

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TIKTOK INC.,

Petitioner,

v.

ADVANCED CODING TECHNOLOGIES LLC,

Patent Owner.

Patent No. 9,445,041

Filing Date: December 26, 2013

Issue Date: September 13, 2016

Inventor: Akiyoshi Jin

Title: MOVING IMAGE DATA PROCESSING APPARATUS AND MOVING
IMAGE DATA PROCESSING METHOD

DECLARATION OF DR. HARI KALVA

Case No. IPR2022-01548

I, Hari Kalva, Ph.D., declare as follows:

I. BACKGROUND AND QUALIFICATIONS

1. A copy of my curriculum vitae that summarizes my education, work history, and publications, is attached to this declaration as **Exhibit A**.

2. I am currently Associate Chair and Professor, as well as the Director of the Multimedia Laboratory of the Department of Electrical Engineering and Computer Science at Florida Atlantic University. I hold Ph.D. and Master of Philosophy degrees in Electrical Engineering from Columbia University, a Master of Science degree in Computer Engineering from Florida Atlantic University, and a Bachelor of Science degree in Electronics and Communications Engineering from N.B.K.R. Institute of Science and Technology, Sri Venkateswara University, Tirupati, India. I have over 30 years of experience in multimedia research, development, and standardization and am a named inventor on more than 18 standard essential patents that are used in virtually all modern video distribution and streaming products and services.

3. I have skills and experience in areas including video compression and video communication with an emphasis on perceptual video processing, MPEG video compression standards, and video analytics. Specifically, my research interests are in the areas of visual computing that considers the entire video pipeline – capture, compression, communication and applications in various domains. My work also

addresses enabling and optimizing visual computing targeting new applications areas and modalities such as AR/VR. One key area of focus is video processing targeting machine consumption. As another example, in the area of secure online file-sharing to the next level, I received a patent from the U.S. Patent and Trademark Office for a novel invention that controls how and when shared documents are displayed. This new technology offers new control mechanisms that limit opportunities for capturing information displayed on screens using an external capture device such as a camera. The system restricts individuals from viewing documents based on individual identity (*e.g.*, face ID, a voice sample), their social network, and when and where the document is being viewed.

4. Through a research partnership with OP Solutions, a Boston-based tech company, my inventions contribute to the novel technology that comprises the latest Versatile Video Coding (VVC) standard alongside some of the biggest companies in the world and has been jointly developed by the International Organization for Standardization (ISO) and the ITU Telecommunications Standardization Sector, which assembles experts from around the world to develop these standards.

5. In July 2022, I was elected to the rank of National Academy of Inventors® (NAI) Fellow for cutting-edge research and innovation in the field of video compression and communication.

6. I have received multiple funding awards to carry out research on

multimedia systems, for example:

- Technology development for Versatile Video Coding
- Personal Cloud for Research and Research-Related Education
- NSF I/UCRC Center for Knowledge Enablement

7. Based in part of this funding, my research in multimedia systems has led to a number of peer-reviewed publications, including:

- Parikh, S. and Kalva, H. (2020). Feature Weighted Linguistics Classifier for Predicting Learning Difficulty Using Eye Tracking. ACM Transactions on Applied Perception, Volume 17 Issue 2, May 2020 Article No.: 5pp 1–25<https://doi.org/10.1145/3380877>
- Parikh, S. S., Ruiz, D., Kalva, H., Fernández-Escribano, G., & Adzic, V. (2018). High bit-depth medical image compression with HEVC. IEEE journal of biomedical and health informatics, 22(2), 552-560.
- Jillani, R., Hussain, S.F., and Kalva, H., “Multi-View Clustering for Fast Intra Mode Decision in HEVC,” 2020 IEEE International Conference on Consumer Electronics (ICCE), 2020, pp. 1-4, doi: 10.1109/ICCE46568.2020.9043106.
- Ruiz, D., Fernández-Escribano, G., Adzic, V., Kalva, H., Martínez, J. L., & Cuenca, P. (2017). Fast CU partitioning algorithm

for HEVC intra coding using data mining. Multimedia Tools and Applications, 76(1), 861-894.

