

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Takahashi et al.
U.S. Patent No.: 10,741,211 Attorney Docket No.: 07314-0056IP1
Issue Date: August 11, 2020
Appl. Serial No.: 15/533,592
Filing Date: November 13, 2015

Title: INFORMATION PROCESSING DEVICE, INFORMATION
RECORDING MEDIUM, AND INFORMATION PROCESSING
METHOD

DECLARATION OF DR. ELI SABER

I currently hold the opinions set expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

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

Dated: July 26, 2026

By: 

Dr. Eli Saber

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RELEVANT CLAIMS

Claim 1	
[1.pre]	An information processing device, comprising:
[1.1]	a data processing unit configured to:
[1.2]	acquire high dynamic range (HDR) image metadata from an MP4 file, wherein
[1.2.1]	the acquired HDR image metadata includes a maximum value of frame average luminance of HDR image data stored in the MP4 file, and
[1.2.2]	the HDR image data stored in the MP4 file is based on an MP4 format;
[1.3]	acquire display function information of a display unit from the display unit;
[1.4]	read the HDR image data from the MP4 file;
[1.5]	execute a conversion process of the read HDR image data based on the acquired HDR image metadata and the acquired display function information of the display unit;
[1.6]	execute an output image generation process based on the execution of the conversion process; and
[1.7]	output an image signal to the display unit based on the executed output image generation process.
Claim 2	
[2.pre]	The information processing device according to claim 1, wherein the data processing unit is further configured to:
[2.1]	acquire a dynamic range of the HDR image data stored in the MP4 file from the acquired HDR image metadata;

[2.2]	determine the HDR image data having the dynamic range is not outputable by the display unit, wherein
[2.3]	the determination is based on the acquired HDR image metadata and the acquired display function information of the display unit;
[2.4]	execute the conversion process of the read HDR image data based on the determination,
[2.5]	wherein the conversion process includes reduction of the dynamic range of the HDR image data; and
[2.6]	output the HDR image data with the reduced dynamic range to the display unit.
Claim 3	
[3.pre]	The information processing device according to claim 1, wherein
[3.1]	the HDR image metadata is recorded in an HDR image metadata storage box,
[3.2]	the HDR image metadata storage box is in a trak box in the MP4 file,
[3.3]	the trak box stores metadata for application of an entire HDR image stored in the MP4 file, and
[3.4]	the data processing unit is further configured to read the HDR image metadata from the HDR image metadata storage box.
Claim 5	
[5.pre]	An information processing device, comprising:
[5.1]	a data processing unit configured to:
[5.2]	generate an MP4 file that stores high dynamic range (HDR) image data;
[5.3]	acquire HDR image metadata associated with the HDR image data, wherein

[5.3.1]	the HDR image data stored in the MP4 file is based on an MP4 format, and
[5.3.2]	the acquired HDR image metadata includes a maximum value of frame average luminance of the HDR image data stored in the MP4 file;
[5.4]	set an HDR image metadata storage box in the MP4 file; and
[5.5]	store the HDR image metadata in the set HDR image metadata storage box.
Claim 6	
[6]	The information processing device according to claim 5, wherein the HDR image metadata further includes maximum luminance information of the HDR image data.
Claim 7	
[7.pre]	The information processing device according to claim 5, wherein
[7.1]	the HDR image metadata storage box is in a trak box in the MP4 file, and
[7.2]	the trak box stores metadata for application of an entire HDR image stored in the MP4 file.
Claim 9	
[9.pre]	A non-transitory computer-readable medium having stored thereon an MP4 file and computer-executable instructions, the computer-executable instructions, when executed by a processor of a reproduction device, cause the processor to execute operations, the operations comprising:
[9.1]	reading high dynamic range (HDR) metadata from an HDR image metadata storage box of the MP4 file, wherein
[9.1.1]	an mdat box of the MP4 file stores HDR image data;

[9.1.2]	the HDR image metadata storage box of the MP4 file stores the HDR image metadata corresponding to the HDR image data,
[9.1.3]	the stored HDR image data is based on an MP4 format, and
[9.1.4]	the stored HDR image metadata includes a maximum value of frame average luminance of the HDR image data;
[9.2]	executing a conversion process of the HDR image data based on the read HDR image metadata; and
[9.3]	reproducing the HDR image data based on the execution of the conversion process.
Claim 10	
[10.pre]	The non-transitory computer-readable medium according to claim 9, wherein
[10.1]	the HDR image metadata storage box is in a trak box, and
[10.2]	the trak box stores metadata for application of an entire HDR image stored in the MP4 file.
Claim 12	
[12.pre]	An information processing method comprising:
[12.1]	in an information processing device:
[12.1.1]	acquiring, by a data processing unit of the information processing device, high dynamic range (HDR) image metadata from an MP4 file, wherein
[12.1.2]	the acquired HDR image metadata includes a maximum value of frame average luminance of HDR image data stored in the MP4 file, and
[12.1.3]	the HDR image data stored in the MP4 file is based on an MP4 format;

[12.2]	acquiring, by the data processing unit, display function information of a display unit from the display unit;
[12.3]	reading, by the data processing unit, the HDR image data from the MP4 file;
[12.4]	executing, by the data processing unit, a conversion process of the read HDR image data based on the acquired HDR image metadata and the acquired display function information of the display unit;
[12.5]	executing, by the data processing unit, an output image generation process based on the execution of the conversion process; and
[12.6]	outputting, by the data processing unit, an image signal to the display unit based on the executed output image generation process.
Claim 13	
[13.pre]	An information processing method comprising:
[13.1]	in an information processing device:
[13.2]	generating, by a data processing unit of the information processing device, an MP4 file that stores high dynamic range (HDR) image data;
[13.3]	acquiring, by the data processing unit, HDR image metadata associated with the HDR image data, wherein
[13.3.1]	the HDR image data stored in the MP4 file is based on an MP4 format, and
[13.3.2]	the acquired HDR image metadata includes a maximum value of frame average luminance of the HDR image data stored in the MP4 file;
[13.4]	setting, by the data processing unit, an HDR image metadata storage box in the MP4 file; and
[13.5]	storing, by the data processing unit, the HDR image metadata in the set HDR image metadata storage box.

Claim 14	
[14.pre]	A non-transitory computer-readable medium having stored thereon computer-executable instructions that, when executed by a processor of an information processing device, cause the processor to execute operations, the operations comprising:
[14.1]	acquiring high dynamic range (HDR) image metadata from an MP4 file, wherein
[14.1.1]	the acquired HDR image metadata includes a maximum value of frame average luminance of HDR image data stored in the MP4 file, and
[14.1.2]	the HDR image data stored in the MP4 file is based on an MP4 format,
[14.2]	acquiring display function information of a display unit from the display unit;
[14.3]	reading the HDR image data from the MP4 file;
[14.4]	executing a conversion process of the read HDR image data based on the acquired HDR image metadata and the acquired display function information of the display unit;
[14.5]	executing an output image generation process based on the execution of the conversion process; and
[14.6]	outputting an image signal to the display unit based on the executed output image generation process.
Claim 15	
[15.pre]	A non-transitory computer-readable medium having stored thereon computer-executable instructions that, when executed by a processor of an information processing device, cause the processor to execute operations, the operations comprising:
[15.1]	generating an MP4 file that stores high dynamic range (HDR) image data;

[15.2]	acquiring HDR image metadata associated with the HDR image data, wherein
[15.2.1]	the HDR image data stored in the MP4 file is based on an MP4 format, and
[15.2.2]	the acquired HDR image metadata includes a maximum value of frame average luminance of the HDR image data stored in the MP4 file;
[15.3]	setting an HDR image metadata storage box in the MP4 file; and
[15.4]	storing the HDR image metadata in the set HDR image metadata storage box.

I, Eli Saber, declare that:

I. ASSIGNMENT

1. I have been retained on behalf of Dolby Laboratories, Inc. (“Petitioner”) to offer technical opinions related to U.S. Patent No 10,741,211 (“the ’211 patent”) (EX1001). I understand that Petitioner is requesting that the Patent Trial and Appeal Board (“PTAB” or “Board”) institute an *inter partes* review (“IPR”) proceeding of the ’211 patent.

2. I have been asked to provide my independent analysis of the ’211 patent based on the prior art publications cited in this declaration.

3. I am not and never have been, an employee of Dolby Laboratories, Inc. or a related entity. I received no compensation for this declaration beyond my normal hourly compensation based on my time actually spent analyzing the ’211 patent, the prior art publications cited below, and issues related thereto, and I will not receive

any added compensation based on the outcome of any IPR or other proceeding involving the '211 patent.

II. QUALIFICATIONS

4. I am over the age of 18 and am competent to write this declaration. I have personal knowledge, or have developed knowledge of these technologies based upon education, training, or experience, of the matters set forth herein.

5. I am a professor in the Electrical and Microelectronic Engineering Department and the Chester F. Carlson Center for Imaging Science at the Rochester Institute of Technology (RIT) in Rochester, New York. I also serve as the Director of the Image, Video, and Computer Vision Laboratory. I joined RIT's full-time faculty in 2004. I have over thirty-five (35) years of industry and academic experience, thirty (30) of which are in the fields of Computer Vision, Digital Image/Video Processing, Pattern Recognition and Machine Learning.

6. I received a Ph.D. in Electrical Engineering from the University of Rochester in 1996. My concentration was on Signal/Image/Video Processing, Pattern Recognition, and Computer Vision. I received a Master's Degree in Electrical Engineering from the University of Rochester in 1992, and I received a Bachelor's Degree in Electrical and Computer Engineering, *summa cum laude*, from the State University of New York at Buffalo in 1988.

7. Before becoming a full-time professor, I worked for Xerox Corporation for 16 years, from 1988 to 2004. During my years at Xerox, I was responsible for delivering color management, image processing innovations, architectures, and algorithms; xerographic sub-systems for a variety of color products; and control systems for toner production facilities. One of several roles I held at Xerox was Advanced Development Scientist and Manager. In that capacity, I established the Advanced Design Laboratory—an Imaging/Xerographics lab—and provided technical and managerial leadership for the Electrical, Imaging and Xerographics Department. In another role, as Product Development Scientist and Manager, I led the research and development of image quality metrics for various product platforms. I also led the Image Science, Analysis, and Evaluation area, with 12 to 15 direct reports and a budget of approximately \$2 million.

8. From 1997 until 2004, I was an adjunct faculty member in the Electrical Engineering Department of RIT and in the Electrical and Computer Engineering Department of the University of Rochester. I was responsible for teaching undergraduate and graduate coursework in signal, image, and video processing; pattern recognition; and communications. Additionally, I performed research in multimedia applications, pattern recognition, image understanding, and color engineering.

9. Since joining RIT full time, I have been responsible for teaching several undergraduate and graduate courses in Digital Signal Processing, Digital Image Processing, Digital Video Processing, Advanced Neural Networks and Deep Learning, Pattern Recognition, Engineering Analysis, Random Signal & Noise, Advanced Engineering Mathematics, Matrix Methods, Communication Systems, Digital Communications, Modern Control Theory, Color Engineering and Linear Systems.

10. I proposed, developed and introduced the “Digital Video Processing” and the “Advanced Neural Network and Deep Learning: Part 1” courses; and reestablished the Pattern Recognition course at the Electrical Engineering Department at RIT. These graduate courses were instrumental in providing MS/PhD students with the proper foundation and knowledge in all aspects of the subject areas in order to perform in-depth research in the field and continue to advance the state of the art.

11. The Digital Video Processing course is designed to provide a thorough and comprehensive coverage of the field. Topics covered include the mathematical representation of digital video including motion and time-varying image formation models, spatio-temporal sampling/reconstruction, sampling structure conversions, motion estimation using optical flow, block-based, pel-recursive, Bayesian and point

correspondence type methodologies, segmentation, motion tracking, filtering, restoration, super-resolution and compression.

12. The Pattern Recognition course, on the other hand, covers pertinent concepts in Bayes decision theory, linear and nonlinear classifiers, artificial neural networks, feature selection/generation/extraction and various methodologies of clustering.

13. The graduate course titled: “Advanced Neural Networks and Deep Learning: Theory, Mathematics and Algorithms: Part 1” is intended to provide an in-depth comprehensive study of the theory, mathematics and algorithms for advanced neural networks and their usage in deep learning. It is primarily targeted for upper graduate students that are planning to pursue advanced studies/research in the field. The course begins with an in-depth study of the mathematical methodologies for neural networks and optimization (zero-, first- and second-order) techniques. It then progresses to provide a thorough study of shallow and deep neural networks architectures and algorithms, activation functions, regression, two- and multi-class classification, unsupervised learning, feature engineering/selection, backpropagation along with applications to a variety of engineering problems.

14. I am currently working to develop a follow-on course (Part 2) to the Advanced Neural Networks and Deep Learning course described above. This course is intended to cover convolutional and recurrent style neural networks, principles of

feature engineering, kernel methods, tree-based learners, attention mechanisms/transformers, reinforcement learning and generative adversarial networks. This course is targeted to debut in Fall 2027.

15. I am also currently working to revamp the graduate course titled: “Image and Video Compression”. The updated version of this course will start by providing a brief history of video coding and video coding standards and then progress to discussing video basics, formats and fundamentals of video compression. It will then progress to cover JPEG, JPEG 2000, H.261, MPEG-1, MPEG-2, H.263, MPEG-4 visual, H.264 and H.265, AV-1 and H.266. The course is intended to debut in Fall 2028.

16. During my tenure at Xerox Corporation, I have developed/led the development of color characterization, calibration and management architectures, algorithms and techniques for multiple digital front ends designed to drive full process as well as highlight color print engines. I have also led the research and development of image quality metrics for various product platforms and their subsequent dissemination throughout the Print Engine Development Division at Xerox Corporation. I have also developed and conducted industrial training at Xerox Corporation in the areas of color engineering, digital image processing and control systems with a distinct focus on digital front ends and print engines and their underlying architectures.

17. My current research focuses on image/video processing for multimedia, military & biomedical applications; computer vision and three-dimensional scene reconstruction; and machine learning for object tracking/remote sensing applications. As a principal investigator or co-principal investigator, I have acquired almost \$6 million in research funding since joining RIT and have managed multiple government grants from the Department of Defense as well as several yearly corporate grants from Hewlett-Packard.

18. In 2012, I was awarded the Prestigious Trustees Scholarship, the highest award at RIT with regard to research recognition.

19. I am the author or co-author of forty (40) peer-reviewed journal publications.

20. I have also authored or co-authored one hundred and four (104) conference and workshop publications and a book entitled Advanced Linear Algebra for Engineers with MATLAB, published by CRC Press in February 2009, and am a named inventor on multiple U.S. and foreign patents.

21. I am a senior member of the Institute of Electrical and Electronic Engineers and a member of the IEEE Signal Processing Society, the Electrical Engineering Honor Society, Eta Kappa Nu.

III. SUMMARY OF CONCLUSIONS FORMED

22. This Declaration explains the conclusions that I have formed based on my analysis. To summarize those conclusions:

- **Ground 1A:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 1, 2, 9, 12, and 14 of the '211 patent are made obvious by Toma881, Toma446, and Dugeon
- **Ground 1B:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claim 2 of the '211 patent is made obvious by Toma881, Toma446, Dugeon, and Toma788
- **Ground 1C:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 3, 9, and 10 of the '211 patent are made obvious by Toma881, Toma446, Dugeon, and Saeki
- **Ground 2A:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 5, 6, 13, and 15 of the '211 patent are made obvious by Toma446 and Dugeon

- **Ground 2B:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claim 7 of the '211 patent is made obvious by Toma446, Drugeon, and Saeki

IV. LEVEL OF ORDINARY SKILL IN THE ART

23. I have been informed that a person of ordinary skill in the art ("POSITA") is a hypothetical person who is presumed to have the skill and experience of an ordinary worker in the field at the time of the alleged invention. The '211 patent claims priority to PCT Application no. PCT/JP20158/082032, which claims priority to Japan Application no. JP 2014-258349, filed 12/22/2014 ("Critical Date"). EX1001, Cover. Because I do not know at what date the invention as claimed was made, if ever, I have used the Critical Date of the '211 patent as the point in time for claim interpretation purposes. My opinion does not change if the invention date is earlier or if the filing date of the PCT application is the actual date of invention for one or more of the claims.

V. LEGAL PRINCIPLES

24. I am not a lawyer and I will not provide any legal opinions in this IPR. Although not a lawyer, I have been advised that certain legal standards are to be applied by technical experts in forming opinions regarding the meaning and validity of patent claims.

A. Claim Interpretation

25. I understand that claim terms are generally given their plain and ordinary meaning based on the patent's specification and file history as understood by a person of ordinary skill in the art at the time of the purported invention. In that regard, I understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood by a POSITA. I further understand that the words of the claims should be given their plain meaning unless that meaning is inconsistent with the patent specification or the patent's history of examination before the Patent Office. I also understand that the words of the claims should be interpreted as they would have been interpreted by a POSITA at the time of the invention was made (not today).

B. Priority

26. I understand that a continuation application is a later-filed application that has the same disclosure (specification and figures) as an earlier filed application to which the later-filed application claims priority. A continuation is generally entitled to the same priority date as the later-filed application to which it claims priority.

C. Anticipation

27. I understand that a patent claim is invalid as anticipated if each and every element as set forth in the claim is found, either expressly or inherently

described, in a single prior art reference. I also understand that, to anticipate, the reference must teach all of the limitations arranged or combined in the same way as described in the claim.

28. With respect to inherency, I understand that the fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. Instead, the inherent characteristic must necessarily flow from the teaching of the prior art.

D. Obviousness

29. I understand that a patent claim is invalid if the claimed invention would have been obvious to a person of ordinary skill in the field at the time of the purported invention, which is often considered the time the application was filed. Even if all of the claim limitations are not found in a single prior art reference that anticipates the claim, the claim can still be invalid.

30. To obtain a patent, a claimed invention must have, as of the priority date, been nonobvious in view of the prior art in the field. I understand that an invention is obvious when the differences between the subject matter sought to be patented 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 a person having ordinary skill in the art.

31. I understand that, to prove that prior art or a combination of prior art makes a patent obvious it is necessary to: (1) identify the particular references that, singly or in combination, make the patent obvious; (2) specifically identify which elements of the patent claim appear in each of the asserted references; and (3) explain a motivation, teaching, need, market pressure or other legitimate reason that would have inspired a person of ordinary skill in the art to combine prior art references to solve a problem.

32. I also understand that certain objective indicia can be important evidence regarding whether a patent is obvious or nonobvious. Such indicia include:

- Commercial success of products covered by the patent claims;
- A long-felt need for the invention;
- Failed attempts by others to make the invention;
- Copying of the invention by others in the field;
- Unexpected results achieved by the invention as compared to the closest prior art;
- Praise of the invention by the infringer or others in the field;
- The taking of licenses under the patent by others;
- Expressions of surprise by experts and those skilled in the art at the making of the invention; and

- The patentee proceeded contrary to the accepted wisdom of the prior art.

33. To the extent these factors have been brought to my attention, if at all, I have taken them into consideration in providing my opinions and conclusions.

E. Means-Plus-Function (MPF)

34. I understand that analysis for any terms with means-plus-function (MPF) limitations involves identifying the specific portions of the specification that describe the structure, material, or acts corresponding to each claimed function. I also understand that claims that use the term “means” are presumed to invoke a means-plus-function claim construction of such a claim term.

35. I also understand that satisfaction of MPF limitations by prior art involves identifying the corresponding structure (or an equivalent) was present in the prior art and performing the same claimed function.

36. I understand that the standard for determining whether the prior art discloses the corresponding structure or an equivalent is whether there are insubstantial differences, which means that if the assertedly equivalent structure performs the claimed function in substantially the same way to achieve substantially the same result as the corresponding structure described in the specification, it is equivalent.

37. I understand that proving structural equivalence does not require a component-by-component analysis, but rather that it is sufficient to show structure, materials, or acts that perform the claimed function in substantially the same way to achieve substantially the same result because the claim limitation is the overall structure corresponding to the claimed function and not individual components.

VI. MATERIALS CONSIDERED

38. My analysis and conclusions set forth in this declaration are based on my educational background and experiences in the field (*see* Section II). Based on my knowledge and experience, I believe that I am considered to be an expert in the field. Also, based on my knowledge and experience, I understand and know of the capabilities of persons of ordinary skill in the field during the early 2000s, and I taught, participated in organizations, and worked closely with many such persons in the field during that time frame.

39. As part of my independent analysis for this declaration, I have considered the following: the background knowledge/technologies that were commonly known to persons of ordinary skill in this art during the time before the earliest claimed priority date for the '211 patent; my own knowledge and experiences gained from my work experience in the field of the '211 patent and related disciplines; and my experience in working with others involved in this field and related disciplines.

40. In addition, I have analyzed the following publications and materials:

- U.S. Patent No. 10,741,211 to Takahashi et al. (“the ’211 Patent”) (EX1001)
- Excerpts from the Prosecution History of the ’211 Patent (“the Prosecution History”) (EX1002)
- U.S. Pat. No. 10,291,881 to Toma et al. (“Toma881”) (EX1004)
- Certified English Translation of U.S. Provisional Pat. App. No. 62/010,096 (“Toma881 provisional”) (EX1006)
- U.S. Pat. No. 9,818,446 to Toma et al. (“Toma446”) (EX1007)
- Certified English Translation of U.S. Provisional Pat. App. No. 61/925,699 (“’699 provisional”) (EX1009)
- Certified English Translation of U.S. Provisional Pat. App. No. 61/944,280 (“’280 provisional”) (EX1011)
- U.S. Pat. App. Pub. No. 2017/0264859 to Drugeon et al. (“Drugeon”) (EX1012)
- U.S. Provisional Pat. App. No. 62/087,035 (“Drugeon provisional”) (EX1013)
- U.S. Pat. No. 9,549,027 to Ali et al. (“Ali”) (EX1014)
- U.S. Pat. No. 11,916,594 to Tsukagoshi (“Tsukagoshi594”) (EX1015)
- U.S. Pat. No. 9,854,333 to Hwang et al. (“Hwang”) (EX1016)
- U.S. Pat. No. 10,038,922 to Hattori et al. (“Hattori”) (EX1017)

- U.S. Pat. No. 9,860,505 to Tsukagoshi (“Tsukagoshi505”) (EX1018)
- U.S. Pat. App. Pub. No. 2009/0284545 to Watanabe et al. (“Watanabe545”) (EX1019)
- U.S. Pat. No. 8,797,347 to Miyachi et al. (“Miyachi”) (EX1020)
- U.S. Pat. No. 9,256,924 to Watanabe et al. (“Watanabe924”) (EX1021)
- U.S. Pat. App. Pub. No. 2014/0218416 to Suzuki et al. (“Suzuki”) (EX1022)
- U.S. Pat. App. Pub. No. 2015/0109346 to Taniguchi et al. (“Taniguchi”) (EX1023)
- U.S. Pat. No. 10,171,788 to Toma et al. (“Toma788”) (EX1024)
- Certified English Translation of U.S. Provisional Pat. App. No. 62/018,912 (“Toma788 provisional”) (EX1026)
- U.S. Pat. App. Pub. No. 2006/0259781 to Saeki et al. (“Saeki”) (EX1027)

41. My analysis and conclusions set forth in this declaration are based on the perspective of a POSITA.

VII. TECHNOLOGY OVERVIEW

A. Overview of High Dynamic Range (HDR) Video

42. As discussed below, the '211 Patent is generally directed toward transmission and conversion of High Dynamic Range (HDR) video content. High Dynamic Range (HDR) imaging emerged in the late 1980s and early 1990s as researchers began to develop techniques to overcome the limited dynamic range of conventional cameras. Early HDR methods combined multiple images captured at different exposure levels to produce a single image with greater detail in both dark and bright regions. A major milestone came in 1997 with the work of Paul E. Debevec and Jitendra Malik, who introduced a practical method for recovering high dynamic range radiance maps from multiple photographs. During the 2000s, advances in camera sensors, image processing, and display technologies made HDR widely available in consumer cameras, smartphones, televisions, and streaming media. This led to HDR being a widely supported feature in televisions, streaming platforms, digital cameras, smartphones, and other display devices, establishing it as the new baseline for premium video delivery and enabling images with greater detail, contrast, and realism.¹

¹ In preparing this summary of the history of HDR technology, I referenced Paul E. Debevec and Jitendra Malik. (1997). *Recovering High Dynamic Range Radiance Maps from Photographs*. In *Proceedings of the 24th Annual Conference on Computer Graphics and Interactive Techniques (SIGGRAPH '97)*, 369–378.

B. The MP4 File Format

43. Image and video compression standards have evolved over several decades to address the growing demand for efficient storage, transmission, and high-quality multimedia. Early image compression was standardized with JPEG in 1992, which uses the discrete cosine transform (DCT) to achieve substantial file size reductions with acceptable visual quality. JPEG quickly became the dominant format for digital photography and the web due to its simplicity and broad compatibility. To improve compression efficiency and support both lossy and lossless coding, JPEG 2000 was introduced in 2000, replacing the DCT with wavelet transforms and adding features such as progressive transmission and region-of-interest coding. Later formats, including JPEG XR, HEIF (typically using HEVC compression), AVIF (based on AV1), and JPEG XL, were designed to provide significantly better compression while supporting modern imaging features such as high dynamic range (HDR), wide color gamut, transparency, animation, and efficient lossless coding.

44. Video compression standards have followed a similar progression, driven by the rapid growth of broadcasting, video conferencing, optical media, and internet streaming. Early standards such as H.261 (1988) and MPEG-1 (1993) enabled practical digital video transmission and storage. Subsequent standards, including MPEG-2 (1995), became the foundation for digital television and DVDs.

The MP4 (MPEG-4 Part 14) file format was later developed as part of the MPEG-4 multimedia standard and was formally standardized in 2001 (with a revised specification published in 2003) based on the ISO Base Media File Format. MP4 was designed as a flexible container capable of storing compressed video, audio, subtitles, and metadata, making it well suited for efficient transmission over Internet Protocol (IP) networks. As broadband Internet access expanded in the early 2000s, MP4 rapidly became the preferred format for downloadable and streaming media because of its compatibility with advanced codecs such as MPEG-4 Visual and later H.264/AVC, and by the mid-2000s it had become the dominant container format for Internet video distribution and portable media devices.²

C. High Dynamic Range (HDR) to Standard Dynamic Range (SDR) Conversion

45. Backward compatibility between high dynamic range (HDR) and standard dynamic range (SDR) refers to the ability of HDR content to remain viewable on legacy SDR devices without requiring separate versions of the content. Since HDR images and videos typically contain a much wider range of luminance and color than SDR displays can reproduce, backward-compatible systems

² In preparing this summary of the image and video compression and file format technology, I referenced ISO/IEC 14496-14:2003, *Information technology—Coding of audio-visual objects—Part 14: MP4 file format*; ISO/IEC 14496-12 (ISO Base Media File Format); Moving Picture Experts Group; and M. Ghanbari, “Standard Codecs: Image Compression to Advanced Video Coding”, 3rd Edition, The Institution of Engineering and Technology, 2011.

incorporate mechanisms that allow SDR devices to display an acceptable approximation of the original content while HDR-capable devices reconstruct or render the full dynamic range. This ensures interoperability across a diverse ecosystem of displays and playback devices. Hence, because HDR video is typically mastered for displays capable of substantially higher brightness, contrast, and color volume than conventional SDR displays, HDR content cannot generally be displayed directly on SDR devices without degrading image quality. To provide backward compatibility with the large installed base of SDR televisions, computer monitors, and mobile devices, HDR video is commonly converted to SDR through a process known as tone mapping, which compresses the HDR luminance and color range into the narrower capabilities of an SDR display while attempting to preserve perceived brightness, contrast, shadow detail, and highlight detail.

46. In image and video coding, backward compatibility is often achieved by using tone-mapping metadata describing the HDR content that enable SDR displays to render a given image while allowing HDR displays to reconstruct the expanded luminance and color information. This approach reduces storage redundancy and simplifies content distribution by maintaining a single master representation that serves both SDR and HDR devices. Key benefits of backward compatibility include: 1) A single content stream can support both SDR and HDR displays, 2) Legacy devices remain functional without software or hardware

upgrades, 3) Storage and transmission costs are reduced by avoiding separate SDR and HDR versions, and 4) Content creators and distributors can deliver a consistent viewing experience across a wide range of display technologies.

VIII. OVERVIEW OF THE '211 PATENT

A. Summary of the '211 Patent Specification

47. The '211 patent (EX1001) is focused on systems and methods for recording a high dynamic range (HDR) image in an MP4 file, together with metadata describing the image, so that the image can later be reproduced in a manner suited to the display that will show it. The patent states that its objective is “recording a high dynamic range (HDR) image according to an MP4 format to make the image reproducible.” EX1001, 2:15-17. As the patent summarizes the result, “the HDR image and the HDR image metadata are stored in the MP4 file, and the reproduction device can reproduce an optimum HDR image based on metadata.” EX1001, 4:3-6.

48. The '211 patent carries out that reproduction through a conversion process that takes account of both the stored metadata and the capabilities of the display. As the patent describes it, “[t]he reproduction device acquires the HDR image metadata stored in the MP4 file, determines whether executing the conversion process of the HDR image read from the MP4 file according to the acquired metadata and the display function information of the display unit, and executes the output image generation process according to the determination result.” EX1001, 4:13-19.

The conversion itself is performed using an electro-optical transfer function (EOTF): the patent describes that “an electrical-optical linear conversion unit 302 converts the display unit drive signal including a decoded 10-bit code value into an optical linear luminance signal, using an electro-optical transfer function (EOTF) 351,” after which “a dynamic range conversion process based on luminance information described in the metadata is performed for the optical linear luminance signal.” EX1001, 9:1-8.

49. The luminance information the '211 patent relies on includes two values carried in the HDR image metadata: “maximum content luminance information” and “maximum frame average luminance information.” EX1001, 11:36-41. The patent explains that these values are used when the display cannot reproduce the recorded luminance: “when the display of the reproduction device cannot output the data having a luminance level recorded in the HDR image metadata, the reproduction device executes a process of adjusting the luminance level of the image data stored in the MP4 file.” EX1001, 11:53-57.

B. Prosecution History

50. The '211 patent issued on August 11, 2020 from U.S. Patent App. No. 15/533,592 (“the '592 Application”). EX1001. The prosecution of the '592 Application included one Restriction Requirement and one Office Actions (*see* EX1002, 151-156, 163-198).

51. The Examiner issued the lone Office Action on 09/19/2019. The Office Action included a §103 rejection based on US 2014/0210847 (“Knibbeler”) and US 2011/0115935 (“Myung”). EX1002, 163-198.

6. Claims 1-3, 5-7, 9, 10, and 12-15 are rejected under 35 U.S.C. 103 as being unpatentable over Knibbeler et al. (U.S. Patent Application Publication 2014/0210847) in view of Myung (U.S. Patent Application Publication 2011/0115935).

EX1002, 166

52. The Applicant filed a Response to Office Action on 12/19, 2019. In response to the rejection, the Applicant amended the independent claims introduce a new claim feature requiring that “the acquired HDR image metadata includes a maximum value of frame average luminance of HDR image data stored in the MP4 file.” *Id.*, 229-241:

1. (Currently Amended) An information processing device, comprising:

a data processing unit configured to:

acquire[[read]] high dynamic range (HDR) image data from an MP4 file that stores data according to an MP4 format and output the HDR image data to a display unit, wherein the data processing unit acquires HDR image metadata from an MP4 file, wherein

the acquired HDR image metadata includes a maximum value of frame average luminance of HDR image data stored in the MP4 file, and

the HDR image data stored in the MP4 file is based on an MP4 format; as metadata regarding the HDR image data stored in the MP4 file,

acquire display function information of a display unit from the display unit;

read the HDR image data from the MP4 file;

determines whether executing execute a conversion process of [[an]]the read HDR image data based on read from the MP4 file according to the acquired HDR image metadata and the acquired display function information of the display unit[[, and]];

execute[[s]] an output image generation process according to a determination result based on the execution of the conversion process; and

output an image signal to the display unit based on the executed output image generation process.

EX1002, 232

Along with these claim amendments, the Applicant argued that Knibbeler and Myung references did not describe or suggest the newly presented feature of ‘the

acquired HDR image metadata includes a maximum value of frame average luminance of the HDR image data.” *Id.*, 229-230.

REJECTIONS UNDER 35 U.S.C. § 103

A. Rejections of Independent Claims 1, 5, 9, and 12-15

The Applicant respectfully submits that the combination of Knibbeler and Myung does not teach, suggest, or render obvious, for example, the newly presented feature of “the acquired HDR image metadata includes a maximum value of frame average luminance of the HDR image data,” as recited in amended independent claim 1.

Therefore, amended independent claim 1 is not taught, suggested or rendered obvious over the combination of Knibbeler and Myung. The Applicant further submits that amended independent claims 5, 9, and 12-15 are also not taught, suggested or rendered obvious over the references cited in the Office Action at least for the reasons stated above with regard to amended independent claim 1.

EX1002, 229-230.

53. In response to these claim amendments and remarks, the Examiner issued a second Notice of Allowance on 04/01/2020. *Id.*, 244-254. The “examiner’s statement of reasons for allowance” simply stated that the prior art “fails to teach or fairly suggest:” followed by a complete recitation of each of the independent claims without specifying specific claim features thought to be missing from the prior art. *Id.* Based on my review of the prosecution history, I believe that the Examiner found

the Applicant's comments regarding the newly added feature of "the acquired HDR image metadata includes a maximum value of frame average luminance of HDR image data stored in the MP4 file" to be persuasive. However, as I discuss below, such a feature was known in the prior art.

C. Claim Construction

54. I understand that, for purposes of my analysis in this *inter partes* review proceeding, the terms appearing in a patent claim should be interpreted according to their "ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent." 37 C.F.R. § 42.100(b). In that regard, I understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood by a POSITA. I further understand that the words of the claims should be given their plain meaning unless that meaning is inconsistent with the patent specification or the patent's history of examination before the Patent Office. I also understand that the words of the claims should be interpreted as they would have been interpreted by a POSITA at the time of the invention was made (not today). Because I do not know at what exact date the invention as claimed was made, if ever, I have used the Critical Date of the '211 patent as the point in time for claim interpretation purposes. My opinions do not change if the invention date is earlier.

1. "based on an MP4 format" (Claims 1, 5, 9, 12, 13, 14, 15)

55. The term “based on an MP4 format” does not appear in the ’211 Patent specification. The closest recitation that I can identify in the specification states that the system “stores high dynamic range (HDR) image data according to an MP4 format.” EX1001, 2:38-40. I therefore interpret the claim recitation of “based on an MP4 format” to merely mean that the HDR image data is stored according to an MP4 format.

D. Level of Ordinary Skill in the Art

56. Based on my knowledge and expertise in the field, and my review of the documents analyzed in this declaration, a person of ordinary skill in the art (“POSITA”) relating to the subject matter of the ’268 patent would have had (1) a bachelor’s degree in electrical engineering, computer engineering, computer science, image science, color science, or a related field, and (2) two to five years of industry experience in digital image/video processing and color management, including creation-side color correction/color grading workflows and LUT-based color transformation and gamut mapping for different display devices (e.g., projectors, CRT/Rec.709-class displays).

