claims 1 and 13 contain a drafting error that recites “a first component” twice. A POSITA would have understood that the second recitation of “a first component” was intended to be “a second component,” because the

specification discloses representing a prediction error signal in a first, transform coded component and a second, spatial-coded component. Ex-1001, 4:18-37, 2:58-3:12, Abs., 3:18-22 (“creating a first and second representations of first and second components”). The specification does not disclose creating first and second representations of a single first component. This interpretation is further supported by dependent claims 3-4. Creusere, ¶¶82-84.

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

The recitation of “the non-outlier values used to replace the outlier values” in claim 19 lacks antecedent basis. To the extent these limitations can be understood, a POSITA would have understood claim 19 to depend from claim 14, instead of claim 13 as recited, due to the parallelism of the claim sets. This reading of claim 19 would be consistent with the disclosures in the specification. Creusere, ¶¶85-86.

VI. CHALLENGED CLAIMS

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

Claims 1, 5-6, 8-13, 17-21 are obvious over Koga. To the extent Nokia argues that a general-purpose processor (e.g., a central processing unit) is required and Koga does not teach it or any other limitations, a POSITA would have found those limitations and claims obvious based on the combination of Koga and Lin. Creusere, ¶88.

1. Independent Claim 1 is rendered obvious by Koga.

Claim 1 is rendered obvious by Koga. Creusere, ¶¶89-125. Ground 2 (Koga and Lin) is discussed subsequently with claim 13.

[1pre] A method, comprising:

The preamble is taught by Koga. Koga teaches a “[m]ethod and arrangement of coding digital image signals” (Ex-1004, [54]), which comprises the elements recited in claim 1. *Id.*, 1:8-23; Creusere, ¶¶90-91.

[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;

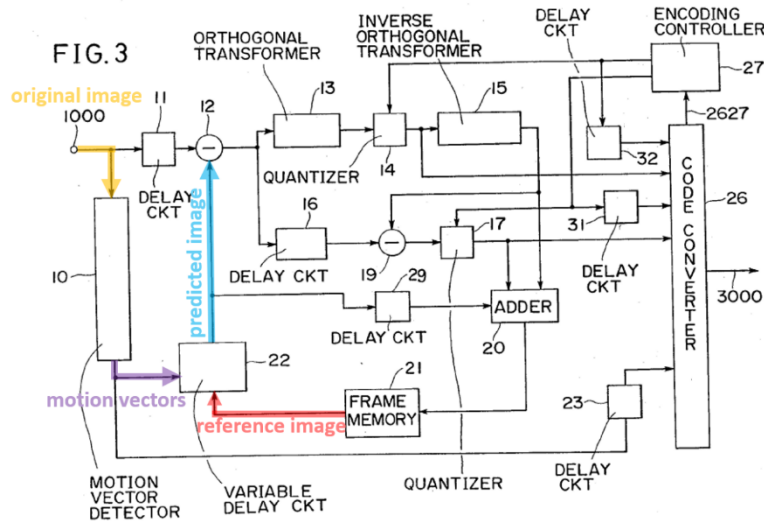
Koga teaches this limitation. Creusere, ¶¶92-102. Koga teaches an encoder that **calculat[es]...a difference signal representing differences between sample values of a predicted block of data and values for an original input block**. For example, Koga calculates a prediction error signal at subtracter 12. Ex-1004, 4:57-61, Fig. 3. A POSITA would have known that 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 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 a 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; Creusere, ¶93.

Because motion compensation does not perfectly encode the movement of all pixels in a frame/block, there are typically differences between an original image and corresponding prediction of the original image (henceforth, the predicted image). 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. Ex-1001, 1:37-40; Creusere, ¶94.

A POSITA would have understood that Koga's encoder determines a prediction error (in the same manner discussed above) as the output of subtracter 12 because the subtracter is subtracting the original image signal from a predicted image signal. Creusere, ¶95.

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:

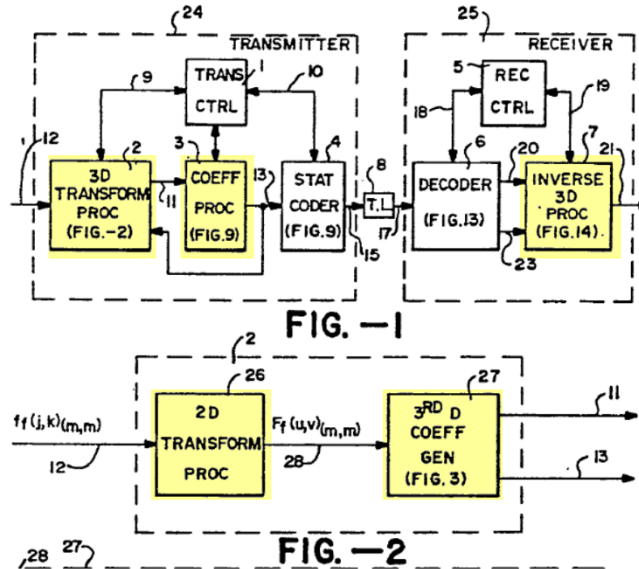


A POSITA would have known from Figure 3 that the frame memory contains the latest decoded frame (the reference image) because the local decoding loop (20-22) is the same as the decoder in Figure 5 (54-56). Accompanying text confirms this by explaining that the output of delay circuit 22 to subtracter 12 is a prediction signal (“*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); Creusere, ¶98.

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). Accompanying text confirms this: “*subtracter 12* determines the difference between the two signals applied thereto, and *outputs prediction error signals...*” Ex-1004, 4:61-64 (emphasis added); Creusere, ¶99.

Koga teaches the calculation is carried out **by a processor**. Koga's blocks and arrangements include "circuits," "circuit elements," and "circuit arrangements." Ex-1004, 3:7-14; 3:35-38, Figs. 5-6. Specifically, Koga's decoder 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 such blocks, circuits, elements, and arrangements comprise the claimed "processor" because they process data to generate a defined output as a result of the processing, and in particular process 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"); Creusere, ¶100.

Moreover, a POSITA would have understood circuitry that implements an encoder/decoder like Koga to be a processor. Prior art, like Chen, demonstrates video processing blocks were considered processors. Ex-1011, 3:60-61, 5:19-23, Figs. 1-2 (highlighted); Creusere, ¶101:

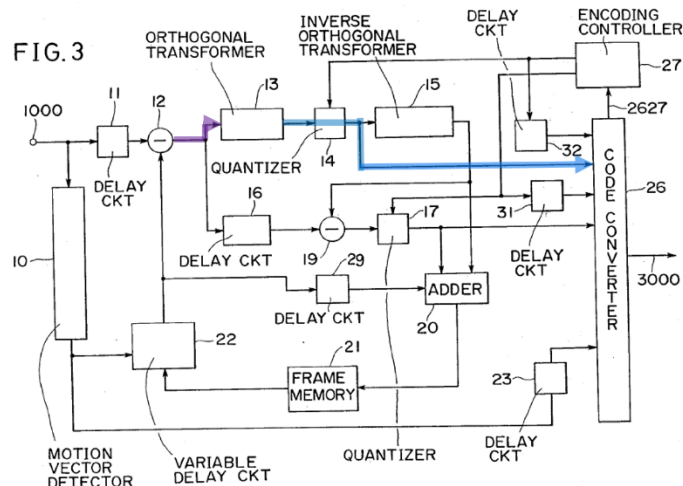


This is consistent with the '991 patent's statement that its codec may be implemented in a device including "codec circuitry 54." Ex-1001, 7:58-8:3, Fig. 9; Creusere, ¶102.