- Garcia, R.; Adzic, V.; Kalva, H., (2017). Adapting Low Bit Rate Skip Mode in Mobile Environment, Circuits and Systems for Video Technology, IEEE Transactions on, Vol. 27, No. 2, pp. 352-365, doi: 10.1109/TCSVT.2014.2365653.

8. I have prepared this Declaration as an expert witness retained by Advanced Coding Technologies LLC. In this Declaration, I provide my opinions as to whether the Challenged Claims of U.S. Patent No. 9,313,244 (the “’244 Patent”) are valid. I provide technical bases for these opinions as appropriate.

9. This Declaration contains statements of my opinions formed to date and the bases and reasons for those opinions. I may offer additional opinions based on further review of the materials in this proceeding, including opinions and/or testimony of other expert witnesses.

10. My time in this matter is being compensated at a customary rate of \$450 per hour. My compensation is not dependent upon the substance of the opinions I offer herein, the outcome of this proceeding, or any issues involved in or related the ’244 patent. I have no financial interest in, or affiliation with, any of the real parties in interest or the patent owner.

II. MATERIALS CONSIDERED

11. The materials I considered include the '041 patent and the prosecution history for the '041 Patent. I also considered the materials that I refer to and that I cite in this declaration.

12. I also considered all papers and exhibits filed in IPR2022-01548 including the petition and the declaration of David Lett.

13. I have also considered the Board's Decision on Institution (IPR2022-01548, Paper 7) in this proceeding.

14. I have also considered any exhibits attached to the Patent Owner's Response in this proceeding.

15. In addition, I have drawn on my experience and knowledge, as discussed above and described more fully in my CV.

III. LEGAL PRINCIPLES

16. I understand that a patent claim is unpatentable as "obvious" if the subject matter of the claim as a whole would have been obvious to a person of ordinary skill in the art as of the time of the invention at issue.

17. I understand that the use of the "person of ordinary skill" rubric is to prevent one from improperly, in the present day, using hindsight to decide whether a claim is obvious.

18. I understand that the following factors must be evaluated to determine

whether the claimed subject matter is obvious: (1) the scope and content of the prior art; (2) the difference or differences, if any, between the scope of the patent claim and the scope of the prior art; and (3) the level of ordinary skill in the art at the time of the invention.

19. I understand that, unlike anticipation, which allows consideration of only one item of prior art, obviousness may be shown by considering more than one item of prior art. I understand that, when considering a combination of prior art references as part of an obviousness analysis, it can be important to ascertain if the references are from the same field of endeavor and also to ascertain whether there is any reason that would have prompted a person of ordinary skill in the relevant art to combine the elements in the way the claim does. In other words, a claim generally cannot be rendered obvious by combining (i) art from across different fields, including outside the field of the claimed invention, or (ii) art that itself teaches away from combination with other art that would otherwise provide its missing limitations, or (iii) art for which there is not at least an articulable, common sense reason to bridge the gap between its disclosure and the claim at issue.

20. Moreover, I understand that so-called “objective indicia of nonobviousness,” also known as “secondary considerations,” are also to be considered when assessing obviousness. I understand that this objective evidence includes at least: the commercial success of the invention; the long felt but

unresolved need to develop the invention; any praise of the invention in the market; and copying by others. I also understand that evidence of objective indicia of non-obviousness must be commensurate in scope with the claimed subject matter; *i.e.*, that there must be a nexus or connection between the criteria and the claim itself.

21. I understand that the disclosure of an asserted prior art reference must provide an enabling disclosure of the desired subject matter and that mere naming or description of the subject matter is insufficient; to be enabling, I understand that it must be able to be produced without undue experimentation.

22. I understand that I must construe a claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and consistent with the prosecution history pertaining to the patent.

IV. LEVEL OF ORDINARY SKILL IN THE ART

26. I understand that I should perform my analysis from the viewpoint of a person of ordinary skill in the art. I understand that this hypothetical person of ordinary skill in the art is considered to have the normal skills of a person in a certain technical field. I understand that factors that may be considered in determining the level of ordinary skill in the art include: (1) the education level of the inventor; (2) the types of problems encountered in the art; (3) the prior art solutions to those problems; (4) rapidity with which innovations are made; (5) the sophistication of the technology; and (6) the education level of active workers in the field.