IX. SUMMARY OF RELEVANT PRIOR ART REFERENCES

A. Overview of Toma881 (EX1004)

57. Toma881 (EX1004) is directed to the same basic problem the ’211 patent addresses: how to take high dynamic range (HDR) video and display it on a

device built for standard dynamic range (SDR), so that the picture takes advantage of what the particular display can do rather than being forced down to a generic 100-nit signal. A person of ordinary skill reading Toma881 would understand it to describe a conversion method, and a conversion apparatus that carries out that method, in which the luminance of an HDR video is re-mapped into a narrower luminance range whose maximum is set by the functional characteristics of the display that will show the video. The reference explains each piece of that process — how the incoming HDR signal is decoded, what information about the content and the display is gathered, and how that information drives the luminance conversion — at the level of detail I summarize below.

58. Toma881 frames its subject matter in terms of the gap between HDR content and SDR displays. It describes itself as relating to “an image conversion-playback method and apparatus for displaying a high dynamic range (HDR) signal, which is a high-luminance signal with a high luminance range, in a display apparatus, such as a TV, projector, tablet, and smart phone, the display apparatus supporting a standard dynamic range (SDR) signal, which is a normal luminance signal having a luminance range with a maximum luminance value of 100 nit.” EX1004, 5:42-49; EX1006, 1, 4-7. The reference identifies the luminance disparity that makes conversion necessary: “while a scheme of the luminance range supported by conventional TV signals is referred to as SDR (Standard Dynamic Range) with

the maximum luminance value of 100 nit, HDR is assumed to extend the maximum luminance value to 1,000 nit or more.” EX1004, 6:6-11; EX1006, 1. Stated at a high level in the Abstract, Toma881’s method acquires a quantized luminance signal and converts its code value “into a second luminance value determined based on a luminance range of the display apparatus.” EX1004, Abstract. Toma881 contemplates that HDR content will reach the display through a range of channels, explaining that the “[a]ssumed specific application of HDR includes broadcast, package media (such as Blu-ray (registered trademark) disc), and Internet delivery, similarly to HD and UHD.” EX1004, 6:16-18; EX1006, 1, 10, 18.

59. Because the conversion in Toma881 is built on electro-optical transfer functions, it helps to begin with what that term means in the reference. Toma881 explains that an EOTF “is commonly called a gamma curve, indicates correspondence between a code value and a luminance value, and converts the code value into the luminance value.” EX1004, 9:11-13; EX1006, 11. The inverse operation runs the other way, quantizing a luminance value back into a code value. The reference identifies a specific, well-known example: “one example of EOTF of HDR and inverse EOTF of HDR is SMPTE 2084 standardized by the United States Society of Motion Picture and Television Engineers (SMPTE).” EX1004, 9:47-50; EX1006, 11. Consistent with that, Toma881 describes the converting step as one carried out “by using an electro-optical transfer function (EOTF) that associates the

luminance value in the first luminance range with a plurality of first code values.” EX1004, 3:35-37; EX1006, 8. This is the same class of conversion function the ’211 patent uses, which likewise converts a decoded code value into a linear luminance signal using an EOTF. EX1001, 9:1-8.

60. Toma881 implements the conversion in a conversion apparatus 100 working together with a display apparatus 200. The process begins by recovering a linear luminance signal from the incoming HDR video: “First, HDR EOTF converter 101 of conversion apparatus 100 acquires the HDR video on which inverse EOTF conversion of HDR is performed.” EX1004, 11:31-33; EX1006, 14, 7-8. A second component then performs the luminance re-mapping. As Toma881 explains, “Next, luminance converter 102 of conversion apparatus 100 performs first luminance conversion that converts the linear signal converted by HDR EOTF converter 101 by using display characteristic information and content luminance information (S102).” EX1004, 11:40-44; EX1006, 14. The point that matters for understanding Toma881 is that this first luminance conversion is driven by two distinct inputs — information about the content (luminance information) and information about the display — each of which the reference describes in turn.

61. The first input is content luminance information, expressed as two parameters. Toma881 states that, “[b]efore step S102, conversion apparatus 100 acquires content luminance information including at least one of a maximum value

of luminance (CPL: Content Peak luminance) of a video (content) and an average luminance value (CAL: Content Average luminance) of a video as information regarding the HDR signal. CPL (first maximum luminance value) is, for example, a maximum value of the luminance values of a plurality of images that constitute the HDR video. CAL is, for example, an average luminance value which is an average of the luminance values of the plurality of images that constitute the HDR video.” EX1004, 12:17-27; EX1006, 15, 18. In plainer terms, CPL is the brightest luminance in the content and CAL is its average luminance. Toma881 explains that this luminance information is provided with the video as metadata: “the luminance information including at least one of CPL and CAL may be acquired as metadata information on the video, and may be acquired via a network.” EX1004, 19:35-38; EX1006, 24, 14-15. Among the acquisition methods the reference lists is “acquisition as metadata information appended to the HDR video.” EX1004, 23:36-39; EX1006, 24.

62. The second input is display characteristic information describing functional characteristics of the display device, which Toma881 obtains from the display device itself. The reference states that, “[i]n addition, before step S102, conversion apparatus 100 acquires the display characteristic information on display apparatus 200 from display apparatus 200,” and that this information indicates “the display characteristic of display apparatus 200, such as a maximum value of

luminance that display apparatus 200 can display (DPL), display mode ... and input-output characteristic (EOTF supported by the display apparatus).” EX1004, 12:28-36; EX1006, 14-15, 18. The display’s peak luminance (DPL) is the value that sets the ceiling for the converted signal.

63. Using these inputs, Toma881 performs the luminance conversion so that the HDR content fits within the display’s capability. The reference explains that an HDR signal at its native peak (HPL) “may not be displayed as it is even if the display apparatus is an HDR TV,” and that, in that situation, “luminance conversion is performed to adapt a linear signal after inverse quantization using EOTF of HDR to a maximum value of the luminance range of the display apparatus (peak luminance (DPL (Display Peak luminance): example 750 nit)).” EX1004, 10:11-19; EX1006, 8-9, 14-15. Toma881 describes the shape of that mapping in terms of the CAL and CPL parameters: “in the first luminance conversion, when the luminance value of SDR is between the average luminance value (CAL) and the first maximum luminance value (CPL), the display luminance value corresponding to the luminance value of HDR is determined using a natural logarithm.” EX1004, 20:31-35; EX1006, 15, 19-20. The reference reduces this to a specific piecewise equation.

$$V = \begin{cases} L & \text{for } 0 \leq L < S1 \\ a * \ln(L) + b & \text{for } S1 \leq L < S2 \\ M & \text{for } S2 \leq L \end{cases}$$

EX1004, 20:9-31; EX1006, 19. In reference to this mathematical expression, Toma881 explains, “L denotes a luminance value normalized to 0 to 1, and S1, S2, a, b, and M are values to be set based on CAL, CPL, and DPL. ln is a natural logarithm.” EX1004, 20:19-21; EX1006, 19. The reference includes a numerical example in which CAL is 300 nit, CPL is 2,000 nit, and DPL is 750 nit. EX1004, 20:22-31; EX1006, 19.

64. Taken together, these disclosures describe a complete HDR-to-display conversion. Toma881 acquires the HDR video and recovers a linear signal through inverse-EOTF and EOTF processing; it gathers content luminance information (CPL and CAL) carried as metadata and display characteristic information (including the display’s peak luminance, DPL) from the display; and it then re-maps the HDR luminance into the display’s range using a conversion — including a natural-logarithm mapping between CAL and CPL — whose maximum is fixed by the display’s own peak luminance. EX1004, Abstract, 11:31-44, 12:17-36, 10:11-19, 20:31-35; EX1006, 14-15, 18-20.

B. Overview of Toma446 (EX1007)

65. Like Toma881 and the ’211 patent, Toma446 (EX1007) describes delivering high dynamic range (HDR) video to displays that may not be HDR-capable, but it approaches that goal from the file-format side. The main focus of Toma446 is directed to producing and using MP4 files for distributing video over a

network. This includes video that originated as optical-disc content in the MPEG-2 transport stream (MPEG-2 TS) format. In one embodiment, Toma446 describes storing HDR video together with the luminance information used to convert that video from the HDR format to a format compatible with a standard dynamic range (SDR) display. EX1007, 2:1-12, 4:59-62. This luminance information is stored in the MP4 file itself as metadata. *Id.* Toma446 teaches how the luminance information that accompanies the video is stored so that an HDR-to-SDR conversion can be performed at playback.

66. Toma446 begins by contrasting the two relevant file formats. It explains that the format historically used on optical discs is MPEG-2 TS, while the format “increasingly used in content distribution through a network is an MP4 system specified by ISO/IEC 14496-12.” EX1007, 1:26-28; EX1009, 12; EX1011, 15. Toma446 explains why MP4 suits network delivery: “The MP4 adopts an extremely flexible data structure on the assumption of application to a randomly accessible medium such as an HDD (Hard Disk Drive) and a flash memory.” EX1007, 1:29-32; EX1009, 12; EX1011, 15. It then ties that format to the devices that consume networked video, observing that “although a smartphone and a tablet do not include an optical disk drive, the smartphone and the tablet are used as a terminal receiving and playing back the content distribution in the network by utilizing high portability, a large screen size, and a finer image.” EX1007, 1:40-45; EX1009, 12; EX1011, 15.

67. Toma446 also addresses the cost of producing an MP4 file from existing, encrypted optical-disc content. The reference explains that converting an encrypted MPEG-2 TS file into MP4 by the conventional route requires decrypting and then re-encrypting the file, that this takes a long time on conversion devices such as a smartphone and a tablet, and that it creates a security concern because the plain-text content is temporarily produced. EX1007, 6:14-21; EX1009, 12; EX1011, 15. Toma446's method avoids that overhead: "Even if the original file is encrypted, it is not necessary to decrypt and re-encrypt the original file. Accordingly, a processing load necessary for the production of the MP4 file can be suppressed." EX1007, 6:40-43; EX1009, 12, 20; EX1011, 15, 27.

68. Against that backdrop, Toma446 describes an embodiment that stores HDR video in an MP4 file. As illustrated in FIG. 41, the reference describes a storage example in which "video data including the luminance within a HDR (High Dynamic Range) luminance range is stored in the MP4 file." EX1007, 4:59-62, FIG. 41; EX1011, 54. Toma446 explains that this HDR video carries luminance beyond the range of the SDR standard (BT.709), so that a display must be HDR-capable to present it natively. EX1007, 45:57-61; EX1011, 54.

69. For an SDR display, Toma446 converts the HDR video down into the SDR range. As the reference puts it, "processing of mapping the HDR luminance range on the SDR luminance range is required to play back the HDR content with

an SDR display.” EX1007, 45:62-65; EX1011, 54. That conversion is driven by luminance information carried with the content. Toma446 explains that, “[d]uring the playback of the HDR content, a gamma curve is adjusted according to the maximum luminance of the display of the output destination using luminance information, such as peak luminance and a white-level luminance, which can be switched in units of streams or scenes.” EX1007, 46:16-20; EX1011, 54. This is the same kind of luminance-information-driven conversion that Toma881 performs, described here in the context of an MP4 file.

70. Toma446 then describes where this information is kept within the MP4 file. The reference states that “whether the HDR content is stored in the MP4 file may be signaled in the header information on the MP4.” EX1007, 46:10-11; EX1011, 54. Toma446 further states that “the luminance information may be stored as the header information on the MP4.” EX1007, 46:21-22; EX1011, 54. Toma446 further distinguishes where that information sits according to whether it is constant: luminance information that is fixed for the file “may be set as the information in the moov,” while information that varies “may be set as the information in the moof.” EX1007, 46:22-27; EX1011, 54. Toma446 further describes that “[t]he HDR-related information may be stored as the metadata managing the MP4 file, instead of being directly stored in the MP4 file.” EX1007, 46:39-41; EX1011, 54.

71. Taken together, Toma446 describes producing and distributing video in an MP4 file format over a network. Toma446 establishes that the MP4 format is suited to random-access media and to devices such as smartphones and tablets that lack optical-disc drives, including storing HDR video in the MP4 file format along with the luminance information (carried as MP4 header information, or as metadata managing the file) used to map the HDR luminance range onto an SDR display's range at playback. EX1007, 1:26-32, 4:59-62, 45:62-65, 46:10-41; EX1009, 12; EX1011, 54.

C. Overview of Dugeon

72. Dugeon (EX1012) addresses the same problem as the '211 patent, Toma881, and Toma446, namely displaying HDR video on devices that may support only SDR. The descriptions in Dugeon relate to the level of how the video is encoded and signaled. Dugeon's system generates HDR video that remains backward-compatible with existing SDR-only reproduction devices, and it does so by encoding the video with a special opto-electrical transfer function (OETF) that an SDR device can still use, while signaling, within the video data itself, the information an HDR-capable device needs to reproduce the full HDR. EX1012, [0030]-[0032]; EX1013, 12-16. A person of ordinary skill would have understood Dugeon to teach both how to generate backward-compatible HDR video using an "SDR-compatible HDR OETF," and how to carry luminance metadata (such as a

maximum average picture level) in the video's supplemental enhancement information (akin to the metadata described in Toma881 and Toma446) so that the relationship between the HDR and SDR reproductions can be controlled. I describe each below.

73. Drugeon frames its goal in terms of compatibility: "It is desired that video data covering such an HDR be reproducible even by an existing reproduction device that supports only the SDR." EX1012, [0030]; EX1013, 12-16. Drugeon achieves that by signaling two transfer functions within the same video data, including storing, in the "video usability information (VUI) in the video data," information identifying a first OETF for an SDR device, and storing, in the "supplemental enhancement information (SEI) in the video data," information identifying a second OETF for an HDR device. EX1012, [0031]; EX1013, 13, 15. As Drugeon explains, an SDR device reproduces the video using the first transfer-function information and an HDR device using the second, so that "video data having backward compatibility can be generated." EX1012, [0032]; EX1013, 12-16.

74. The conversion function at the center of Drugeon is the OETF. Drugeon describes that "[i]mage signal generator 111 converts a luminance value of a source image covering the HDR into a code value using an opto-electrical transfer function (OETF)," and specifies that it "uses an SDR-compatible HDR OETF." EX1012, [0064]; EX1013, 12-21. Drugeon explains what makes that OETF SDR-compatible:

it is a hybrid function “including a part expressed as a power of luminance and a part expressed as a logarithm of luminance, such as a BBC hybrid gamma OETF.” EX1012, [0078]; EX1013, 14. Because the characteristics of that hybrid OETF substantially match those of the ordinary SDR OETF in the low-luminance range, an existing SDR device can still reproduce the encoded video. EX1012, [0083]; EX1013, 14.

75. Along with the transfer-function information, Drugeon carries luminance metadata in the SEI. The reference describes “storing, into the SEI, maximum average picture level information indicating a highest average luminance value among average luminance values of all pictures included in a video sequence.” EX1012, [0041]; EX1013, 15-17. Drugeon defines that value: “The maximum average picture level information (`maximum_average_picture_level`) indicates the highest average picture level among all the pictures included in a video sequence.” EX1012, [0092]; EX1013, 16. Drugeon stores this together with dynamic range increase information (a value indicating the difference between the video’s luminance dynamic range and that of SDR) likewise in the SEI. EX1012, [0122], [0040]; EX1013, 16-17.

76. Drugeon describes the benefit of carrying these values. As to the OETF, because the hybrid and SDR transfer functions substantially match in the low-luminance range, Drugeon explains that “it is possible to reduce the difference in

luminance value between when the video is reproduced by an HDR device and when the video is reproduced by an SDR device, and therefore video that is less likely to provide a feeling of discomfort can be reproduced even when the video is reproduced using the SDR OETF.” EX1012, [0083]; EX1013, 16. As to the metadata, Drugeon explains that “the use of the dynamic range increase information and the maximum average picture level information allows the difference from the SDR to be set within an arbitrary range.” EX1012, [0093]; EX1013, 16-17.

77. Taken together, Drugeon describes generating HDR video that an existing SDR-only device can use to reproduce the video by encoding it with an SDR-compatible (hybrid) HDR OETF, and signaling within the video data — in the VUI and the SEI — both the transfer-function information that distinguishes SDR from HDR reproduction and luminance metadata, including the maximum average picture level and a dynamic range increase value, that allows the difference between the HDR and SDR reproductions to be controlled. EX1012, [0030]-[0032], [0064], [0041], [0092]-[0093]; EX1013, 12-17.

D. Overview of Toma788 (EX1024)

78. Toma788 (EX1024) addresses the same basic problem as Toma881 and the '211 Patent: converting video between a high dynamic range (HDR) luminance range and a standard dynamic range (SDR) luminance range so that HDR content can be shown on a device that cannot display the full HDR range. As would have

been understood by a POSITA, Toma788, Toma881 share inventors and describe the same field of HDR-to-SDR conversion technology, which I discuss further below in connection with the motivation to combine in my analysis of Ground 1B. EX1004, Face; EX1024, Face.

79. Toma788 explains the same luminance-range disparity that motivates Toma881's conversion. It states that "the HDR luminance range is a luminance range where a maximum value is increased from 100 nit which is a maximum value in the SDR luminance range to 1000 nit." EX1024, 6:3-6; EX1026, 1-2, 9. This is consistent with Toma881's own description of SDR as having a maximum value of 100 nit and HDR as extending to 1,000 nit or more, discussed above in connection with the Overview of Toma881. EX1004, 6:6-10; EX1006, 1.

80. Toma788's first exemplary embodiment describes a conversion device 210, situated in a Blu-ray disc player (BD player) 200, that performs the HDR-to-SDR conversion when the connected display cannot show HDR video. As Toma788 illustrates in FIG. 5B, conversion device 210 "has an obtainer and a converter," where "[t]he obtainer obtains a first luminance signal (an HDR signal) compatible with a first luminance range (HDR)." EX1024, 7:39-41; EX1026, 1-2. A POSITA would have recognized that conversion device 210, so configured, converts an HDR signal into an SDR-compatible signal for a display that is not HDR-capable: as Toma788 explains, "conversion device 210 converts the HDR signal to the SDR

signal so as to output the SDR signal, but the device may convert the SDR signal to the HDR signal and output the HDR signal” in the reverse case. EX1024, 7:55-59; EX1026, 6.

81. Toma788 explains that this conversion is carried out by a remap processor within conversion device 210 having four functional components. As Toma788 describes, “[r]emap processor 220 is included in conversion device 210... remap processor 220 has EOTF determiner 221, process target determiner 222, luminance value variable remapper 223, and luminance value fixed remapper 224, storage 225 that temporarily stores a stream of content (a video).” EX1024, 8:19-24; EX1026, 9. EOTF determiner 221 decides whether the incoming content’s transfer function differs from the transfer function needed for the connected display, and process target determiner 222 decides whether the content being processed is video or graphics, so that the remapper appropriate to that content type performs the conversion. EX1024, 8:25-34; EX1026, 9.

82. A POSITA would have recognized that Toma788 ties the type of remapping to the type of content being converted. Toma788 explains that “[w]hen the content (the video) is a video, the second remapping is made, and when the content (the video) is graphics, the first remapping is made.” EX1024, 9:6-8; EX1026, 2. The second remapping, performed by luminance value variable remapper 223, is the luminance-value-variable remapping applied to video, while

the first remapping, performed by luminance value fixed remapper 224, is the luminance-value-fixed remapping applied to graphics such as subtitles and menus. EX1024, 8:35-42, 9:6-8; EX1026, 2, 9.

83. Toma788 further discloses that the device carrying the converted signal to the display may also carry metadata identifying the transfer function used, information a POSITA would have recognized as useful to a receiving display. Toma788 states that, “when outputting the signal to the display through an interface such as an HDMI, conversion device 210 may transmit information for identifying the EOTF of the output signal as meta-information,” so that “conversion device 210 may further output the second luminance signal converted from the obtained first luminance signal as well as the meta-information for identifying the second EOTF.” EX1024, 10:2-7; EX1026, 9.

84. Toma788 separately describes a playback-device determination of whether the connected display can handle HDR graphics content, which becomes relevant to the motivation to combine that I discuss in my Ground 1B analysis, below. Toma788 explains that “the playback control program determines whether the playback device is compatible with HDR graphics (has a function for executing HDR graphics).” EX1024, 32:64-33:3; EX1026, 2, 6, 9, 41-42. Depending on that determination, the playback device either plays the HDR graphics content directly

or converts it for compatibility with the display's actual capability. EX1024, 33:3-25; EX1026, 41-42.

85. In further examples, Toma788 describes an architecture that closely parallels the conversion apparatus 100 and display apparatus 200 that Toma881 uses. As Toma788 describes, "conversion device 500 includes HDR EOTF converter 501, luminance converter 502, inverse luminance converter 503, and inverse SDR EOTF converter 504. Further, display device 600 includes display setting unit 601, SDR EOTF converter 602, luminance converter 603, and display unit 604." EX1024, 18:12-17; EX1026, 22. A POSITA would have recognized this four-stage conversion sequence, together with a matching display-side sequence, as substantially the same architecture Toma881 uses for its own conversion apparatus 100 and display apparatus 200. I note that Toma788's provisional application describes this same sequence at the level of its process steps rather than by named structural components. *See, e.g.*, EX1026, 22.

86. Continuing with this example in Toma788, HDR EOTF converter 501 "performs the HDR EOTF conversion on an HDR signal of the obtained HDR video (S101)." EX1024, 18:28-30; EX1026, 22. Luminance converter 502 then "performs first luminance conversion for converting the linear signal converted by HDR EOTF converter 501 using display characteristics information and content luminance information (S102)." EX1024, 18:34-38; EX1026, 22-23. The content luminance

information Toma788 uses at this step is expressed in the same terms Toma881 uses: “at least one of a maximum luminance value of the video (content) (CPL: Content Peak Luminance) and an average luminance value of the video (CAL: Content Average Luminance).” EX1024, 19:11-14; EX1026, 23. Inverse luminance converter 503 then “performs second luminance conversion for converting the luminance values set in the display luminance range to luminance values set in the SDR luminance range (0 to 100 [nit]) (S103),” EX1024, 19:37-40; EX1026, 22, 25, and inverse SDR EOTF converter 504 “performs inverse SDR EOTF conversion so as to generate pseudo-HDR video (S104).” EX1024, 19:52-54; EX1026, 22.

87. On the display side, Toma788 describes a sequence that mirrors Toma881’s display apparatus 200 as well. SDR EOTF converter 602 of display device 600 “performs the SDR EOTF conversion on the obtained pseudo-HDR signal (S106),” and luminance converter 603 then “performs third luminance conversion for converting the SDR luminance values set in the SDR luminance range (0 to 100 [nit]) to display luminance values set in the display luminance range (0 to DPL [nit]) (S107).” EX1024, 20:52-65; EX1026, 22, 25. A POSITA implementing Toma881 would have recognized this display-side conversion as functionally equivalent to the luminance-converter and inverse-EOTF stages of Toma881’s own display apparatus 200.

E. Overview of Saeki (EX1027)

88. Saeki discloses methods and systems for detecting whether the metadata associated with an item of digital content has been altered or falsified. As Saeki states, “[d]isclosed are methods and systems (and related data structures) for processing metadata in files, including media files, so that an alteration or falsification of the metadata can be detected.” EX1027, [0009]. According to Saeki, this is accomplished because “the metadata includes hash values and digital signatures that were generated by a content server,” and “these hash and signature values can be used by a client to authenticate the metadata.” *Id.* Saeki describes this same mechanism in the context of an exemplary content-distribution system in which “the metadata 24 includes hash values and digital signatures that were generated by the content server 14,” so that “these hash values and digital signatures can be used by the client 18 to authenticate the metadata 24.” EX1027, [0026].

89. Saeki discloses that this metadata-protection scheme is implemented within an MP4 file structure. As Saeki explains, “[r]eferring to FIG. 3 a modified MPEG-4 (sometimes called ‘MP4’) data structure is shown having a first portion and a second portion comprising, respectively, of metadata and underlying audio-visual content.” EX1027, [0035]. A POSITA would have recognized that this is the same general MPEG-4 technology described in Toma446, discussed above in connection with the Overview of Toma446, in which “the data is encapsulated into

structures called ‘atoms’ or ‘boxes’“ and the format “separates all the presentation level information (i.e. the metadata) from actual multimedia data samples... and puts the metadata into one integral structure inside the file, which is called the ‘movie box.’” EX1027, [0036]. Saeki describes, “the media data is referenced and interpreted by the metadata boxes.” *Id.*

90. Saeki explains the respective roles of the moov box and the mdat box that make up this data structure. As Saeki describes, “the moov box 64 stores the information, etc., necessary for decoding the metadata of the entire MPEG-4 file, i.e., an encoded codec data stream of a media, for example information describing an attribute, an address, etc. for data decoding,” while “the mdat box 66 stores an actually encoded codec stream of a media, i.e., content data such as a video stream or an audio stream.” EX1027, [0039]. As shown in Saeki’s FIG. 3, the moov box in turn encapsulates the tracks that carry this metadata: “the moov box 64 encapsulates several other boxes, including a movie header (‘mvhd’) box 68, a first movie-level user data (‘ucdt’) box 70, a second movie-level user data (‘ucd2’) box 72, an audio track (‘trak’) box 74 and a video track (‘trak’) box 76.” EX1027, [0040]. Saeki further explains that “the audio and video track boxes 74, 76 contain other boxes which hold meta information on each media according to a type of the media included in the moov box 64.” EX1027, [0041].

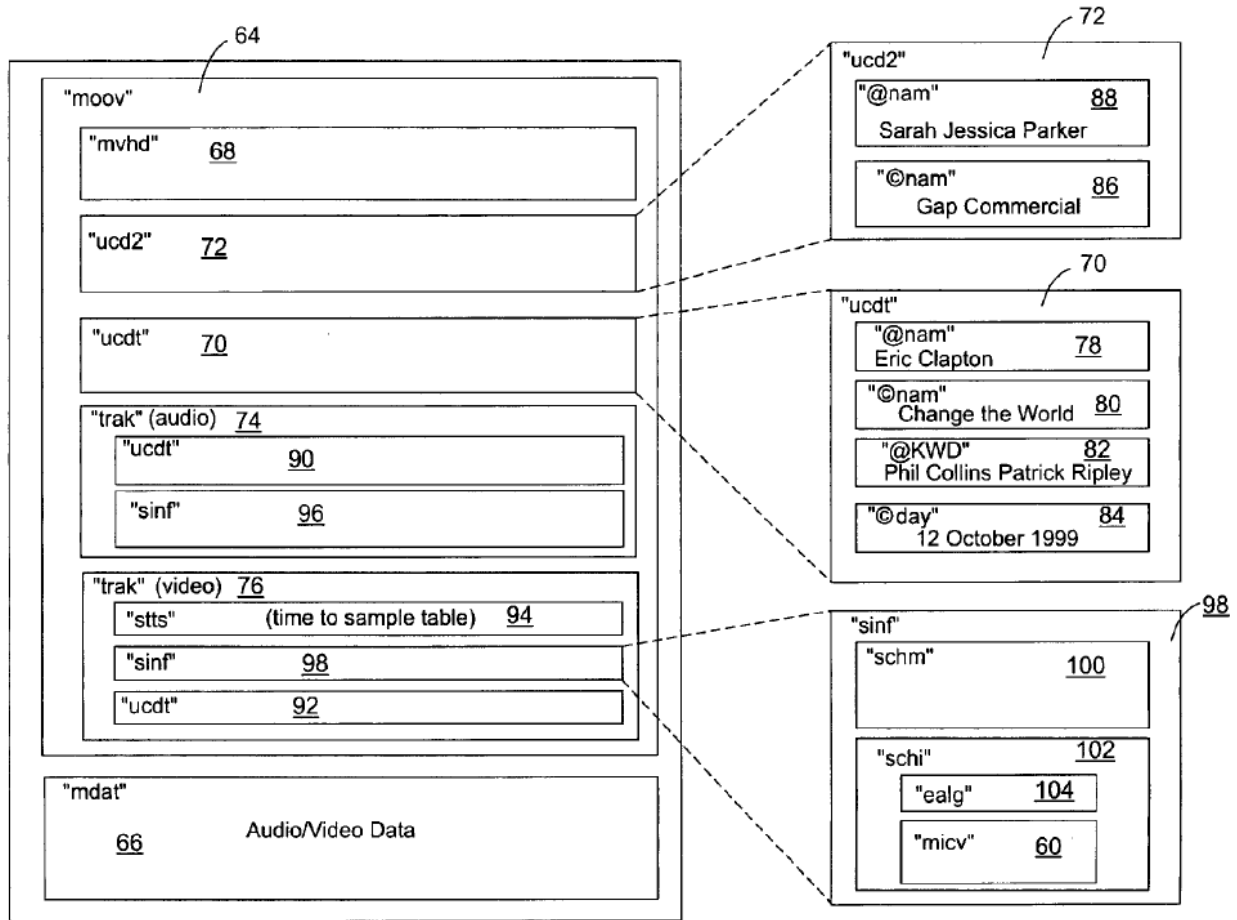


FIG. 3

EX1027, FIG. 3.

91. Saeki discloses that its protection mechanism is implemented through a nested set of boxes contained within these audio and video trak boxes. As Saeki explains, “[s]inf boxes are parent boxes for other boxes containing information relating to DRM or other data security-related methods.” EX1027, [0047]. Nested within a sinf box, in turn, is a box that Saeki identifies as its metadata integrity check value box: “also contained within the schi box 102 is the metadata integrity check value (‘micv’) box 60.” EX1027, [0050]. As Saeki explains, the micv box is itself

“a container for an integrity information (‘iinf’) box 106,” which “is the container for an integrity check scheme (‘isch’) box 108, an integrity target (‘itrg’) box 110, and an integrity check value (‘icvi’) box 112, as well as other boxes.” *Id.*

92. Saeki explains how this nested set of boxes is used to detect whether metadata has been altered. As Saeki describes, “the client will locate and access the target entry data in the itrg box 110, and then perform a hash calculation on that data to obtain a local hash value,” and “this local hash value will be compared against the integrity check value (stored in the icvi box 112) that was calculated by the content server for that same target entry data.” EX1027, [0062]. According to Saeki, “if the values match, then the user can have confidence that the metadata likely was not altered by unauthorized persons.” *Id.* As would have been understood by a POSITA, this comparison of a client-calculated hash value against the content-server-calculated hash value stored in the file itself is the specific mechanism by which Saeki’s data structure permits detection of metadata alteration or falsification, consistent with the general disclosure discussed above. EX1027, [0009].

93. Saeki further discloses that digital signatures may be used together with, or as an alternative to, hash values for this same purpose. As Saeki explains, “[i]n alternative embodiments, rather than using hash algorithms, digital signatures are used,” such that “rather than calculating a hash of the target entry data, a digital signature of the target entry data is used.” EX1027, [0064]. Saeki explains that “these

digital signatures can be verified by the client with public keys obtained from the content provider server (or some other external source) in order to confirm that the hash and security information data likely have not been tampered.” EX1027, [0067]. As would have been understood by a POSITA, Saeki’s hash-and-signature mechanism provides a technique for verifying the integrity of metadata of the kind stored in an MP4 file, which I discuss further below in connection with the motivation to combine Saeki with the combination of Toma881, Toma446, and Drugeon.

X. GROUND 1A – CLAIMS 1, 2, 9, 12, AND 14 ARE OBVIOUS BASED ON TOMA881 IN VIEW OF TOMA446 AND DRUGEON

A. A Person of Ordinary Skill in the Art Would Have Been Motivated to Combine Toma881 with Toma446 and Drugeon, With a Reasonable Expectation of Success

94. A person of ordinary skill in the art (“POSITA”) seeking to implement the HDR-to-pseudo-HDR conversion process taught by Toma881 would have been prompted to draw on two complementary teachings. First, a POSITA would have applied the teachings of Toma446 to the system of Toma881 such that the HDR image data described in Toma881 is stored in an MP4 file using the MP4 format according to the suggestion of Toma446. EX1007, 45:56-46:41; EX1011, 54. Second, a POSITA would have applied the teachings of Drugeon to the system of Toam881 such that the maximum average picture level taught by Drugeon is carried as part of the luminance metadata used to convert HDR video, either *as* the Content

Peak Luminance (CPL) expressly disclosed by Toma881 or as additional luminance information metadata for use in the conversion. EX1012, [0122]; EX1013, 16-17. Each of these applications of Toma446 and Drugeon to Toma881's system would have led to predictable outcomes without disturbing how the system works, and each addresses a need that Toma881 itself creates but does not fully resolve. I explain below why a POSITA would have made each modification and why that artisan would have expected the combined system to function as intended.

1. Storing Toma881's HDR data in an MP4 file format, as taught by Toma446

95. Toma881 describes delivering its HDR content over the internet, but it does not prescribe a particular file format for that delivery. A POSITA implementing Toma881 therefore would have looked to other similar references to provide details on a container in which to package the HDR video and its associated luminance information for transmission and storage. Toma446 supplies exactly that container, and several considerations would have led a POSITA to select Toma446's MP4 approach such that in the resulting system, the HDR video image data is stored in the MP4 file based on an MP4 format.

96. Multiple reasons would have prompted a POSITA to apply the suggestions of Toma446 to Toma881 to store Toma881's HDR image data in an MP4 file based on an MP4 format. *As a first reason*, MP4 was, by the relevant time, the prevailing format for distributing video over a network, which is the very

distribution channel Toma881 contemplates. Toma881 identifies Internet delivery as an intended use of its HDR content, explaining that the “[a]ssumed specific application of HDR includes broadcast, package media (such as Blu-ray (registered trademark) disc), and **Internet delivery**, similarly to HD and UHD.” EX1004, 6:16-18; EX1006, 1, 10, 18; *see also* EX1004, 18:34-39, 18:54-56, 7:27-35. Toma446, in turn, describes MP4 as the format that had become standard for distribution of media content over the Internet, stating that “a nowadays file format that is increasingly used in content distribution through a network is an MP4 system specified by ISO/IEC 14496-12.” EX1007, 1:26-36; EX1009, 12; EX1011, 15. Because MP4 was a known, widely adopted format defined by an industry standard (ISO/IEC 14496-12), a POSITA would have understood that adopting it for Toma881’s network-delivered HDR video would yield broad compatibility across devices and would avoid the time, cost, and risk of designing a new and untested format from scratch.

97. This understanding was not idiosyncratic. Other references from the same field confirm that MP4 was a widely used container for transmitting HDR video over networks such as the Internet, with one contemporary reference observing “[i]n case of distribution via the Internet, MP4 or other format containers are often used for distribution.” EX1018, 18:61-67, 6:32-39, 10:6-12; *see also* EX1014, 4:1-17 (describing an MP4 container for HDR video data having a file name “movieA_HDR.mp4”); EX1015, 2:32-37 (“...a format of MP4 used for distribution

on the Internet or the like”), 1:53-67 (describing distribution of HDR video data), 16:1-15 (“In the distribution over the Internet, distribution is often carried out on a container of MP4 or other formats.”); EX1016, 15:16-22, 23:42-61; EX1017, 50:4-11, 12:39-48, 18:56-67.