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

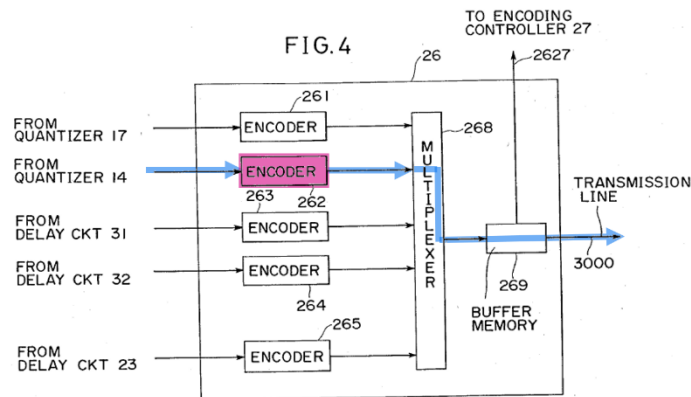
Koga teaches this limitation. Creusere, ¶¶103-108. Koga teaches **performing...transform coding to the difference signal**. For example, Figures 3-4 disclose that the prediction error signal is orthogonally transformed, quantized, and then entropy coded and multiplexed by the code converter into signal 3000. Koga's teaching is commensurate with the '991 patent's similar hybrid-video coding process, where "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; Creusere, ¶104.



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

Koga teaches that the transform coefficients are quantized and multiplexed into signal 3000 by code converter 26 (shown in further detail by Figure 4). Ex-1004, 5:4-8, 3:18-19 (linking Figs. 3-4). Figure 4 shows that the transform coefficients from quantizer 14 are encoded by encoder 262 and then multiplexed (268) into output signal 3000:



Ex-1004, Fig. 4 (annotated); Creusere, ¶106.

A POSITA would have understood Koga's transform coding **thereby creat[es] a first representation of a first component of the difference signal**, because the transform produces a representation (encoded transform coefficients) that represent a component (e.g., the corresponding block of pixel values) of the difference signal (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. Ex-1004, 4:64-5:7, 7:20-43. This is a first representation in relation to Koga's teaching of a second representation explained below for limitation [1c]. Creusere, ¶107.

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]; Creusere, ¶108.

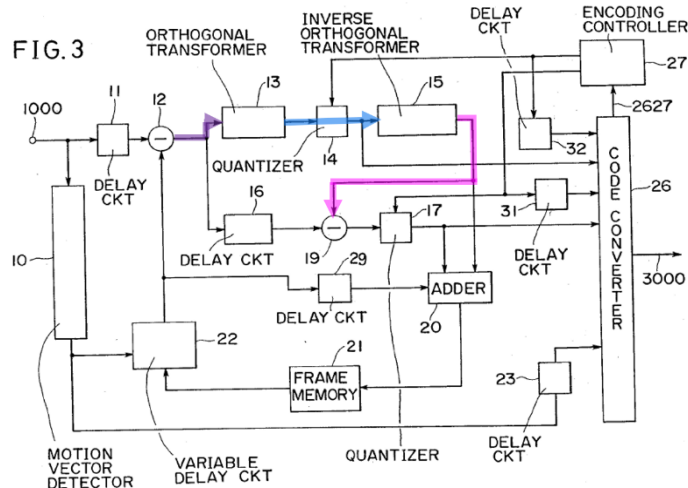
[1c] performing, by a processor, spatial coding to the difference signal, thereby creating a second representation of a first component of the difference signal;
--

Koga teaches this limitation. Creusere, ¶¶109-117. Koga teaches **performing...spatial coding to the difference signal**. For example, Figure 3 discloses the spatial coding of spatial samples produced at subtracter 19. The spatial samples produced at subtracter 19 are quantized at quantizer 17 and then entropy coded at the code converter 26 without transformation. They are spatial coded because they are processed as-is: coded (quantized and entropy coded) in the spatial domain. *See supra* §V.B; Creusere, ¶110.

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

Ex-1004, Fig. 3 (annotated); Creusere, ¶111.

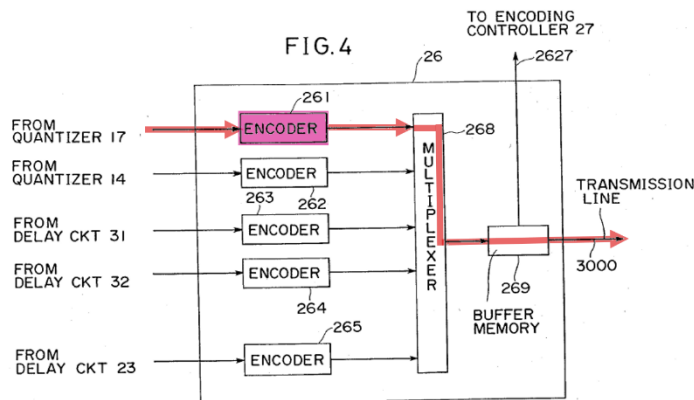
The second input to subtracter 19 is a reconstructed prediction error. As explained above, Figure 3 shows the prediction error (from subtracter 12) is orthogonally transformed (at 13) and then quantized (at 14). A POSITA would have understood that the output of quantizer 14 is quantized transform coefficients resulting from transforming the prediction error signal from the spatial domain to a transform domain (e.g., the frequency domain if DCT was applied). This was well-known. Creusere, ¶94. Figure 3 further shows that the quantized transform coefficients (at 14) are applied to inverse orthogonal transformer 15. Ex-1004, 5:4-7, Fig. 3 (annotated):



A POSITA would have understood that applying the inverse operation (e.g., by inverse orthogonal transformer 15) transforms the quantized transform coefficients back to the spatial domain. This was well-known. Creusere, ¶¶112-113.

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 (“[S]ubtractor 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. Creusere, ¶114.

Koga teaches that the residual of the prediction error (the output of subtracter 19) is quantized (at 17) and sent to code converter 26. Ex-1004, 5:16-19. Figure 4 and accompanying text disclose that the quantized residual of the prediction error is entropy coded (by encoder 261) and multiplexed into signal 3000. Ex-1004, 6:4-9, 6:15-22 (disclosing that output of encoder 261 is combined by the multiplexer), Fig. 4 (annotated):



Creusere, ¶115.

A POSITA would have understood the foregoing **thereby creat[es] a second representation of a second⁵ component of the difference signal**, because 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. Creusere, ¶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 explained 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 discarded for not being efficiently transform coded; they were

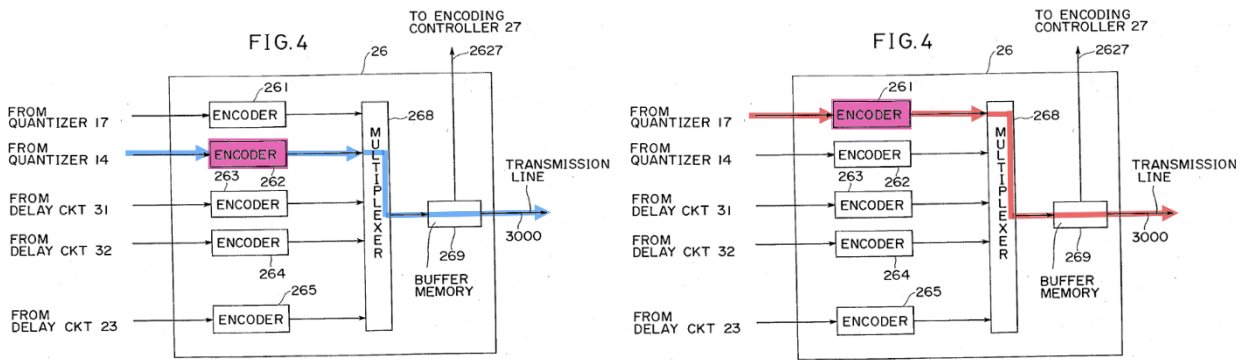
⁵ *Supra* §V.F.

not well correlated with the basis functions of the orthogonal transform. Creusere, ¶116.