27. In my opinion, a person of ordinary skill in the art would have a Bachelor of Science degree in an academic discipline emphasizing the design of electrical, computer, or software technologies, in combination with experience with memory management technologies such as caching. I also agree that a person could also have qualified as a person of ordinary skill in the art with some combination of (1) more formal education (such as master's of science degrees) and less technical experience, or (2) less formal education and more technical or professional experience in the fields listed above.

28. My qualifications and experience exceed those of a person of ordinary skill in the art. Nonetheless, my analysis and opinions herein regarding the '244 patent are given from the perspective of a person of ordinary skill in the art.

V. CLAIM CONSTRUCTION

29. I have been informed by Counsel that, for purposes of my analysis in this *inter partes* review proceeding, claim terms should be given their ordinary and customary meaning within the context of the patent in which the terms are used, *i.e.*, the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention in light of what the patent teaches, unless it appears that the inventors were using them to mean something else. Additionally, the specification and prosecution history must be consulted to confirm whether the patentee has acted as his/her own lexicographer (*i.e.*, provided special meaning to

any disputed terms), or intentionally disclaimed, disavowed, or surrendered any claim scope).

30. I have further been informed by Counsel that a person of ordinary skill in the art is deemed to read a claim term not only in the context of the particular claim in which the disputed term appears, but also in the context of the entire patent, including the specification and the prosecution history. The prosecution file history provides evidence of how both the Patent Office and the inventors understood the terms of the patent, particularly in light of what was known in the prior art. Further, where the specification describes a claim term broadly, arguments and amendments made during prosecution may require a more narrow interpretation. For these reasons, the words of the claim must be interpreted in view of, and be consistent with, the entire specification. The specification is the primary basis for construing the claims and provides a safeguard such that correct constructions closely align with the specification. Ultimately, the interpretation to be given a term can only be determined and confirmed with a full understanding of what the inventors actually invented and intended to envelop with the claim as set forth in the patent itself.

31. I have further been informed by Counsel that, to determine how a person of ordinary skill would understand a claim term, one should look to those sources available that show what a person of skill in the art would have understood disputed claim language to mean. Such sources include the words of the claims

themselves, the remainder of the patent's specification, the prosecution history of the patent (all considered "intrinsic" evidence), and "extrinsic" evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art. I understand that one looks primarily to the intrinsic patent evidence, but extrinsic evidence may also be useful in interpreting patent claims when the intrinsic evidence itself is insufficient. Additionally, the context in which a term is used in the Asserted Claims can be highly instructive. Likewise, other claims of the patent in question, both asserted and not asserted, can inform the meaning of a claim term. For example, because claim terms are normally used consistently throughout the patent, the usage of a term in one claim can often illuminate the meaning of the same term in other claims. Differences among claims can also be a useful guide in understanding the meaning of particular claim terms.

32. I have further been informed by Counsel that, while intrinsic evidence is of primary importance, extrinsic evidence, *e.g.*, all evidence external to the patent and prosecution history, including expert and inventor testimony, dictionaries, and learned treatises, can also be considered. For example, technical dictionaries may help one better understand the underlying technology and the way in which one of skill in the art might use the claim terms. Extrinsic evidence should not be considered, however, divorced from the context of the intrinsic evidence. Evidence beyond the patent specification, prosecution history, and other claims in the patent

should not be relied upon unless the claim language is ambiguous in light of these intrinsic sources. Furthermore, while extrinsic evidence can shed useful light on the relevant art, it is less significant than the intrinsic record in determining the legally operative meaning of claim language.

33. I understand that a patent claim may be expressed using functional language. 35 U.S.C. § 112 ¶ 6 provides that a structure may be claimed as a “means . . . for performing a specified function” and that an act may be claimed as a “step for performing a specified function.” There is a rebuttable presumption that § 112 ¶ 6 applies when the claim language includes “means” or “step for” terms, and that it does not apply in the absence of those terms. The presumption stands or falls according to whether one of ordinary skill in the art would understand the claim with the functional language, in the context of the entire specification, to denote sufficiently definite structure or acts for performing the function.