98. As a second reason for applying Toma446’s suggestions to Toma881, a POSITA would have recognized the flexibility of the MP4 format. Toma446 explains that “[t]he MP4 adopts an extremely flexible data structure,” (EX1007, 1:29-32; EX1009, 12; EX1011, 15) which a POSITA would have recognized as making the MP4 format well suited to the range of videos and display devices a real-world implementation of Toma881 would encounter, including videos of different types and lengths and displays of differing capability. As a POSITA would have known, MP4, formally MPEG-4 Part 14, is a highly compatible multimedia container that holds video, audio, subtitles, and metadata in a single file. The file is organized as a hierarchy of data blocks called boxes (or atoms). The MP4 file begins with an ftyp (file type box) which is placed at the very beginning to identify compatibility profiles and decoder requirement. The ftyp tells a media player exactly what kind of file it is dealing with and what decoders it needs. From there, the player looks for the moov (movie box), the “brain” of the file, which holds the master map of all timing data, frame sizes, and sample layouts. Finally, using this structural map, the player dives into the massive mdat box (media data box), which holds the raw

payload of interleaved video frames and audio samples, decoding them on the fly for seamless playback. A POSITA would also have known that this structure carried well-recognized advantages: near-universal playback compatibility across operating systems, browsers, and media players; efficient compression that delivers high-definition video at modest file sizes; and support for web streaming, including the ability to relocate the “moov” index to the front of the file so that playback can begin before the file finishes downloading. A POSITA would have recognized that these properties make the MP4 format attractive for the network-delivered HDR use case Toma881 describes.

99. As a third reason for combining Toma881 and Toma446 in the described manner, use of an MP4 format for the HDR image data would have provided compatibility with display devices that were becoming popular during the relevant period. Toma446 explains that “the smartphone and a tablet do not include an optical disk drive.” EX1007, 1:37-45; EX1009, 12; EX1011, 15. Toma446 goes on to describe that such devices carry many functions and processing compatible with MP4 while support for the older MPEG2-TS format had not progressed comparably. EX1007, 1:45-49; EX1009, 12; EX1011, 15. Storing Toma881’s HDR content in an MP4 file would therefore have provided convenient compatibility with the smartphones and tablets that increasingly served as playback devices and that lacked the optical media on which older formats relied.

100. A fourth reason for combining Toma881 and Toma446 in the proposed manner is that the conversion was straightforward to perform. Toma881 expressly contemplates use of MPEG compression schemes, including MPEG-2 TS and MPEG-4 AVC, for its video. EX1004, 22:8-47; EX1006, 22. Toma446 teaches that converting such MPEG-compressed content into an MP4 file is uncomplicated, describing techniques by which an MP4 file can be produced from the underlying stream so that the MP4 file can easily be produced. EX1007, 6:13-50; EX1009, 12, 18-23; EX1011, 15-16, 21-25. A POSITA would thus have expected to package Toma881's MPEG-compressed HDR video into MP4 without difficulty.

101. As a fifth reason for making the proposed combination, a POSITA would have recognized that application of Toma446's suggestions to Toma881 would have led to reduction in processing load that Toma446's MP4-generation techniques provide. Toma446 explains that its approach avoids re-processing the source content, stating that "it is not necessary to decrypt and re-encrypt the original file" and that, "[a]ccordingly, a processing load necessary for the production of the MP4 file can be suppressed." EX1007, 6:34-43. Toma446 repeats this benefit throughout its disclosure, describing that "a load of special processing of the playback device can be reduced," and that "the processing load can be suppressed." EX1007, 8:29-32, 10:15-18; EX1011, 27, 37, 39; *see also* EX1007, 9:25-31, 10:40-42, 15:6-15. Toma446 summarizes that "[t]he present disclosure has the advantage

that can suppress the processing load.” EX1007, 48:35-39; EX1009, 20, 24, 34; EX1011, 27, 37, 39. A POSITA would have valued this benefit when implementing Toma881, because reducing processing load conserves energy, lessens the need for larger and more costly processing hardware, and frees processing capacity for other tasks.

102. As a sixth reason for applying the suggestions of Toma446 to Toma881 is that such a combination would have resulted in a reduction in file size that Toma446’s techniques afford. Toma446 explains that “the file size can be reduced by indicating the information specifying the multiplexing unit of the output MP4 file in the copy manifest file, and it is effective in reducing the file size for the large number of copy manifest files.” EX1007, 32:25-29; EX1009, 28, 34; EX1011, 33, 37. Smaller files reduce the transmission and storage resources required, which a POSITA would have recognized as a further advantage for the network-delivered HDR content of Toma881. Toma446 likewise notes that storing size information in the copy manifest can “largely reduce the processing of searching the video stream,” and identifies as “another advantage” that the start code format of the MPEG2-TS can be converted into the NAL size format of the MP4 using that information. EX1007, 32:60-33:9, EX1009, 28, 34; EX1011, 33, 37.

2. Including Drugeon’s maximum average picture level as part of Toma881’s luminance metadata

103. A POSITA would also have been prompted to apply Dugeon's teaching of a maximum average picture level to Toma881, using Dugeon's "maximum average picture level information (maximum_average_picture_level)" either as Toma881's CPL (Content Peak luminance) value or as an additional item of luminance information in the combined system. EX1012, [0041], [0122]; EX1013, 16-17; EX1004, 23:33-35, 12:17-27; EX1006, 15. The reason is that Toma881 relies on a per-image luminance value but does not provide express details on how to compute such a per-image luminance value, whereas Dugeon supplies precisely such a value that a POSITA would have recognized as useful in and compatible with Toma881's system.

104. Several reasons would have motivated a POSITA to apply the suggestions of Dugeon to Toma881 in such a manner. *As a first reason*, Dugeon provides implementation details that compliment the disclosures of Toma881 by providing missing details. For example, Toma881 determines luminance on an image-by-image basis, using CPL as one of the luminance values driving its HDR conversion. Toma881 defines CPL as a per-image maximum, explaining that "CPL (first maximum luminance value) is, for example, a maximum value of the luminance values of a plurality of images that constitute the HDR video." EX1004, 12:17-27, 15:4-20, 20:9-48; EX1006, 15, 18-20. In another example, Toma881 describes CPL as "a first maximum luminance value that is a maximum value of

luminance values of a plurality of images that constitute the video.” EX1004, cl. 1. Toma881 distinguishes this image-level approach for determining luminance values from techniques that operate at the level of a single pixel, noting that an earlier image signal processing apparatus instead “calculates linear luminance for each pixel,” that is, computes “luminance for each pixel” rather than for each image as a whole. EX1004, 2:57-3:7, 12:17-27, 19:17-30.

105. What Toma881 does not provide is a method for arriving at the per-image luminance value from which CPL (and the corresponding content average luminance, CAL) is taken. Dugeon fills that gap. Dugeon describes “maximum average picture level information indicating a highest average luminance value among average luminance values of all pictures included in a video sequence.” EX1012, [0041]; EX1013, 16-17. In other words, Dugeon determines a luminance value for each image by computing an average luminance value for that image, and then, in the same manner Toma881 uses for CPL, takes the highest such value across the images. A POSITA would therefore have used Dugeon’s maximum average picture level as one of the luminance values in Toma881, for example as the CPL value or in addition to it.

106. This choice to use Dugeon’s maximum average picture level as one of the luminance values in Toma881 is further supported by the fact that the average picture level was an established measure of image luminance, so a POSITA adopting

it would not have had to devise a luminance metric from scratch and would have produced a system compatible with existing equipment that already used average picture level. The prior art confirms that determining the average luminance, or “average picture level,” of each image was a known way to quantify image luminance, with one contemporary reference describing for example an “average picture level (APL) expressing the average luminance of an image” and a calculation of “the one-screen average image luminance (i.e., the average picture level (APL)) of an individual screen (i.e., frame).” EX1019, [0009], [0048]-[0049]; *see also* EX1020, 5:55-59; EX1021, 4:55-58, 7:30-35, 29:26-34 (“...calculate an average picture level (APL) of a target decoded image”); EX1022, [0086]; EX1023, [0027] (“...an indicator indicative of a degree of brightness of a video, (i) an APL (Average Picture Level) of the video”).

107. As a second reason, Drugeon’s maximum average picture level value provides control over the conversion. Drugeon explains that using the maximum average picture level “allows the difference from the SDR to be set within an arbitrary range” when HDR video is converted for display on an SDR or other non-HDR device. EX1012, [0092]-[0093]; EX1013, 16-17. A POSITA would have recognized that the use of the maximum average picture level value is directly useful in Toma881’s conversion, which adapts HDR content for display within the capability of the receiving display device because it provides information about the

brightest sustained scenes in the content, rather than just the brightest individual pixels. This allows the tone-mapping algorithm to make better decisions about compressing HDR luminance into the much smaller SDR brightness range while preserving the overall appearance of the scene. For example, suppose two HDR videos both have a brightest individual pixel luminance of 1,000 nits where Video A contains a mostly dark night scene with only a few bright stars while Video B contains a snow-covered landscape under bright sunlight. Although the highest individual pixel brightness is identical, Video B has a much higher average picture level. If a tone-mapping algorithm relied only on luminance level of the brightest individual pixel, it might preserve the bright highlights but cause the snow scene to appear flat or clipped in SDR. On the other hand, by using maximum average picture level value, the algorithm would recognize that a large portion of the image is bright and can apply a different tone curve—compressing the overall luminance more gradually to preserve contrast and visible detail across the scene. Thus, maximum average picture level value helps distinguish between isolated bright highlights and sustained high-brightness scenes. This enables more perceptually optimized tone mapping, reducing clipping, maintaining shadow and highlight detail, and producing SDR output that more closely resembles the artistic intent of the original HDR content.

108. As a third reason, such an application of Drugeon to Toma881 would provide improvement in the viewing experience. Drugeon explains that using the maximum average picture level as a conversion value makes it “possible to reduce the difference in luminance value between when the video is reproduced by an HDR device and when the video is reproduced by an SDR device, and therefore video that is less likely to provide a feeling of discomfort can be reproduced even when the video is reproduced using the SDR OETF.” EX1012, [0083]; EX1013, 16. Reducing that difference serves the same goal Toma881 pursues, namely producing pseudo-HDR video that closely resembles the original HDR content on a display that is not HDR-capable.

3. Reasonable expectation of success

109. A POSITA would have expected the combined system to work as intended. Both modifications apply known techniques to a known method. Toma446’s MP4 format and Drugeon’s maximum average picture level were established techniques, and Toma881’s HDR conversion method was a known method that was ready for the improvements those techniques supply. Applying them would have produced predictable results, because neither modification alters the underlying structure or function of Toma881’s conversion process. Storing the HDR video and its luminance information in an MP4 file changes the container, not the conversion, and supplying a maximum average picture level gives Toma881 a

concrete way to compute a luminance value it already calls for (Content Peak Luminance).

110. Two further points reinforce that expectation. The three references arise from the same line of work and share overlapping inventors, so a skilled artisan looking to implement Toma881 would naturally have consulted Toma446 and Drugeon for additional implementation detail contemplated by the same inventors. EX1004, Face; EX1007, Face; EX1012, Face. And all three references address the same problems in the same field, namely transmitting HDR video over the internet and converting HDR video for display on SDR devices, so a skilled artisan would have turned to Toma446 and Drugeon as a matter of course and would have expected to combine their teachings without disrupting Toma881's operation. Toma881 itself invites this kind of refinement, stating that "various modifications" by a person skilled in the art fall within the scope of its disclosure. EX1004, 23:63-24:6. Toma446 and Drugeon disclose exactly the sort of known and beneficial variations Toma881 anticipates.

B. Analysis - The Combination of Toma881, Toma446, and Drugeon Discloses Every Limitation of Claims 1-3, 5, 12-14, 20-22, And 24

1. Claim 1

111. As shown in detail below, the combination of Toma881, Toma446, and Drugeon ("the combination") satisfies all limitations of Claim 1. Toma881 discloses a conversion apparatus that acquires HDR video information, acquires display

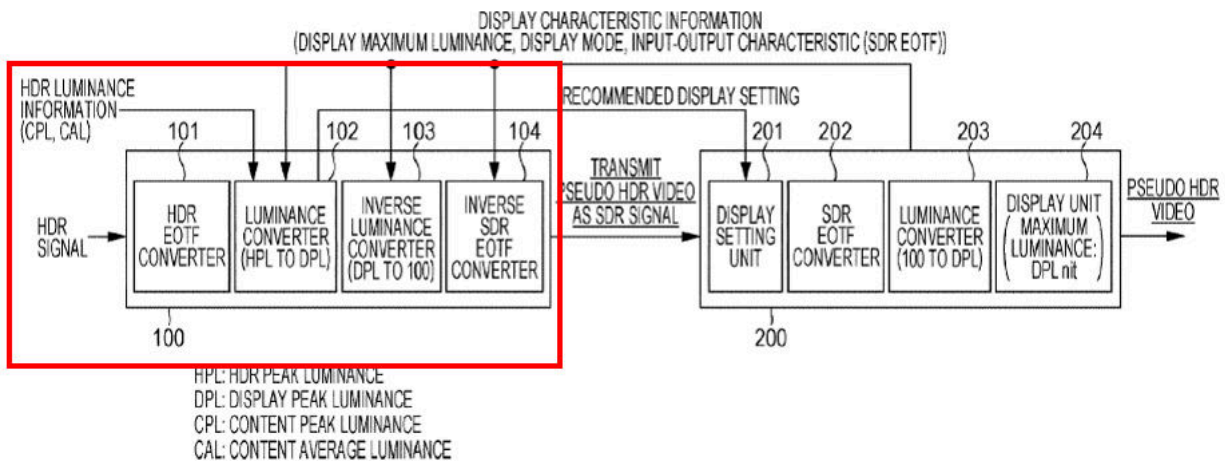
characteristic information, performs luminance conversion based on HDR luminance metadata and display characteristics, generates a pseudo-HDR video, and outputs a signal for display. Toma446 teaches storing HDR image data and HDR-related metadata in an MP4-formatted file. Drugeon teaches HDR metadata including maximum average picture level information and dynamic-range information. Accordingly, Toma881 provides the HDR processing architecture, Toma446 provides the MP4 storage framework, and Drugeon provides HDR metadata values used in HDR processing. A POSITA would have combined these teachings to implement Toma881's HDR conversion processing using HDR metadata stored in the MP4 structures taught by Toma446, including the luminance and dynamic-range information taught by Drugeon.

[1.pre] An information processing device, comprising:

112. To the extent the preamble is treated as limiting, the combination of Toma881, Toma446, and Drugeon provides the recited information processing device. Toma881 discloses such a device in the form of its conversion apparatus 100. Toma881 is directed to a "conversion apparatus regarding luminance of a video," and it describes conversion apparatus 100 as the component that receives high dynamic range (HDR) video and converts it into a pseudo-HDR signal that an ordinary standard dynamic range (SDR) display can show. EX1004, 11:4-51, 12:41-63, 1:8-9; 18:57-61; EX1006, 8-9, 13-14, 18. As Toma881 illustrates in FIG. 11,

conversion apparatus 100 is built from an HDR EOTF converter (101), a luminance converter (102), an inverse luminance converter (103), and an inverse SDR EOTF converter (104).

FIG. 11



EX1004, FIG. 11; EX1006, 13.

113. In operation, conversion apparatus 100 carries out a four-step conversion sequence that Toma881 labels S101 through S104. In step S101, the HDR EOTF converter applies the HDR electro-optical transfer function to the acquired HDR signal so as to recover a linear signal representing luminance; Toma881 describes that the converter “performs EOTF conversion of HDR on the HDR signal of the acquired HDR video.” EX1004, 11:35-36; EX1006, 24, 11. In step S102, the luminance converter maps the HDR luminance range onto the display's luminance range, using the display characteristic information and the content luminance information so that the converted signal does not exceed the

display's peak luminance. EX1004, 11:40-51; EX1006, 24. In step S103, the inverse luminance converter adjusts the signal according to the display mode of display apparatus 200, bringing it into the SDR luminance range. EX1004, 12:41-60; EX1006, 24. And in step S104, the inverse SDR EOTF converter produces the output, as Toma881 describes when it states that conversion apparatus 100 “performs inverse SDR EOTF conversion to generate the pseudo HDR video.” EX1004, 12:61-63; EX1006, 24. The full sequence is described at EX1004, 11:31-13:16 and depicted in FIG. 11 and FIG. 12. *See also* EX1006, 24, 8-9, 13-14, 18.

114. Toma881 confirms that conversion apparatus 100 is a device of the kind the claim recites by describing the many forms it can take. Toma881 explains that “Conversion apparatus 100 (HDR to pseudo HDR conversion processor) may exist within a disc player, disc recorder, set-top box, TV, personal computer, and smart phone. Conversion apparatus 100 may exist within a server apparatus on the Internet.” EX1004, 18:57-61; EX1006, 18. Each of these is an information processing device. A POSITA would have recognized that the conversion apparatus 100, as implemented in the combination of Toma881, Toma446, and Drugeon, is therefore an information processing device within the meaning of [1.pre].

[1.1] a data processing unit configured to:

115. Element [1.1] recites that the information processing device includes a data processing unit configured to perform the operations recited in the elements that follow. Toma881 describes exactly such a unit that performs the claimed HDR image processing operations recited by further elements of Claim 1. Toma881 explains that the components of conversion apparatus 100 may be realized in hardware or in a processor running software, stating that “each component may be made of dedicated hardware” and that, alternatively, “[e]ach component may be implemented by a program execution unit, such as a CPU or a processor, reading and executing the software program recorded in a recording medium.” EX1004, 23:55-62; see also EX1004, 18:57-61; EX1006, 13-14, 18.

116. A POSITA would have recognized the CPU or processor that Toma881 identifies is a data processing unit, and conversion apparatus 100 includes it. That processing unit is what executes the S101 through S104 conversion sequence described above and the acquisition, reading, conversion, and output operations recited in Elements [1.2] through [1.7] when Toma881 is predictably combined with Toma446 and Drugeon. Conversion apparatus 100 in the combination of Toma881, Toma446, and Drugeon therefore includes a data processing unit configured to perform those operations, as [1.1] recites.

***[1.2] acquire high dynamic range (HDR) image metadata from an MP4 file,
wherein***

117. The HDR image metadata is information that describes the HDR image, and in the combination of Toma881, Toma446, and Drugeon that information includes the content luminance information that Toma881 uses to drive its conversion. In the combination of Toma881, Toma446, and Drugeon, the MP4 file is the container in which that information is stored and from which it is acquired, which the combination supplies through Toma446. I address the acquisition of the HDR image metadata first, then the MP4 file from which it is acquired.

118. Toma881's conversion apparatus 100 acquires the HDR video to be converted along with its associated metadata including luminance information such as CPL (Content Peak Luminance) and CAL (Content Average Luminance), for use in HDR video processing. EX1004, 11:31-39, 12:17-27; EX1006, 13-15, 18-20. Toma881 describes that the "conversion apparatus 100 acquires the HDR video on which inverse EOTF conversion of HDR is performed." EX1004, 11:31-39; EX1006, 14, 7-8, 18.

FIG. 11

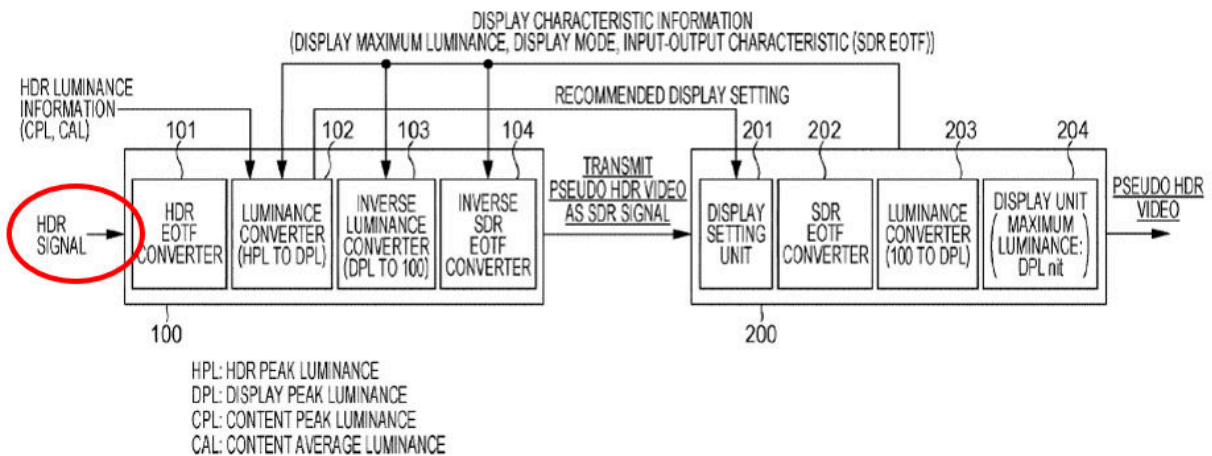


FIG. 11. Along with the HDR video, the apparatus acquires metadata describing the luminance of that video. Toma881 explains that “conversion apparatus 100 acquires content luminance information including at least one of a maximum value of luminance (CPL: Content Peak luminance) of a video (content) and an average luminance value (CAL: Content Average luminance) of a video as information regarding the HDR signal.” EX1004, 12:17-27; EX1006, 13, 15, 18-20, 24. The CPL and CAL values are the HDR image metadata: each describes a luminance characteristic of the HDR image content. I note that this content luminance information is distinct from the display characteristic information, such as the display's peak luminance (DPL), that the apparatus separately obtains from the display; CPL is metadata about the content, whereas DPL describes the display.

119. Toma881 teaches that this luminance information is carried as metadata associated with the video. It states that “luminance information including at least one

of the first maximum luminance value and an average luminance value that is an average of the luminance values of the plurality of images that constitute the video may be acquired as metadata information of the video.” EX1004, 4:7-30; EX1006, 24, 18. Toma881 makes the same point in describing how the apparatus obtains the values, explaining that “the luminance information including at least one of CPL and CAL may be acquired as metadata information on the video, and may be acquired via a network.” EX1004, 19:31-38; EX1006, 24, 18. Consistent with that network delivery, Toma881 contemplates “Internet delivery” of its HDR content and metadata. EX1004, 6:15-18; EX1006, 1, 10, 18; *see also* EX1004, 18:34-39, 18:54-56, 7:27-35. Toma881 likewise describes the “acquisition method of the luminance information on the HDR video,” identifying among the options “acquisition as metadata information appended to the HDR video.” EX1004, 23:36-39; EX1006, 24. These passages confirm that, in Toma881, luminance information, including the CPL and CAL, travels with the video as metadata that the conversion apparatus acquires.

120. What remains for [1.2] is that the HDR image metadata is acquired from an MP4 file. The combination of Toma881, Toma446, and Drugeon supplies that container. As I explained in connection with the motivation to combine, a POSITA would have stored Toma881’s HDR video and its accompanying luminance metadata in an MP4 file as taught by Toma446, which describes storing HDR image

data in an MP4 file using the MP4 format. EX1007, 45:56-46:41 (“The HDR-related information may be stored as the meta-data managing the MP4 file.”); EX1011, 54. In the combined system, the conversion apparatus therefore acquires the CPL and CAL luminance metadata from the MP4 file in which Toma881’s HDR video and metadata are stored. I address the storage of the HDR image data and its metadata in the MP4 file in greater detail in my analysis of limitations [1.2.1] and [1.2.2]. The combination of Toma881, Toma446, and Dugeon therefore acquires HDR image metadata from an MP4 file, as [1.2] recites.

[1.2.1] the acquired HDR image metadata includes a maximum value of frame average luminance of HDR image data stored in the MP4 file, and

121. As I explained above for [1.2], the HDR image metadata in the combination of Toma881, Toma446, and Dugeon is the content luminance information that is transmitted with the HDR video and is stored in the MP4 file. EX1004, 12:17-27, 4:7-30, 19:31-38, 23:36-42, FIG. 11; EX1006, 13, 15, 18-20, 24; EX1007, 4:59-62, 45:57-46:41; EX1011, 54, 42. Element [1.2.1] specifies that this metadata includes a particular value, a maximum value of frame average luminance of HDR image data stored in the MP4 file, and the combination of Toma881, Toma446, and Dugeon supplies that value through Dugeon.

122. I will start by discussing what Toma881 itself provides. Toma881’s content luminance information includes a content peak luminance value that it computes across the images of the video. Toma881 describes “a maximum value of

luminance (CPL: Content Peak luminance) of a video (content),” and explains that this value “is, for example, a maximum value of the luminance values of a plurality of images that constitute the HDR video.” EX1004, 12:17-27; EX1006, 15, 18-20. Toma881 claims the same value, reciting “a first maximum luminance value that is a maximum value of luminance values of a plurality of images that constitute the video.” EX1004, cl. 1. Toma881 confirms that this luminance information is carried as metadata, stating that “CPL and CAL may be acquired as metadata information on the video.” EX1004, 19:17-38; EX1006, 24; *see also* EX1004, 15:4-20. Toma881 therefore takes a maximum across luminance values determined for the individual images, or frames, of the HDR video.

123. What Toma881 does not specify is how the luminance value for each frame is determined. Dugeon supplies that detail, and in doing so it supplies the claimed maximum value of frame average luminance. Dugeon describes “maximum average picture level information indicating a highest average luminance value among average luminance values of all pictures included in a video sequence.” EX1012, [0041]; EX1013, 15-17, 21, 26. Dugeon states the same teaching in terms of the value itself: “(maximum_average_picture_level) indicates the highest average picture level among all the pictures included in a video sequence.” EX1012, [0092]; *see also* [0031], [0052]. Dugeon thus computes, for each picture (that is, each frame or image), an average picture level, and then takes the highest of those per-frame

values across the sequence. Dugeon confirms that the average picture level is a measure of luminance, explaining that “[t]he average picture level means the average value of pixel luminance expressed in percentage of the maximum luminance.” EX1012, [0092]; EX1013, 16. The `maximum_average_picture_level` is, by Dugeon’s own definition, the maximum across frames of a per-frame average luminance, which is a maximum value of frame average luminance.

124. Dugeon carries this value as metadata accompanying the video. Dugeon describes that the encoder “store[s], into the SEI, maximum average picture level information,” where the SEI is supplemental enhancement information carried within the video data. EX1012, [0122], [0009]; EX1013, 15-16, 26. In the combination of Toma881, Toma446, and Dugeon, that maximum average picture level information becomes part of the HDR image metadata that, as I explained for [1.2] and address further for [1.2.2], is stored in the MP4 file with the HDR video.

125. As I explained in connection with the motivation to combine, a POSITA would have used Dugeon’s maximum average picture level *as* Toma881’s CPL value, or alternatively as additional luminance information used in Toma881’s conversion. Either way, the result is that the HDR image metadata acquired in the combination of Toma881, Toma446, and Dugeon includes Dugeon’s maximum average picture level, which is a maximum value of the per-frame average luminance of the HDR image data. A POSITA would have recognized Dugeon’s

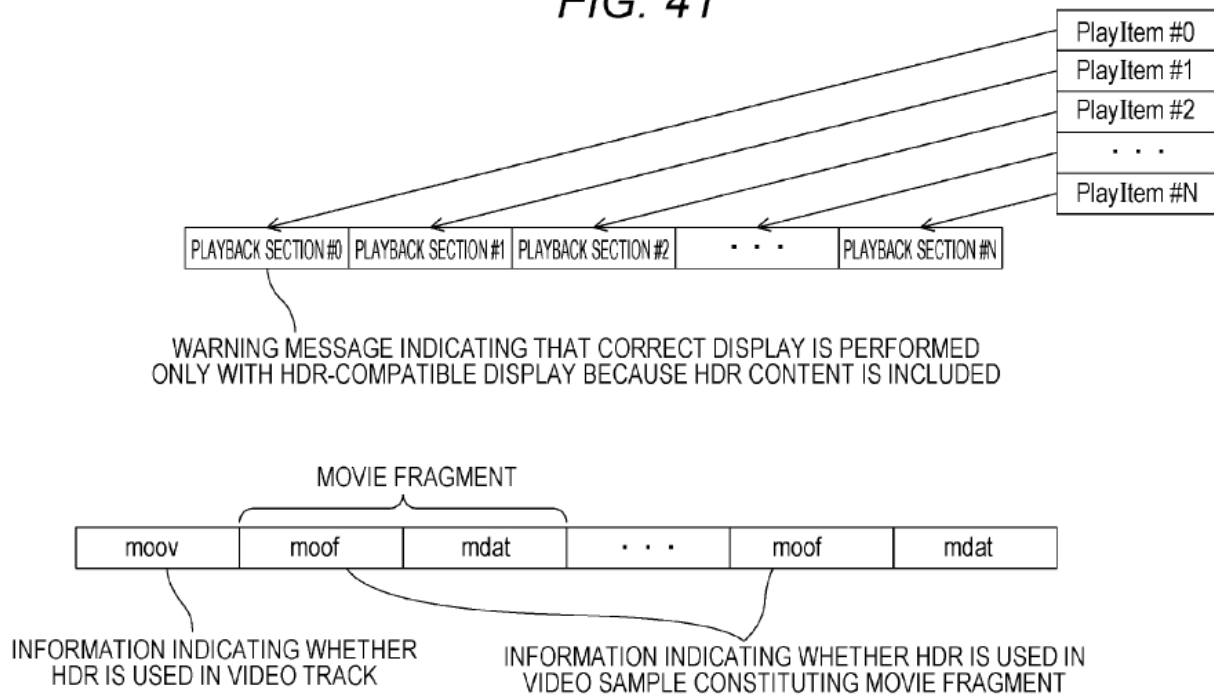
maximum_average_picture_level as a maximum value of frame average luminance of the HDR image data, and the combination therefore meets [1.2.1].

[1.2.2] the HDR image data stored in the MP4 file is based on an MP4 format;

126. Element [1.2.2] recites that “the HDR image data stored in the MP4 file is based on an MP4 format.” As I discussed in paragraph 55 above, it is my understanding from the ’211 patent that this means the HDR image data is stored according to an MP4 format based on the specification describing a system that “stores high dynamic range (HDR) image data according to an MP4 format.” EX1001, 2:38-40. The combination of Toma881, Toma446, and Dugeon meets this requirement through Toma446, which stores HDR image data and metadata in an MP4 file using the MP4 format.

127. Toma446 describes storing HDR video in an MP4 file in its brief description of the drawings, stating that “video data including the luminance within a HDR (High Dynamic Range) luminance range is stored in the MP4 file.” EX1007, 4:59-62; EX1011, 54. Toma446 describes the same storage in detail in connection with FIG. 41, explaining that it illustrates “a storage example when the video data including luminance of a high luminance area [...] called a HDR (High Dynamic Range) is stored in the MP4 file.” EX1007, 45:57-61; EX1011, 54. FIG. 41 itself depicts the MP4 format used for the HDR image data.

FIG. 41



EX1007, FIG. 41; EX1011, 54. In particular, in FIG. 41, the HDR image data is stored in an MP4 format by being broken into movie fragments stored in mdat boxes with the moof boxes indicating whether HDR is used in the corresponding video sample stored in the mdat box.

128. Toma446 gives further descriptions indicating that the HDR luminance metadata is stored according to the MP4 format in the combination of Toma881, Toma446, and Drugeon, within the structures that the MP4 format defines. Toma446 explains that “luminance information may be stored as the header information on the MP4,” and that, where “the luminance information is fixed in the MP4 file,” it “may be set as the information in the moov.” EX1007, 46:16-28; EX1011, 54. Toma446 likewise describes storing HDR-related information in the MP4 structures, stating

that “information indicating that HDR-related information is fixed in the video track may be stored in MP4,” and that “[t]he HDR-related information may be stored as the metadata managing the MP4 file,” rather than being “directly stored in the MP4 file.” EX1007, 46:29-41; EX1011, 54. These passages confirm that, in Toma446, the HDR image data and its associated metadata are stored according to the MP4 format, in the boxes and header structures that the MP4 format specifies.

129. In the combination of Toma881, Toma446, and Drugeon, the HDR video data of Toma881, together with its luminance metadata including Drugeon’s maximum average picture level, is stored in the MP4 file in this manner. The HDR image data stored in the MP4 file is therefore based on an MP4 format, as [1.2.2] recites.

[1.3] acquire display function information of a display unit from the display unit;

130. The display function information is information describing what the display is capable of doing, such as the luminance it can produce, the display modes it offers, and the transfer function it uses. Toma881 acquires exactly this information from the display.

131. Turning first to the disclosures of the ’211 Patent specification with respect to display function information, it describes that “the data processing unit of the information processing device acquires display unit information of the display unit (display) that executes the image output,” and “[t]o be specific, the data

processing unit acquires outputable dynamic range information (outputable luminance range information) and the like.” EX1001, 16:16-21. The specification adds that this information comes from the display itself, explaining that when the device “is connected with the display unit through an HDMI [...] cable, the display unit information can be acquired through the HDMI [...] cable.” EX1001, 16:22-26.

132. Toma881 describes acquiring this same type of information (dynamic range information of the display) from the display device. For example, Toma881 explains: “In addition, before step S102, conversion apparatus 100 acquires the display characteristic information on display apparatus 200 from display apparatus 200. Note that the display characteristic information is information indicating the display characteristic of display apparatus 200, such as a maximum value of luminance that display apparatus 200 can display (DPL), display mode (refer to later description) of display apparatus 200, and input-output characteristic (EOTF supported by the display apparatus).” EX1004, 12:28-36; EX1006, 8, 13-18, 24. A POSITA would have recognized this information, such as “maximum value of luminance that display apparatus 200 can display” as corresponding to the dynamic range information described in the ’211 Patent specification. Toma881 confirms that this information comes from the display unit and is acquired in a similar manner to that discussed by the ’211 patent (as I indicated above), describing that it “may be acquired from display apparatus 200 through an HDMI cable or LAN cable” and

that conceivable acquisition methods include “automatic acquisition through HDMI or a network.” EX1004, 18:64-67, 23:20-26; EX1006, 24.

133. A POSITA would have recognized that at least the maximum displayable luminance (DPL), the display mode, and the EOTF that Toma881 acquires are display function information, because each is a parameter that relates to a function of the display. The display mode in particular governs how the display renders luminance. Toma881 explains that “[t]he display mode is, for example, mode information including a theater mode of relatively dark display on the SDR display and a dynamic mode of relatively bright display,” EX1004, 14:56-59, and it describes performing a different luminance conversion for each mode, EX1004, 10:49-57, 17:30-35; EX1006, 14. Because these parameters describe and control functions (operating characteristics and capabilities) of the display and are obtained from the display itself, it is my opinion that the combination of Toma881, Toma446, and Drugeon acquires display function information of a display unit from the display unit, as [1.3] recites.

[1.4] read the HDR image data from the MP4 file;

134. In the combination of Toma881, Toma446, and Drugeon, the HDR image data(the HDR video) is stored in the MP4 file taught by Toma446, as I explained for [1.2.2], above. To perform the conversion process, Toma881’s

conversion apparatus draws on that stored data, which means it reads the HDR image data from the MP4 file.

135. In more detail, Toma881 describes how its conversion apparatus 100 obtains and processes the HDR video before converting it for display. Toma881 explains that “HDR EOTF converter 101 of conversion apparatus 100 acquires the HDR video on which inverse EOTF conversion of HDR is performed.” EX1004, 11:31-39; see also EX1004, 11:52-12:7, 6:15-17; EX1006, 14, 7-8, 18. Toma881 then describes the first step of the conversion the apparatus performs on that acquired video, explaining that HDR EOTF converter 101 “converts the acquired HDR signal into a linear signal that indicates the luminance value.” EX1004, 11:33-45; EX1006, 14, 8. This initial conversion of the HDR video is part of an “HDR to pseudo HDR conversion process[]” that permits “displaying the HDR video on the SDR TV,” so that the HDR video “may be displayed on the SDR TV as a pseudo HDR video close to the original HDR video.” EX1004, 18:8-15; EX1006, 14, 7-10.