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]; Creusere, ¶117.

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

Koga teaches this limitation. Creusere, ¶118-122. 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) and the residual samples from quantizer 17 (entropy coded by encoder 261) are multiplexed (268) into output signal 3000. *Id.*, Fig. 4 (annotated):



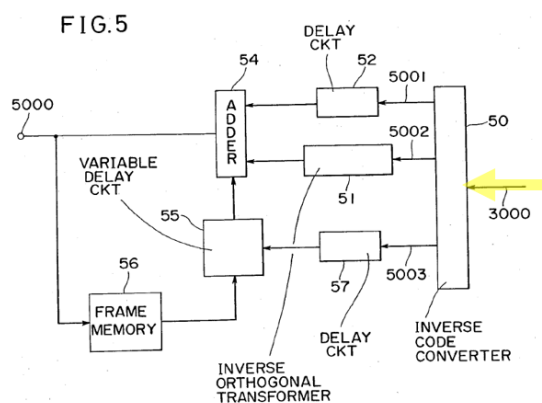
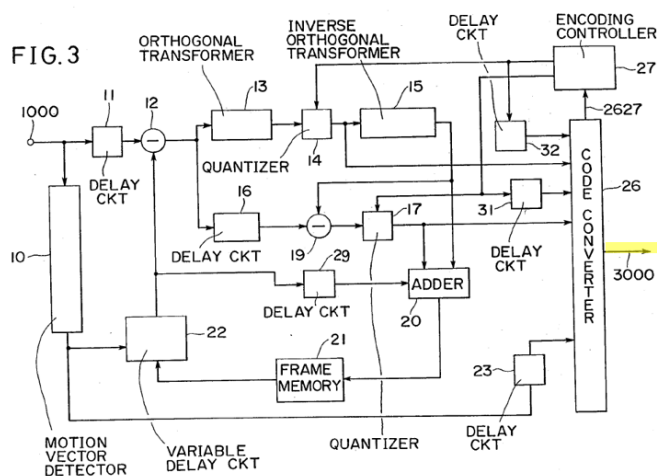
Creusere, ¶119. The accompanying text confirms that the encoded, quantized transform coefficients and the encoded, quantized residual samples are joined with the other components of Koga’s encoded signal. Ex-1004, 6:15-22; Creusere, ¶120.

A POSITA would have understood the two coded representations of the prediction error signal, joined in a “predetermined order,” **to form a coded prediction error signal**, that is included in video signal 3000, because it is the encoded output that comprises the full prediction error signal. *Supra* §VI.A.1.[1c]; Creusere, ¶121.

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]; Creusere, ¶122.

[1e]	at least one of transmitting or storing the coded prediction error signal.
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Koga teaches this limitation. Creusere, ¶123-125. Koga teaches **transmitting...the coded prediction error signal**. For example, Figures 3 and 5 teach transmitting the encoded prediction error signal over “transmission line 3000” from the encoder to the decoder:



Ex-1004, Figs. 3, 5 (annotated), 6:15-26 (“the coded information applied from the multiplexer 268 [is] fed [] into the transmission line 300[0]....”); 3:6-12 (explaining 3000 in Figs. 3 and 5 denote the same thing), 3:18-19; Creusere, ¶124.

Koga also teaches **storing the coded prediction error signal**. For example, Koga teaches “feed[ing the coded signal 3000] into...a suitable storage medium.” Ex-1004, 6:15-26; Creusere, ¶125.

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

Claim 1 recites a method with steps performed by a processor. Claim 13 is substantially the same (excluding limitation [1a]), but recites an apparatus with a processor and “a memory unit communicatively connected to a controller” including computer code for performing claim 1’s steps. Creusere, ¶126. Dr. Creusere provides a side-by-side claim comparison demonstrating this. Creusere, ¶127.

While Koga teaches a hardware-based encoder/decoder pair that performs claim 1’s method (*supra* §VI.A.1), Koga does not expressly disclose an apparatus comprising a processor and a memory unit containing computer code for performing its encoding method. A POSITA would have found it obvious to implement Koga’s encoding method in such an apparatus. It was customary by 2007 to implement video codecs using computers, including processors and memory including computer code to process image data being encoded/decoded. A POSITA would have found it obvious to do the same with Koga’s codec. *Supra* §I.G; Creusere, ¶131. A POSITA would have also found it obvious to combine Koga’s encoder/decoder teachings with Lin’s teachings of 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; Creusere, ¶128.

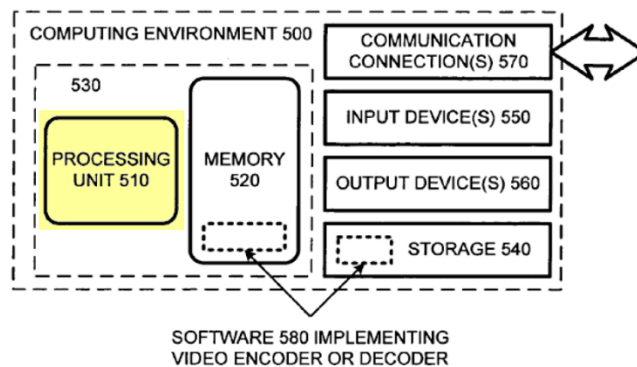
[13pre] An apparatus, comprising:

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

The Koga-Lin combination teaches the preamble and limitation [13a].

Creusere, ¶¶129-143. Lin teaches **a processor; and a memory unit connected to a controller**. For example, Lin discloses its computing environment includes a “processing unit,” and “memory” and “storage” 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 is a “processor.” *Id.*, ¶0052, ¶¶0058-0059. The computing environment further includes connections between the components: “[a]n interconnection mechanism (not shown) such as a bus, *controller*, or network interconnects the components of the computing environment 500” to “coordinate[] activities of the components.” Ex-1005, ¶0053 (emphasis added). A POSITA would have understood Lin’s memory and storage to be communicatively connected to an “interconnection mechanism” such as a controller. Creusere, ¶130.

A POSITA would have been motivated to implement Koga’s codec using a processor and controller with memory communicatively connected thereto, and further including computer code for processing video data, as taught by Lin for several reasons. Creusere, ¶132.

Motivation to Combine

First, Koga and Lin provide express teachings that would have motivated a POSITA to combine them. Lin suggests combining its teachings with other video coding methods. 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.” Ex-1005, ¶0152, ¶0050. Indeed, Koga teaches a video codec that could be implemented on Lin’s teachings of a computing environment (Ex-1005, ¶¶0050-0060) to process video using Koga’s encoding/decoding methods.

Likewise, Koga presents its invention as improvements on and additions to known hybrid-coding video encoders/decoders, like Lin. *See* Ex-1004, 1:6-2:42; Ex-1005, Figs. 1-4, 6-7. Creusere, ¶133.

Second, such a combination of prior art elements according to known methods yields predictable results. Koga teaches a hybrid-video codec where the prediction error is coded in transformed and non-transformed parts. Ex-1004, 3:67-4:10, 5:41-6:26, 7:3-7:19. Lin teaches a computing environment that includes memory embodying computer-executable instructions coupled in communication with processors. Ex-1005, ¶¶0050-0060. The combination yields the predictable results of implementing Koga's codec teachings using Lin's computing environment teachings. Creusere, ¶134.