34. When it applies, § 112 ¶ 6 limits the scope of the functional term to only the structure, materials, or acts described in the specification as corresponding to the claimed function and equivalents thereof. Construing a means-plus-function limitation involves multiple steps. The first step is a determination of the claimed function of the means-plus function limitation. The next step is to determine the corresponding structure disclosed in the specification and equivalents thereof. A structure disclosed in the specification is “corresponding” structure only if the

specification or prosecution history clearly links or associates that structure to the function recited in the claim. The focus of the “corresponding structure” inquiry is not merely whether a structure is capable of performing the recited function, but rather whether the corresponding structure is clearly linked or associated with the recited function. The corresponding structure must include all structure that actually performs the recited function. However, § 112 ¶ 6 does not permit incorporation of structure from the written description beyond that necessary to perform the claimed function.

35. For § 112 ¶ 6 limitations implemented by a programmed general purpose computer or microprocessor, the corresponding structure described in the patent specification must include an algorithm for performing the function. The corresponding structure is not a general purpose computer but rather the special purpose computer programmed to perform the disclosed algorithm.

36. I have been asked to provide my opinion on the terms noted below:

<u>Claim Term</u>	<u>Patent / Claim(s)</u>	<u>Patent Owner’s Proposed Construction</u>
“an input frame rate specification unit configured to specify the first frame rate of the first moving image data and the second frame rate of the second moving image data, the first and	'041 Patent Claim 1	Subject to 112 p. 6 Structure: Software algorithm that performs the steps of: • Receiving input moving image data • Specifying input frame rate • Transmitting specified

second moving image data having been input into the moving image data input unit”		input frame rate to frame rate conversion unit Function: specify the first frame rate of the first moving image data and the second frame rate of the second moving image data, the first and second moving image data having been input into the moving image data input unit ’041 Patent, 7:12-8:10; 13:63-15:19, FIGS. 1, 3, 4A, 4B, 4C, 5, 6, 9.
“an output frame rate specification unit configured to specify output frame rate of the first moving image data and output frame rate of the second moving image data that have been input into the moving image data input unit”	’041 Patent Claim 1	Subject to 112 p. 6 Structure: Software algorithm that performs the steps of: • Specifying variable frame rates for each of different moving image data • Transmitting specified output frame rates to frame rate conversion unit Function: specify variable output frame rate of the first moving image data and variable output frame rate of the second moving image data that have been input into the moving image data input unit ’041 Patent, 8:11-57, 11:46-12:60, 14:32-15:50, 16:65-17:14, Figs. 1, 6, 7A, 7B, 9

“specify[ing] [the] output frame rate”	'041 Patent Claims 1 and 4-6	“specify[ing] [the] variable output frame rate”
“a playback speed specification unit configured to specify a same playback speed for the first moving image data and the second moving image data”	'041 Patent Claim 1	Subject to 112 p. 6 Structure: Software algorithm that performs the steps of: • Specifying a same playback speed for the first moving image data and the second moving image data • Transmitting the specified playback speed to the frame rate conversion unit Function: specify a same playback speed for the first moving image data and the second moving image data '041 Patent, 8:58-9:17; 13:4-62, 14:24-15:26, 17:15-48. 18:36-19:43, FIGS. 1, 6, 8, 9.
“a frame rate conversion unit configured to change a frame rate of the first moving image data based on the first frame rate, the output frame rate, and the playback speed, and change a frame rate of the second moving image data based on the second frame rate, the output frame rate,	'041 Patent Claim 1	Subject to 112 p. 6 Structure: Software algorithm that performs the steps of: • Receiving specified input frame rate and specified output frame rate for each of the first and second moving image data and receiving specified playback speed for both the first and second moving image data • Converting input frame rate

and the playback speed”		to a frame rate that is output, for each of the first moving image data and second moving image data, based on the received specified input frame rates, specified output frame rates, and specified playback speed • Transmitting converted frame rate(s) to the moving image data output unit, for each of the first moving image data and second moving image data, to be output at the converted frame rate(s) Function: change a frame rate of the first moving image data based on the first frame rate, the output frame rate, and the playback speed, and change a frame rate of the second moving image data based on the second frame rate, the output frame rate, and the playback speed ’041 Patent, 9:18-26, 13:4-30, 14:23-15:26, FIGS. 1, 6.
“operating unit”	’041 Patent Claim 2	Subject to 112 p. 6 Structure: Buttons, dials, or equivalents thereof for accepting various inputs related to the moving image data Function: accept [an] input[s] ’041 Patent, 6:20-44; 8:20-39,