136. Toma881 confirms that the conversion apparatus operates on the HDR video using the content luminance information stored with that video. As I explained for [1.2] and [1.2.1], above, Toma881 describes that “[l]uminance converter 102 of conversion apparatus 100 performs the first luminance conversion of converting the linear signal (luminance value of HDR) obtained in step S101 by using the display characteristic information and the content luminance information on the HDR

video.” EX1004, 14:46-50; *see also* EX1004, 23:33-42; EX1006, 14-15, 18-20. As I explained for [1.2.1] and [1.2.2], above, in the combination of Toma881, Toma446, and Dugeon this content luminance information, which includes Dugeon’s maximum average picture level, is stored in the MP4 file as metadata, where Toma446 describes that “luminance information may be stored as the header information on the MP4.” EX1007, 46:16-41; EX1011, 54; EX1004, 4:7-30, 19:31-38; EX1006, 24, 18.

137. Because Toma881’s conversion apparatus uses, in its conversion, the HDR image data and the content luminance information that are stored in the MP4 file in the combination of Toma881, Toma446, and Dugeon, a POSITA would have recognized that the apparatus reads the HDR image data from the MP4 file. In other words, because the conversion apparatus performs this conversion on the acquired HDR video image data using the content luminance information stored with it, a POSITA would have recognized that the conversion apparatus 100 must read the HDR image data from the MP4 file in order to perform the conversion. At a minimum, it would have been obvious to a POSITA to implement Toma881’s conversion apparatus 100 to read the acquired HDR image data from the MP4 file, so that the apparatus could perform on that data the conversion process Toma881 expressly describes. Reading the stored data from the MP4 file in this way is also consistent with Toma446, which describes a “playback device that reads the MP4

file.” EX1007, 9:1-6; EX1011, 15. To the extent Toma881 does not expressly state that the conversion apparatus reads the HDR image data from the MP4 file, it would have been obvious to a POSITA to implement Toma881’s conversion apparatus to read the received HDR image data and metadata from the MP4 file so that it could use that information in the conversion process that Toma881 expressly describes. As such, a POSITA would have understood that in the combination of Toma881, Toma446, and Dugeon, the conversion apparatus reads the HDR image data from the MP4 file so that the HDR image data can be used in the conversion process and therefore satisfies [1.4].

[1.5] execute a conversion process of the read HDR image data based on the acquired HDR image metadata and the acquired display function information of the display unit;

138. Toma881’s luminance conversion (as predictably modified by Toma446 and Dugeon in the combination) does exactly as this claim element recites, using both the acquired HDR image metadata and the acquired display function information of the display unit inputs together in the conversion process of the read HDR image data. As such, the combination of Toma881 with Toma446 and Dugeon teaches executing a conversion process of the read HDR image data based on acquired HDR image metadata and acquired display function information of the display unit.

139. Toma881 describes that its luminance converter performs the conversion using both the display characteristics and the content luminance metadata. It states that “[l]uminance converter 102 of conversion apparatus 100 performs the first luminance conversion of converting the linear signal (luminance value of HDR) obtained in step S101 by using the display characteristic information and the content luminance information on the HDR video.” EX1004, 14:46-50; *see also* EX1004, 11:40-51 (S102); EX1006, 15-16, 18, 24. In another example, Toma881 explains that “in the first luminance conversion, CAL and CPL out of the content luminance information are used.” EX1004, 15:4-5; EX1006, 15-16, 18, 24; *see also* EX1004, 20:9-48.

140. The two inputs to that conversion correspond to the two inputs the claim recites. The first is the HDR image metadata. As I explained for [1.2] and [1.2.1], that metadata is the content luminance information, which Toma881 describes as “a maximum value of luminance (CPL: Content Peak luminance) of a video (content) and an average luminance value (CAL: Content Average luminance) of a video as information regarding the HDR signal,” and which in the combination of Toma881, Toma446, and Dugeon includes Dugeon’s “maximum average picture level information indicating a highest average luminance value among average luminance values of all pictures included in a video sequence,” used as the CPL value. EX1004, 12:17-27; EX1006, 24, 14-18; EX1012, [0041]; EX1013, 15-17. Dugeon describes

using that value in a similar HDR to SDR conversion process, explaining that the maximum average picture level value “allows the difference from the SDR to be set within an arbitrary range.” EX1012, [0092]-[0093]; EX1013, 16-17. The second input is the display function information. As I explained for [1.3], that information is the display’s maximum luminance (DPL), display mode, and EOTF that the apparatus acquires from the display. EX1004, 12:28-36, 15:13-16; EX1006, 15-21, 24. In one example, Toma881 describes “using the peak luminance value and the display mode of the SDR display to convert the HDR video.” EX1004, 20:9-64; EX1006, 15-21, 24.

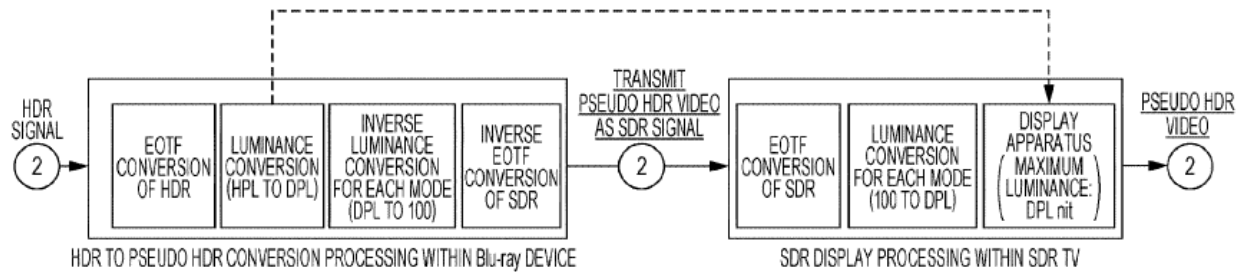
141. Because Toma881’s luminance conversion of the read HDR data uses both the content luminance metadata (which in the combination of Toma881, Toma446, and Drugeon includes Drugeon’s maximum average picture level) and the display function information, a POSITA would have recognized that the combination of Toma881, Toma446, and Drugeon executes a conversion process of the read HDR image data based on the acquired HDR image metadata and the acquired display function information of the display unit, as [1.5] recites.

[1.6] execute an output image generation process based on the execution of the conversion process; and

142. The combination of Toma881 with Toma446 and Drugeon teaches executing an output image generation process based on execution of the conversion

process because, after performing the luminance conversion process described above, Toma881's conversion apparatus uses the results of that conversion process to generate a new output image, namely a pseudo HDR video for display on the SDR TV. More specifically, after the luminance conversion, Toma881 generates a pseudo-HDR output signal from the converted signal, which is an example of the output image generation process the claim recites. Toma881 describes two further steps that take the converted luminance and produce the output. First, the apparatus “performs inverse luminance conversion according to the display mode of display apparatus 200.” EX1004, 12:43-44. Then the apparatus “performs inverse SDR EOTF conversion to generate the pseudo HDR video.” EX1004, 12:62-63; EX1006, 7-10, 13-18, 20, 24. Toma881 describes the same generation in terms of the resulting signal, explaining that “[c]onversion apparatus 100 quantizes the luminance value of SDR by using EOTF of SDR to generate the SDR signal compatible with pseudo HDR.” EX1004, 13:17-25; EX1006, 15-18. The purpose of generating this output is to let an ordinary display show the content, as Toma881 explains when it describes “converting the HDR-enabled HDR signal into the SDR signal in the SDR luminance [...] allows the SDR TV to display the SDR video obtained by conversion from the HDR video.” EX1004, 7:37-42; EX1006, 17. FIG. 10C shows the output image signal generated by the conversion apparatus.

FIG. 10C



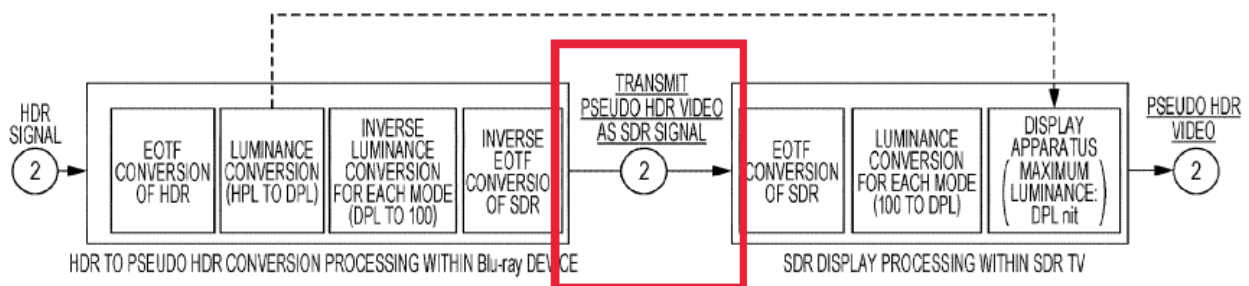
EX1004, FIG. 10C; EX1006, 9, 13.

143. Generating the pseudo-HDR video from the result of the luminance conversion is an output image generation process based on the execution of the conversion process, as [1.6] recites.

[1.7] output an image signal to the display unit based on the executed output image generation process.

144. Toma881 outputs the generated pseudo-HDR signal to the display. It describes that, after generating the pseudo HDR video in step S104, “conversion apparatus 100 outputs the pseudo HDR signal (SDR signal) generated in step S104 to display apparatus 200.” EX1004, 13:14-16; EX1006, 9-10, 13-14, 17-18, 23.

FIG. 10C



EX1004, FIG. 10C; EX1006, 9, 13.

145. The display then shows the result, as Toma881 explains: “Finally, display unit 204 of display apparatus 200 displays the pseudo HDR video on display apparatus 200 based on the converted display luminance value (S108).” EX1004, 14:38-40; see also EX1004, 20:49-56, 21:21-29; EX1006, 17.

146. The signal that conversion apparatus 100 outputs to display apparatus 200 is the pseudo-HDR signal produced by the output image generation process of [1.6], and it is output for the express purpose of letting the display present the converted video. As Toma881 puts it, the conversion “allows the SDR TV to display the SDR video obtained by conversion from the HDR video.” EX1004, 7:37-42; EX1006, 17-18. As a POSITA would have recognized based on these disclosures of Toma881, the combination of Toma881, Toma446, and Dugeon outputs an image signal to the display unit based on the executed output image generation process, as [1.7] recites. The combination of Toma881, Toma446, and Dugeon therefore discloses every limitation of claim 1.

2. Claim 2

(a)

147. As I discussed with respect to Claim 1, the combination of Toma881, Toma446, and Dugeon teaches acquiring HDR image metadata from an MP4 file, determining whether HDR image data is compatible with a display device, and

performing HDR conversion based on display capabilities. Claim 2 further requires acquiring dynamic-range information from the HDR image metadata, determining that the HDR image data is not outputable by the display unit based on that dynamic range, reducing the dynamic range of the HDR image data, and outputting the converted image data. The combination satisfies these additional limitations because Toma881 acquires and processes HDR luminance metadata and display characteristics, Drugeon teaches HDR metadata containing dynamic-range information, and Toma446 teaches storing such HDR-related metadata in an MP4 file.

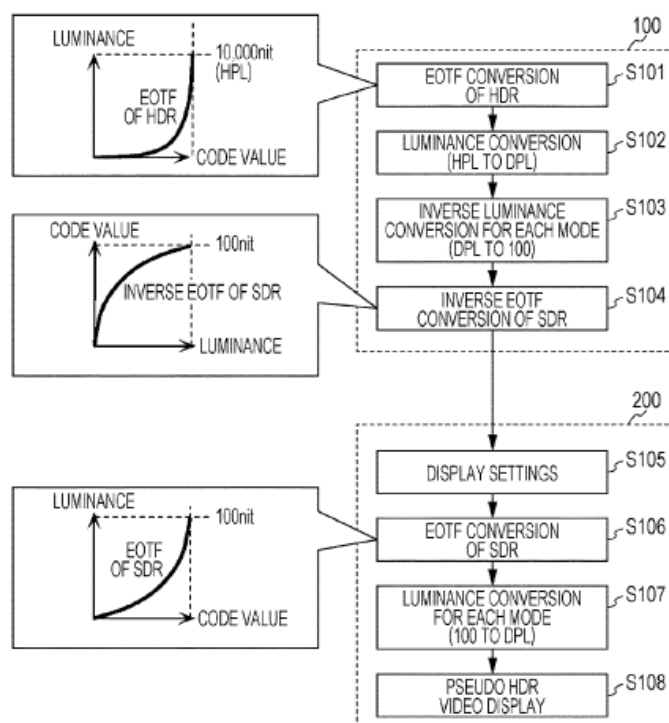
[2.pre]-[2.1] The information processing device according to claim 1, wherein the data processing unit is further configured to: acquire a dynamic range of the HDR image data stored in the MP4 file from the acquired HDR image metadata;

148. Element [2.1] calls for the data processing unit to acquire, from the HDR image metadata read out of the MP4 file, the dynamic range of the HDR image data. In plain terms, the dynamic range is the span of brightness the HDR content can occupy. The combination of Toma881, Toma446, and Drugeon teaches acquiring the dynamic range of HDR image data from HDR image metadata because Toma881 acquires HDR luminance metadata, Drugeon discloses metadata expressly indicating HDR dynamic-range characteristics, and Toma446 teaches storing such HDR-related information as metadata in an MP4 file. Toma881's acquired luminance metadata, including CPL and CAL luminance information, provides

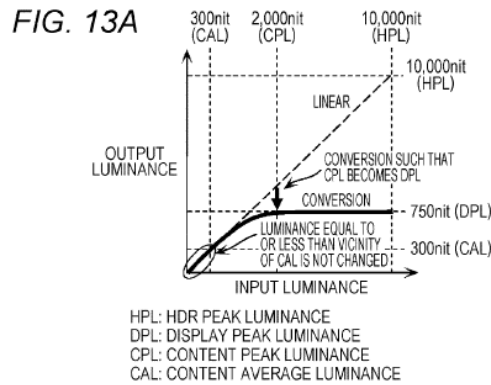
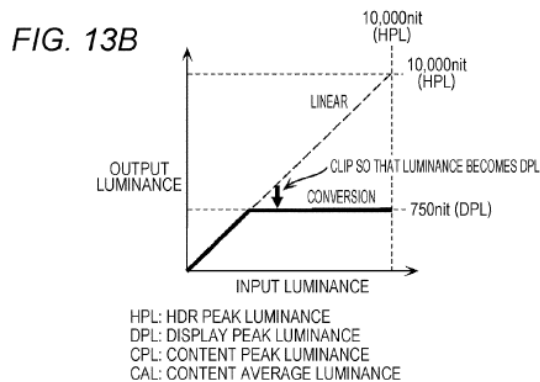
information regarding luminance characteristics of the HDR video that are used in HDR processing and are indicative of the HDR video's dynamic range.

149. Toma881 describes content luminance information stored as metadata for the HDR video. It describes that “conversion apparatus 100 acquires content luminance information” for the HDR video. EX1004, 12:17-18; EX1006, 13, 15, 18-20, 24. That content luminance information tells the apparatus how bright the HDR content is. Toma881 also explains how the HDR signal itself encodes luminance: “HDR EOTF converter 101 uses the acquired HDR signal and EOTF of HDR to determine the luminance value of HDR associated with the code value of HDR by EOTF of HDR,” and “the HDR signal indicates the code value of HDR obtained by quantization of the luminance value of a video (content) by using inverse EOTF of HDR that associates the luminance value in the luminance range of HDR with the plurality of HDR code values.” EX1004, 11:65-12:7; EX1006, 11-12, 15, 19. The luminance range that this encoding spans is a known one. Toma881 describes that “the luminance value (luminance value of the HDR-enabled video) in the luminance range of up to 10,000 nit is converted into the HDR signal of a 10-bit code value by quantization based on inverse EOTF.” EX1004, 9:29-32; EX1006, 11, 18. Figures 12 to 14 of Toma881 show examples of the luminance range (the claimed dynamic range) of the HDR image data being used as an input for the conversion process.

FIG. 12



EX1004, FIG. 12; EX1006, 14-16.



EX1004, FIG. 13A-13B; EX1006, 14-16. Specifically, the dynamic range (luminance range) is the range from zero to the peak luminance (CPL) as shown in the above graphs. The CPL value stored as luminance information in Toma881's metadata is therefore an indication of the dynamic range of the HDR image data.

150. Toma881 further teaches that this luminance information can be carried as metadata that accompanies the video. It states that “the luminance information including at least one of CPL and CAL may be acquired as metadata information on the video, and may be acquired via a network” and, among the ways it lists to acquire that information, it identifies “acquisition as metadata information appended to the

HDR video,” EX1004, 19:35-38, 23:36-42; EX1006, 24, 18. A POSITA would understand from these passages that the luminance information describing the HDR content’s range are delivered to the apparatus as metadata.

151. In the combination of Toma881, Toma446, and Dugeon, that luminance metadata is stored in the MP4 file, as I explained for [1.2], [1.2.1], and [1.2.2], above, and this luminance metadata expressly represents the dynamic range of the HDR content. Dugeon describes that “the hybrid SEI message may include ... dynamic range increase information (dynamic_range_increase) and maximum average picture level information (maximum_average_picture_level).” EX1012, [0090]; EX1013, 16-17. Dugeon further describes that “dynamic range increase information indicat[es] a difference between the luminance dynamic range of the video data and luminance dynamic range SDR.” EX1012, [0122]; EX1013, 16-17. A POSITA would have therefore recognized that the dynamic range increase information provides, within the metadata itself, how much wider the HDR luminance range is than the SDR range, which is a direct expression of the HDR content’s dynamic range.

152. Toma446 completes the picture by specifying that this HDR information is stored in the MP4 file. It describes that “whether the HDR content is stored in the MP4 file may be signaled in the header information on the MP4. For example, whether the HDR is used in at least a part of the playback sections of the

video track is indicated in the moov, and whether the HDR is used in the video sample constituting the movie fragment is indicated in the moof.” EX1007, 46:10-15; EX1011, 54. It adds that “[t]he HDR-related information may be stored as the metadata managing the MP4 file.” EX1007, 46:39-41; EX1011, 54.

153. Based on these disclosures of the references that make up the combination of Toma881, Toma446, and Dugeon, a POSITA implementing this combination would have recognized that the metadata read from the MP4 file, which signals that the video data is HDR content and carries the dynamic range increase information and the maximum average picture level, tells the apparatus the dynamic range of the HDR image data, namely a luminance range that reaches well above the standard range and up to as much as 10,000 nit. EX1004, 9:29-32; EX1006, 11, 18. Because the apparatus obtains that dynamic range from the very metadata it acquired from the MP4 file, it is my opinion that the combination of Toma881, Toma446, and Dugeon acquires a dynamic range of the HDR image data stored in the MP4 file from the acquired HDR image metadata, as [2.1] recites.

[2.2] determine the HDR image data having the dynamic range is not outputable by the display unit, wherein

154. A POSITA would have recognized that the conversion apparatus in the combination of Toma881, Toma446, and Dugeon determines that the HDR image data, because of its dynamic range, cannot be output by the display unit as it is. This follows from the mismatch between the wide luminance range of HDR content and

the narrower range an SDR display can reproduce, thus leading to the requirement for the HDR content to be converted to the lower luminance range that can be supported by the SDR display. As such, the combination teaches determining that HDR image data having the acquired dynamic range is not outputable by the display unit by comparing the HDR luminance range indicated by the HDR metadata to the luminance range supported by the display unit. As I discussed above, the HDR-related metadata identifies HDR content and associated luminance-range characteristics of the video data.

155. Toma446 explains why HDR content cannot simply be shown on an SDR display. It describes HDR as “video data including luminance of a high luminance area exceeding a luminance range used in BT.709 standard (SDR: Standard Dynamic Range),” and it states that “mapping the HDR luminance range on the SDR luminance range is required to play back the HDR content with an SDR display.” EX1007, 45:58-65; EX1011, 54. Because the HDR luminance range runs past what the SDR display can display, the HDR content is not outputable on that display without first being mapped down.

156. Toma881 describes the same recognition built into its conversion apparatus. The converter 101 of conversion apparatus 100 turns “the code value indicated by the HDR signal acquired by the acquisition unit into the display luminance value *compatible with* the luminance range of the display determined

based on the luminance range of the display (display apparatus 200).” EX1004, 11:57-61; EX1006, 20. The apparatus thus works from the display’s own luminance range, maximum (DPL), which Toma881 elsewhere describes as being smaller than the HDR maximum (HPL), and it maps the HDR values down into that smaller range. A POSITA would have recognized that an apparatus that must map the HDR range down to the display’s range before the content can be shown has necessarily determined that the HDR image data, with its dynamic range, is not outputable by the display unit as it stands. For example, Toma881 describes that for content luminance values not exceeding the luminance range of the display “conversion is not performed. EX1004, 20:9-36; EX1006, 19. It is therefore my opinion that the combination of Toma881, Toma446, and Dugeon meets [2.2].

[2.3] the determination is based on the acquired HDR image metadata and the acquired display function information of the display unit;

157. The combination of Toma881, Toma446, and Dugeon used both the acquired HDR image metadata and the acquired display function information in the determination. The display function information, is acquired from the display, as I explained for [1.3], above. Toma881 describes that “conversion apparatus 100 acquires the display characteristic information on display apparatus 200 from display apparatus 200,” including “a maximum value of luminance that display apparatus 200 can display (DPL).” EX1004, 12:28-36; EX1006, 8, 13-18, 24. The DPL tells the apparatus the ceiling of what the display can reproduce. The other input, the

HDR image metadata, tells the apparatus the dynamic range of the content, as I explained for [2.1]. That the video data falls in the HDR range is signaled in the metadata of the MP4 file. EX1007, 46:10-15, 46:39-41; EX1011, 54.

158. A POSITA would have recognized that the determination that the HDR image data is not outputable by the display is reached by comparing these two inputs. The apparatus knows, from the HDR metadata, that the content's luminance range extends above the standard range, and it knows, from the display function information, the maximum luminance the display can produce. When the content's range exceeds the display's DPL, the content cannot be shown as it is. Because that determination draws on both the acquired HDR image metadata and the acquired display function information, it is my opinion that the combination of Toma881, Toma446, and Dugeon satisfies [2.3].

[2.4] execute the conversion process of the read HDR image data based on the determination,

159. In the combination of Toma881, Toma446, and Dugeon, the determination that the HDR content cannot be displayed as it triggers the conversion process that is described for [1.5] above. Toma446 ties the conversion to that determination. It describes that "mapping the HDR luminance range on the SDR luminance range is required to play back the HDR content with an SDR display." EX1007, 45:63-65; EX1011, 54. As such, a POSITA would have recognized that once the apparatus has determined that the content is HDR and that the display is an

SDR display whose range is exceeded, that determination calls for the conversion process, because mapping the HDR range onto the display range is what makes the content playable. The combination of Toma881, Toma446, and Drugeon therefore executes the conversion process of the read HDR image data based on the determination, as [2.4] recites.

[2.5] wherein the conversion process includes reduction of the dynamic range of the HDR image data; and

160. The combination of Toma881, Toma446, and Drugeon discloses that the conversion process that I described at [1.5], above, includes a reduction of the dynamic range of the HDR image data. Specifically, the conversion in Toma881 takes luminance values that span the wide HDR range and remaps them into the narrower range the display can show. Toma881 describes the reduction directly. In its first luminance conversion, “the luminance value compatible with the luminance range of HDR (hereinafter referred to as “luminance value of HDR”), which is the first luminance range, is converted into the luminance value compatible with the luminance range of the display (hereinafter referred to as “display luminance value”), which is the second luminance range.” EX1004, 11:44-50; EX1006, 13-16, 19-20. Toma881 explains that this conversion “allows appropriate conversion of the luminance in the first luminance range into luminance in the second luminance range with a reduced luminance range.” EX1004, 3:32-34; EX1006, 19-20. This reduction in luminance range is shown, for example, in Figures 13A-13B:

FIG. 13A

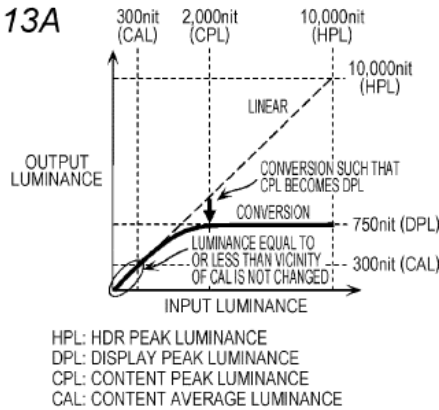
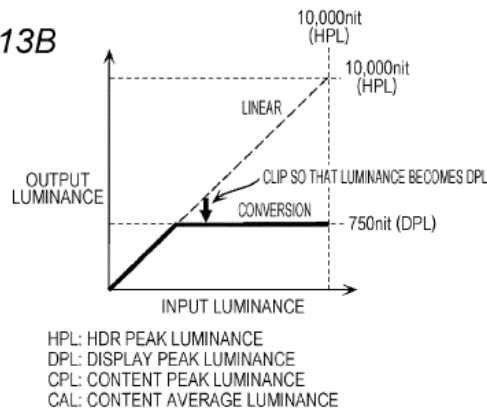


FIG. 13B



EX1004, FIGs. 13A-13B; EX1006, 15.

161. The magnitudes shown in the above graphs of the conversion confirm that the range shrinks. Toma881 describes that “[t]he maximum luminance of the HDR video (HPL) may not be 10,000 nit, and may be, for example, 4,000 nit or 1,000 nit” and elsewhere that the HDR luminance range runs up to 10,000 nit, EX1004, 19:48-50, 9:29-32; EX1006, 18. The display, by contrast, has a much lower ceiling; Toma881 gives the DPL of an SDR display in one example as “300 nit.” EX1004, 10:30; EX1006, 4, 8, 19-21. Converting content that reaches thousands of nits so that it fits a display of a few hundred nits is a reduction of the dynamic range.

Toma881 describes the same operation as cutting back brightness the display cannot show: the conversion serves to “reduce non-displayable brightness information ... For example, for a display with a peak luminance of 1,000 nit, overall brightness is maintained by conversion into the pseudo HDR video with a peak luminance reduced to 1,000 nit.” EX1004, 20:65-66, 21:1-4; EX1006, 19-21. As such, the conversion process in the combination of Toma881, Toma446, and Drugeon includes a reduction of the dynamic range of the HDR image data, as [2.5] recites.

[2.6] output the HDR image data with the reduced dynamic range to the display unit.

162. Element [2.6] is met by the output step I described for Element [1.7], above, carried through to the signal produced by the range-reducing conversion of Elements [1.5]/[2.5].

163. After the conversion produces the reduced-range signal, Toma881 sends it to the display. It describes that, having generated the pseudo HDR video, “conversion apparatus 100 outputs the pseudo HDR signal (SDR signal) generated in step S104 to display apparatus 200.” EX1004, 12:62-63, 13:14-16; EX1006, 9-10, 13-14, 17-18, 23. The pseudo HDR signal is the HDR content after its dynamic range has been reduced to fit the display, as I explained for Elements [1.5]/[2.5] above. Because the apparatus outputs that reduced-range signal to the display unit, the combination of Toma881, Toma446, and Drugeon outputs the HDR image data with the reduced dynamic range to the display unit, as [2.6] recites.

3. *Claim 9*

[9.pre] A non-transitory computer-readable medium having stored thereon an MP4 file and computer-executable instructions, the computer-executable instructions, when executed by a processor of a reproduction device, cause the processor to execute operations, the operations comprising:

164. The Toma881, Toma446, Drugeon combination provides a non-transitory computer-readable medium having stored thereon an MP4 file and computer-executable instructions, the computer-executable instructions, when executed by a processor of a reproduction device, cause the processor to execute the operations recited in the remaining elements of claim 9. Toma881 implements its processing in software that a processor runs from a recording medium. It teaches that “[e]ach component may be implemented by a program execution unit, such as a CPU or a processor, reading and executing the software program recorded in a recording medium such as a hard disk or a semiconductor memory.” EX1004, 23:58-62; EX1006, 18, 5. Toma881 also identifies the kinds of devices its conversion apparatus lives in. The HDR video reaches the apparatus by, among other paths, “Internet delivery” and the conversion apparatus itself is a consumer playback device: “Conversion apparatus 100 (HDR to pseudo HDR conversion processor) may exist within a disc player, disc recorder, set-top box, TV, personal computer, and smart phone. Conversion apparatus 100 may exist within a server apparatus on the Internet.” EX1004, 18:35, 18:57-61; EX1006, 18, 5.

165. A POSITA would have understood that the playback devices Toma881 lists, such as a set-top box, a personal computer, or a smartphone, contain memory, and that the received HDR video would be held in that memory so that the processor could carry out the conversion of the HDR video, as I explained for [1.5], above. A POSITA would likewise have understood Toma881's conversion apparatus 100 to be a reproduction device, because it takes in HDR video content and reproduces it for display on an SDR display, again as I explained for [1.5], above. In the combination of Toma881, Toma446, and Drugeon, the HDR metadata is stored in an MP4 file, as I explained for [1.2], above. EX1007, 45:57-61; EX1011, 54. A POSITA would have recognized that the MP4 file is at least temporarily stored in the memory discussed above to allow for the MP4 file to be processed by the conversion apparatus as I discussed with respect to claim 1, above. As such, the combination of Toma881, Toma446, and Drugeon provides, or at least renders obvious, a non-transitory computer-readable medium holding both an MP4 file and computer-executable instructions that a processor of a reproduction device runs to perform the operations claim 9 recites.

***[9.1] reading high dynamic range (HDR) metadata from an HDR image
metadata storage box of the MP4 file, wherein***

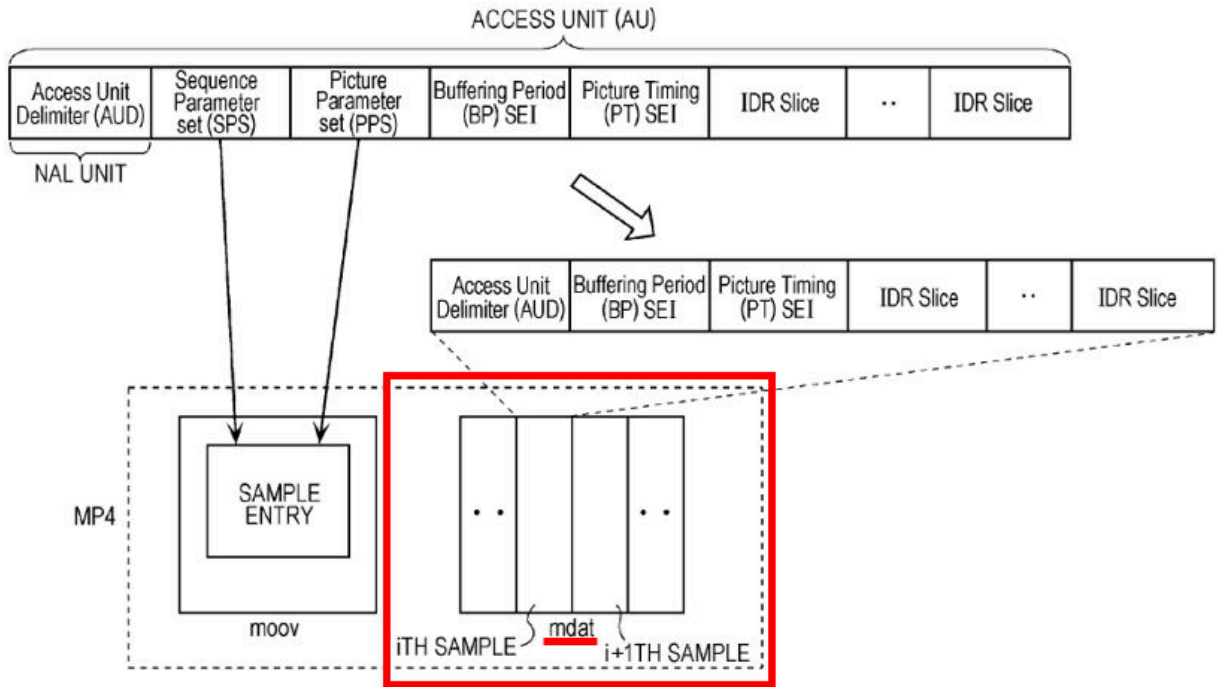
166. In the combination of Toma881, Toma446, and Drugeon, the HDR video and its metadata are held in the MP4 file, as I explained for Element [1.2], above, and Toma446 describes the very box the metadata sits in. Toma446 teaches

that an MP4 file includes “a meta-data storing box” for holding metadata. EX1007, 34:8; EX1011, 38-39. It further teaches that, when the video in the MP4 file is HDR video, “[t]he HDR-related information may be stored as the meta-data managing the MP4 file.” EX1007, 46:39-41; EX1011, 54. The HDR metadata held in that box is the metadata that Toma881’s conversion apparatus 100 reads and uses, as I explained for [1.2] and [1.5], above. EX1004, 23:36-42, 19:35-38, 14:51-52; EX1006, 14-15, 18-20, 24. A POSITA would have therefore recognized that the combination of Toma881, Toma446, and Drugeon reads the HDR metadata out of the meta-data storing box of the MP4 file and therefore meets [9.1].

[9.1.1] an mdat box of the MP4 file stores HDR image data;

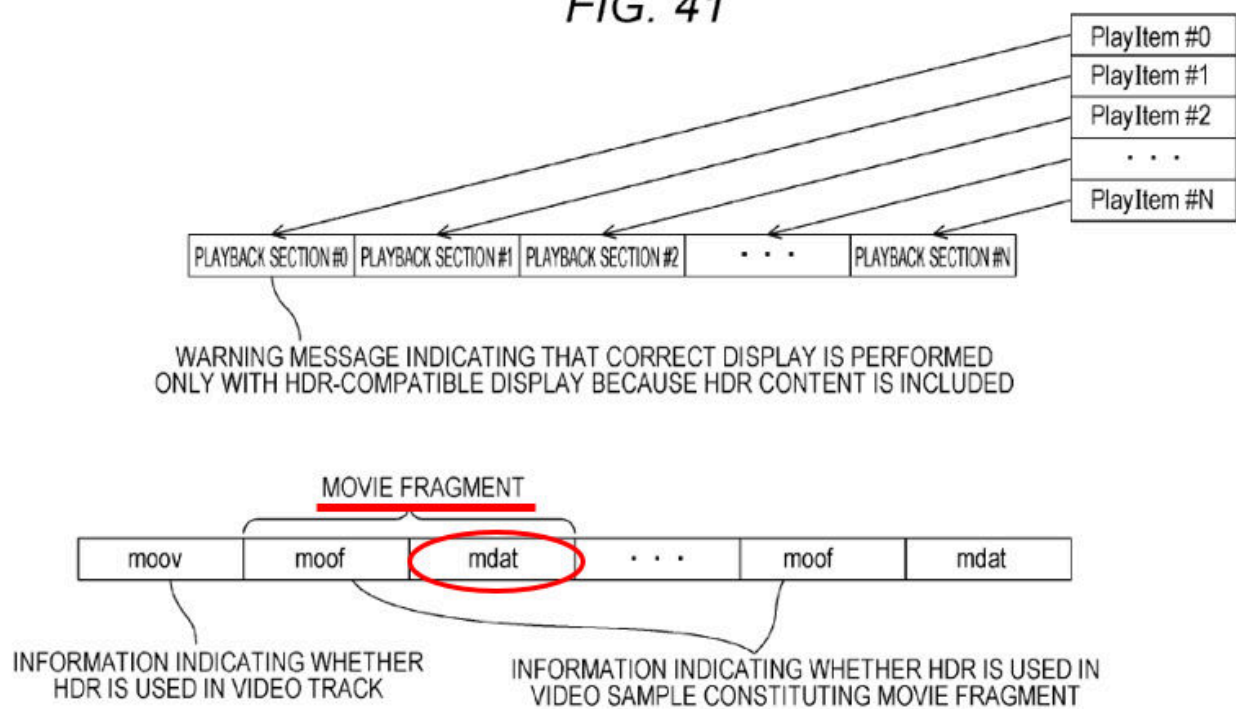
167. In the MP4 file format Toma446 describes, the mdat box is where the picture data (HDR image data) is kept, separate from the header information and metadata. Toma446 explains that the sample data, which represents the coded picture data, is stored in the mdat box. Using an MPEG-4 AVC access unit as its example, and identifying that access unit as an “IDR (Instantaneous Decoder Refresh) picture,” Toma446 teaches that “[o]ther pieces of data included in the access unit are stored in the mdat as the sample data,” EX1007, 19:35-40; EX1011, 24, 27.