Third, Koga and Lin share a similar purpose and architecture. Koga and Lin each teach block-based interframe coding (Ex-1004, 1:35-49, 4:42-5:24; Ex-1005, ¶¶0013-0014, ¶¶0019-0020) and correcting errors resulting from predicting blocks using a prediction error signal. Ex-1004, 2:55-3:4, 4:42-5:24; Ex-1005, ¶¶0120-0122, ¶¶0015-0020. Moreover, both employ adaptive coding techniques to achieve better quality at a lower bitrate. Ex-1004, 2:3-42, 3:67-4:33; Ex-1005, ¶¶0089-0090, ¶¶0140-0141; Creusere, ¶135.

Fourth, Koga's method and apparatus were ready for improvement. Koga teaches a video processing method of "high quality [for] still to very rapidly

moving content.” (Ex-1004, 2:45-54), but implemented on 20 years-old systems by 2007 (Ex-1004, [22]). Lin teaches a modern computing environment to implement similar processes. Ex-1005, ¶¶0051-0060. Thus, combining the two would have involved applying a known technique (video coding with processors etc.) to a known device/method (hybrid codec) ready for improvement to yield predictable results. Implementing Koga’s method as software to execute on newer, more powerful processor(s) would have been straight-forward, because it was well-known and customary to do so. Ex-1005, ¶0058; *supra* §I.G; Creusere, ¶¶136-137.

Fifth, the combination would have had several known advantages. For example, Lin’s computing environment provides a flexible solution, e.g., rewritable computer instructions. A POSITA would have appreciated the ease in writing/improving software code running on general-/special-purpose processors. This would provide time and cost savings in terms of developing, implementing, and updating the codec. Creusere, ¶138.

The widespread availability of standardized computer environments greatly reduced the need to distribute custom hardware. Instead, the codec could be distributed as software—cheaply replicable computer programs. Aware of such benefits, a POSITA would have been motivated. Creusere, ¶139.

The combination 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, just with straightforward changes or additional details. It would have been a matter of substituting and remapping known techniques, which are fundamentally mathematical algorithms that process data, and as such, can be implemented as software programs running on a computer. Creusere, ¶140.

A POSITA would have had a reasonable expectation of success because the combination is based on compatible devices and techniques in video and image processing/coding, based on the same hybrid-coding scheme. The teachings 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 use a hybrid-coding scheme, quantize and entropy code the prediction error signal in transformed and non-transformed parts, and transmit the encoded video; all well-known in the art. Creusere, ¶141.

A POSITA would have been 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. Hybrid coding, predictive coding, transform coding, entropy coding, and quantization were well-known in the prior art. *Supra* §§I.A-E. The combination is

directed to the easier aspects of combining such known techniques, integrating and interfacing their inputs and outputs, and programming a general-purpose computer to practice those techniques. Creusere, ¶142.

Developing software and hardware for video coding was common for POSITAs, and routinely involved combining and modifying different coding techniques and technologies. A POSITA would have been able to combine Koga and Lin. *See also supra* §IV; Creusere, ¶143.

[13b] computer code for performing transform coding...; [13c] computer code for performing spatial coding...; and [13d] computer code for joining....

The Koga-Lin combination teaches these limitations. Creusere, ¶¶144-146. A POSITA would have found it obvious to implement Koga’s encoding method on an apparatus according to Lin’s teachings, implementing Koga’s encoding method as software: computer code stored in Lin’s memory. *Supra* §VI.A.2.[13pre]/[13a]; Creusere, ¶144.

A POSITA would have understood “the difference signal” recited in claim 13 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]. *Supra* §V.D. As explained above, Koga teaches limitation 1[a] and the shared substantive limitations of [1b]-[1d] (*supra* §§VI.A.1) that

correspond to limitations [13b]-[13d]. A POSITA would have found it obvious to implement those teachings in the combination of Koga and Lin for the same reasons explained for claim 1. Creusere, ¶145. If Nokia contends that the construction of “by a processor” requires limitations [1a]-[1d] to be performed by more than circuitry (for example, by a general-purpose processor), such construction is satisfied by the Koga-Lin combination because the combination would use Lin’s processor to execute the coding method stored in Lin’s memory. Creusere, ¶146.

3. Dependent Claims 2/14

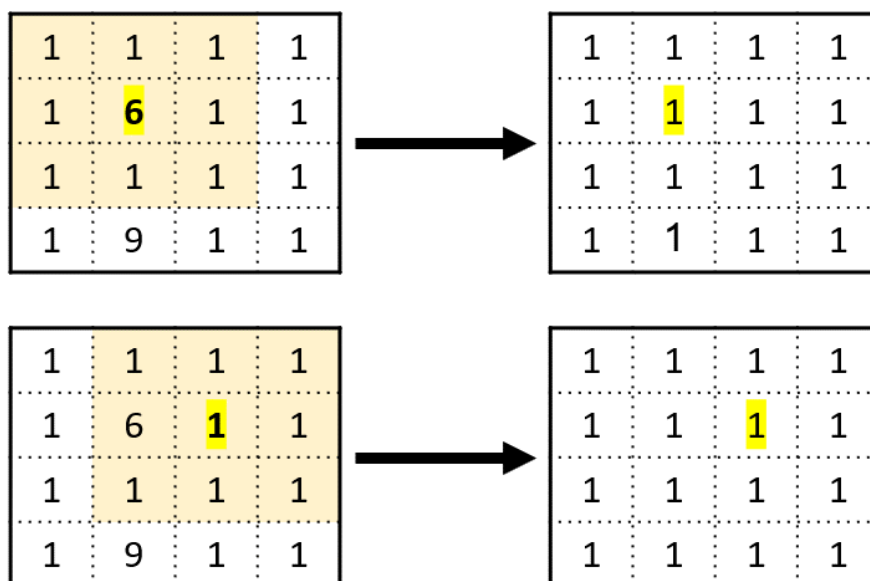
- 2. **The method of claim 1, further comprising, before performing transform coding and spatial coding, substituting outlier values in the difference signal with non-outlier values to create a modified prediction error signal.**

- 14. **The apparatus of claim 13, wherein the memory unit further comprises computer code for, before performing....**

The additional limitations of dependent claims 2 and 14 are rendered obvious by Lin’s teaching of applying a median filter to smooth out values to enhance compressibility before performing a frequency transformation (DCT). Ex-1005, ¶0120-0125. Creusere, ¶¶147-158. 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 replaces values that exceed or fall short of the median value

(outliers) with the median value (non-outlier value) of a surrounding set of values.

Supra §I.D. Applying a median filter to a prediction error signal would result in a modified prediction error signal, because the values in it have been changed. The following diagram prepared by Dr. Creusere illustrates how an outlying value (the pixel value of six) can be substituted with the non-outlier, median value of one by applying a median filter. Creusere, ¶¶148-149:



In a similar manner, Lin's median filtering substitutes the outlier values (e.g., "isolated, 'salt and pepper noise' values") in the prediction error, creating a modified (e.g., smoothed out) version of the prediction error. Ex-1005, ¶0122.

A POSITA would have understood Lin's isolated noise values are outlier values that significantly differ from those for neighboring pixels. *Supra* §V.E. Lin's filter substitutes them with the median value to create a modified prediction error

signal. This is consistent with the '991 patent's example of 3 being the outlier out of [1, 1, 3, 1]. Ex-1001, 5:51-65, Figs. 1, 2(a)-2(c). Creusere, ¶150.

The '991 patent does not describe how to determine whether a value is sufficiently different enough to be an outlier. Ex-1001, 5:24-50. Lin's teaching of using different filter sizes (Ex-1005, ¶0071) is consistent with the '991 patent in showing how the threshold can be varied. Creusere, ¶151.

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). Creusere, ¶152. A POSITA would have been motivated to combine Koga and Lin in this manner for a number of advantages. Creusere, ¶152.