		9:38-10:53, 11:3-38, 11:61-12:29, 13:31-62, 15:11-50, 17:24-19:5, FIGS. 1-4C, 6.
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A. “an input frame rate specification unit configured to specify the first frame rate of the first moving image data and the second frame rate of the second moving image data, the first and second moving image data having been input into the moving image data input unit”

37. A person of ordinary skill in the art would find no specific structure disclosed in “an input frame rate specification unit configured to specify the first frame rate of the first moving image data and the second frame rate of the second moving image data, the first and second moving image data having been input into the moving image data input unit” or the rest of the claim, but rather a number of different ways that a person of ordinary skill in the art would understand to build the functionality that is disclosed in this claim limitation. This understanding is confirmed by Petitioner’s expert. Ex. 2004, at 34:11-23 (“There’s a number of different ways to build this functionality, and a POSITA would understand those.”).

38. In my opinion, a person of ordinary skill in the art reading the claim in light of the specification would understand the specified output frame rate to be subject to 35 U.S.C. 112 ¶ 6 with the following Structure and Function:

Structure: Software algorithm that performs the steps of:

- Receiving input moving image data
- Specifying input frame rate

- Transmitting specified input frame rate to frame rate conversion unit

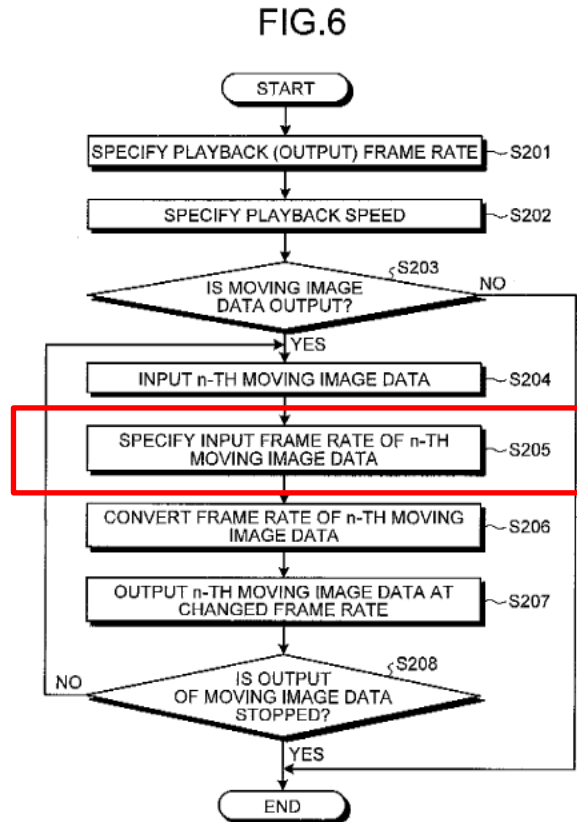
Function: specify the first frame rate of the first moving image data and the second frame rate of the second moving image data, the first and second moving image data having been input into the moving image data input unit

See '041 Patent, 7:12-8:10; 13:63-15:19, FIGS. 1, 3, 4A, 4B, 4C, 5, 6, 9.

39. A person of ordinary skill in the art would understand the structure of the input frame rate specification unit to be a software algorithm. The patent specification describes such a software algorithm as a “method.” Ex. 1001, 7:66-8:2 (“Moreover, the *method performed* based on the image capture frame rate information, the *method performed* by analyzing input moving image data, and the like are conceivable as a *method for specifying* the input frame rate.”), 14:7-15 (“If first moving image data of the plurality of moving image data is input in Step S204, the input frame rate specification unit 303 specifies a frame rate of the moving image data input first (step S205). The *method performed* based on the image capture frame rate information, the *method performed* by analyzing moving image data to be input, and the like are conceivable as a *method for specifying* the input frame rate.”)