FIG. 12



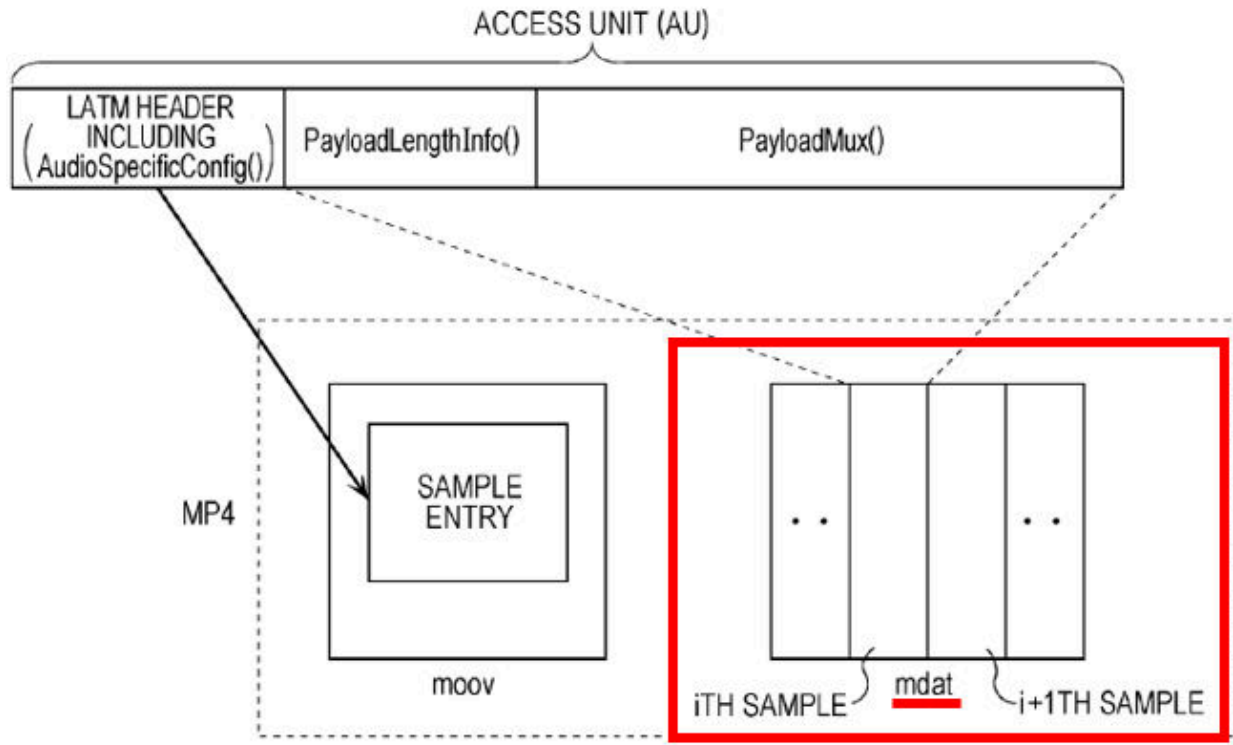
EX1007, FIG. 12; EX1009, 21; EX1011, 24, 27. It gives the same treatment to the audio payload, teaching that “[o]nly the PayloadLengthInfo() and PayloadMux() are stored in the mdat as the sample data.” EX1007, 20:9-10; EX1009, 20-22; EX1011, 23-25. A POSITA would have recognized that this reference to “the mdat” refers to, or at least renders obvious, an mdat box. For HDR video in particular, Toma446 stores the video portion of the movie fragments in the mdat box, with the moov indicating whether a video sample is HDR, as shown in FIG. 41.

FIG. 41



EX1007, 45:57-61, FIG. 41; EX1011, 54.

FIG. 11



EX1007, FIG. 11; EX1011, 54. A POSITA would have therefore recognized that the mdat box of the MP4 file stores the HDR image data, as [9.1.1] recites.

[9.1.2] the HDR image metadata storage box of the MP4 file stores the HDR image metadata corresponding to the HDR image data,

168. As I explained for Elements [1.2] and [1.5], above, the HDR file in the combination of Toma881, Toma446, and Drugeon carries HDR image metadata that corresponds to the HDR image data. EX1004, 23:36-42, 19:35-38, 14:51-52; EX1006, 14-15, 18-20, 24. Toma446 places that metadata in the metadata box: the video metadata is stored in “a meta-data storing box” and, when the video is HDR video, “[t]he HDR-related information may be stored as the meta-data managing the

MP4 file.” EX1007, 34:8, 46:39-41; EX1011, 38-39, 54. Therefore the metadata storage box of the MP4 file stores the HDR image metadata corresponding to the HDR image data, as [9.1.2] recites.

[9.1.3] the stored HDR image data is based on an MP4 format, and

169. As I explained for Element [1.2.2], above, the stored HDR image data in the combination of Toma881, Toma446, and Dugeon is based on an MP4 format. That analysis applies here without change, and in my opinion the combination of Toma881, Toma446, and Dugeon satisfies [9.1.3].

[9.1.4] the stored HDR image metadata includes a maximum value of frame average luminance of the HDR image data;

170. As I explained for Element [1.2.1], above, the stored HDR image metadata in the combination of Toma881, Toma446, and Dugeon includes a maximum value of frame average luminance of the HDR image data, which is Dugeon’s maximum average picture level. EX1012, [0031], [0041], [0052]; EX1013, 15-17, 21, 26; EX1004, 12:17-27, 4:7-30, 19:31-38, 23:36-42, FIG. 11; EX1006, 13, 15, 18-20, 24. That analysis applies here without change, and in my opinion the combination of Toma881, Toma446, and Dugeon satisfies [9.1.4].

[9.2] executing a conversion process of the HDR image data based on the read HDR image metadata; and

171. As I explained for Element [1.5], above, the combination of Toma881, Toma446, and Dugeon executes a conversion process of the HDR image data based

on the HDR image metadata read from the MP4 file. That analysis applies here without change, and in my opinion the combination of Toma881, Toma446, and Drugeon satisfies [9.2].

[9.3] reproducing the HDR image data based on the execution of the conversion process.

172. As I explained for Elements [1.6] and [1.7], above, once the conversion process runs, Toma881's conversion apparatus 100 generates an output video signal from the result of that conversion and outputs the signal to the display, so that the content is reproduced and shown as the pseudo-HDR image. Because the reproduction follows from and rests on the execution of the conversion process, it is my opinion that the combination of Toma881, Toma446, and Drugeon reproduces the HDR image data based on the execution of the conversion process, as [9.3] recites for the reasons that I discussed in my analysis of Elements [1.6] and [1.7], above.

173. For example, Toma881 describes that "[c]onversion apparatus 100 quantizes the luminance value of SDR by using EOTF of SDR to generate the SDR signal compatible with pseudo HDR." EX1004, 13:17-25; EX1006, 15-18. The purpose of generating this output is to let an ordinary display show the content, as Toma881 explains when it describes "converting the HDR-enabled HDR signal into the SDR signal in the SDR luminance [...] allows the SDR TV to display the SDR video obtained by conversion from the HDR video." EX1004, 7:37-42; EX1006, 17;

see also EX1004, FIG. 10C; EX1006, 9, 13. A POSITA would have recognized that this output of pseudo-HDR video is a reproduction of the HDR image data based on the execution of the conversion process.

4. Claim 12

174. Claim 12 recites an information processing method corresponding to the information processing device of Claim 1. For substantially the same reasons discussed with respect to Claim 1, the combination teaches the claimed information processing method.

[12.pre] An information processing method comprising:

175. Toma881, when predictably combined with Toma446 and Drugeon, provides the claimed information processing method. For example, Toma881 discloses a “conversion method for converting luminance of a video to be displayed on a display apparatus.” EX1004, 1:23-24; EX1006, 1. That conversion method is an information processing method, and the device that carries it out is Toma881’s conversion apparatus 100, which is the information processing device I identified for Element [1.pre], above. The combination of Toma881, Toma446, and Drugeon therefore performs an information processing method, as [12.pre] recites. The steps of that method correspond to the operations of the claim 1 device and are therefore taught by the combination for the reasons I discussed with respect to claim 1, which I address element by element below.

[12.1] in an information processing device:

176. As I explained for Element [1.pre], above, the Toma881, Toma446, and Drugeon combination is implemented in an information processing device, namely Toma881's conversion apparatus 100. EX1004, 11:4-51, 12:41-63, 1:8-9; 18:57-61; EX1006, 8-9, 13-14, 18. In my opinion, the combination of Toma881, Toma446, and Drugeon meets [12.1].

[12.1.1] acquiring, by a data processing unit of the information processing device, high dynamic range (HDR) image metadata from an MP4 file, wherein

177. As I explained for Element [1.1], above, the information processing device includes a data processing unit such as a CPU or processor. EX1004, 23:55-62, 18:57-61; EX1006, 13-14, 18. Additionally, as I discussed for Element [1.2], above, in the combination of Toma881, Toma446, and Drugeon the data processing unit acquires the HDR image metadata from the MP4 file. The combination of Toma881, Toma446, and Drugeon meets [12.1.1] for the same reasons that I discussed with respect to Elements [1.1] and [1.2], above.

[12.1.2] the acquired HDR image metadata includes a maximum value of frame average luminance of HDR image data stored in the MP4 file, and

178. As I explained for Element [1.2.1], above, the acquired HDR image metadata in the combination of Toma881, Toma446, and Drugeon includes a maximum value of frame average luminance of HDR image data stored in the MP4 file, which is Drugeon's maximum average picture level. EX1012, [0041], [0092],

[0031], [0052]; EX1013, 15-17, 21. The combination of Toma881, Toma446, and Drugeon meets [12.1.2] for the same reasons that I discussed with respect to Element [1.2.1], above.

[12.1.3] the HDR image data stored in the MP4 file is based on an MP4 format;

179. As I explained for Element [1.2.2], above, the HDR image data stored in the MP4 file in the combination of Toma881, Toma446, and Drugeon is based on an MP4 format. EX1007, 45:57-46:41, FIG. 41; EX1011, 54. The combination of Toma881, Toma446, and Drugeon meets [12.1.3] for the same reasons that I discussed with respect to Element [1.2.2], above.

[12.2] acquiring, by the data processing unit, display function information of a display unit from the display unit;

180. As I explained for Element [1.3], above, in the combination of Toma881, Toma446, and Drugeon the data processing unit acquires that display function information from the display. EX1004, 12:28-36, 18:64-67, 23:20-26; EX1006, 8, 13-18, 24. The combination of Toma881, Toma446, and Drugeon meets [12.2] for the same reasons that I discussed with respect to Element [1.3], above.

[12.3] reading, by the data processing unit, the HDR image data from the MP4 file;

181. The combination of Toma881, Toma446, and Drugeon meets [12.3] for the same reasons that I discussed with respect to Element [1.4], above.

[12.4] executing, by the data processing unit, a conversion process of the read HDR image data based on the acquired HDR image metadata and the acquired display function information of the display unit;

182. As I explained for Element [1.5], above, the combination of Toma881, Toma446, and Drugeon executes that conversion process on the read HDR image data based on both the read HDR image data using both the acquired HDR image metadata and the acquired display function information. The combination of Toma881, Toma446, and Drugeon meets [12.4] for the same reasons that I discussed with respect to Element [1.5], above.

[12.5] executing, by the data processing unit, an output image generation process based on the execution of the conversion process; and

183. As I explained for Element [1.6], above, in the combination of Toma881, Toma446, and Drugeon the data processing unit performs that output image generation process based on the result of the conversion. The combination of Toma881, Toma446, and Drugeon meets [12.5] for the same reasons that I discussed with respect to Element [1.6], above.

[12.6] outputting, by the data processing unit, an image signal to the display unit based on the executed output image generation process.

184. As I explained for Element [1.7], above, in the combination of Toma881, Toma446, and Drugeon the data processing unit outputs the image signal to the display based on that output image generation process. The combination of

Toma881, Toma446, and Drugeon meets [12.6] for the same reasons that I discussed with respect to Element [1.7], above.

5. *Claim 14*

185. Claim 14 recites a non-transitory computer-readable medium storing instructions that, when executed by a processor of an information processing device, cause the processor to perform the same operations recited in Claim 12. As discussed below, the combination teaches storing processor-executable instructions and performing the claimed HDR image processing operations, including acquiring HDR metadata, acquiring display function information, reading HDR image data, executing conversion processing, generating output image data, and outputting an image signal for display.

[14.pre] A non-transitory computer-readable medium having stored thereon computer-executable instructions that, when executed by a processor of an information processing device, cause the processor to execute operations, the operations comprising:

186. Claim 14 casts the operations of claim 1 as computer-executable instructions carried on a non-transitory medium and run by a processor of an information processing device. Toma881 implements its processing in software that a processor runs from a recording medium. It teaches that “[e]ach component may be implemented by a program execution unit, such as a CPU or a processor, reading and executing the software program recorded in a recording medium such as a hard disk or a semiconductor memory.” EX1004, 23:58-62; EX1006, 18, 5. Toma881

also identifies the kinds of devices its conversion apparatus lives in. The HDR video reaches the apparatus by, among other paths, “Internet delivery” and the conversion apparatus itself is a consumer playback device: “Conversion apparatus 100 (HDR to pseudo HDR conversion processor) may exist within a disc player, disc recorder, set-top box, TV, personal computer, and smart phone. Conversion apparatus 100 may exist within a server apparatus on the Internet.” EX1004, 18:35, 18:57-61; EX1006, 18, 5.

187. A POSITA would have understood that the playback devices Toma881 lists, such as a set-top box, a personal computer, or a smartphone, contain memory, and that the received HDR video would be held in that memory so that the processor could carry out the conversion of the HDR video, as I explained for [1.5], above. A POSITA would likewise have understood Toma881’s conversion apparatus 100 to be a reproduction device, because it takes in HDR video content and reproduces it for display on an SDR display, again as I explained for [1.5], above. As such, the combination of Toma881, Toma446, and Dugeon provides, or at least renders obvious, a non-transitory computer-readable medium having stored thereon computer-executable instructions that, when executed by a processor of an information processing device, cause the processor to execute the operations of claim 14.

[14.1] acquiring high dynamic range (HDR) image metadata from an MP4 file, wherein

188. As I discussed for Element [1.2], above, in the combination of Toma881, Toma446, and Dugeon the data processing unit of Toma881's conversion apparatus 100 acquires the HDR image metadata from the MP4 file in the combination. The combination of Toma881, Toma446, and Dugeon meets [14.1] for the same reasons that I discussed with respect to Element [1.2], above.

[14.1.1] the acquired HDR image metadata includes a maximum value of frame average luminance of HDR image data stored in the MP4 file, and

189. As I explained for Element [1.2.1], above, the acquired HDR image metadata in the combination of Toma881, Toma446, and Dugeon includes a maximum value of frame average luminance of HDR image data stored in the MP4 file, which is Dugeon's maximum average picture level. EX1012, [0041], [0092], [0031], [0052]; EX1013, 15-17, 21. The combination of Toma881, Toma446, and Dugeon meets [14.1.1] for the same reasons that I discussed with respect to Element [1.2.1], above.

[14.1.2] the HDR image data stored in the MP4 file is based on an MP4 format,

190. As I explained for Element [1.2.2], above, the HDR image data stored in the MP4 file in the combination of Toma881, Toma446, and Dugeon is based on an MP4 format. EX1007, 45:57-46:41, FIG. 41; EX1011, 54. The combination of

Toma881, Toma446, and Drugeon meets [14.1.2] for the same reasons that I discussed with respect to Element [1.2.2], above.

[14.2] acquiring display function information of a display unit from the display unit;

191. As I explained for Element [1.3], above, in the combination of Toma881, Toma446, and Drugeon the data processing unit acquires that display function information from the display. EX1004, 12:28-36, 18:64-67, 23:20-26; EX1006, 8, 13-18, 24. The combination of Toma881, Toma446, and Drugeon meets [14.2] for the same reasons that I discussed with respect to Element [1.3], above.

[14.3] reading the HDR image data from the MP4 file;

192. The combination of Toma881, Toma446, and Drugeon meets [14.3] for the same reasons that I discussed with respect to Element [1.4], above.

[14.4] executing a conversion process of the read HDR image data based on the acquired HDR image metadata and the acquired display function information of the display unit;

193. As I explained for Element [1.5], above, the combination of Toma881, Toma446, and Drugeon executes that conversion process on the read HDR image data based on both the read HDR image data using both the acquired HDR image metadata and the acquired display function information. The combination of Toma881, Toma446, and Drugeon meets [14.4] for the same reasons that I discussed with respect to Element [1.5], above.

[14.5] executing an output image generation process based on the execution of the conversion process; and

194. As I explained for Element [1.6], above, in the combination of Toma881, Toma446, and Drugeon the data processing unit performs that output image generation process based on the result of the conversion. The combination of Toma881, Toma446, and Drugeon meets [14.5] for the same reasons that I discussed with respect to Element [1.6], above.

[14.6] outputting an image signal to the display unit based on the executed output image generation process.

195. As I explained for Element [1.7], above, in the combination of Toma881, Toma446, and Drugeon the data processing unit outputs the image signal to the display based on that output image generation process. The combination of Toma881, Toma446, and Drugeon meets [14.6] for the same reasons that I discussed with respect to Element [1.7], above.

XI. GROUND 1B – CLAIM 2 IS OBVIOUS BASED ON TOMA881 IN VIEW OF TOMA446, DRUGEON, AND TOMA788

A. A Person of Ordinary Skill in the Art Would Have Been Motivated to Apply Toma788 to the Combination of Toma881, Toma446, and Drugeon, With a Reasonable Expectation of Success

196. A POSITA seeking to implement the HDR-to-pseudo-HDR conversion of Toma881, already combined with Toma446 and Drugeon as I described above, would have been prompted to further apply the teaching of Toma788 that a playback device first determines whether the connected display can handle HDR before

converting the signal. EX1024, 32:64-33:3; EX1026, 2, 6, 9, 41-42. Applying that teaching to the existing combination would have caused the conversion apparatus to convert the HDR signal to an SDR-compatible signal only when the connected display is in fact an SDR (or otherwise non-HDR-compatible) display, and to leave the HDR signal unconverted when the display can show HDR directly. Several reasons would have prompted a POSITA to make that modification.

1. Reasons to apply Toma788's display-capability determination to the Toma881-Toma446-Druegon combination

197. As a first reason, applying Toma788 to the Toma881-Toma446-Druegon combination such that the resulting system makes a determination as to if the HDR signal (having the higher luminance range) can be displayed on the display device would have allowed the full HDR video to be displayed on the connected device when that device is HDR-capable, rather than forcing every display to receive a converted SDR signal while still ensuring that a converted SDR signal is provided when the display is not HDR compatible. EX1024, 8:43-60; EX1026, 6, 9, 41-42. Toma881 itself recognizes the value of showing HDR content on a display able to present it, explaining that an HDR display is “required in order to take full advantage of original video representation of HDR.” EX1004, 7:2-3; EX1006, 3. A POSITA would have understood that converting HDR video to a lower-capability SDR signal when the display can already show HDR discards the very advantage Toma881 seeks

to preserve, and that Toma788's determination avoids that loss by routing HDR-capable displays to the unconverted HDR signal.

198. A second reason is the saving of processing resources. Toma788 teaches that when the connected display is HDR-enabled, the conversion is simply not performed: after the determination that the display's transfer function matches the content, "the content signal is output without remapping." EX1024, 8:55-56; EX1026, 2, 6-9. A POSITA would have recognized that skipping the conversion in that case avoids the processing that Toma881's luminance-conversion sequence would otherwise require. As a POSITA would have recognized, when remapping "occurs on a frame-by-frame basis," "the processing load is particularly high for high-resolution images such as 4K," a POSITA would have appreciated that omitting the conversion for HDR-capable displays conserves meaningful processing resources in the combined system. EX1026, 6.

199. A third reason is that the modification would have made the resulting system compatible with both HDR and SDR displays. With Toma788's determination in place, the combined system converts HDR content to a pseudo-HDR signal for an SDR display while passing full-quality HDR content to an HDR display, so that the same system serves both kinds of display and presents the highest-quality signal each display can show. The resulting system can achieve this functionality without having to transmit separate HDR and SDR signals for the

video. In my opinion, a POSITA implementing Toma881 for real-world use, where the connected display might be either HDR-capable or SDR-only, would have found that flexibility a natural and desirable improvement.

2. Reasonable expectation of success

200. A POSITA would have expected the combined system to work as intended. Applying Toma788's determination adds a known technique, a threshold check of the display's capability, to a known method, Toma881's HDR-to-SDR conversion, and does so without altering the structure or function of that conversion. The conversion Toma881 (as modified by Toma446 and Drugeon) performs is unchanged; Toma788's determination simply decides whether that conversion runs at all for a given display. Applying a known technique to a known method in this way would have yielded predictable results, and a POSITA would have had a reasonable expectation of success in making the modification without disrupting the operation of Toma881, Toma446, and Drugeon.

201. Two further points reinforce that expectation. Toma788 and Toma881 share inventors and arise from the same line of work, so a POSITA looking to implement Toma881 would naturally have consulted Toma788 for additional implementation detail contemplated by the same inventors. EX1004, Face; EX1024, Face. And all four references, Toma881, Toma446, Drugeon, and Toma788, address the same field of converting HDR video for display on SDR devices, so a POSITA

would have turned to Toma788 as a matter of course for additional useful teachings in that field and would have expected to combine those teachings without significantly altering or hindering the structure and function of Toma881's systems and methods. Toma881 itself invites this kind of refinement, stating that "various modifications conceivable by a person skilled in the art" fall within the scope of its disclosure. EX1004, 23:63-24:6. Toma788 discloses exactly the sort of known and beneficial variation Toma881 anticipates.

B. Analysis - The Combination of Toma881, Toma446, Drugeon, and Toma788 Discloses Every Limitation of Claim 2

1. Claim 2

[2.pre]-[2.1] The information processing device according to claim 1, wherein the data processing unit is further configured to: acquire a dynamic range of the HDR image data stored in the MP4 file from the acquired HDR image metadata;

202. As I explained for Elements [2.pre]-[2.1] in my Ground 1A analysis, above, the Toma881-Toma446-Drugeon combination acquires the dynamic range of the HDR image data from the luminance metadata that the apparatus reads out of the MP4 file, including the CPL and CAL content luminance values Toma881 uses and the dynamic range increase information Drugeon supplies, all stored in and read from the MP4 file as taught by Toma446. For example, Toma881 describes that "conversion apparatus 100 acquires content luminance information" for the HDR video. EX1004, 12:17-18; EX1006, 13, 15, 18-20, 24. That content luminance

information tells the apparatus how bright the HDR content is. Toma881 also explains how the HDR signal itself encodes luminance: “HDR EOTF converter 101 uses the acquired HDR signal and EOTF of HDR to determine the luminance value of HDR associated with the code value of HDR by EOTF of HDR,” and “the HDR signal indicates the code value of HDR obtained by quantization of the luminance value of a video (content) by using inverse EOTF of HDR that associates the luminance value in the luminance range of HDR with the plurality of HDR code values.” EX1004, 11:65-12:7; EX1006, 11-12, 15, 19. The luminance range that this encoding spans is a known one. Toma881 describes that “the luminance value (luminance value of the HDR-enabled video) in the luminance range of up to 10,000 nit is converted into the HDR signal of a 10-bit code value by quantization based on inverse EOTF.” EX1004, 9:29-32; EX1006, 11, 18. The combination therefore acquires a dynamic range of the HDR image data stored in the MP4 file from the acquired HDR image metadata, as Element [2.1] recites.

203. Toma788 corroborates that the resulting system acquires a dynamic range of the HDR image data stored in the MP4 file from the acquired HDR image metadata, describing the HDR content is carried as metadata associated with the video, just as Toma881 teaches. Toma788 lists, as one way its conversion device obtains that information, that “luminance information is obtained as meta-information associated with an HDR video.” EX1024, 29:57-60; EX1026, 9.

Toma788 also confirms the same HDR dynamic range that the metadata describes, explaining that “[t]he HDR luminance range is a luminance range where a maximum value is increased from 100 nit which is a maximum value in the SDR luminance range to 1000 nit.” EX1024, 6:3-6; EX1026, 1-2. A POSITA would have recognized that Toma788’s meta-information describing an HDR luminance range that runs well above the SDR maximum is the same kind of luminance metadata, describing the same kind of HDR dynamic range, that the combination reads from the MP4 file to satisfy [2.1].

204. Toma788 further describes storing, as metadata, an indication of where a signal’s peak luminance falls relative to the SDR range. In connection with authoring graphics whose luminance is kept within the SDR range, Toma788 explains that “identification information representing that the peak luminance is within the SDR luminance range” may be stored, and that “when output is carried out by an interface such as HDMI, the identification information may be stored as meta-information of the output interface.” EX1024, 11:9-18; EX1026, 7. While that passage concerns Toma788’s graphics-authoring process rather than the video luminance metadata that principally drives the claimed conversion, it confirms that a POSITA would have understood luminance-range information of this kind to be indicated by the stored metadata, consistent with the combination’s storage of the HDR dynamic range in the MP4 file metadata.

[2.2] determine the HDR image data having the dynamic range is not outputable by the display unit, wherein

205. As I explained for [2.2] in my Ground 1A analysis, above, the Toma881-Toma446-Druegon combination determines that the HDR image data, because its dynamic range exceeds what the display can reproduce, is not outputable by the display unit as it stands. That determination follows from the mismatch between the wide HDR luminance range and the narrower range the display can show, and Toma881's apparatus works from the display's own luminance range in mapping the HDR values down. The combination therefore meets Element [2.2].

206. However, I have been asked to additionally analyze the combination of Toma881-Toma446-Druegon-Toma788 and based on my analysis, I confirm that the additional teachings of Toma788 also disclose Element [2.2] in even greater detail than the references I discussed in Ground 1A.

207. Toma788 expressly describes determination of the display's capability that decides whether the HDR content can be output as it is. Toma788 describes that "the playback control program determines whether the playback device is compatible with HDR graphics (has a function for executing HDR graphics)." EX1024, 32:64-33:3; EX1026, 41-42. When the display cannot show HDR, Toma788 performs the conversion: it describes that, "since TV 310 is not compatible with the HDR display, BD player 200 remaps the HDR data of the video and the graphics into SDR data." EX1024, 7:22-30; EX1026, 6. A POSITA would have

recognized this as a determination that the HDR image data, with its dynamic range, is not outputable by the SDR display and must be converted. Conversely, when the TV is HDR compatible, no remapping is performed and the system simply “outputs an HDR signal obtained by the synthesis to TV 300 compatible with HDR display.” 7:16-21; 33:4-6 (“When the playback device is compatible with the HDR graphics (Yes at S401), the playback control program plays graphics content of the HDR signal (S403).”); EX1026, 2, 6, 9, 41-42.

208. Toma788 describes the same determination at the level of the transfer functions. Its EOTF determiner “determines whether an EOTF compatible with a signal of obtained content (a video and graphics) is different from an EOTF compatible with an output signal to be output to the display.” EX1024, 8:41-45; EX1026, 9. A POSITA would have understood this determination to decide whether the HDR signal can be output to the display as it is or must instead be converted. Toma788 confirms the two outcomes: when the transfer functions differ, the conversion steps are executed, but when they do not, “the content signal is output without remapping.” EX1024, 8:55-56; EX1026, 9. Because Toma788 determines, from the display’s capability and the mismatch between the content’s and the display’s transfer functions, that HDR content bound for an SDR display cannot be output as it is, it is my opinion that the combination determines the HDR image data having the dynamic range is not outputable by the display unit, as [2.2] recites.

Accordingly, Toma788 determines whether HDR image data having the HDR dynamic range is outputable by the playback device and performs conversion only when the playback device lacks compatibility with the HDR signal, thereby satisfying this limitation.

[2.3] the determination is based on the acquired HDR image metadata and the acquired display function information of the display unit;

209. As I explained above for Element [2.3] in my Ground 1A analysis, the combination's determination rests on two inputs: the HDR image metadata, which tells the apparatus the dynamic range of the content, and the display function information acquired from the display, including the display's maximum luminance (DPL), which tells the apparatus the ceiling of what the display can reproduce. The determination is reached by comparing the two, so that when the content's range exceeds the display's DPL the content cannot be shown as it is. The combination therefore satisfies [2.3].

210. Toma788 confirms that its conversion device likewise uses both content luminance information and display characteristics obtained from the display. Toma788 describes that the conversion device "obtains display characteristics information of display device 600 from display device 600," and that "[t]he display characteristics information is information representing display characteristics of display device 600, such as a maximum value of luminance (DPL) that can be displayed by display device 600, a display mode of display device 600 (see

description made later), and input and output characteristics (EOTF compatible with the display device).” EX1024, 19:22-29; EX1026, 23-24. When the display cannot show HDR (because the luminance range of the display device is SDR, having a luminance range less than HDR), Toma788 performs the conversion: it describes that, “since TV 310 is not compatible with the HDR display, BD player 200 remaps the HDR data of the video and the graphics into SDR data.” EX1024, 7:22-30; EX1026, 6. A POSITA would have recognized this as a determination that the HDR image data, with its dynamic range, is not outputable by the SDR display and must be converted based on the acquired HDR image metadata and the acquired display function information of the display unit. Conversely, when the TV is HDR compatible, no remapping is performed and the system simply “outputs an HDR signal obtained by the synthesis to TV 300 compatible with HDR display.” 7:16-21; 33:4-6 (“When the playback device is compatible with the HDR graphics (Yes at S401), the playback control program plays graphics content of the HDR signal (S403).”); EX1026, 2, 6, 9, 41-42.

211. Accordingly, Toma788, like Toma881, bases the determination on both content luminance information and display characteristics information. Thus, the determination that the HDR image data is not outputable by the display unit is based on the HDR image metadata indicating the HDR luminance range and the acquired

display function information indicating the display's supported luminance range, consistent with the two inputs [2.3] recites.

[2.4] execute the conversion process of the read HDR image data based on the determination,

212. As I explained above for Element [2.4] in my Ground 1A analysis, the combination carries out the conversion process on the read HDR image data in response to the determination that the HDR content cannot be displayed as it is, because mapping the HDR range onto the display range is what makes the content playable on an SDR display. The combination therefore executes the conversion process of the read HDR image data based on the determination, as [2.4] recites.

213. Toma788 even more expressly ties the execution of its conversion directly to the display-capability determination. When the display is not HDR-capable, the conversion runs: “since TV 310 is not compatible with the HDR display, BD player 200 remaps the HDR data of the video and the graphics into SDR data.” EX1024, 7:16-30; EX1026, 6. When the display can show the content as it is, the conversion does not run, because on the “No” branch of the determination “the content signal is output without remapping.” EX1024, 8:55-56; EX1026, 9. A POSITA would have recognized that Toma788 executes its conversion process on the HDR content precisely when, and because, the determination establishes that the content cannot be output to the display as it is, consistent with [2.4].

[2.5] wherein the conversion process includes reduction of the dynamic range of the HDR image data; and

214. As I explained above for Element [2.5] in my Ground 1A analysis, the conversion process in the combination reduces the dynamic range of the HDR image data by remapping luminance values that span the wide HDR range into the narrower range the display can show, converting content that reaches thousands of nits so that it fits a display of a few hundred nits. The combination therefore meets [2.5]. Toma788 describes the same reduction of luminance. It explains that, in its conversion, “luminance values are reduced such that undisplayable brightness becomes displayable brightness.” EX1024, 27:34-36; EX1026, 29. A POSITA would have recognized this as the same reduction of the HDR content’s dynamic range that Toma881’s conversion performs, bringing brightness the display cannot show down into the range it can, consistent with [2.5].

[2.6] output the HDR image data with the reduced dynamic range to the display unit.

215. As I explained above for Element [2.6] in my Ground 1A analysis, the combination outputs the HDR image data, now with its dynamic range reduced to fit the display, to the display unit; this is the output step I described for Element [1.7], carried through to the reduced-range signal produced by the conversion of Element [2.5]. The combination therefore outputs the HDR image data with the reduced dynamic range to the display unit, as [2.6] recites.

216. Toma788 likewise confirms that the converted signal is output to the display. It describes that, when the display is not HDR-capable, “the playback device converts the output signal to an SDR signal compatible with the SDR so as to output the converted signal.” EX1024, 7:1-3; EX1026, 6. A POSITA would have recognized that Toma788, like Toma881, outputs to the display the signal whose dynamic range has been reduced to fit that display, consistent with [2.6]. For these reasons, it is my opinion that the combination of Toma881, Toma446, Drugeon, and Toma788 discloses every limitation of claim 2.

XII. GROUND 1C – CLAIMS 3, 9, AND 10 ARE OBVIOUS BASED ON TOMA881 IN VIEW OF TOMA446, DRUGEON, AND SAEKI

A. A Person of Ordinary Skill in the Art Would Have Been Motivated to Apply Saeki to the Combination of Toma881, Toma446, and Drugeon, With a Reasonable Expectation of Success

217. A POSITA seeking to implement the Toma881-Toma446-Drugeon combination, which as I explained above already stores the HDR luminance metadata within an MP4 file per Toma446’s teaching, would have been prompted to apply Saeki’s further teaching that such metadata can be protected against undetected alteration or falsification using a hash value or digital signature stored within the MP4 file’s trak box. EX1027, [0009], [0035]-[0036], [0047]. Applying that teaching to the existing combination would have caused the resulting MP4 file to store the HDR luminance metadata, together with a hash value or digital signature calculated from that metadata, within a metadata box nested in a trak box of the file,

so that a client device could verify before use that the metadata had not been altered.

Several reasons would have prompted a POSITA to make that modification.