Motivation to Combine

First, Lin suggests combining its teachings with other video coding methods. Ex-1005, ¶0050, ¶¶0152-0153. 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). A POSITA would have understood that applying Lin’s median filtering to Koga’s prediction error would “adds redundancy, which makes subsequent lossless compression more efficient” (*id.*, ¶0122) as well as making orthogonal transforms(e.g., DCT or Hadamard) more efficient. Creusere, ¶153.

Second, a POSITA would have looked to Lin to improve the efficiency of Koga’s encoding teachings because they share a similar purpose and architecture. Both references teach similar hybrid-video coding methods. 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. 6-7; *supra* §VI.A.2.[13pre]/[13a] (motivation to combine). Both references aim to increase image compression. Ex-1004, 2:3-42, 3:67-4:33; Ex-1005, ¶¶0089-0090, ¶¶0140-0141; Creusere, ¶154.

A POSITA would have realized that Koga’s 20 year old method and apparatus were ready for improvement (Ex-1004, [22]) and found it obvious and been motivated to apply various improvements, such as Lin’s teaching of median filtering of prediction errors, to improve performance. The modification would have provided benefits without necessitating changes to Koga’s decoder. Furthermore, the ability of the decoder to reconstruct video frames without errors in the absence of encoder quantization for the modified encoder (asymptotic

perfect reconstruction as Dr. Creusere explains) would further motivate a POSITA. Creusere, ¶155.

Combining Koga's and Lin's teachings would not have changed either reference's principle of operation. For similar reasons, a POSITA would have had a reasonable expectation of success in applying Lin's median filter to Koga's encoder, that would have been a simple matter of remapping the input and output of known techniques. Creusere, ¶¶156-157.

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). Creusere, ¶158.

4. Dependent Claims 3/15

- 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....**

The additional limitations are rendered obvious by Koga's teaching of orthogonal transforming a prediction error and spatial coding the residual of the prediction error. Ex-1004, Figs. 3-4; Creusere, ¶¶159-162. Applying Lin's median

filter to Koga's prediction error from subtracter 12 creates a modified prediction error signal (*supra* §VI.A.3) that would be passed to orthogonal transformer 13 per Koga's usual coding path, where **transform coding is applied to the modified prediction error signal**. *Supra* §VI.A.1.[1b] (incorporated by reference). Creusere, ¶160.

The combination teaches **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. 3-4; *Supra* §VI.A.1.[1c] (incorporated by reference). Inverse orthogonal transformer 15 reconstructs the modified prediction error, which is subtracted from the original prediction error to calculate a residual. This residual is then spatial coded. Creusere, ¶161.

A POSITA would have been motivated to combine Lin's median filtering teachings to Koga's codec in this manner because the advantage of the combination in improving compression efficiency results from the transform and spatial coding of the modified prediction error and residual. *See supra* §VI.A.3 (motivation to combine); Creusere, ¶162.

5. Dependent Claims 5/17

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

The additional limitations are rendered obvious by Koga's generating of "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; Creusere, ¶¶163-167. For example, Koga's quantization control signal controls quantizer 14. Ex-1004, 2:27-39; 5:41-5:59. 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, 4:21-33. Creusere, ¶164.

Koga's technique quantizes the transform coefficients to zero when spatial coding performs better than the orthogonal transform. *See* Ex-1004, 2:27-39; *Supra* §I.D. Koga's technique later became known as dead-zoning. *See e.g.*, Ex-1005, ¶0130. Creusere, ¶¶165-167.

6. Dependent Claims 6/18

- 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....**

The additional limitations are rendered obvious by Koga's teaching of generating and transmitting "quantization characteristic control signals" that control quantizer 17 have all, including **at least one spatial samples [] set to zero** in the residual of the prediction, which occurs "if the motion vector reaches around the motion compensation limit." Ex-1004, 7:44-64. Creusere, ¶¶168-171. After setting the residual spatial samples to zero at quantizer 17, 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. The same teachings and analysis explained above for claims 5 and 17 equally apply to the quantization control signal here, differing only in the encoding path and the signal quantized to zero. *Id.*, 6:4-26; *Supra* §VI.A.5 (incorporated by reference); Creusere, ¶¶169.

Koga quantizes the spatial samples to zero in the opposite case explained for the transform coefficients, when it is more efficient to encode the prediction error in the spatial domain. Creusere, ¶¶170-171.

7. Dependent Claim 7

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.**

The additional limitations are rendered obvious by Lin's teaching of replacing outlier values with median values calculated by a median filter. Ex-1005, ¶¶0071, 0120-0125. Creusere, ¶¶172-174. Lin teaches **wherein the non-outlier values used to replace the outlier values comprise an average of neighboring prediction error values**, because Lin's median replacement value is a statistical average of neighboring values. As was known in the art, a median is a type of statistical average. Ex-1020, 000004-000006. Statistical methods and techniques were commonly used in video compression applications. *Supra* §I.D. The '991 patent discloses a similar 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. Creusere, ¶173.

To the extent Nokia argues that the '991 patent requires replacing the outlier values with the statistical mean, it would have been obvious to a POSITA to use other average calculating methods, such as the mean that was known and commonly used in the art for smoothing purposes. *Supra* §I.D. Lin suggests making variations to its filter (Ex-1005, ¶0125) and 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. . Creusere, ¶174.

8. Dependent Claim 10

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.
--

The additional limitations are rendered obvious by Koga's teaching of orthogonal transforming with DCT or Hadamard transforms. Ex-1004, 4:61-5:4. Creusere, ¶175-177. Koga teaches **wherein for the transform coding, a transform coefficient is formed**. Koga's encoder orthogonal transforms the prediction error from subtracter 12 to form "transformation coefficient signals." Ex-1004, 8:36-39, Fig. 3; supra §VI.A.1.[1b] (incorporated by reference). Creusere, ¶176.

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 basis vectors contribution to the spatial reconstruction of the block when inverse transformed. 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. Creusere, ¶177.

9. Dependent Claim 11

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

The additional limitations are rendered obvious by Koga's teaching of orthogonal transforming with DCT or Hadamard transforms. Ex-1004, 4:61-5:4. As was known in the art, both DCT and Hadamard transforms were commonly used discrete orthogonal transforms (*supra* §I.C), and therefore, Koga teaches **wherein the discrete transform comprises a discrete orthogonal transform.** Creusere, ¶¶178-179.

10. Dependent Claim 12

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

Claim 12 depends from claim 1 and recites additional limitations similar to claim 13 ("computer code...") that recast claim 1's method into the form of computer code for performing the method. *See also* §VI.A.2 (explaining shared

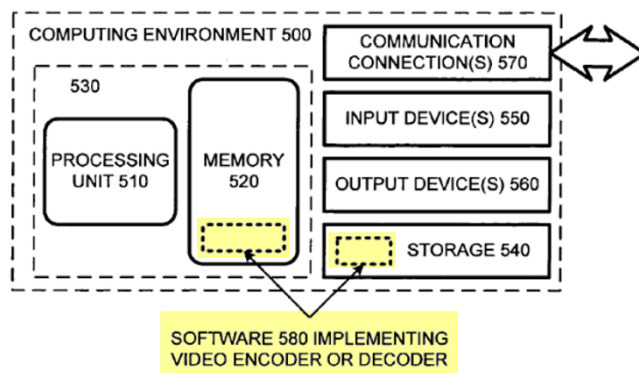
limitations between claims 1 and 13). Koga alone, and combined with Lin, each render obvious claim 12. Creusere, ¶¶180-186.

By 2007, a POSITA would have found it obvious to implement Koga's video codec in the form of a computer program product, embodied in a non-transitory computer-readable medium. When Koga published in 1988, it was common for video codecs to be implemented in the form of circuitry.