40. Each of the algorithm steps is disclosed explicitly in FIG. 6 of the '041 Patent which shows receiving “INPUT n-TH MOVING IMAGE DATA” from Step 204, “SPECIFY INPUT FRAME RATE OF n-TH MOVING IMAGE DATA” in Step

205, and transmitting the specified input frame rate of Step 205 to the frame rate conversion unit to “CONVERT FRAME RATE OF n-TH MOVING IMAGE DATA” in Step 206.



Ex. 1001, FIG. 6.

41. A person of ordinary skill in the art would further understand based on the '041 patent specification, that the specifying step of the algorithm can be programmed in several ways to specify, such as based on the image capture frame rate information, analyzing moving image data to be input, analyzing the frame configuration of moving image data, “and the like.” *See Id.*, 8:2-10; 14:7-23 (“If first

moving image data of the plurality of moving image data is input in Step S204, the input frame rate specification unit 303 specifies a frame rate of the moving image data input first (step S205). The method performed based on the image capture frame rate information, the method performed by analyzing moving image data to be input, and the like are conceivable as the method for specifying the input frame rate. In other words, if the image capture frame rate information or information of a similar kind, is described in a predetermined data area, or is present as metadata, the input frame rate is specified based on them. On the other hand, if the image capture frame rate information or information of a similar kind is not present, the input frame rate is specified by analyzing the frame configuration of moving image data.”).

42. A person of ordinary skill in the art would also understand that the specified input frame rates for each of the first and second moving image data would be transmitted to the frame rate conversion unit because “the frame rate conversion unit 306 changes the frame rate of the input moving image data based on the input frame rate, the output frame rate, and the playback speed.” *Id.* at 14:32-60 (“***Assuming the specified input frame rate is F_{in}*** , the output frame rate is F_{out} , and the multiplier of the playback speed relative to the equal speed is M , a change multiplier x of the total number of frames of the input moving image data has a relationship expressed in the following equation (1). $x = F_{out}/M \cdot F_{in}$ (1). Therefore, for example, if the output frame rate is specified as 60 fps in step S201, the playback

speed as the equal speed in step S202, and *the input frame rate of the first moving image data input in step S204 as 600 fps, the frame rate conversion unit 306 sets the total number of frames of moving image data to be output as one tenth of the total number of frames of the input moving image data...* In other words, the *frame rate conversion unit 306 changes the frame rate* of the input moving image data *based on the input frame rate*, the output frame rate, and the playback speed.”).

43. A person of ordinary skill in the art would find the function of the “input frame rate specification unit” to be apparent from the claim language of Claim 1, which states that the “an input frame rate specification unit [is] configured to *specify the first frame rate of the first moving image data and the second frame rate of the second moving image data, the first and second moving image data having been input into the moving image data input unit.*” Ex. 1001, Claim 1.

B. “an output frame rate specification unit configured to specify output frame rate of the first moving image data and output frame rate of the second moving image data that have been input into the moving image data input unit”

44. A person of ordinary skill in the art would find no specific structure disclosed in “an output frame rate specification unit configured to specify output frame rate of the first moving image data and output frame rate of the second moving image data that have been input into the moving image data input unit” or the rest of the claim, but rather a number of different ways that a person of ordinary skill in the art would understand to build the functionality that is disclosed in this claim limitation. This

understanding is confirmed by Petitioner's expert. Ex. 2004, at 34:24-36:4 (“[A] person of ordinary skill in the art would understand how to build the functionality that's described...[T]hey would know, you know, how to build it, and multiple ways on how to build it...I would say there's multiple ways to – multiple components, multiple ways to build this functionality.”).

45. A person of ordinary skill in the art would understand “an output frame rate specification unit configured to specify output frame rate of the first moving image data and output frame rate of the second moving image data that have been input into the moving image data input unit” to be subject to 35 U.S.C. 112 ¶ 6 with the following Structure and Function.