1. Reasons to apply Saeki's MP4 file format teachings to the Toma881-Toma446-Druegon combination

218. *As a first reason*, a POSITA would have recognized that applying Saeki's protection technique to the Toma881-Toma446-Druegon combination would have improved the accuracy and security of the resulting system. As Saeki explains, its techniques are directed to "processing metadata in files, including media files, so that an alteration or falsification of the metadata can be detected," using metadata that "includes hash values and digital signatures that were generated by a content server," so that "these hash and signature values can be used by a client to authenticate the metadata." EX1027, [0009]. Saeki explains that "an improved method and data structure of protection mechanisms are desirable to accomplish delivery of protected data or content," EX1027, [0008], and that its FIG. 3 "illustrates simplified view of a data structure for securing metadata." EX1027, [0034]. Saeki further discloses that the digital signatures it employs can be verified by a client "with public keys obtained from the content provider server (or some other external source) in order to confirm that the hash and security information data likely have not been tampered." EX1027, [0067]. A POSITA applying this technique to the Toma881-Toma446-Druegon combination would have obtained an MP4 file

whose HDR metadata could be verified as unaltered before use, improving the accuracy and security of the resulting system.

219. A second reason is that applying Saeki's technique would have saved storage and processing resources relative to more complex content-protection alternatives. As Saeki explains, "DRM usually encompasses a complex set of technologies and business models to protect digital media or other data or to provide revenue to content owners." EX1027, [0003]. A POSITA would have recognized that Saeki's hash-and-signature technique, which need only calculate and compare a hash value or verify a digital signature, is less complex to implement than a full digital-rights-management system of the kind Saeki describes, and would have applied Saeki's technique to the Toma881-Toma446-Drugeon combination to obtain metadata protection without the storage and processing burden of a more complex scheme.

220. A third reason is that applying Saeki's technique to the resulting combination would have helped prevent the unauthorized distribution of duplicated HDR content that unprotected metadata invites. As Saeki explains, "digital content by its very nature is easy to duplicate or alter either with or without the owner's authorization," and that same delivery technology "permits widespread distribution of unauthorized, duplicated content." EX1027, [0002]. Saeki addresses this concern by providing the client with content having "metadata 24 with certain data protection

attributes.” EX1027, [0025]. A POSITA would have applied Saeki’s hash-and-signature protection to the metadata of the Toma881-Toma446-Drugeon combination’s MP4 file for the same reason, to guard against unauthorized alteration or duplication of the HDR metadata it stores.

221. A fourth reason for making the combination is that applying Saeki’s technique would have allowed the resulting system to leave certain HDR metadata unencrypted and readable while still protecting it against undetected alteration. As Saeki explains, content providers may deem it “desirable that potential users have access to this type of metadata,” such as “the title of the work, the artist, and other information about the underlying audio-visual content itself,” so that a user can “make a purchase decision, etc. prior to ordering and receiving a license with the associated decryption keys.” EX1027, [0006]. A POSITA would have recognized that Saeki’s hash-and-signature technique allows this kind of descriptive metadata to remain unencrypted, while still being protected against undetected tampering, an advantage a POSITA would have wanted to obtain in the Toma881-Toma446-Drugeon combination’s MP4 file.

222. A fifth reason for making the proposed combination is that the Toma881-Toma446-Drugeon combination already stores the HDR metadata in an MP4 file, as I explained above based on Toma446’s teaching, so a POSITA implementing that combination would naturally have looked to Saeki for further

detail on how to secure the metadata stored within that same file. Saeki provides exactly this detail, disclosing “a data structure for securing metadata” within an MP4 file. EX1027, [0034]. A POSITA would have applied Saeki’s teaching to most efficiently implement the metadata-security aspect of the Toma881-Toma446-Druegon combination, having already adopted the MP4 file format that Saeki’s teaching is designed to secure.

223. As a sixth reason, applying Saeki’s metadata-protection technique to the Toma881-Toma446-Druegon combination was the application of a known technique, hash-and-signature verification of file metadata, to a known method, storage of HDR metadata in an MP4 file, and would have yielded predictable results. All four references, Toma881, Toma446, Druegon, and Saeki, disclose techniques for distributing video media, and a POSITA would have predictably turned to Saeki for additional useful teachings in that field.

2. Reasonable expectation of success

224. A POSITA would have expected the combined system to work as intended. Applying Saeki’s hash-and-signature technique adds a known technique, verification of stored metadata against a hash value or digital signature, to a known method, the Toma881-Toma446-Druegon combination’s storage of HDR metadata in an MP4 file, and does so without altering the structure or function of that storage or of the HDR-to-SDR conversion the combination performs. The metadata itself,

and the conversion process that reads it, remain unchanged; Saeki's technique simply adds a hash value or digital signature alongside that metadata so that its integrity can be verified. Applying a known technique to a known method in this way would have yielded predictable results, and a POSITA would have had a reasonable expectation of success in making the modification without disrupting the operation of Toma881, Toma446, and Dugeon.

225. This expectation is reinforced by the fact that all four references, Toma881, Toma446, Dugeon, and Saeki, address the same general field of distributing digital video content, so a POSITA would have turned to Saeki as a matter of course for additional useful teachings in that field and would have expected to combine those teachings without significantly altering or hindering the structure and function of Toma881's systems and methods. Toma881 itself invites this kind of refinement, stating that "various modifications conceivable by a person skilled in the art" fall within the scope of its disclosure. EX1004, 23:63-24:6. Saeki discloses exactly the sort of known and beneficial variation Toma881 anticipates.

B. Analysis - The Combination of Toma881, Toma446, Dugeon, and Saeki Discloses Every Limitation of Claims 3, 9, and 10

1. Claim 3

226. In the resulting combination of Toma881 with Toma446, Dugeon, and Saeki, Toma881 provides the HDR processing architecture, Toma446 provides storage of HDR image data and HDR metadata in an MP4 file, Dugeon provides

HDR metadata including maximum average picture level information and dynamic-range information, and Saeki provides MP4 metadata storage structures including metadata boxes associated with trak boxes. Thus, the combined system stores HDR image metadata corresponding to HDR image data in MP4 metadata structures associated with track information, including metadata boxes within trak boxes, satisfying the additional limitations of Claims 3 and 10.

[3.pre]-[3.1] The information processing device according to claim 1, wherein the HDR image metadata is recorded in an HDR image metadata storage box,

227. The combination of Toma881, Toma446, Drugeon, and Saeki provides an information processing device according to claim 1, as I explained above in my Ground 1A analysis, in which the HDR image metadata is recorded in an HDR image metadata storage box. Toma446 explains that an MP4 file includes “a meta-data storing box” for holding metadata, and that when the video in the MP4 file is HDR video, “[t]he HDR-related information may be stored as the meta-data managing the MP4 file, instead of being directly stored in the MP4 file.” EX1007, 34:7-11, 46:39-41; EX1011, 38-39, 54. Saeki confirms and provides further details regarding this same kind of storage box in an MP4 data structure. As Saeki explains, “the audio and video track boxes 74, 76 contain other boxes which hold meta information on each media according to a type of the media included in the moov box 64,” and “the media data is referenced and interpreted by the metadata boxes.” EX1027, [0041],

[0036]. A POSITA would have therefore recognized that in the combination the HDR image metadata in the combination is recorded in a metadata storage box of this kind, as [3.1] recites.

[3.2] the HDR image metadata storage box is in a trak box in the MP4 file,

228. Saeki discloses that in the combination of Toma881, Toma446, Drugeon, and Saeki, the metadata storage boxes are located within trak boxes of the MP4 file. As Saeki explains, “[t]he moov box 64 encapsulates several other boxes, including... an audio track (‘trak’) box 74 and a video track (‘trak’) box 76,” EX1027, [0040], and “the audio and video track boxes 74, 76 contain other boxes which hold meta information on each media according to a type of the media included in the moov box 64.” EX1027, [0041].

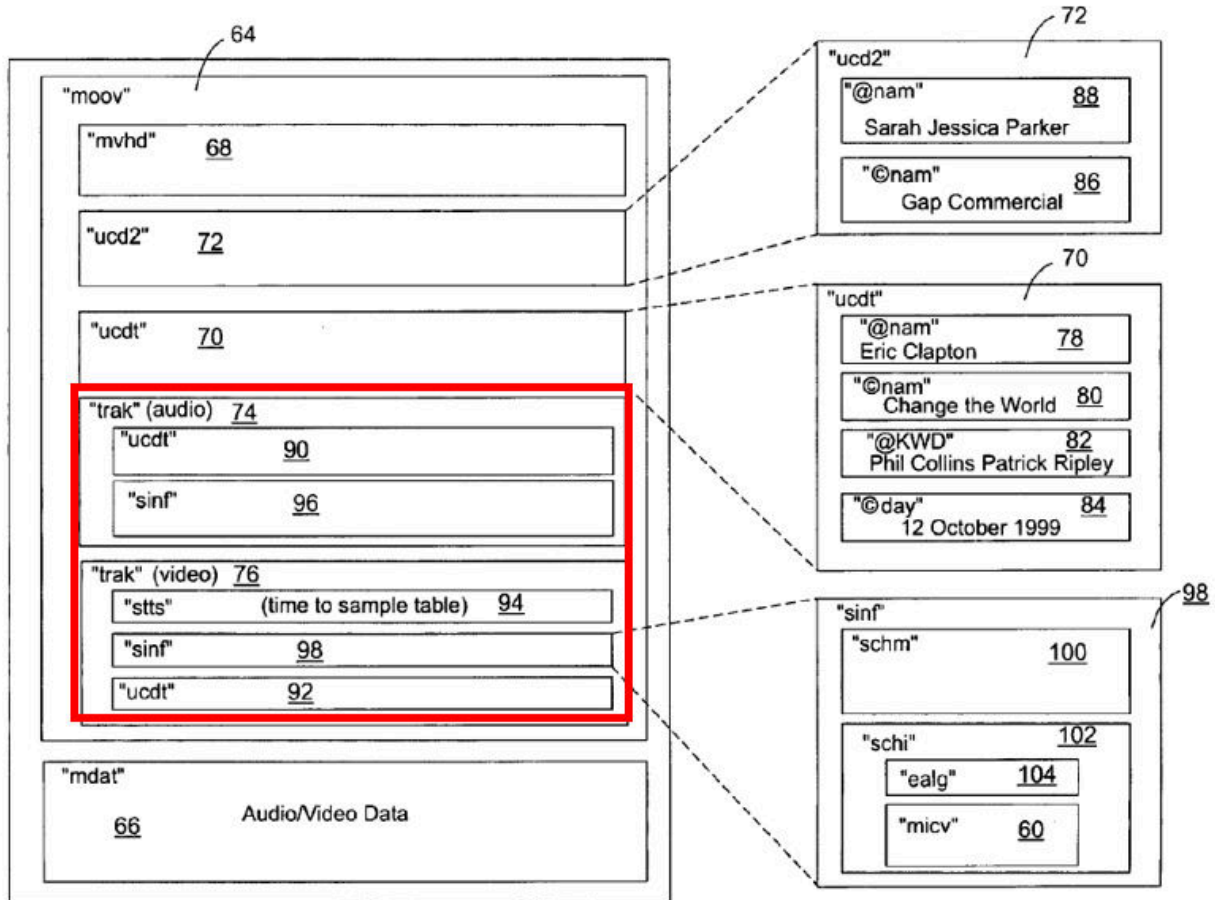


FIG. 3

EX1027, FIG. 3.

229. Saeki further explains that the moov box containing these trak boxes is distinct from the mdat box that stores the actual encoded content: “the moov box 64 stores the information... necessary for decoding the metadata of the entire MPEG-4 file,” while “the mdat box 66 stores an actually encoded codec stream of a media.” EX1027, [0039]. A POSITA applying Saeki’s teaching to the Toma881-Toma446-Druegon combination would have recognized that the HDR image metadata storage

box described in Toma446, discussed above for [3.1], is located within one of these trak boxes in the resulting combination, as [3.2] recites.

[3.3] the trak box stores metadata for application of an entire HDR image stored in the MP4 file, and

230. As I explained in my Ground 1A analysis, above, the MP4 file in the combination stores metadata for the entire HDR image, including the luminance information Toma881 and Dugeon supply. EX1004, 23:36-42, 4:7-30, 19:31-38, 18:34-39, 18:54-56, 7:27-35; EX1006, 24, 18. As Toma446 explains, “[t]he HDR-related information may be stored as the meta-data managing the MP4 file, instead of being directly stored in the MP4 file.” EX1007, 46:39-41; EX1011, 54. Saeki provides further details confirming that this metadata for the entire HDR image is stored within a trak box specifically. As Saeki explains, “the audio and video track boxes 74, 76 contain other boxes which hold meta information on each media according to a type of the media included in the moov box 64.” EX1027, [0041]. That meta information can include the kind of protection-related metadata I discussed above in the Overview of Saeki, such as the hash and security information nested within the sinf, schi, and micv boxes contained in each trak box. EX1027, [0047], [0050]. A POSITA would have recognized that the reference to meta information “on each media” would have included the entire HDR image stored in the MP4 file in the combination, as [3.3] recites.

[3.4] the data processing unit is further configured to read the HDR image metadata from the HDR image metadata storage box.

231. As I explained above in my Ground 1A analysis of Elements [1.2] and [1.5], above, the HDR file in the combination of Toma-881, Toma446, Drugeon, and Saeki includes HDR image metadata that Toma881's conversion apparatus 100 reads and uses to perform its conversion process. EX1004, 23:36-42, 4:7-30, 19:31-38, 14:46-50, 23:33-42; EX1006, 14-15, 18-20, 24. That metadata is stored in the metadata storage box discussed above for Elements [3.1] through [3.3]. Saeki confirms that a client device reads content and its associated metadata from the MP4 file in order to reproduce that content, explaining that "the client 18 decrypts and reproduces the received item of content." EX1027, [0033]. Saeki further explains that, in reading this content, "the client will locate and access the target entry data" associated with the file's metadata. EX1027, [0062]. A POSITA would have recognized that, in the combination of Toma-881, Toma446, Drugeon, and Saeki, Toma881's conversion apparatus reading the HDR image metadata from the HDR image metadata storage box for use in converting the image data is consistent with, and further supported by, this same reading operation Saeki describes, as [3.4] recites.

2. Claim 9

[9.pre] A non-transitory computer-readable medium having stored thereon an MP4 file and computer-executable instructions, the computer-executable

instructions, when executed by a processor of a reproduction device, cause the processor to execute operations, the operations comprising:

232. As I explained above in my Ground 1A analysis of this element, Toma881 implements its processing in software that a processor runs from a recording medium, teaching that each component may be implemented by a processor “reading and executing the software program recorded in a recording medium such as a hard disk or a semiconductor memory.” EX1004, 23:58-62; EX1006, 18, 5. Toma881’s conversion apparatus is itself a consumer playback device of the kind claim 9 recites, existing within devices such as “a disc player, disc recorder, set-top box, TV, personal computer, and smart phone,” or within “a server apparatus on the Internet.” EX1004, 18:35, 18:57-61; EX1006, 18, 5. As I previously explained, a POSITA would have recognized that these playback devices contain memory holding the MP4 file discussed below, at least temporarily, so that the processor can carry out the conversion Toma881 describes. For the same reasons I gave in my Ground 1A analysis, the combination of Toma881, Toma446, and Drugeon, further modified by Saeki as I described above, provides a non-transitory computer-readable medium holding both an MP4 file and computer-executable instructions that a processor of a reproduction device runs to perform the operations claim 9 recites.

***[9.1] reading high dynamic range (HDR) metadata from an HDR image
metadata storage box of the MP4 file, wherein***

233. As I explained above in my Ground 1A analysis of this element, Toma446 describes the metadata storage box in which the HDR video's metadata is held, teaching that an MP4 file includes "a meta-data storing box" and that, when the video is HDR video, "[t]he HDR-related information may be stored as the meta-data managing the MP4 file." EX1007, 34:7-11, 46:39-41; EX1011, 38-39, 54. The HDR metadata held in that box is the same metadata that Toma881's conversion apparatus 100 reads and uses, as I explained for [1.2] and [1.5], above. EX1004, 23:36-42, 19:35-38, 14:51-52; EX1006, 14-15, 18-20, 24. For the same reasons I gave there, the combination of Toma-881, Toma446, Dugeon, and Saeki reads the HDR metadata out of the metadata storage box of the MP4 file, as [9.1] recites.

[9.1.1] an mdat box of the MP4 file stores HDR image data;

234. As I explained in my Ground 1A analysis of this element, Toma446 teaches that in the resulting combination of Toma-881, Toma446, Dugeon, and Saeki, the coded HDR picture data is stored in the mdat box of the MP4 file, separate from the header information and metadata, teaching that "[o]ther pieces of data included in the access unit are stored in the mdat as the sample data." EX1007, 19:35-40; EX1011, 24, 27. For HDR video specifically, Toma446 discloses that the video portion of the movie fragments is stored in the mdat box, with the moof box indicating whether a given video sample is HDR. EX1007, 45:57-61, FIG. 41;

EX1011, 54. However, to the extent Toma446's data structure for storing the HDR image data is not expressly described using the term "mdat box," Saeki confirms that this same kind of box, as used in an MP4-like data structure, is properly understood as an mdat box that stores HDR image data of exactly this kind. As Saeki explains, "the mdat box 66 stores an actually encoded codec stream of a media, i.e., content data such as a video stream or an audio stream." EX1027, [0039].

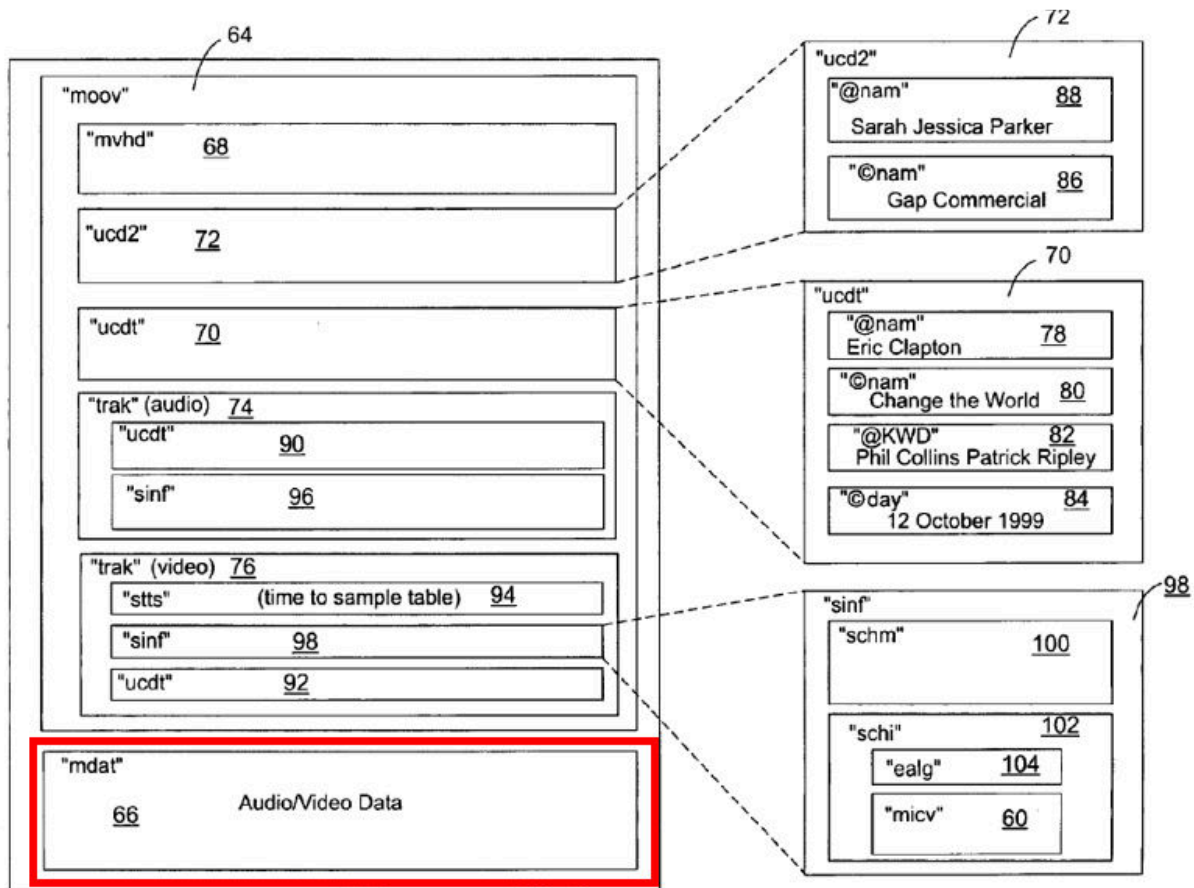


FIG. 3

EX1027, FIG. 3.

235. A POSITA would have recognized that the video stream Saeki describes as stored in the mdat box is the same kind of encoded HDR video data that Toma446 stores in its mdat data structure, confirming that the mdat box of the MP4 file in the combination of of Toma-881, Toma446, Dugeon, and Saeki stores HDR image data, as [9.1.1] recites.

[9.1.2] the HDR image metadata storage box of the MP4 file stores the HDR image metadata corresponding to the HDR image data,

236. As I explained above in my Ground 1A analysis of this element, the HDR file in the combination of Toma-881, Toma446, Dugeon carries HDR image metadata that corresponds to the HDR image data. EX1004, 23:36-42, 19:35-38, 14:51-52; EX1006, 14-15, 18-20, 24. Toma446 places that metadata in the metadata storage box discussed above for [9.1]. EX1007, 34:7-11, 46:39-41; EX1011, 38-39, 54. For the same reasons I gave there, the metadata storage box of the MP4 file in the combination of Toma-881, Toma446, Dugeon, and Saeki stores the HDR image metadata corresponding to the HDR image data, as [9.1.2] recites.

[9.1.3] the stored HDR image data is based on an MP4 format, and

237. As I explained above in my Ground 1A analysis of Element [1.2.2], the stored HDR image data in the combination of Toma-881, Toma446, Dugeon, and Saeki is based on an MP4 format. That analysis applies here without change. Saeki's own MP4-like data structure, discussed throughout my analysis of Ground 1C above,

further confirms that the combination's use of an MP4 format is consistent with, and reinforced by, Saeki's teaching. In my opinion, the combination satisfies [9.1.3].

[9.1.4] the stored HDR image metadata includes a maximum value of frame average luminance of the HDR image data;

238. As I explained above in my Ground 1A analysis of Element [1.2.1], the stored HDR image metadata in the combination of Toma-881, Toma446, Drugeon, and Saeki includes a maximum value of frame average luminance of the HDR image data, which is Drugeon's maximum average picture level. EX1012, [0031], [0041], [0052]; EX1013, 15-17, 21, 26; EX1004, 12:17-27, 4:7-30, 19:31-38, 23:36-42, FIG. 11; EX1006, 13, 15, 18-20, 24. That analysis applies here without change, and in my opinion the combination satisfies [9.1.4].

[9.2] executing a conversion process of the HDR image data based on the read HDR image metadata; and

239. As I explained in my Ground 1A analysis of Element [1.5], above, the combination of Toma-881, Toma446, Drugeon, and Saeki executes a conversion process of the HDR image data based on the HDR image metadata read from the MP4 file. That analysis applies here without change, and in my opinion the combination satisfies [9.2].

[9.3] reproducing the HDR image data based on the execution of the conversion process.

240. As I explained in my Ground 1A analysis of Elements [1.6] and [1.7], above, Toma881's conversion apparatus 100 generates an output video signal from the result of the conversion process and outputs that signal to the display, reproducing the content as the pseudo-HDR image. Because the reproduction follows from and rests on the execution of the conversion process, it is my opinion that the combination of Toma-881, Toma446, Drugeon, and Saeki reproduces the HDR image data based on the execution of the conversion process, as [9.3] recites, for the reasons I gave in my Ground 1A analysis of Elements [1.6] and [1.7].

3. Claim 10

[10.pre]-[10.1] The non-transitory computer-readable medium according to claim 9, wherein the HDR image metadata storage box is in a trak box, and

241. As I explained for Element [3.2], above, Saeki discloses that the moov box of its MP4-like data structure encapsulates the audio and video trak boxes, and that these trak boxes contain the metadata boxes that hold meta information on each media. EX1027, [0040]-[0041]. For the same reasons I gave there, the HDR image metadata storage box in the combination of Toma-881, Toma446, Drugeon, and Saeki, as recited in claim 9 and discussed above, is located in a trak box, as [10.pre]-[10.1] recites.

[10.2] the trak box stores metadata for application of an entire HDR image stored in the MP4 file.

242. As I explained for Element [3.3], above, the trak box in the combination of Toma-881, Toma446, Dugeon, and Saeki stores metadata for application of the entire HDR image stored in the MP4 file, including the luminance information Toma881 and Dugeon supply and the metadata Toma446 and Saeki describe as held within the trak box's metadata boxes. For the same reasons I gave there, the trak box stores metadata for application of an entire HDR image stored in the MP4 file, as [10.2] recites.

XIII. GROUND 2A – CLAIMS 5, 6, 13, AND 15 ARE OBVIOUS BASED ON TOMA446 IN VIEW OF DRUGEON

A. A Person of Ordinary Skill in the Art Would Have Been Motivated to Apply Dugeon to Toma446, With a Reasonable Expectation of Success

243. Toma446 describes generating an MP4 file that, in some implementations, stores HDR video data and luminance information for that HDR video as metadata managing the MP4 file. EX1007, 45:57-46:41; EX1011, 54. Dugeon, in turn, describes a particular luminance value, which it calls the maximum average picture level, that characterizes HDR video and that can be used by a device when handling that video. EX1012, [0041]; EX1013, 16-17. Several reasons would have prompted a POSITA to implement Toma446's file-generation techniques to include Dugeon's maximum average picture level information among the

luminance information that Toma446 stores as metadata in its MP4 HDR video file. Furthermore, a POSITA would have had a reasonable expectation of success in doing so.

244. As a first reason, Dugeon's maximum average picture level value would have improved the gamma-curve adjustment that Toma446 already performs. Toma446 explains that, when HDR content is played back, its system tailors the picture to the capabilities of the display by adjusting a gamma curve using stored luminance information. Toma446 states that "[d]uring the playback of the HDR content, a gamma curve is adjusted [...] using luminance information, such as peak luminance and a white-level luminance, which can be switched in units of streams or scenes." EX1007, 46:16-20; EX1011, 54 (the luminance information "is used to adjust the gamma curve according to the maximum luminance of the output display"). Dugeon's maximum average picture level is itself a luminance value that a POSITA would have recognized as being useful in such a conversion, in at least some circumstances. Dugeon defines it as "maximum average picture level information indicating a highest average luminance value among average luminance values of all pictures included in a video sequence," and further explains that "[t]he average picture level means the average value of pixel luminance expressed in percentage of the maximum luminance." EX1012, [0041], [0092]; EX1013, 16-17. Because Toma446 adjusts its gamma curve using luminance information, and

because Drugeon's maximum average picture level is a luminance value describing the same HDR video, a POSITA would have recognized that this value is the kind of luminance information Toma446 uses for that adjustment. Furthermore, a POSITA would have recognized that adding this value, which reports a frame-average luminance across the whole sequence rather than only the peak and white-level figures Toma446 names, would give the gamma-curve adjustment an additional and more representative measure of the content's luminance, and would therefore have understood that including it would allow Toma446's system to adjust the gamma curve.

245. As a second reason, including Drugeon's maximum average picture level value would have given Toma446's system finer control over how HDR video is fitted to a display that does not support the full HDR luminance range. Drugeon explains that "the use of the dynamic range increase information and the maximum average picture level information allows the difference from the SDR to be set within an arbitrary range." EX1012, [0092]-[0093]; EX1013, 16-17. A POSITA would have understood that this ability to set the difference from the SDR range within an arbitrary range is useful in Toma446's system, which likewise contemplates mapping the HDR luminance range onto the narrower SDR luminance range when HDR content is shown on a display that is not HDR-compatible. EX1007, 45:57-46:4; EX1011, 54.

246. As a third reason, using Dugeon's maximum average picture level value as a luminance value in this conversion would have reduced the visible mismatch a viewer perceives between HDR and SDR reproduction of the same video. Dugeon teaches that its approach makes it "possible to reduce the difference in luminance value between when the video is reproduced by an HDR device and when the video is reproduced by an SDR device, and therefore video that is less likely to provide a feeling of discomfort can be reproduced even when the video is reproduced using the SDR OETF." EX1012, [0083]; EX1013, 16. A POSITA would have recognized this reduction in perceived luminance mismatch as a direct benefit in Toma446's system, which is concerned with the same problem of reproducing HDR content acceptably on displays of differing capability. EX1007, 45:57-46:4; EX1011, 54.

247. As a fourth reason, a POSITA would have been prompted to apply Dugeon's teaching to Toma446 because doing so amounts to using a known technique, Dugeon's maximum average picture level luminance value, in a known method, Toma446's generation of an MP4 file that stores HDR luminance information as metadata, to yield the predictable result of storing one more useful luminance value in that metadata. A POSITA seeking to implement Toma446 would also have been led to Dugeon in particular because the two references name a common inventor, Tadamasa Toma. EX1007, Face; EX1012, Face. A POSITA

looking to implement Toma446's file-generation teaching would naturally have consulted the further HDR teachings of a reference by the same inventor for additional implementation detail.

248. A POSITA also would have had a reasonable expectation of success in making this combination. Both Toma446 and Drugeon address the same field, namely the transmission of HDR video data and the reproduction of that video on displays that do or do not support the full HDR luminance range, and both treat luminance information as the mechanism for fitting HDR video to a given display. EX1007, 45:57-46:41; EX1011, 54; EX1012, [0083], [0092]-[0093]; EX1013, 16-17. Storing Drugeon's maximum average picture level value among the luminance information Toma446 already stores as MP4 metadata would not have altered the structure or operation of Toma446's file-generation process; it would only have added one further luminance value to the metadata that process already produces. A POSITA would therefore have expected the combination to work as intended without difficulty. Toma446 itself invites this kind of refinement, stating that "various changes of the exemplary embodiments and modifications conceivable by those skilled in the art and a combination of the components of the exemplary embodiments and modifications are also included in one or the plurality of aspects without departing from the scope of the present disclosure." EX1007, 47:11-20,

48:25-34; EX1011, 54. Drugeon's maximum average picture level value is exactly the sort of known and beneficial variation that Toma446 contemplates.

B. Analysis - The Combination of Toma446 and Drugeon Discloses Every Limitation of Claims 5, 6, 13, and 15

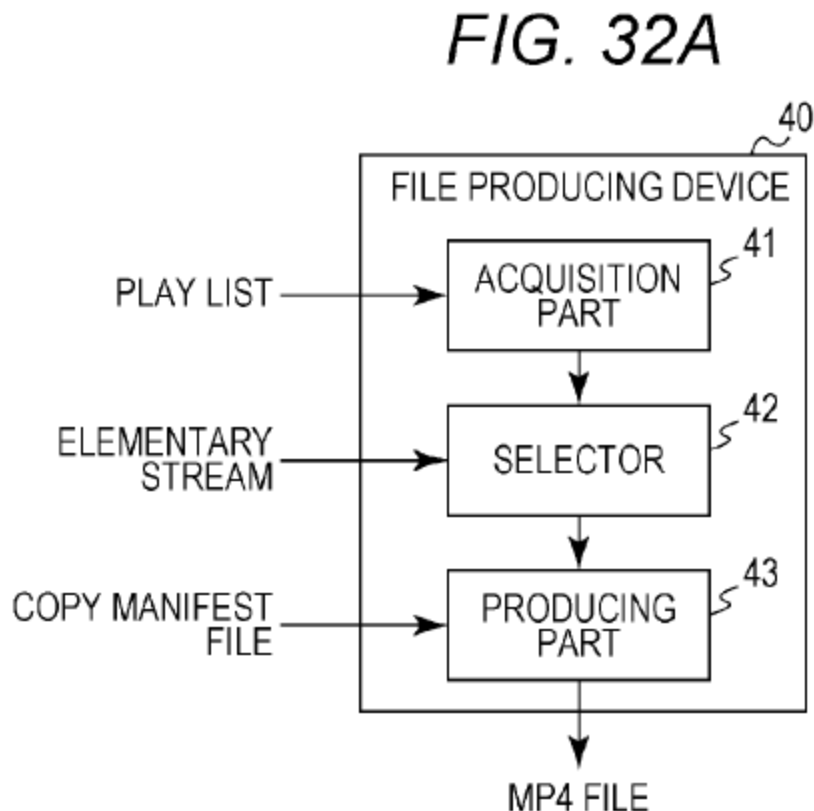
1. Claim 5

249. In the resulting combination of Toma446 with Drugeon, Toma446 provides the MP4 storage framework for storing HDR image data and HDR image metadata, including luminance data for the HDR video, and Drugeon provides that the HDR metadata includes maximum average picture level information and dynamic-range information. Thus, the combined system stores HDR image data and corresponding HDR metadata in an MP4 file for use in HDR processing and conversion.

[5.pre] An information processing device, comprising:

250. To the extent the preamble is treated as an element, the combination of Toma446 and Drugeon discloses an information processing device. Toma446 is directed to a device that produces MP4 files, and it explains that its teachings can be embodied in a range of physical forms. Toma446 states that "general or specific embodiments may be implemented as a system, a method, an integrated circuit, a computer program, a storage medium, or any selective combination thereof." EX1007, 2:18-21; EX1009, 12, 27; EX1011, 55, 15, 30, 40-42. Toma446 then describes a specific device that carries out this file production. As shown in FIG.

32A, Toma446 discloses that “[f]ile producing device 40 [...] is a file producing device producing the MP4 file from the elementary stream, and file producing device 40 includes acquisition part 41, selector 42, and producing part 43.” EX1007, 37:33-51; EX1011, 48-49.



EX1007, FIG. 5; EX1011, 49. In my opinion, Toma446’s file producing device is an information processing device within the meaning of this element, because it is a device that receives video data and processes that data to produce an MP4 file. Although FIG. 32A does not appear in the Second Toma446 provisional application (EX1011), a POSITA would have recognized from the disclosures of EX1011 of a

device for generating MP4 files that EX1011 provides sufficient support for the portions of Toma446 that at least render obvious the claimed information processing device. EX1011, 55, 15, 30, 40-42, 48-49, 54. Indeed, discussion of MP4 technology and encoding throughout EX1011 indicates to a POSITA an information processing device as such technologies are rooted in computing systems.

[5.1] a data processing unit configured to:

251. Toma446 discloses that the operations of its file producing device are carried out by a data processing unit. Toma446 describes each functional block of its device, such as acquisition part 41, selector 42, and producing part 43, as a component realized by a shared processing element. Toma446 states that “[e]ach component may be constructed by a program executing part such as a CPU and a processor which reads and executes a software program recorded in the recording medium such as a hard disk and a semiconductor memory.” EX1007, 46:66-47:10. A POSITA would have understood from this disclosure that the functional “parts” Toma446 names are not separate physical machines but rather the operations of a common program-executing processor, that is, a data processing unit.

252. Toma446 confirms this understanding by describing the device as a unified computer system and by offering integrated hardware alternatives. Toma446 explains that “each of the devices is a computer system constructed with a microprocessor, a ROM, a RAM, a hard disk unit [...]” and that this microprocessor

“is operated according to the computer program, thereby implementing the function of each device.” EX1007, 47:33-43. Toma446 further teaches that “[a] part of or all the components constituting each of the devices may be constructed by one system LSI,” which it describes as a “super multi-function LSI that is produced by integrating a plurality of components on one chip.” EX1007, 47:44-53. A POSITA would have recognized from these teachings that Toma446’s acquisition, selection, and producing operations are performed by a single data processing unit, whether realized as a program-executing processor or as an integrated circuit that carries out those operations.