Advancements in general purpose processors made it feasible and common to implement video codecs in the form of computer code executed on a general purpose processor, as shown by references such as Lin. *E.g.*, Ex-1014, ¶0003; Ex-1005, ¶0006. Hence, a POSITA would have considered and been motivated to do the obvious and customary: embody Koga's codec as a computer program product comprising computer code stored on non-transitory computer-readable media for repeated use. *See supra* §I.G; Creusere, ¶¶181-182.

To the extent Nokia argues that Koga does not teach this limitation, Lin teaches computer program products embodied in non-transitory computer readable media. For example, Lin teaches ***a computer program product***, *e.g.*, “software 580 implementing a video encoder...or decoder.” Ex-1005, ¶0052, ¶0050, Fig. 5 (annotated):

FIG. 5



It was known that such software is developed and marketed as a computer program product for use in computing environments, like Lin's. Ex-1005, ¶¶0053, ¶0058 (“computer-executable instructions, such as those included in program modules”). “Microsoft Corporation's Windows Media Video, Version 8 [‘WMV8’]” was one such computer program product. *Id.*, ¶0006 (brackets in original). Creusere, ¶¶183-184.

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...*non-volatile memory (e.g., ROM, EEPROM, flash memory, etc.)*, or some combination of the two.” Ex-1005, ¶0052 (emphasis added), Fig. 5. As known in the art, non-volatile memory refers to durable non-transitory storage media. Creusere, ¶185.

Lin additionally teaches storing the software in “storage 540[, which is]... any [] medium which can be used to store information” and therefore, non-

transitory. Ex-1005, ¶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 explained above for Koga. The motivation to combine Koga with Lin for claims 1/13 equally applies here and is incorporated by reference. *Supra* §VI.A.2.[13pre]/[13a]; Creusere, ¶186.

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

19. The apparatus of claim 13, wherein the non-outlier values....
--

Claim 19 lacks antecedent basis for certain terms. *Supra* §V.G. Because its limitations have the same scope, claim 19 is rendered obvious for the same reasons as claim 7, to the extent it can be understood. Ex-1005, ¶¶0120-0125; *supra* §VI.A.7 (incorporated by reference); Creusere, ¶187.

12. Independent Claim 39

Claim 39 is directed to a method that recites language substantively similar to a combination of claims 1-4. Dr. Creusere provides a side-by-side claim comparison demonstrating this. Creusere, ¶188-189.

[39pre] A method, comprising:

[39a] calculating, by a processor, a difference signal...;

[39b] substituting, by a processor, outlier values...;

Koga combined with Lin teaches these limitations. Because Grounds 1-2 satisfy limitations [1pre]-[1a], those same teachings also teach limitations [39pre]-[39a]. *Supra* §§VI.A.1.[1pre]-[1a], VI.A.2.[13pre]/[13a] (incorporated by reference); Creusere, ¶190. Because claim 2 is narrower than limitation [39b] and Ground 2 satisfies claim 2, those same teachings teach limitation [39b]. *Supra* §VI.A.3 (incorporated by reference); Creusere, ¶190-191.

[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

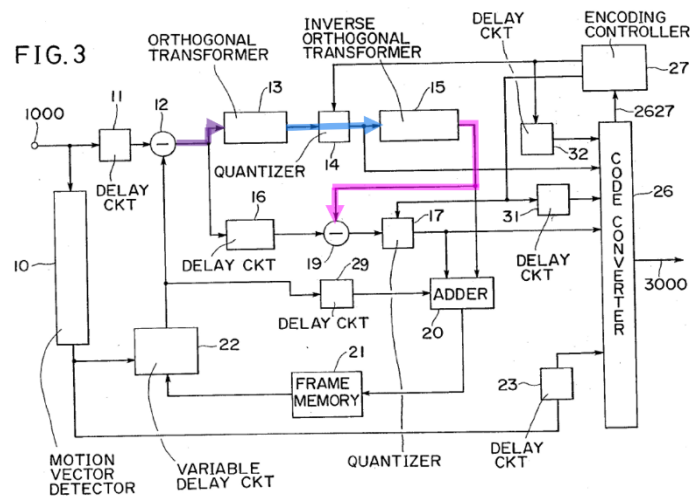
[39d] performing, by a processor, an inverse of the one of transform coding and spatial coding:

[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;

Koga combined with Lin teaches these limitations. Creusere, ¶¶192-195. Together, limitations [39c], [39d], and [39e] amount to either (1) claim 3 (transform coding the modified prediction error signal, decoding the transformed modified prediction error signal, and spatial coding the residual); or (2) claim 4 (spatial coding the modified prediction error signal and transform coding the residual). Creusere, ¶192.

Because Ground 2 satisfies claim 3, the same teachings and analysis apply here to limitations [39c] and [39e]. *Supra* §VI.A.4 (incorporated by reference); *see also* §§VI.A.3 (Lin's teaching of median filtering), VI.A.1.[1b]-[1c] (Koga's teachings of orthogonal transforming a prediction error and encoding the spatial residual). The combination teaches performing the video coding method, including limitations [39c] and [39e] by a processor. *Supra* §§VI.A.1.[1a], VI.A.2. Creusere, ¶193.

Koga further teaches **performing, by a processor, an inverse of the one of transform coding and spatial coding** (limitation [39d]). For example, Koga teaches inverse orthogonal transforming the transform coefficients. Ex-1004, 5:4-7. Figure 3 shows the quantized transform coefficients (from 14) are applied to inverse orthogonal transformer 15. Ex-1004, Fig. 3 (annotated):



Creusere, ¶194.

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. Dr. Creusere explained this in detail for limitation [1c]. *Supra* §VI.A.1.[1c]; Creusere, ¶113, ¶195.

[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.
--

Koga combined with Lin teaches these limitations. Grounds 1-2 satisfy limitations [1d]-[1e], and those same teachings also teach limitations [39f]-[39g]. *Supra* §§VI.A.1.[1d]-[1e] (incorporated by reference); Creusere, ¶196.

B. Grounds 3-4: Obviousness over the combinations of Koga, and Koga and Lin, each further in view of Narroschke

Grounds 3-4 respectively 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. The combinations render obvious the Challenged Claims discussed herein. Creusere, ¶197.

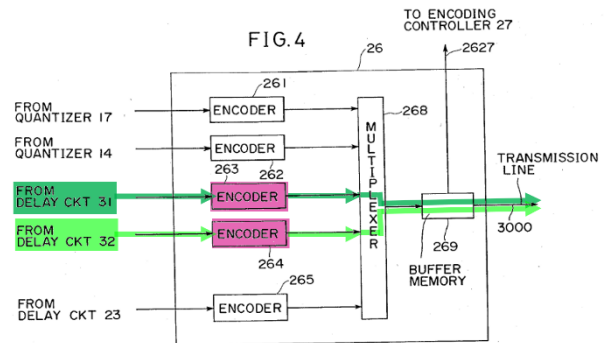
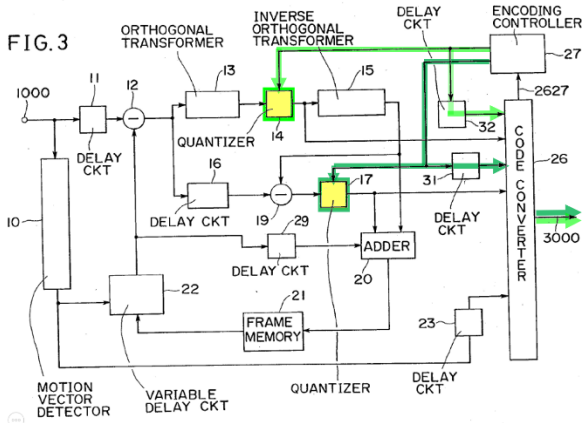
1. Dependent Claims 8 and 20 are rendered obvious by Koga, and Koga and Lin, each further in view of Narroschke.