Structure: Software algorithm that performs the steps of:

- Specifying variable frame rates for each of different moving image data
- Transmitting specified output frame rates to frame rate conversion unit

Function: specify variable output frame rate of the first moving image data and variable output frame rate of the second moving image data that have been input into the moving image data input unit

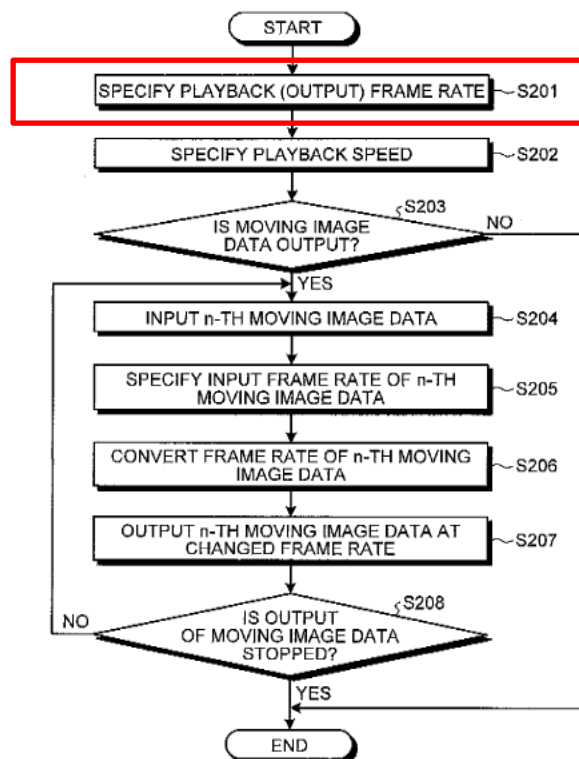
'041 Patent, 8:11-57, 11:46-12:60, 14:32-15:50, 16:65-17:14, Figs. 1, 6, 7A, 7B, 9

46. A person of ordinary skill in the art would understand the structure of the output frame rate specification unit to be a software algorithm. The patent specification describes such a software algorithm as a “method.” Ex. 1001, 8:15-8:19 (“A *method* based on selection by the user, a *method* based on the setting of an external device being an output destination, and the like are conceivable as a *method*

for specifying the output frame rate.”), 11:46-53 (“When the imaging apparatus 1 plays back the moving image data, the output frame rate specification unit 304 first specifies the output frame rate of the moving image data to be output for playback (step S201). As described above, the *method* based on selection by the user, the *method* based on the setting of an external device being an output destination, and the like are conceivable as, the *method* for specifying the output frame data.”).

47. Each of the algorithm steps is disclosed explicitly in FIG. 6 of the '041 Patent which shows “SPECIFY PLAYBACK (OUTPUT) FRAME RATE” in Step 201, and transmitting the specified output frame rate of Step 201 to the frame rate conversion unit to “CONVERT FRAME RATE OF n-TH MOVING IMAGE DATA” in Step 206.

FIG.6



Ex. 1001, FIG. 6.

48. A person of ordinary skill in the art would further understand based on the '041 patent specification, that the specifying step of the algorithm can be programmed in several ways to specify, such as “based on selection by the user, [] based on the setting of an external device being an output destination, and the like.” *See Id.*, 8:11-57; 11:46-12:55.

49. A person of ordinary skill in the art would also understand that the specified output frame rate would be transmitted to the frame rate conversion unit because “the frame rate conversion unit 306 changes the frame rate of the input moving image data based on the input frame rate, the output frame rate, and the

playback speed.” *Id.* at 14:32-60 (“***Assuming*** the specified input frame rate is F_{in} , ***the output frame rate is F_{out}*** , and the multiplier of the playback speed relative to the equal speed is M , a change multiplier x of the total number of frames of the input moving image data has a relationship expressed in the following equation (1). $x = F_{out}/M \cdot F_{in}$ (1). Therefore, for example, ***if the output frame rate is specified as 60 fps in step S201***, the playback speed as the equal speed in step S202, and the input frame rate of the first moving image data input in step S204 as 600 fps, ***the frame rate conversion unit 306 sets the total number of frames of moving image data to be output as one tenth of the total number of frames of the input moving image data...***In other words, the frame rate conversion unit 306 changes the frame rate of the input moving image databased on the input frame rate, the output frame rate, and the playback speed.”).