253. Furthermore, a POSITA would have recognized from the disclosures of EX1011 of a device for generating MP4 files, including computing operations that a POSITA would have recognized as being carried out by a processing device that performs processing and as such, these disclosures of EX1011 provides sufficient support for the portions of Toma446 that at least render obvious the claimed a data processing unit. EX1011, 55, 15, 30, 40-42, 48-49, 54. Indeed, discussion of MP4 technology and encoding throughout EX1011 indicates to a POSITA a data processing unit as such technologies are rooted in computing systems having data processing units.

254. Drugeon corroborates that a POSITA would have implemented these processing operations in exactly this way. Drugeon, addressing the same field of

generating and reproducing HDR video data, describes the structural elements of its own devices in the same terms, stating that “[e]ach of the structural elements may be realized by means of a program executing unit, such as a central processing unit (CPU) and a processor, reading and executing the software program recorded on a recording medium such as a hard disk or a semiconductor memory.” EX1012, [0153]; EX1013, 16-17. It is notable that Dugeon uses the phrase “program executing unit” to describe the very element that performs its data-generation operations, which maps directly onto the “data processing unit” recited in this element. Based on Toma446’s disclosure of a program-executing CPU and processor realizing each component of its file producing device, and Dugeon’s parallel disclosure of a program executing unit performing the same class of operations, it is my opinion that the combination of Toma446 and Dugeon discloses a data processing unit configured to perform the operations recited in claim 5.

[5.2] generate an MP4 file that stores high dynamic range (HDR) image data;

255. The combination of Toma446 and Dugeon discloses generating an MP4 file that stores HDR image data. Toma446 discloses that its device generates the MP4 file itself. As I explained for Element [5.pre], above, Toma446’s producing part carries out this generation, and Toma446 states that “[p]roducing part 43 produces the MP4 file by converting the data included in the elementary stream into the MP4 file format based on the manifest file.” EX1007, 37:44-48; EX1011, 48-49.

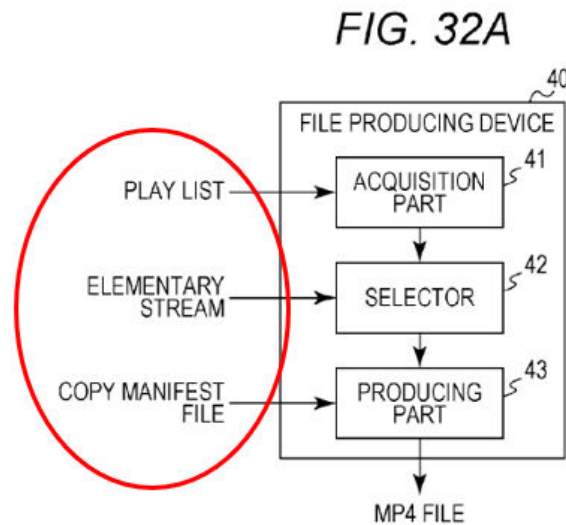
Toma446 further discloses that the video data stored in that MP4 file can be HDR video data. In its sixth modification of the fourth exemplary embodiment, Toma446 describes a storage example in which “the video data including luminance of a high luminance area exceeding a luminance range used in BT.709 standard (SDR: Standard Dynamic Range) called a HDR (High Dynamic Range) is stored in the MP4 file.” EX1007, 45:57-46:4; EX1011, 54 (“an example of storing video data with luminance levels beyond the range of the BT.709 standard (SDR: Standard Dynamic Range), known as HDR (High Dynamic Range), in an MP4 file”). In my opinion, Toma446’s generation of an MP4 file that stores this HDR video data satisfies this element, because the device produces the MP4 file and the video data it stores includes luminance in the HDR range.

***[5.3] acquire HDR image metadata associated with the HDR image data,
wherein***

256. The combination of Toma446 and Dugeon discloses acquiring HDR image metadata associated with the HDR image data. As I explained for Element [5.2], above, Toma446’s file producing device receives the elementary stream and converts its data into the MP4 file. EX1007, 37:44-48; EX1011, 48-49. Toma446 discloses that the luminance information for the HDR video is part of what is handled and stored in connection with that file. Toma446 explains that “the luminance information may be stored as the header information on the MP4,” and that “[t]he

HDR-related information may be stored as the meta-data managing the MP4 file, instead of being directly stored in the MP4 file,” EX1007, 46:21-41; EX1011, 54.

257. A POSITA would have understood that, in order to store this luminance information as metadata for the MP4 file it generates, the file producing device must first acquire that luminance information.



EX1007, FIG. 32A.

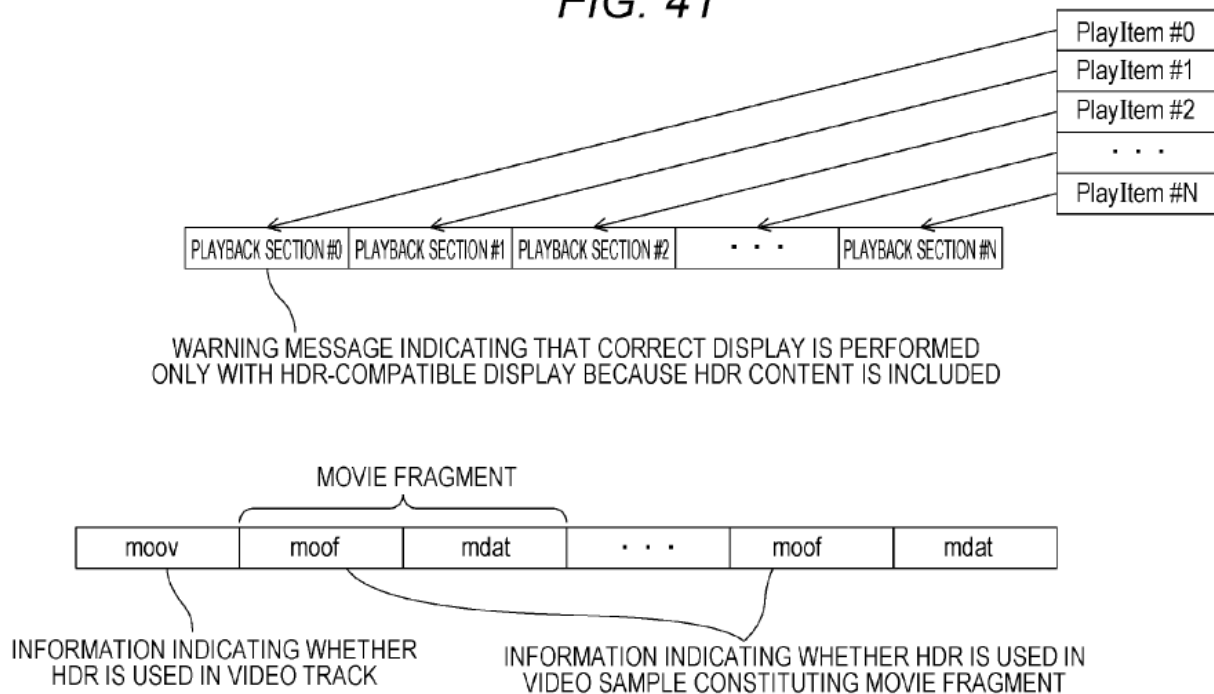
258. The luminance information describes the HDR video contained in the elementary stream, so when the device receives the elementary stream to produce the MP4 file, it acquires the associated HDR image metadata. Alternatively, even if the luminance information were supplied separately, it would have been obvious that the device acquires it, because the device could not store the luminance information as metadata without first obtaining it. On either understanding, it is my opinion that

the combination discloses acquiring HDR image metadata associated with the HDR image data as recited in this element.

[5.3.1] the HDR image data stored in the MP4 file is based on an MP4 format, and

259. The combination of Toma446 and Drugeon discloses that the stored HDR image data is based on an MP4 format. As I explained for Element [5.2] above, Toma446's device converts video data into the MP4 file format, and Toma446 describes its overall method as "converting the selected elementary stream into an MP4 file format." EX1007, 2:5-10; EX1011, 48-49. Toma446 illustrates the storage of HDR video data in this format. FIG. 41 of Toma446 shows "a storage example" for the HDR video data stored in the MP4 file, corresponding to the sixth modification in which the HDR video data "is stored in the MP4 file." EX1007, 45:57-46:4; FIG. 41; EX1011, 54 (FIG. 38 showing the same HDR-in-MP4 storage example).

FIG. 41



EX1007, FIG. 41; EX1011, 54. Because the HDR video data is stored in Toma446's MP4 file and is formatted according to the MP4 format, a POSITA would have recognized that the combination discloses that the HDR image data stored in the MP4 file is based on an MP4 format as recited in this element.

[5.3.2] the acquired HDR image metadata includes a maximum value of frame average luminance of the HDR image data stored in the MP4 file;

260. The combination of Toma446 and Drugeon discloses that the acquired HDR image metadata includes a maximum value of frame average luminance of the stored HDR image data. As I explained for Element [5.3] above, Toma446 stores luminance information as HDR metadata for the MP4 file, disclosing that "the luminance information may be stored as the header information on the MP4" and

that “[t]he HDR-related information may be stored as the meta-data managing the MP4 file.” EX1007, 46:21-22, 46:39-41; EX1011, 54. As I explained in the motivation to combine above, a POSITA would have included Dugeon’s maximum average picture level value among that luminance information.

261. Dugeon’s maximum average picture level value is a maximum value of frame average luminance. Dugeon describes storing “maximum average picture level information indicating a highest average luminance value among average luminance values of all pictures included in a video sequence.” EX1012, [0041]; EX1013, 16-17. Dugeon further defines the underlying quantity, explaining that “[t]he average picture level means the average value of pixel luminance expressed in percentage of the maximum luminance.” EX1012, [0092]; EX1013, 16 (“the average picture level being the average pixel luminance expressed in percentage of the maximum luminance”). A POSITA would have recognized that an average of pixel luminance taken across a picture is a frame average luminance, and that the highest such value among all pictures in the sequence is a maximum value of that frame average luminance. Dugeon also confirms that this value is acquired and stored on the generation side, disclosing that “encoder 112 may store, into the SEI [...] maximum average picture level information indicating the highest average luminance value among the average luminance values of all the pictures included in the video sequence.” EX1012, [0122]; EX1013, 16. In my opinion, the maximum

average picture level value that a POSITA would have stored as luminance metadata in Toma446's MP4 file is a maximum value of frame average luminance of the HDR image data, and the combination therefore discloses this element.

[5.4]-[5.5] set an HDR image metadata storage box in the MP4 file; and store the HDR image metadata in the set HDR image metadata storage box.

262. The combination of Toma446 and Dugeon discloses setting a metadata storage box in the MP4 file and storing the HDR image metadata in that box. Toma446 discloses that metadata for the MP4 file is stored in a dedicated box within the file. Toma446 describes information that "may be stored in a meta-data storing box in the MP4," and describes information "stored in the box indicating the meta-data of the MP4 file." EX1007, 34:7-11, 34:45-50; EX1011, 38-39 ("the Box used for metadata storage in MP4). As I explained for Elements [5.3] and [5.3.2] above, the HDR luminance information, including Dugeon's maximum average picture level value in the combination, is the metadata managing the MP4 file. EX1007, 46:39-41; EX1011, 54.

263. A POSITA would have stored that HDR luminance metadata in the metadata storing box that Toma446 discloses. Toma446 expressly contemplates combining its embodiments and modifications, stating "The exemplary embodiments and the modifications may be combined," and noting that "various changes of the exemplary embodiments and modifications [...] are also included" within its scope. EX1007, 48:25-34, 47:11-20; EX1011, 54. A POSITA reading

these teachings together would have stored the HDR luminance metadata described in Toma446's HDR implementation in the metadata storing box described elsewhere in Toma446. Alternatively, it would have been obvious to do so, because the metadata storing box is the disclosed structure of Toma446's MP4 file for holding exactly this kind of metadata, and the inventors of Toma446 expressly contemplated storing metadata there. In my opinion, the combination discloses setting an HDR image metadata storage box in the MP4 file and storing the HDR image metadata in that box, as recited in these elements.

2. *Claim 6*

[6] The information processing device according to claim 5, wherein the HDR image metadata further includes maximum luminance information of the HDR image data.

264. Claim 6 depends from claim 5 and adds the recitation that the HDR image metadata further includes maximum luminance information of the HDR image data. As I explained for Elements [5.pre] through [5.5] above, the Toma446-Drueon combination discloses every element of claim 5. The Toma446-Drueon combination also discloses the additional element of claim 6.

265. Toma446 discloses that the luminance information it stores as HDR metadata for the MP4 file includes a maximum luminance value for the HDR content. As I explained for Element [5.3.2] above, Toma446 adjusts the gamma curve during HDR playback “using luminance information, such as peak luminance

and a white-level luminance, which can be switched in units of streams or scenes.” EX1007, 46:16-20; EX1011, 54. Toma446 further discloses that this luminance information is stored as metadata for the MP4 file, stating that “the luminance information may be stored as the header information on the MP4,” and that “[t]he HDR-related information may be stored as the meta-data managing the MP4 file.” EX1007, 46:21-22, 46:39-41; EX1011, 54. A POSITA would have recognized that the peak luminance Toma446 identifies for its HDR content is a maximum luminance value of that content, because peak luminance is, by definition, the highest luminance level present. The peak luminance that Toma446 stores as metadata for the HDR content in the MP4 file is therefore maximum luminance information of the HDR image data.

266. Dugeon confirms that a maximum luminance value is a defining characteristic of HDR video that a POSITA would expect to be represented in HDR metadata. Dugeon explains that HDR “has been gaining attention as a scheme covering a luminance range with an increased maximum luminance value,” and that whereas SDR “has the maximum luminance value of 100 nit,” HDR “is expected to have an increased maximum luminance value of at least 1,000 nit.” EX1012, [0029]. A POSITA would have understood from Dugeon that the maximum luminance value distinguishes HDR video from SDR video, which reinforces that Toma446’s stored peak luminance for its HDR content is maximum luminance information of

the HDR image data. Drugeon goes on to disclose a “maximum luminance” value that would have been stored as metadata in the combination. EX1012, [0092], [0143] (“maximum value of L” where “L is the luminance of an image.”), [0029]; EX1013, 16-17. It is my opinion that the combination of Toma446 and Drugeon discloses the additional element of claim 6, and that claim 6 as a whole is therefore disclosed by the combination.

3. Claim 13

[13.pre] An information processing method comprising:

267. The preamble [13.pre] recites an information processing method that carries out the same generating, acquiring, setting, and storing operations recited in claim 5. Toma446 discloses that its teaching takes the form of such a method, describing itself as directed to “a file producing method for producing an MP4 file.” EX1007, 1:12-13; EX1011, 48-49. As I explained for preamble [5.pre] above, Toma446’s file producing device performs these operations, and a POSITA would have understood that the operations that device performs are the steps of the method claim 13 recites.

[13.1] in an information processing device:

268. As I explained for preamble [5.pre], above, Toma446’s file producing device is an information processing device, and its operations are performed within that device. EX1007, 37:33-51; EX1011, 48-49.

[13.2] generating, by a data processing unit of the information processing device, an MP4 file that stores high dynamic range (HDR) image data;

269. As I explained for Elements [5.1] and [5.2] above, Toma446's data processing unit generates the MP4 file, and the video data stored in that file is HDR image data. EX1007, 37:44-48, 45:57-46:4, 46:66-47:10, 47:33-53; EX1011, 48-49, 54; EX1012, [0153]; EX1013, 16-17. This element is disclosed for the reasons I gave for the corresponding operation in claim 5.

[13.3] acquiring, by the data processing unit, HDR image metadata associated with the HDR image data, wherein

270. I explained for Element [5.3] above, the data processing unit acquires the HDR image metadata associated with the HDR image data when it receives the elementary stream to produce the MP4 file. EX1007, 37:44-48, 46:21-22, 46:39-41; EX1011, 48-49, 54. This element is disclosed for the reasons I gave for the corresponding operation in claim 5.

[13.3.1] the HDR image data stored in the MP4 file is based on an MP4 format, and

271. As I explained for Element [5.3.1] above, the HDR image data stored in Toma446's MP4 file is formatted according to the MP4 format. EX1007, 2:5-10, 45:57-46:4; FIG. 41; EX1011, 48-49, 54. This element is disclosed for the reasons I gave for the corresponding element in claim 5.

[13.3.2] the acquired HDR image metadata includes a maximum value of frame average luminance of the HDR image data stored in the MP4 file;

272. As I explained for Element [5.3.2] above, the acquired HDR image metadata includes Drugeon's maximum average picture level value, which is a maximum value of frame average luminance of the HDR image data. EX1007, 46:21-22, 46:39-41; EX1011, 54; EX1012, [0041], [0092], [0122]; EX1013, 16-17. This element is disclosed for the reasons I gave for the corresponding element in claim 5.

[13.4]-[13.5] setting, by the data processing unit, an HDR image metadata storage box in the MP4 file; and storing, by the data processing unit, the HDR image metadata in the set HDR image metadata storage box.

273. As I explained for Elements [5.4]-[5.5] above, the data processing unit sets the HDR image metadata storage box in the MP4 file and stores the HDR image metadata in that box. EX1007, 34:7-11, 34:45-50, 48:25-34; EX1011, 38-39, 54. These elements are disclosed for the reasons I gave for the corresponding operations in claim 5. Because every step of claim 13 is disclosed by the combination of Toma446 and Drugeon for the reasons given for claim 5, it is my opinion that claim 13 as a whole is disclosed by the combination.

4. Claim 15

[15.pre] A non-transitory computer-readable medium having stored thereon computer-executable instructions that, when executed by a processor of an

information processing device, cause the processor to execute operations, the operations comprising:

274. Claim 15 recites a non-transitory computer-readable medium storing computer-executable instructions that, when executed by a processor, cause the processor to perform the same generating, acquiring, setting, and storing operations recited in claim 5. Toma446 discloses that its file producing operations are implemented as a software program stored on a recording medium and executed by a processor. As I explained for [5.1] above, Toma446 states that “[e]ach component may be constructed by a program executing part such as a CPU and a processor which reads and executes a software program recorded in the recording medium such as a hard disk and a semiconductor memory.” EX1007, 46:66-47:10; *see also* EX1012, [0153]; EX1013, 16-17.

275. Toma446 expressly discloses storing that software program on a computer-readable recording medium. Toma446 states that “[t]he present disclosure may be one in which the computer program or the digital signal is recorded in a computer-readable recording medium such as a flexible disk, a hard disk, a CD-ROM, a Blu-ray disc, and a semiconductor memory.” EX1007, 48:1-7. Toma446 further discloses that this software carries out the claimed operations, explaining that “the software implementing the file producing device of the above exemplary embodiments and modifications causes a computer to perform each step included in the flowcharts in FIGS. 8, 17, 22B, 22D, and 32B.” EX1007, 46:66-47:10. Drugeon

corroborates this implementation approach, disclosing that its structural elements “may be realized by means of a program executing unit, such as a central processing unit (CPU) and a processor, reading and executing the software program recorded on a recording medium such as a hard disk or a semiconductor memory.” EX1012, [0153]; EX1013, 16-17. A POSITA would have recognized that a recording medium storing Toma446’s file producing software is a non-transitory computer-readable medium storing computer-executable instructions that, when executed by a processor, cause the processor to perform the recited operations.

276. A POSITA would have recognized from the disclosures of EX1011 of a device performing computer operations that generate MP4 files that EX1011 provides sufficient support for the portions of Toma446 that at least render obvious the claimed non-transitory computer-readable medium storing instructions. EX1011, 55, 15, 30, 40-42, 48-49, 54. Indeed, discussion of MP4 technology and encoding throughout EX1011 indicates to a POSITA an information processing device that executes computer instructions stored in a non-transitory computer-readable medium as such technologies are rooted in computing systems.

[15.1] generating an MP4 file that stores high dynamic range (HDR) image data;

277. As I explained for Element [5.2] above, execution of the stored instructions generates the MP4 file that stores HDR image data. EX1007, 37:44-48,

45:57-46:4; EX1011, 48-49, 54. This operation is disclosed for the reasons I gave for the corresponding operation in claim 5.

[15.2]“acquiring HDR image metadata associated with the HDR image data, wherein

278. As I explained for Element [5.3] above, execution of the stored instructions acquires the HDR image metadata associated with the HDR image data. EX1007, 37:44-48, 46:21-22, 46:39-41; EX1011, 48-49, 54. This operation is disclosed for the reasons I gave for the corresponding operation in claim 5.

[15.2.1] the HDR image data stored in the MP4 file is based on an MP4 format, and

279. As I explained for Element [5.3.1] above, the HDR image data stored in the MP4 file is based on an MP4 format. EX1007, 2:5-10, 45:57-46:4; FIG. 41; EX1011, 48-49, 54. This element is disclosed for the reasons I gave for the corresponding element in claim 5.

[15.2.2] the acquired HDR image metadata includes a maximum value of frame average luminance of the HDR image data stored in the MP4 file;

280. As I explained for Element [5.3.2] above, the acquired HDR image metadata includes Drugeon’s maximum average picture level value, which is a maximum value of frame average luminance of the HDR image data. EX1007, 46:21-22, 46:39-41; EX1011, 54; EX1012, [0041], [0092], [0122]; EX1013, 16-17. This element is disclosed for the reasons I gave for the corresponding element in claim 5.

[15.3]-[15.4] setting an HDR image metadata storage box in the MP4 file; and storing the HDR image metadata in the set HDR image metadata storage box.

281. As I explained for Elements [5.4]-[5.5] above, execution of the stored instructions sets the HDR image metadata storage box in the MP4 file and stores the HDR image metadata in that box. EX1007, 34:7-11, 34:45-50, 48:25-34; EX1011, 38-39, 54. These operations are disclosed for the reasons I gave for the corresponding operations in claim 5. Because every operation recited in claim 15 is disclosed by the combination for the reasons given for claim 5, and because Toma446 discloses (or at least renders obvious) storing the instructions that perform those operations on a non-transitory computer-readable medium, it is my opinion that claim 15 as a whole is disclosed by the combination.

XIV. GROUND 2B – CLAIM 7 IS OBVIOUS BASED ON TOMA446 IN VIEW OF DRUGEON AND SAEKI

A. A Person of Ordinary Skill in the Art Would Have Been Motivated to Apply Saeki to Toma446 and Drugeon, With a Reasonable Expectation of Success

282. As I explained in the motivation to combine for Ground 2A above, a POSITA would have combined Toma446 and Drugeon so that the resulting MP4 file stores HDR video data together with HDR luminance metadata, including Drugeon's maximum average picture level value. A POSITA would have further applied Saeki to that Toma446-Drugeon combination so that the resulting MP4 file

uses the metadata protection structure Saeki describes, including storing metadata in a metadata box within a trak box of the MP4 file. A POSITA would have been prompted to make such a modification to the Toma446-Drugeon combination based on Saeki's suggestions for the same reasons I discussed in Ground 1C above, and a POSITA would have had a reasonable expectation of success in doing so.

283. As a first reason, Saeki's techniques would have improved the security and integrity of the metadata stored in the Toma446-Drugeon MP4 file. Saeki is directed to detecting tampering with metadata, and it explains that its methods and data structures process metadata in media files "so that an alteration or falsification of the metadata can be detected." EX1027, [0009]-[0010], [0026]. Saeki accomplishes this using verification values that a receiving device can check, disclosing that "[t]hese hash values and digital signatures can be used by the client 18 to authenticate the metadata 24." EX1027, [0026]. Saeki describes these as needed protections, explaining that "an improved method and data structure of protection mechanisms are desirable to accomplish delivery of protected data or content." EX1027, [0008]; see also EX1027, [0034] ("a data structure for securing metadata"), [0067]. A POSITA would have recognized that applying these techniques to the Toma446-Drugeon MP4 file would have improved the accuracy and security of the HDR metadata stored in that file.

284. As a second reason, Saeki's approach would have conserved storage and processing resources relative to other contemporaneous content-protection techniques. Saeki explains that conventional digital rights management "usually encompasses a complex set of technologies and business models to protect digital media or other data." EX1027, [0003]; see also EX1027, [0002], [0004]. A POSITA would have understood that Saeki's metadata-protection technique is less complex to implement than such systems, and that using it in the Toma446-Druegon MP4 file would therefore have saved storage and processing resources.

285. As a third reason, Saeki's metadata-protection techniques would have helped prevent unauthorized copying of the protected content. Saeki explains that the ease of duplicating digital content "permits widespread distribution of unauthorized, duplicated content." EX1027, [0002]; see also EX1027, [0008]-[0010], [0025]. A POSITA would have recognized that applying Saeki's improved metadata protection to the Toma446-Druegon MP4 file would have helped guard against such unauthorized distribution.

286. As a fourth reason, Saeki's approach would have allowed some metadata to remain unencrypted while other metadata is protected, which a POSITA would have found desirable. Saeki explains that it is "desirable that potential users have access to this type of metadata," such as "the title of the work, the artist, and other information about the underlying audio-visual content itself," so that users can

“make a purchase decision, etc. prior to ordering and receiving a license with the associated decryption keys.” EX1027, [0006]. A POSITA would have recognized this selective-protection capability as a useful addition to the Toma446-Druegon MP4 file, in which luminance and other HDR metadata are stored.

287. As a fifth reason, because the Toma446-Druegon combination already stores the HDR video data and metadata in an MP4 file, a POSITA implementing that combination would naturally have consulted Saeki for additional details on how to structure metadata within an MP4 file. Saeki provides exactly that detail, describing “a data structure for securing metadata” in a modified MPEG-4 file. EX1027, [0034]-[0035]. A POSITA seeking to implement the Toma446-Druegon MP4 file most efficiently would have turned to Saeki’s disclosed MP4 metadata structure.

288. As a sixth reason, applying Saeki to the Toma446-Druegon combination amounts to using a known technique, Saeki’s data structure for securing MP4 metadata, in a known method, the Toma446-Druegon generation of an MP4 file that stores HDR video data and metadata, to yield the predictable result of an MP4 file whose metadata is protected in the manner Saeki describes.

289. A POSITA would have had a reasonable expectation of success in making this combination. Toma446, Druegon, and Saeki all address the handling of video media and its associated metadata in the MP4 file format, and a POSITA

would have turned to Saeki for additional useful teachings in that same field. Applying Saeki's metadata-protection structure to the Toma446-Drueon MP4 file would not have significantly altered or hindered the structure or function of Toma446's file-generation process; it would only have organized and protected the metadata that process already stores. Toma446 itself invites this kind of refinement, stating that "various changes of the exemplary embodiments and modifications conceivable by those skilled in the art and a combination of the components of the exemplary embodiments and modifications are also included in one or the plurality of aspects without departing from the scope of the present disclosure." EX1007, 47:11-20; EX1011, 54. Saeki's data structure for securing metadata is exactly the sort of known and beneficial variation that Toma446 anticipates.

B. Analysis

1. Claim 7

[7.pre]-[7.1] The information processing device according to claim 5, wherein the HDR image metadata storage box is in a trak box in the MP4 file, and

290. Claim 7 depends from claim 5 and adds the recitation that the HDR image metadata storage box is in a trak box in the MP4 file. As I explained for Elements [5.pre] through [5.5], above, the Toma446-Drueon combination discloses every element of claim 5. Applying Saeki to that combination discloses the additional trak-box element of claim 7.

291. For the reasons I explained for Element [3.2] in Ground 1C above, Saeki discloses that the metadata storage box in an MP4 data structure is located within a trak box. Saeki describes the arrangement of boxes in its MPEG-4 file, explaining that “[t]he moov box 64 encapsulates several other boxes, including [...] an audio track (‘trak’) box 74 and a video track (‘trak’) box 76.” EX1027, [0040]. Saeki further explains that “the audio and video track boxes 74, 76 contain other boxes which hold meta information on each media according to a type of the media included in the moov box 64.” EX1027, [0041]. A POSITA applying Saeki’s teaching to the Toma446-Druegon combination would have recognized that the HDR image metadata storage box that Toma446 describes, discussed above for claim 5, is located within one of these trak boxes in the resulting combination, as this element recites.

[7.2] the trak box stores metadata for application of an entire HDR image stored in the MP4 file.

292. The combination discloses that the trak box stores metadata for application of an entire HDR image stored in the MP4 file. As I explained for [5.3] and [5.3.2] above, Toma446 stores luminance information for the HDR video as metadata managing the MP4 file, disclosing that “[t]he HDR-related information may be stored as the meta-data managing the MP4 file, instead of being directly stored in the MP4 file.” EX1007, 46:39-41; EX1011, 54. As I explained for Element [5.3.2] above, that HDR metadata includes luminance information describing the

HDR image, such as Drugeon's maximum average picture level value. EX1007, 46:16-28; EX1011, 54.

293. Saeki confirms that a trak box stores this kind of metadata for the media it corresponds to. As I explained for [7.pre]-[7.1] above, Saeki discloses that "the audio and video track boxes 74, 76 contain other boxes which hold meta information on each media according to a type of the media included in the moov box 64." EX1027, [0041]. Saeki explains that this metadata governs the associated media data, stating that "[t]he media data is referenced and interpreted by the metadata boxes." EX1027, [0036]. Saeki further describes the purpose of these boxes, explaining that "user data boxes allow one to define and store data associated with an MPEG-4 object, such as a movie, track, or media." EX1027, [0042]. And Saeki explains that the metadata in a trak box pertains to that track's media in particular, disclosing that track-level user data "relates only to the particular track (e.g. audio or video)." EX1027, [0045].

294. A POSITA would have recognized that Saeki's meta information held "on each media" within a trak box, in the Toma446-Drugeon-Saeki combination, includes the HDR luminance metadata that applies to the entire HDR image stored in that track of the MP4 file. Because the trak box in the combination stores the HDR luminance metadata that governs the entire HDR image, and because that metadata is used to reproduce or convert that image, it is my opinion that the combination

discloses that the trak box stores metadata for application of an entire HDR image stored in the MP4 file, as this element recites. Claim 7 as a whole is therefore disclosed by the combination.

XV. CONCLUSION

295. The findings and opinions set forth in this declaration are based on my work and examinations to date.

296. I may continue my examinations. I may also receive additional documentation and other factual evidence over the course of this IPR that will allow me to supplement and/or refine my opinions. I reserve the right to add to, alter, or delete my opinions and my declaration upon discovery of any additional information. I reserve the right to make such changes as may be deemed necessary.

297. In signing this declaration, I recognize that the declaration will be filed as evidence in an IPR before the PTAB. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

APPENDIX A

Prof. Eli Saber

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EXPERIENCE

Computer Vision, Machine Learning, Digital Signal/Image/Video Processing, Video Compression and Coding

EDUCATION

Ph.D., Electrical Engineering, University of Rochester, Rochester, New York (March 1996)

Concentration: Signal/Image/Video Processing, Pattern Recognition, and Computer Vision.

Dissertation: Automatic image annotation and query-by-example using color, shape and texture information.

M.S., Electrical Engineering, University of Rochester, Rochester, New York (May 1992)

Concentration: Signal/Image/Video Processing, Pattern Recognition, Computer Vision, Communications.

B.S., Electrical and Computer Engineering, Summa Cum Laude, State University of New York at Buffalo, Buffalo, New York (May 1988).

Concentration: Computers, Microprocessors, Communications, Instrumentation.

A.S., Engineering Science, Mohawk Valley Community College, Utica, New York (May 1986)

CAREER MAJOR HIGHLIGHTS

❖ Academic Experience:

- **Teaching**: Taught/continue to teach undergraduate and graduate courses in the signal/image/video processing, computer vision, controls and communications focus areas with excellent feedback from students from 1996 to Present. Founded new coursework in Digital Video Processing and Pattern Recognition.
- **Research**: Conducted research on multiple acquired government and industry grants in the areas of: 1) image/video processing for multimedia, military and biomedical applications, 2) deep learning/artificial intelligence for object detection and tracking purposes, 3) three-dimensional scene reconstruction for remote sensing, and 4) color image processing for printing and multimedia applications. Graduated several PhD and MS students. Currently co-advising 2 PhD students.
- **External Funding**: Acquired external funding as PI in excess of \$3.5 Million and as PI/Co-PI in excess of \$5 Million over the period of September 2004 to present from government agencies and industry partners.
- **Publications**: 1 Book, 2 Special Issues, 38 Journal, 100 Conference and 11 Patents/Patent Publications.
- **Service**: Served/chaired several department, college and university level committees. Chaired the Graduate Program at the EE department for a period of five years. Served on the academic senate for a period of 9 years and on the Academic Senate Executive Committee for a period of 3 years.

❖ Industrial Experience: Worked for Xerox Corporation from 1988 until 2004 in a variety of engineering, managerial and scientific positions ending as Product Development Scientist and Manager.

❖ Consulting/Litigation Experience: Served as an expert in several patent and non-patent cases representing numerous companies. Provided declarations in support of multiple Inter Partes Reviews (IPR), expert opinions and reports with regards to validity/invalidity, infringement/non-infringement and domestic industry, tutorial at Markman hearing, multiple depositions, and multiple testimonies in court proceedings.

- ❖ **Professional Activities:** Served on several IEEE and SPIE conferences in various chair positions including Finance, Tutorials, Plenaries and Technical Program. Served as general chair for two conferences.
- ❖ **Honors & Awards:** RIT Trustees Award (2012), KGCOE Scholarship Award (2012), EME Gleason Professor (2011-2013), and PI Millionaire (2011).

RESEARCH INTERESTS

- Machine Learning for Imaging, Video and Remote Sensing Applications
- Image and Video Processing for Multimedia, Military & Biomedical Applications.
- Computer Vision and Three-Dimensional Scene Reconstruction.
- Color Image Processing for Printing and Multimedia Applications.

ACADEMIC EXPERIENCE

Professor (Associate 2004 – 2010, Full 2010 – Present), Department of Electrical and Microelectronic Engineering (EME), Kate Gleason College of Engineering (KGCOE), Rochester Institute of Technology.

Extended Faculty (2004 – Present), Center for Imaging Science (CIS), Rochester Institute of Technology.

Director of the Image, Video and Computer Vision Laboratory (2004 – Present)

Graduate Program Director (2010 – 2014)

- ❖ **Teaching:** Responsible for teaching undergraduate & graduate courses in Digital Signal Processing, Digital Image Processing, Digital Video Processing, Advanced Neural Network and Deep Learning, Engineering Analysis, Advanced Engineering Mathematics, Random Signal & Noise, Pattern Recognition, Communication Systems, Digital Data Communications, Computer Vision, Modern Control Theory, Linear Systems, and Matrix Methods. Typically teaching two courses per semester. Have taught three per semester on occasion to fulfill department needs.
- ❖ **Research:** Director of the Image, Video and Computer Vision Laboratory. Currently co-advising 2 PhD and 2 MS students on deep learning/machine learning/artificial intelligence applications for object detection and tracking. Advised several PhD and MS students in image/video segmentation, hierarchical image decomposition, video mosaicking/3-dimensional scene reconstruction, image/video understanding, object tracking/recognition. All students are/were funded under various government or corporate grants.
- ❖ **Funding:** Acquired funding as PI in excess of \$3.5 Million and as PI/Co-PI in excess of \$5 Million over the period of September 2004 – Present from various government agencies and industrial partners.
- ❖ **Service (Department, College and University):**
 - ❖ Advised/currently advising several undergraduate and graduate students on curriculum issues.
 - ❖ Member of the Academic Senate Resource Allocation and Budget Committee, the University Compensation Committee and of the Kate Gleason College of Engineering Promotion Committee.
 - ❖ Former Member (KGCOE representative) of the Academic Senate (2007 – 2013 and 2014-2017) and of the Academic Senate Executive Committee (2009-2010, 2016-2017).
 - ❖ Served as Chair of the RIT Vision 2025 committee per request from RIT President Dr William Destler. Committee was commissioned, over the summer of 2009, to review 80+ ideas submitted from all colleges and provide a recommendation to upper administration.
 - ❖ Former Member and Chair of KGCOE graduate committee.
 - ❖ Former Member of Graduate Council.
 - ❖ Served on several committees for curriculum development, recognition, and faculty search.