- 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....**

Grounds 1-2 teach claims 1/13 (incorporated by reference). Combining Grounds 1-2 with Narroschke further teaches the additional limitations of claims 8/20. Creusere, ¶¶198-221.

Koga (Grounds 1-2) teaches claims 8 and 20.

For example, Koga's teaching of generating and transmitting quantization characteristic control signals that indicate whether transform coefficients are set to zero teaches **further comprising providing an indication**. Ex-1004, 7:44-64; Creusere, ¶¶199-207. Koga's "qua[n]tization characteristics control signals" are included in the encoder's output signal 3000. Ex-1004, 6:4-26. Figure 4 shows the quantization control signal for the transform coefficients is sent to code converter 26 via block 32 and entropy coded. *Id.*, 5:60-6:3, Figs. 3-4 (annotated):



Creusere, ¶200. Like the rest of the encoded video signal, the encoded quantization control signal for the transform coefficients (from 32) is multiplexed and provided to the decoder. Ex-1004, 6:4-58, Fig. 6; *supra* §VI.A.1.[1d]-[1e]; Creusere, ¶201.

Control signal 32 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 coding the residual in the spatial domain. *Supra* §VI.A.1.[1b]-[1d]. 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; Creusere, ¶202.

Koga teaches using quantization characteristic control signals to achieve this bit allocation. Koga generates two control signals: control signal 32 controls quantizer 14 that is applied to the transform coefficients, and control signal 31 controls quantizer 17 that is applied to the spatial samples/residual. Ex-1004, 5:41-5:59. At the decoder, the respective control signals control the dequantization while decoding the entropy-coded transform coefficients and spatial residual. *Id.*, 6:51-7:19; Creusere, ¶203.

Koga provides an example of how the quantization can be controlled:

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 qu[an]tization characteristics, to realize a medium picture quality as compared to the case where the quantizers 14 and 17 is utilized independently.

Ex-1004, 7:44-64. For the italicized latter portion of the above excerpt, Dr. Creusere explains how Koga proposes quantizing the transform coefficients to zero when the image is still or moving slowly, and using only spatial coding to encode the prediction error. Creusere, ¶204. Dr. Creusere also explains how, for the bolded earlier portion, Koga conversely proposes quantizing the spatial coding of the residual to zero when the image is moving rapidly, and instead encoding the prediction error only by orthogonal transformation. Creusere, ¶205.

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, because the inverse transform and addition at adder 54 would have the same effect. Creusere, ¶206. A POSITA would have understood Koga's control signal indicates the absence of transform coefficients, that would allow the decoder to skip unnecessary processing and increase compression. Indeed, increasing compression is one of Koga's aims (Ex-1004, 1:8-23). Koga's technique came to be known as dead-zoning in the art (e.g., Ex-1005, ¶0130) and it was customary for such side information to be provided as indicators (*id.*, ¶0138, ¶0062). A POSITA would have understood Koga's control signal provides similar information to indicate the absence of non-zero transform coefficients. Creusere, ¶¶206-207.

Additionally, Koga's motion vectors also teach this limitation because "a zero or close to zero value" indicates the orthogonal transformation is not used.

Compare Ex-1004, 4:21-33, *with id.*, 7:44-64. Koga teaches they can be used in lieu of the quantization characteristics. *Id.*, 4:21-33; Creusere, ¶208.

Narroschke further teaches claims 8 and 20.

To the extent Nokia argues that Koga's quantization control signal 32 does not sufficiently teach the claimed **indication...** even when Koga's control signal 32 indicates the transform coefficients have been set to zero, it would nevertheless be rendered obvious by Narroschke. Narroschke teaches setting a flag indicating whether an entire slice/macroblock of a frame is coded in the spatial domain or in the frequency (transformed) domain. Ex-1005, ¶0019, ¶0041. A POSITA would have been motivated to combine Narroschke's flag teaching with Grounds 1-2 to indicate whether the transform coefficients have all been set to zero for several reasons, as explained further below. Creusere, ¶209.

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 (whether "a [block] may be coded only in one of the two domains"). In one example, Narroschke's flag provides the indication "by a specific bit in the coded video data signal." *Id.*, ¶0041 (e.g., "Slice_FD_SD_coding_flag"). Narroschke proposes using the flag for different sizes and levels of blocks. *Id.*

When Narroschke’s flag indicates, for example, that “an entire macroblock is coded in the spatial domain” (*id.*), this indicates no transform coefficients exist in the block of data. If there are values *only* in the spatial domain, that means there are none in the transform (frequency) domain, ergo no transform coefficients; and vice-versa. Creusere, ¶¶210-211.

Motivation to Combine

First, Narroschke expressly suggests that its side-information scheme “may be applied in other video coding algorithms for the prediction error coding.” Ex-1006, ¶0042. Narroschke and Koga teach similar hybrid video architectures with prediction error coding. Ex-1004, 4:42-5:24, Figs. 1, 3, 5; Ex-1006, ¶¶0002-0005, Figs. 1-2. The combination would have been obvious because a POSITA would have recognized that Narroschke provides a simple implementation method for Koga’s similar teachings. Ex-1004, 5:41-59, 6:59-7:19; Ex-1006, ¶0018-0019, ¶¶0040-0041; Creusere, ¶212.

A POSITA would have been motivated because Narroschke’s flag provides a simple and efficient way to code the information—e.g., as a single “specific bit.” Ex-1006, ¶0041. As Narroschke teaches, this “results in a decreased data rate and a more efficient coding mechanism for the side information.” Ex-1006, ¶0019. Thus, the combination involves using a known technique to improve similar devices/methods in the same way. Creusere, ¶213.

Second, it was common in the art (including known video standards) to define and set flags to indicate options for encoding/decoding. *See supra* §I.A. Narroschke builds upon and repurposes such use of flags in the “H.264/AVC coding scheme.” Ex-1006, ¶¶0042, Claims 35-36, Tables 2-4. A POSITA would have been motivated to incorporate the indication technique taught by Narroschke into Koga, which were compatible with video standards as of 2007. Creusere, ¶214.

A POSITA would have realized Koga’s method and apparatus were ready for improvement because Koga was 20 years old by 2007-2008. Ex-1004, [22], [45]. Applying Narroschke’s methods to Koga’s codec would have been straightforward, because Narroschke explains how to implement its techniques in other video standards. Ex-1006, ¶¶0036-0041, Tables 1-4. Creusere, ¶215.

Third, such a combination of prior art elements according to known methods would yield predictable results. Grounds 3-4 each add Narroschke’s teachings of a flag to Koga’s video codec. Koga teaches a hybrid-coding codec with independent quantization of transformed and non-transformed parts of the prediction error. Ex-1004, 3:67-4:10, 5:41-6:26, 7:3-7:19. For Ground 4, Lin facilitates the combination with a modern computing environment (general processor communicatively coupled with memory/storage that includes computer program code). *See supra* §§VI.A.2.[13pre]-[13d], VI.A.12. The combined result is, e.g., a

hybrid-video codec taught by Koga, with improvements to coding and transmitting flags as taught by Narroschke, implemented in Lin's computing environment. The combinations would not require significant changes and the reference's respective teachings would have been used in a conventional manner. Creusere, ¶216.

Fourth, Koga, Lin, and Narroschke share a similar block-based hybrid coding architecture with prediction error coding. Creusere, ¶179; 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. A POSITA would have looked to similar references and combined their teachings because it would improve similar video coding methods and devices in the same way. Creusere, ¶217.

Combining Koga's, Lin's, and Narroschke's teachings would not have changed the references' principles of operation because it simply uses teachings in the manner taught by each reference. The references' similarities reinforce the fact that the combination would not change the principles of operation. 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. Creusere, ¶218.

A POSITA would have had a reasonable expectation of success when combining the teachings of Koga and Narroschke, and further with Lin, because the combination is based on compatible devices and techniques in video and image processing/coding based on the same, well-known hybrid coding scheme. The teachings 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 have carried out well-known video coding functions on a computer. Creusere, ¶219.

A POSITA would have been fully capable of combining these references, including making routine modifications that would have involved straightforward processing of information using mathematically defined algorithms for hybrid video coding, predictive coding, transform coding, entropy coding, and quantization that were all known in the prior art. *Supra* §I.A-E. The combination is directed to the easier 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. Creusere, ¶220.

As explained above for Ground 2, developing software and hardware for video coding was a common task, routinely involving combining and modifying different coding techniques and technologies. A POSITA would have been able to combine the features of Koga, Narroschke and Lin because such combination

would have been straightforward, among other reasons. *Supra*

§§VI.A.2.[13pre]/[13a] (discussing reasonable expectation of success), IV;

Creusere, ¶221.

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....

Grounds 1-2 teach claims 1/13 (incorporated by reference). Combining Grounds 1-2 with Narroschke further teaches the additional limitations of claims 9/21. Creusere, ¶¶222-229.

Koga (Grounds 1-2) teaches claims 9 and 21.

Koga teaches generating and transmitting quantization characteristic control signals that indicate whether the spatial samples in the residual of the prediction error are set to zero. Ex-1004, 7:44-64; Creusere, ¶¶190-196. Koga teaches **further comprising providing an indication.** For example, Koga's "qua[n]tization characteristics control signals," including the control signal 31 used at quantizer 17, are included in the encoder's output signal 3000. Ex-1004, 6:4-26, Figs. 3, 4. As explained above for claims 8/20, 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, differing

only in that quantizer 17 is controlled by the signal that passes through delay circuit 31 and encoder 263. Ex-1004, 6:4-26; *Supra* §VI.B.1 (incorporated by reference). Creusere, ¶223.

As explained above for claims 8/20, 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 signals); Creusere, ¶224.

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.” *Id.*, 7:3-19; Creusere, ¶225.

Koga teaches the control signal is an **indication that no spatial samples exist in the block of data if appropriate**. As explained above for claims 8/20, Koga’s control signals indicate “[w]hether or not the orthogonal transformation [or spatial residual] is utilized.” Ex-1004, 4:21-33; *supra* §VI.B.1 (discussing Koga’s teachings). Koga teaches a second quantization control signal 31 for quantizer 17 that indicates whether the spatial samples in the residual are set to zero are not. Ex-1004, 7:44-64. A POSITA would have understood this to indicate the absence of spatial samples, in like manner to the transform coefficients as explained for

claims 8/20, because setting all of the residual samples to zero is effectively the same as not existing for the purposes of decoding. Creusere, ¶¶226-227.

Additionally, Koga's "motion vectors" further teach this limitation for the same reasons as explained above for claims 8/20, but just in an inverse relationship between the motion vectors and spatial samples. Ex-1004, 4:21-33, 7:44-64. Koga teaches they can be used in lieu of the quantization characteristics. *Id.*, 4:21-33; Creusere, ¶228.

Narroschke further teaches claims 9 and 21.

To the extent Nokia argues that Koga does not teach the claimed *indication...*, the respective combinations with Narroschke each teach these claims. As explained above for claims 8/20, 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 Narroschke's flag teachings; incorporated by reference). A POSITA would have been motivated to use Narroschke's flag in Koga's codec for the same reasons explained above. *Supra* §VI.B.1 (motivation to combine; incorporated by reference). Creusere, ¶229.

VII. CONCLUSION

For the foregoing reasons, Petitioners request *inter-partes* review and that the challenged claims be canceled as unpatentable.

VIII. DISCRETIONARY ANALYSIS FOR REVIEW

Fintiv. Discretionary denial is not warranted. The '991 patent is asserted in a parallel ITC proceeding. "The PTAB will not discretionarily deny petitions based on applying *Fintiv* to a parallel ITC proceeding." June 21, 2022 Memorandum, 5-7. Even under *Fintiv*, this Petition's merits are compelling, which "alone demonstrates that the PTAB should not discretionarily deny institution under *Fintiv*." *See id.*, 3-5. No case management conference has occurred. No case schedule has issued.

Advanced Bionics. Denial under §325(d) is likewise unwarranted because Koga, Lin, and Narroschke were not cited or considered during prosecution. This is the only IPR filed against the challenged claims to date. *General Plastic* factors do not weigh against institution.

IX. STANDING

Petitioners certify that Petitioners are not barred or estopped from requesting this inter partes review and the '991 patent is IPR eligible.

X. MANDATORY NOTICES AND FEES

1. **Real Party In Interest:** The real parties-in-interest here are Amazon.com, Inc. and Amazon.com Services, LLC. No other parties directed, controlled, or funded this Inter Partes Review proceeding (IPR).

2. **Related Matters:**

- *Nokia Corporation and Nokia Technologies Oy v. Amazon.com, Inc. and Amazon.com Services, LLC*, Case No.1-23-cv-01232 (D. Del.)
- *Nokia Technologies Oy, v. HP, Inc.*, Case No.1:23-cv-01237 (D. Del.)
- Certain Video Capable Electronic Devices, Including Computers, Streaming Devices, Televisions, and Components and Modules Thereof; Inv. No. 337-TA-1380 (ITC)

3. **Lead and Backup Counsel:** Pursuant to 37 C.F.R. §42.8(b)(3) and 42.10(a), Petitioners designate Harper Batts (Reg. No. 56,160) as lead counsel and Chris Ponder (Reg. No. 77,167) and Jeffrey Liang (Reg. No. 69,043) as back-up counsel, each of Sheppard, Mullin, Richter & Hampton LLP.

4. **Service Information:** Petitioners consent to service by electronic mail addressed to:

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Petitioners' counsel may also be served by mail or hand delivery at Sheppard, Mullin, Richter & Hampton LLP, 1540 El Camino Real Suite 120, Menlo Park, CA 94025. Petitioners' counsel may be reached by telephone at (650) 815-2673 and by facsimile at (650) 815-4668.

5. **Fees:** The Office is authorized to charge fees for this Petition to Deposit Account 50-4561, Ref. 16AG-382973.

Respectfully submitted,

SHEPPARD, MULLIN,
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/Harper Batts/

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CLAIM APPENDIX

[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.

CERTIFICATE OF SERVICE

The undersigned hereby certifies that on July 2, 2024, true and correct copies of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 8,077,991 and Exhibits 1001-1021 were served in entirety on the Patent Owner at the following addresses of record as listed on PAIR, via Priority Mail Express®:

Nokia Corporation and Alston & Bird LLP
Vantage South End
1120 South Tryon Street, Suite 300
Charlotte, NC 28203-6818
Official Correspondence Address

The undersigned certifies that true and correct copies of the Petition for *Inter Partes* Review of U.S. Patent No. 8,077,991 and Exhibits 1001-1021 were also sent via electronic mail to the attorneys of record for Plaintiff in the concurrent litigation matter(s):

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**CERTIFICATE OF COMPLIANCE WITH
TYPE-VOLUME LIMITATION, TYPEFACE REQUIREMENTS,
AND TYPE STYLE REQUIREMENTS**

1. This Petition complies with the type-volume limitation of 14,000 words, comprising 13,958 words, as counted using the Microsoft Word software that was used to prepare this paper, excluding the parts exempted by 37 C.F.R. § 42.24(a).

2. This Petition complies with the general format requirements of 37 C.F.R. § 42.6(a) and has been prepared using Microsoft® Word in 14-point Times New Roman.

Respectfully submitted,

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