❖ **Professional Activities:**

- ❖ Senior member of the Institute of Electrical and Electronic Engineers (IEEE) society.
- ❖ Former Member of the IEEE Industry Technical Committee on DSP.
- ❖ Former Member of the IEEE Image and Multidimensional Digital Signal Processing (IMDSP) technical Committee.
- ❖ Former Area Editor for the Journal of Electronic Imaging.
- ❖ Former member of the Imaging Science and technology (IS&T) society.
- ❖ International Conference on Image Processing (ICIP) 2002 Finance Chair, ICIP 2007 and ICIP 2009 Tutorial Chair, ICIP 2012 General Chair, ICASSP 2017 Technical Program Chair, ICIP 2021 Plenary Chair.
- ❖ Co-founder and General Chair of the Video Surveillance and Transportation Imaging Conference within the Electronic Imaging Symposium.

❖ **Honors and Awards:**

- ❖ Awarded the Prestigious Trustees Scholarship award – the highest award at RIT with regards to research recognition
- ❖ Elected in 2011 as PI Millionaire.
- ❖ Awarded the EME Gleason Professor for 3 years (2011-2013).
- ❖ Elected as the Kate Gleason College of Engineering Scholarship award winner.

Adjunct Faculty Member, Dept. of Electrical & Computer Engineering, University of Rochester. (09/96-07/04)

- ❖ Taught undergraduate & graduate courses in Digital Signal Processing, Digital Image Processing, Pattern Recognition/Advanced Image Processing, Detection/Estimation Theory, and Analog & Digital Communications.
- ❖ Advised and graduated 1 Ph.D. student in the areas of “Image Understanding” and “Database Content Indexing”.
- ❖ Co-advised 1 Ph.D. student in the areas of “Watermarking”.
- ❖ Advised and graduated 1 MS student in the area of “Color Rendering” and “Printer Characterization”.
- ❖ Served as a committee member on several doctoral dissertations.
- ❖ Served on PhD qualifying examinations for the Signal Processing and Communications Concentration.
- ❖ Sought and captured funding from the National Science Foundation for the development of an intelligent image database system. Proposal funded for 4 years under NSF Grant IIS – 9820721
- ❖ Sought and captured industrial funding from Xerox Corporation for Printer Color Characterization & Digital Front End Object Oriented Rendering.

Adjunct Faculty Member, Dept. of Electrical Engineering, Rochester Institute of Technology. (03/98-07/04)

- ❖ Taught undergraduate and graduate courses in Pattern Recognition, Digital Video Processing, Random Signal & Noise, Image and Video Compression, and Communications.
- ❖ Advised and graduated a master student in the area of “Texture Classification”.

INDUSTRIAL EXPERIENCE

Product Development Scientist & Manager, Print Engine Development Unit, Xerox Corporation. (10/98-08/04)

Major responsibilities included:

- ❖ Lead the Image Science, Analysis and Evaluation area (12-15 direct reports and ~\$2 Million budget).
- ❖ Lead the development of highlight color specifications for the Sorrento print engine.
- ❖ Lead the development of color characterization algorithms for the iGen3 print engine.
- ❖ Lead the image quality integration of two color front end for the iGen3 Product.
- ❖ Lead the development of ROS and LED based imaging systems and image path architectures for upcoming highlight & full color products.
- ❖ Lead the development of xerographic hardware/algorithms & imaging systems for the DP92C highlight color product. (Product launched 9/30/99 and follow-on launched 4/20/00)
- ❖ Lead the research and development of image quality metrics for various product platforms and their dissemination throughout the Print Engine Development Unit and Xerox Corporation.

- ❖ Collaborate with the Department of Electrical & Computer Engineering (Univ. of Rochester) & the Center for Electronic Imaging Systems.

Advanced Development Scientist and Manager, Print Cartridge Delivery Unit, Xerox Corporation. (2/97 – 9/98)

Major responsibilities included:

- ❖ Establish the Advanced Design Laboratory (an imaging/xerographics lab) and provide technical and managerial leadership for the Electrical, Imaging and Xerographics Dept.
- ❖ Perform image processing and xerographic hardware/software design and development for low/mid volume color copiers and printers for current and future programs.
- ❖ Perform technology development, modeling, and product design for upcoming Xerox color products, specifically image on paper and image on belt products..
- ❖ Lead the development of the xerographic module for a color intermediate belt transfer product with direct technical and management responsibilities.
- ❖ Collaborate with the Department of Electrical & Computer Engineering (Univ. of Rochester) & the Center for Electronic Imaging Systems.

Research and Development Scientist, Production Systems Group, Xerox Corporation. (1/96-1/97)

Major responsibilities included:

- ❖ Lead the design and development of color characterization/management and image quality algorithms and specifications for digital front ends destined to drive high quality, high speed color print engines.
- ❖ Integrate color management & image processing algorithms into the Raster Image Processing module.
- ❖ Participate in the design and development of a high speed raster image processing architecture.
- ❖ Benchmark developed algorithms against existing products & systems both internally and externally.
- ❖ Collaborate with the Department of Electrical & Computer Engineering of the University of Rochester and the Center for Electronic Imaging Systems.

Research and Development Engineer, Corporate Research, Xerox Corporation (8/93-12/95) & Department of Electrical & Computer Engineering, University of Rochester. (1/95-12/95). Major responsibilities included:

- ❖ Design and develop query by image content and query by example image annotation algorithms utilizing color, shape, texture and motion cues. System is able to perform query by keywords, color, shape, texture, and/or a combination of the above cues.
- ❖ Design and develop intelligent image segmentation algorithms. These algorithms are currently utilized in the query by image content and query by example systems described above.
- ❖ Design and develop face detection and facial feature extraction approaches.
- ❖ Design and develop color characterization/calibration and image quality algorithms for Digital Front Ends aimed at driving high speed / high quality print engines.

(Note: Image annotation/content analysis research was done in conjunction with the Department of Electrical & Computer Engineering and Center for Electronic Imaging Systems leading to the Ph.D.)

Electronic, Computer and Instrumentation Engineer, New Toner/Developer Facility Engineering, Xerox Corporation. (6/88-7/93). Major responsibilities included:

- ❖ Provide design, development, installation, startup, and training for multiple toner production facilities.
- ❖ Provide development and implementation of control system database, software and displays for several systems.
- ❖ Evaluate vendor supplied electrical specifications and drawings.
- ❖ Manage and coordinate the efforts of technicians, electrical support, construction crew, and industrial workforce during the design, construction, startup, and implementation phases.
- ❖ Supervise and complete a number of upgrade projects for toner & photoreceptor production including software development, preparation of electrical design, procurement of necessary equipment and parts, supervision of technicians, contractors and industrial workforce, and scheduling of construction.

During this time, I gained extensive experience in the following systems: Fisher distributive control, unit operation controller, Provue console, Acrison material handling, Werner and Pfleiderer extrusion, Alpine air grinding, Majac/Micropul centrifugal classifiers, dry/wet material screening, Waeschle and others bulk powder storage and pneumatic convey, Ingersoll Rand and Joy compressed air equipment, Statistical process control.

CONSULTING EXPERIENCE

Expert on Legal Cases: Served as an expert in several patent and non-patent cases representing numerous companies. Provided declarations in support of multiple Inter Partes Reviews (IPR), expert opinions and reports with regards to validity/invalidity, infringement/non-infringement and domestic industry, tutorial at Markman hearing, multiple depositions, and multiple testimonies in court proceedings.

Summary of Experience:

- IPR/Declarations: Provided declarations in support of multiple IPR proceedings.
- Depositions: Provided multiple depositions.
- Court Testimony: Testified in International Trade Commission Court in Sept. 2018, Oct. 2019 and Sept. 2024
- Expert Opinions: Provided multiple expert opinions and reports in support of validity/invalidity, infringement/non-infringement, domestic industry and rebuttals.
- Claim Construction: Provided reports in support of claim construction.
- Hearings: Attended one Markman hearing and provided a brief technology tutorial.

Industrial Training: Developed and conducted industrial training at Xerox Corporation for engineering personnel over three separate summer periods in the areas of signal and image processing, color engineering, and control systems with a distinct focus on digital front ends and print engines. I have also provided pattern recognition/shape matching expertise for Leica corporation.

BOOKS

1. S. Dianat and E. Saber, “Advanced Linear Algebra for Engineers with MATLAB”, CRC press, February 2009.

SPECIAL ISSUES

1. H. J. Trussell, E. Saber and M. Vrhel, “Color Image Processing”, IEEE SP magazine, January 2005.
2. R. Loce and E. Saber, “Video Surveillance and Transportation Imaging”, Journal of Electronic Imaging, 22(4), Dec. 2013

PEER-REVIEWED JOURNAL PUBLICATIONS

1. M. Sharma, J. Heard, E. Saber and P. Markopoulos, “Convolutional Neural Network Compression via Dynamic Parameter Rank Pruning”, IEEE access Journal, January 2025.
2. S. Singh, E. Saber, P. Markopoulos and J. Heard, “Regulating Modality Utilization within Multimodal Fusion Networks”, Multidisciplinary Digital Publishing Institute (MDPI) Sensors – Special Issue: Deep Learning Methods for Aerial Imagery, Sept. 2024
3. M. Sharma, M. Dhararaj, S. Karnam, D. Chachlakis, R. Ptucha, P. Markopoulos and E. Saber, “YOLOrs: Object Detection in Multimodal Remote Sensing Imagery”, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, Vol. 14, 2020.
4. S. Piramanayagam, E. Saber, and N. Cahill, “Gradient Driven Unsupervised Video Segmentation using Deep Learning Techniques”, Journal of Electronic Imaging, 29 (1), 013019, 2020
5. U. Gewali, S. Monteiro and E. Saber, “Spectral Super-Resolution with Optimized Bands”, Remote Sensing, 11(14), 2019

6. U. Gewali, S. Monteiro and E. Saber, "Gaussian Processes for Vegetation Parameter Estimation from Hyperspectral Data with Limited Ground Truth", *Journal of Remote Sensing*, 11(13), 2019.
7. Y. Liang, P. Markopoulos and E. Saber, "Spatial-Spectral Segmentation of Hyperspectral Images for Subpixel Target Detection", *Journal of Applied Remote Sensing*, 13(3), 2019.
8. Y. Liu, S. Piramanayagam, S. Monteiro, and E. Saber. "Semantic segmentation of multisensor remote sensing imagery with deep ConvNets and higher-order conditional random fields." *Journal of Applied Remote Sensing* 13, no. 1 (2019): 016501
9. U. Gewali, S. Monteiro and E. Saber, "Machine Learning Based Hyperspectral Image Analysis : A Survey", *arXiv preprint*, 2018.
10. S. Piramanayagam, E. Saber, W. Schwartzkopf, F.W. Koehler, "Supervised Classification of Multisensor Remotely Sensed Images using a Deep Learning Framework", *Remote Sensing Journal*, 10 (9), 2018.
11. S. R. Vantaram, Y. Hu, E. Saber and S. Dianat, "Synthesis of Intensity Gradient and Texture Information for Efficient Three-Dimensional Segmentation of Medical Volumes", *Journal of Medical Imaging* 2, no. 2 (2015): 024003-024003.
12. S. R. Vantaram, S. Piramanayagam, E. Saber and D. Messinger, "Spatial Segmentation of Multi/Hyperspectral Imagery by Fusion of Spectral-Gradient-Textural Attributes", *Journal of Applied and Remote Sensing*, Vol. 9, No. 1, pp. 095086 (1-37), 2015.
13. S. R. Vantaram and E. Saber, "A Survey of Contemporary Trends in Color Image Segmentation", *Journal of Electronic Imaging*, 21(4), 040901, Oct-Dec 2012.
14. M. S. Erkilinc, M. Jaber, E. Saber, "Text, Photo and Line Extraction in Scanned Documents", *Journal of Electronic Imaging*, Vol. 21, 033006, July 2012.
15. T. Keane, E. Saber, H. Rhody, A. Savakis and J. Raj, "Practical Image Registration Concerns Overcome by the Weighted and Filtered Mutual Information Metric", *Journal of Electronic Imaging*, Vol. 21(2), 023029, June 2012.
16. P. Gurram, E. Saber and H. Rhody, "Semi-automated System for three-dimensional Modeling of Buildings from Aerial Video", *Journal of Electronic Imaging*, Vol. 21(1), 013007, Jan-Mar 2012.
17. M. Jaber and E. Saber, "Probabilistic Approach for Extracting Regions of Interest in Digital Images", *Journal of Electronic Imaging*, Vol. 19, No. 2, April - June 2010.
18. X. Fan, H. Rhody and E. Saber, "A Spatial Feature Enhanced MMI Algorithm for Multimodal Airborne Image Registration", *IEEE Transaction on Geoscience and Remote Sensing*, Vol. 48, Issue 6, pp. 2580 – 2589, 2010.
19. P. Gurram, E. Saber and H. Rhody, "A Segment-Based Mesh design for Building Parallel-Perspective Stereo Mosaic", *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 48, No. 3, March 2010.
20. S. Vantaram, E. Saber, S. Dianat, M. Shaw and R. Bashkar, "Multiresolution Adaptive and Progressive Gradient-based color image Segmentation", *Journal of Electronic Imaging*, Volume 19, Number 1, pp. 1-21, January-March 2010.
21. L. Garcia, E. Saber, S. Vantaram, V. Amuso, M. Shaw and R. Bhaskar, "Automatic Image Segmentation by Dynamic Region Growth and Multi-resolution Merging", *IEEE Transactions on Image Processing*, Vol. 18, No. 10, Oct. 2009.
22. H. Santos, E. Saber, and W. Wu, "Streak Detection in Mottled and Noisy Images", *Journal of Electronic Imaging*, Vol. 16, No. 4, 2007.
23. O. Ugbeme, E. Saber and W. Wu, "An Automated Algorithm for the Identification of Artifacts in Mottled and Noisy Images", *Journal of Electronic Imaging*, Vol. 16, No. 3, 2007.
24. V. Misic, V. Sampath, Y. Yu and E. Saber, "Prostate Boundary Detection and Volume Estimation Using TRUS Images for Brachytherapy Applications", *International Journal of Computer Assisted Radiology and Surgery*, Vol. 2, No. 2, pp. 87-98, August 2007.
25. A. Ononye, A. Vodacek and E. Saber, "Towards Automatic Extraction of Fire Line Parameters from Multispectral Infrared Images", *Journal of Remote Sensing of Environment*, Vol. 108, pp. 179 – 188, 2007.
26. E. Saber, S. Dianat and L. Mestha, "DSP utilization in Digital Color Printing", *IEEE SP Magazine*, July 2005.
27. E. Saber, Y. Xu, and A. M. Tekalp, "Partial Shape Recognition by sub-matrix matching for partial matching guided image labeling", *Pattern Recognition*, Vol. 38, pp. 1560 – 1573, 2005.
28. M. Celik, G. Sharma, A. M. Tekalp, E. Saber, "Lossless Generalized-LSB Data Embedding", *IEEE Trans. on Image Processing*, Vol. 14, No. 2, pp. 253 – 266, February 2005.

29. M. Vrhel, E. Saber, and H. J. Trussell, "Color Image Generation and Display Technologies: An overview of methods, devices, and research", IEEE Signal Processing Magazine, January 2005.
30. H. J. Trussell, E. Saber and M. Vrhel, "Color Image Processing: Basics and Special Issue Overview", IEEE Signal Processing Magazine, January 2005.
31. Y. Xu, E. Saber, and A. M. Tekalp, "Dynamic Learning from Multiple Examples for Semantic Object Segmentation and Search", Computer Vision and Image Understanding, Vol. 95, No. 3, pp. 334-353, Sept 2004.
32. Y. Xu, P. Duygulu, E. Saber, A. M. Tekalp, and F. T. Yarman-Vural, "Object-Based Image Labeling through Learning by Example and Multi-Level Segmentation", Pattern Recognition, Vol. 36 (6), pp. 1407-1423, June 2003.
33. Y. Xu, E. Saber, and A. M. Tekalp, "Object Segmentation and Labeling by Learning from Examples", IEEE Transactions on Image Processing, Vol. 12, No. 6, June 2003.
34. M. Celik, G. Sharma, E. Saber, and A. M. Tekalp, "Hierarchical watermarking for secure image authentication with localization", IEEE Trans. on Image Processing, vol. 11, no. 6, June 2002.
35. M. Xia, E. Saber, G. Sharma, and A. M. Tekalp, "End-to-End Color Calibration by Total Least Squares Regression", IEEE Transactions on Image Processing, Vol. 8, No. 5, May 1999.
36. E. Saber and A. M. Tekalp, "Facial Pattern Detection and Eye Localization using Color, Shape and Symmetry-Based Cost Functions", Pattern Recognition letters, Vol. 19, 1998.
37. E. Saber and A. M. Tekalp, "Integration of Color, Shape and Texture for Automatic Image Classification, Annotation and Retrieval", Journal of Electronic Imaging, Vol. 7, No. 3, July 1998.
38. E. Saber and A. M. Tekalp "Region-Based Affine Shape Matching for Automatic Image Annotation and Query-by-Example", Journal of Visual Communication and Image Representation, March 1997.
39. E. Saber, A. M. Tekalp, and G. Bozdagi, "Fusion of Color and Edge Information for Improved Segmentation and Edge Linking," Image and Vision Computing, Vol. 15, 1997.
40. E. Saber, A. M. Tekalp, R. Eschbach and K. Knox, "Automatic Image Annotation using Color Classification", Graphical Models and Image Processing, Volume 58, Number 2, March 1996.

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2. D. Velychko, S. Singh, P. Markopoulos, E. Saber, J. Heard, "Image Preprocessing and YOLO Architectures for Enhanced Small and Slow-Moving Object detection", Western NY Image and Signal Processing Workshop, 2024
3. S. Singh, P. Markopoulos, E. Saber, J. Lew and J. Heard, "Measuring Modality Utilization in Multi-Modal Neural Networks", 2023 IEEE Conference on Artificial Intelligence (CAI 2023), Santa Clara, CA.
4. S. Singh, M. Sharma, J. Heard, J. Lew, E. Saber and P. Markopoulos, "Multimodal Aerial View Object Classification with Disjoint Unimodal Feature Extraction and Fully-Connected-Layer Fusion", SPIE: Defense and Commercial Sensing 2023, Orlando, FL.
5. M. Sharma, P. P. Markopoulos, E. Saber, M. S. Asif, and A. Prater-Bennette, "Convolutional Auto-Encoder with Tensor-Train Factorization," Proc. International Conference on Computer Vision, (ICCV 2021), RLS-CV workshop.
6. M. Sharma, P. P. Markopoulos, and E. Saber, "YOLOrs-LITE: A Lightweight CNN for Real-time Object Detection in Remote Sensing," Proc. IEEE International Geoscience and Remote Sensing Symposium (IEEE IGARSS), Brussels, Belgium, July 2021.
7. M. Dhanaraj, M. Sharma, T. Sarkar, S. Karnam, D. Chachlakis, R. Ptucha, P. Markopoulos and E. Saber, "Vehicle Detection from Multi-modal Aerial Imagery using YOLOv3 with Mid-level Fusion", Big Data II: Learning, Analytics, and Applications, SPIE, April 2020.
8. Y. Liu, S. Piramanayagan, S. Monteiro and E. Saber, "Dense Semantic Labeling of Very High Resolution Aerial Imagery and LIDAR with Fully Convolutional Neural Networks and Higher Order CRFs", CVPR, 2017
9. Y. Liu, S. Piramanayagan, S. Monteiro and E. Saber, "Semantic segmentation of remote sensing data using Gaussian processes and higher order CFRs", IGARSS, Fort Worth, TX, July 2017.

10. Y. Liang, S. T. Monteiro, and E. Saber, "Gaussian processes for object detection in high resolution remote sensing images", IEEE International Conference on Machine Learning and Applications (ICMLA 2016), Anaheim, CA, December 2016.
11. S. Piramanayagam, W. Schwartzkopf, F.W. Koehler, E. Saber, "Classification of remote sensed images using random forests and deep learning framework", Proc. SPIE 10004, Image and Signal Processing for Remote Sensing XXII, 100040L, October 2016;
12. Y. Liang, S. T. Monteiro, and E. Saber, "Transfer learning for high resolution aerial image classification", to appear in IEEE Applied Imagery Pattern Recognition Workshop (AIPR 2016), Washington, D.C., October 2016.
13. Y. Liang, P. P. Markopoulos, and E. Saber, "Subpixel target detection in hyperspectral images with local matched filtering in SLIC superpixels", IEEE Workshop on Hyperspectral Image and Signal Processing: Evolutions in Remote Sensing (WHISPERS 2016), Los Angeles, CA, August 2016.
14. Y. Hu, S. Monteiro and E. Saber, "Super Pixel Based Classification using Conditional Random Fields for Hyperspectral Images", ICIIP 2016, Phoenix, AZ.
15. O. de Lima, S. Janakiraman, E. Saber, D. C. Day, M. Shaw, P. Bauer, R. S. Twede, and P. Lea, "Signature Line Detection in Scanned Documents", ICIIP 2016, Phoenix, AZ.
16. Y. Liang, P.P. Markopoulos, and E. Saber, "Subpixel Target Detection in Hyperspectral Images from Superpixel Background Statistics," IGARSS, Beijing, China, July 2016.
17. Y. Liu, S.T. Monteiro, and E. Saber. "Vehicle detection from aerial color imagery and airborne LiDAR data", IGARSS, Beijing, China, 2016.
18. Y. Wang, J. Mathew, E. Saber, D. Larson, P. Bauer, G. Kerby and J. Wagner. "Scanned Document Enhancement Based on Fast Text Detection," International Conference on Acoustics, Speech and Signal Processing, Shanghai, China, 2016
19. Y. Liu, S. Monteiro, and E. Saber, "An Approach for Combining Airborne LiDAR and High Resolution Aerial Color Imagery using Gaussian Processes", Proc. SPIE 9643, Image and Signal Processing for Remote Sensing XXI, Oct. 2015.
20. Y. Liang, N. Cahill, E. Saber and D. Messinger, "A Game-Theoretic Tree Matching Approach for Object Detection in High Resolution Remotely Sensed Images", Proc. SPIE 9643, Image and Signal Processing for Remote Sensing XXI, Oct. 2015.
21. Y. Hu, S. T. Monteiro and E. Saber, "Comparing Inference Methods for Conditional Random Fields for Hyperspectral Image Classification", *Workshop on Hyperspectral Image and Signal Processing: Evolution in Remote Sensing*, Tokyo, Japan, 2015
22. Y. Hu, N. Cahill, S. Monteiro, E. Saber and D. Messinger, "Dimensionality Reduction for Hyperspectral Imagery Classification in Conditional Random Fields", Proc. SPIE 9643, Image and Signal Processing for Remote Sensing XXI, Oct. 2015.
23. S. Piramanayagam, P. J. Cutler, W. Schwartzkopf, F.W. Koehler, E. Saber, "Application of gradient based image segmentation to SAR imagery", IGARSS, Milan, Italy, July 2015.
24. S. Piramanayagam, E. Saber, N. D. Cahill, and D. Messinger, "Shot Boundary Detection and Label Propagation for Spatio-Temporal Video Segmentation", SPIE/IS&T: Electronic Imaging Symposium, San Francisco, CA, Feb, 2015.
25. M. Yousefhusien, R. Easton, R. Ptucha, M. Shaw, B. Bradburn, J. Wagner, D. Larson and E. Saber, "Flatbed Scanner Simulation to Analyze the Effect of Detector's Size on Color Artifacts", SPIE/IS&T: Electronic Imaging Symposium, San Francisco, CA, Feb. 2015.
26. K. Shah, E. Saber and K. Verrier, "Improved Metrology of Implant Lines on Static Images of Textured Silicon Wafers using Line Integral Method", SPIE/IS&T: Electronic Imaging Symposium, San Francisco, CA, Feb. 2015.
27. Y. Hu, E. Saber, S. Monteiro, N. Cahill and D. Messinger, "Classification of Hyperspectral Images Based on Conditional Random Fields", SPIE/IS&T: Electronic Imaging Symposium, San Francisco, CA, Feb. 2015.
28. R. Kothari, E. Saber, M. Nelson, M. Stauffer and D. Bohan, "Image Enhancement for Low Resolution Display Panels", SPIE/IS&T: Electronic Imaging Symposium, San Francisco, CA, Feb. 2015.
29. Y. Liang, A. H. Syed, N. Cahill, E. Saber, and D. Messinger, "Application of Tree Matching Techniques to High Resolution Remotely Sensed Images toward Object Detection", GEOBIA, May 2014.
30. Y. Hu, A. H. Syed, E. Saber, N. Cahill, and D. Messinger, "Dynamic scale-space representation based on a MRF region merging model", GEOBIA, May 2014
31. Y. Liu, M. Helguerra and E. Saber, "Measurement of blood flow velocity in vivo video sequences with motion estimation methods", SPIE Medical Imaging, San Diego, 2014.

32. Y. Wang, O. F. de Lima, and E. Saber, "Improved edge directed Super resolution with hardware realization for surveillance, transportation, and multimedia applications", SPIE/IS&T: Electronic Imaging Symposium, San Francisco, CA, Feb. 2014.
33. J. Whitesell, D. Patru, E. Saber, G. Roylance and B. Larson, "Design for Implementation of Color Image Processing Algorithms", SPIE/IS&T: Electronic Imaging Symposium, San Francisco, CA, Feb. 2014
34. R. Toukatly, D. Patru, E. Saber, E. Peskin, G. Roylance and B. Larson, "Performance Analysis of a Color Space Conversion Engine Implemented using Dynamic Partial Reconfiguration", SPIE/IS&T: Electronic Imaging Symposium, San Francisco, CA, Feb. 2013.
35. O. De Lima, S. R. Vantaram, S. Piramanayagam, E. Saber and K. Bengtson, "An Edge Directed Super Resolution Technique for Surveillance and Printing Applications", SPIE/IS&T: Electronic Imaging Symposium, San Francisco, CA, Feb. 2013.
36. M. YousefHussien, K. Garvin, D. Dalecki, E. Saber and M. Helguera, "Three-Dimensional Volume Analysis of Vasculature in Engineered Tissues", SPIE/IS&T: Electronic Imaging Symposium, San Francisco, CA, Feb. 2013
37. A. Mykyta, D. Patru, E. Saber. G. Roylance and B. Larson, "Reconfigurable Framework for High-Bandwidth Stream-Oriented Data Processing", IEEE International SoC Conference (SOCC), Buffalo, NY, Sept. 2012.
38. S. R. Vantaram, and E. Saber, "Unsupervised Video Segmentation by Dynamic Volume Growing and Multivariate Volume Merging using Color-Texture-Gradient Features", *IEEE International Conference on Image Processing, Orlando, Florida, September 2012*.
39. A. H. Syed, E. Saber and D. Messinger, "Encoding of Topological Information in Multi-Scale Remotely Sensed Data: Applications to Segmentation and Object-Based Image Analysis", International Conference on geographic Object-Based Image Analysis (GEOBIA), Rio de Janeiro, May 2012. (Best paper Award)
40. S. Piramanayagam, E. Saber and D. Heavner, "Measurement of Glucose by Image Processing of Thin Film Slides", SPIE: Medical Imaging, San Diego, CA, 2012.
41. Y. Hu, E. Saber, S. Dianat, S. R. Vantaram and V. Abhyankar, "An Automatic Approach for 3D Registration of CT Scans", SPIE/IS&T: Electronic Imaging Symposium, San Francisco, CA, Jan. 2012
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44. S. R. Vantaram, and E. Saber, "A Method for Improved Localization of Edges in multi/hyperspectral Imagery", Proceedings of the SPIE Optical Engineering + Applications Conf., San Diego, CA, Aug. 2011.
45. M. Jaber, M. S. Bailly, Y. Wang, and E. Saber, "An image-set for identifying multiple regions/levels of interest in digital images," *Proceedings of the SPIE Optical Engineering + Applications Conference*, San Diego, CA, Aug. 2011.
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47. S. R. Vantaram, and E. Saber, "An Adaptive Bayesian Clustering and Multivariate Region Merging-based Technique for Efficient Segmentation of Color Images", IEEE International Conference on Acoustics, Speech and Signal Processing, Prague, Czech Republic, May 2011.
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49. M. Jaber and E. Saber, "Image Understanding Algorithm for Segmentation Evaluation and Region-of-Interest Identification using Bayesian Networks", SPIE Defense, Security, and Sensing, Orlando, Florida, Apr 2011.
50. T. Keane, E. Saber, H. Rhody, A. Savakis and J. Raj, "Unsupervised automated panorama creation for realistic surveillance scenes through weighted mutual information registration ", SPIE/IS&T: Electronic Imaging Symposium, San Francisco, CA, Jan. 2011.
51. M. S. Erkilinc, M. Jaber, E. Saber and R. Pearson, "Line and Streak Detection on Polished and textured Surfaces using Line Integrals", SPIE/IS&T: Electronic Imaging Symposium, San Francisco, CA, Jan. 2011.
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53. M. Jaber and E. Saber, "A Bayesian Network-Based Approach for Identifying Regions of Interest Utilizing Global Image Features," Proceedings of the SPIE Optical Engineering + Applications Conference, Vol. 7798, San Diego, CA, Aug. 2010.
54. M. Jaber, E. Saber, M. Shaw, J. Hewitt, "A robust and fast approach for multiple image components stitching," Proceedings of SPIE/IS&T: Electronic Imaging Symposium, San Jose, CA, Jan. 2010.
55. S. R. Vantaram, E. Saber, S. Dianat, M. Shaw and R. Bhaskar, "An Adaptive and Progressive Approach for Efficient Gradient-based Multi-resolution Color Image Segmentation", International Conference on Image Processing, Cairo, Egypt, November 2009.
56. S. Khullar, E. Saber, S. Dianat, J. Trask, R. Lawton, and M. Shaw, "Automatic Multi-resolution Spatio-Frequency Analysis for Print Mottle Evaluation", Proceedings of the SPIE: 17th Color Imaging Conference, Albuquerque, NM, November 2009.
57. P. Gurram, E. Saber, H. Rhody, "Automated 3d Object Identification Using Bayesian Network", AIPR workshop, Washington, D.C., October 2009.
58. X. Fan, H. Rhody and E. Saber, "A Novel Improvement for the HCL-MMI Multi-modal Image Registration by SIFT Algorithm", IEEE Western NY Image Processing Workshop, Sept. 2009.
59. M. Jaber, E. Saber, F. Sahin, "Extraction of Memory Colors Using Bayesian Networks", IEEE SMC International Conference on System of Systems Engineering, Albuquerque, NM, June 2009.
60. S. R. Vantaram, E. Saber, V. Amuso, M. Shaw, R. Bhaskar, "Unsupervised Image Segmentation by Automatic Gradient Thresholding for Dynamic region Growth in the CIE L*a*b* Color Space", SPIE/IS&T: Electronic Imaging Symposium, San Jose, CA, Jan. 2009.
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EXTERNAL FUNDING/FUNDED PROPOSALS

Proposals Funded while at RIT

- Acquired/continue to acquire funding with multiple grants from government agencies and corporate partners (Hewlett-Packard, Dataphysics, Lenel, Xerox) in excess of \$3.5 Million as PI and in excess of \$5 Million as PI/Co-PI (total Portfolio) since joining RIT. A complete statement listing the details of each grant can be provided upon request.

Proposals Funded prior to Joining RIT as an employee of Xerox Corporation and University of Rochester:

- A. M. Tekalp and E. Saber (co-PI), "An intelligent visual database system: Hierarchical content description and matching using integrated similarity metrics", funded for \$243K for four years at the University of Rochester by the National Science Foundation under NSF Grant IIS – 9820721.

HONORS AND AWARDS

- Awarded the Prestigious Trustees Scholarship award – the highest award at RIT with regards to research recognition (2012)

- Elected as the Kate Gleason College of Engineering Scholarship award winner (2012).
- Elected as Electrical and Microelectronic Engineering Gleason Professor for 3 years Fall 2011 – Summer 2014.
- Elected as PI Millionaire by RIT Sponsored research organization.
- Winner of an M.S./Ph.D. scholarship for graduate study from Xerox Corporation.
- Winner of the quality recognition award from Xerox Corporation for outstanding performance.
- Core member of a toner/developer facility engineering project team recognized as "The 1991 and 1993 team of the year" by the Delaware Valley Chapter of the Project Management Institute.
- Elected to the Electrical Engineering Honor Society, Eta Kappa Nu.
- Winner of Gibran Khalil Gibran Scholarship for outstanding academic achievements.
- Valedictorian of the Electrical and Computer Engineering Department at the University of Buffalo.
- Recipient of several prizes and awards from the University of Buffalo and the Mohawk Valley Comm. College for excellent academic achievements; and from Xerox Corporation for outstanding performance.

PROFESSIONAL ACTIVITIES

- Senior Member of the Institute of Electrical & Electronic Engineers.
- Member of the IEEE Signal Processing Society.
- Plenary Chair for ICIP 2021.
- Technical Program Chair for ICASSP 2017 in New Orleans.
- General Chair for ICIP 2012.
- Member of the IEEE Signal Processing society conference board for 3 year team starting January 2013.
- Tutorial chair for the International Conferences on Image Processing, ICIP 2007 and ICIP 2009.
- Special session chair on Color Image Processing for the European Signal Processing Conference, Sept. 2006.
- Finance Chair for the International Conference on Image Processing 2002 held in Rochester, NY.
- Former Area Editor for the Journal of Electronic Imaging.
- Guest Editor for the "Color Image Processing" issue of the Signal Processing Magazine.
- Associate Editor for the IEEE Transactions on Image Processing for five years. Term ended: April 2009.
- Former Associate Editor for the IEEE Signal Processing Magazine for DSP Applications Forum.
- Former Member of the IEEE Image & Multidimensional Digital Signal Processing Technical Committee.
- Former Member of IEEE Tech. Comm. on Industry DSP Technology in 2003 & 2004 & Chair for 2005, 2006.
- Technical program committee member for ICIP 2009 and prior ICIPs.
- Technical program committee member for ICASSP 2010 and prior ICASSPs.
- Session chair for several ICIP & ICASSP Conferences and Workshops.
- Chairman, vice-chairman, treasurer, and secretary of the IEEE Rochester Chapter of the signal processing society in 1998, 1997, 1996 and 1995 respectively.
- Reviewer for the IEEE Trans. on Image Processing, IEEE Trans. on Pattern Analysis and Machine Intelligence, Graphical Models and Image Processing, IEEE Trans. on Signal Processing, IEEE Signal Processing Letters, Color Research and Applications, Graphical Modeling and Image Understanding, Image and Vision Computing, Optical Engineering, Journal of Imaging Science and Technology, and the Journal of Electronic Imaging.
- Technical committee for Western New York Imaging Workshop in 1997 and 1999 and general chair in 1998.
- Co-Chair of the Xerox Electronic Image and Video Processing Technology Council.

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