50. The prosecution history of the '041 patent also confirms (1) that the output specification unit's structure is an algorithm that includes the step of specifying ***variable*** frame rates for each of the different moving image data; and (2) that the function of specifying an output frame rate involves specifying a variable output frame rate.

51. I understand that during prosecution, the pending claims of the '041 Patent were rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent Application Publication No. 2010/0310229 to Iwata (“Iwata,” Ex. 2001).

52. Iwata disclosed a “video processing apparatus and a video processing method for controlling a video image playback speed.” Ex. 2001, [0002]. Iwata discloses a method in which a range of acceptable playback speeds are determined based on audio characteristics of the video data (Ex. 2001, [0030]), and discloses that decimation or interpolation of the frames is performed based on a relationship between the playback speed and a shooting frame rate C, a playback frame rate P, and decimation or interpolation N of the video data. *Id.*, [0046], [0047]. Thus, if the “Slow Playback” option is selected, the video data will be played back at the slowest speed that is possible while maintaining the intelligibility of the audio in the video data, while decimation or interpolation is performed according to the above relationship. While Iwata discloses variable output *speeds*, Iwata does not disclose variable output *frame rates*. *Id.*, [0031] (“a playback frame rate is fixed at 60 fps”); [0039] (“the playback frame rate is fixed (60 fps)”). Applicant distinguished the pending claims over Iwata, noting that “Iwata fails to disclose ‘**an output frame rate specification unit** configured to **specify output frame rate** of the first moving data and **output frame rate** of the second moving image data that have been input into the moving image data input unit.’” Ex. 1002 at 71 (emphases in original).

53. The Examiner agreed, issuing a Notice of Allowance, and noting that “[t]he closest prior art Iwata [] either singularly or in combination, fail[s] to anticipate or render the above underlined limitation obvious.” *Id.* at 14. In other

words, a prior art reference disclosing selectable playback speeds but fixed output frame rates does not render the claims anticipated or obvious.

54. The '041 specification describes that even when the output frame rate is set based upon the requirements of an external device, that frame rate is still *variable* based on the specific external device. Ex. 1001, 8:49-53. In other words, the frame rate for the external device is acquired by the central control unit, which then uses this as one factor to specify the output frame rate. *Id.*

55. A person of ordinary skill in the art would find the function of the “output specification unit” to be apparent from the claim language of Claim 1, which states that “an output frame rate specification unit [is] configured to *specify output frame rate of the first moving image data and output frame rate of the second moving image data that have been input into the moving image data input unit.*” Ex. 1001, Claim 1. Based on the prosecution history of the '041 patent related to this claim limitation, the specified output frame rate is a specified variable output frame rate.

C. “specify[ing] [the] output frame rate”

56. A person of ordinary skill in the art would understand “specify[ing] [the] output frame rate” to be construed as “specify[ing] [the] variable output frame rate since the output specification unit is specifying a variable output frame rate for both the first and second moving image data that have been input into the moving image

data input unit).

D. “a playback speed specification unit configured to specify a same playback speed for the first moving image data and the second moving image data”

57. A person of ordinary skill in the art would find no specific structure disclosed in “playback speed specification unit configured to specify a same playback speed for the first moving image data and the second moving image data” or the rest of the claim, but rather a number of different ways that a person of ordinary skill in the art would understand to build the functionality that is disclosed in this claim limitation. Ex. 2004, at 36:5-24 (“There are multiple ways to build this functionality of a playback speed specification unit that a POSITA would understand...As I stated, I believe that a POSITA would understand multiple ways to build this functionality.”).

58. A person of ordinary skill in the art would understand “a playback speed specification unit configured to specify a same playback speed for the first moving image data and the second moving image data” to be subject to 35 U.S.C. 112 ¶ 6 with the following Structure and Function.

Structure: Software algorithm that performs the steps of:

- Specifying a same playback speed for the first moving image data and the second moving image data
- Transmitting the specified playback speed to the frame rate conversion unit

Function: specify a same playback speed for the first moving image data and the second moving image data

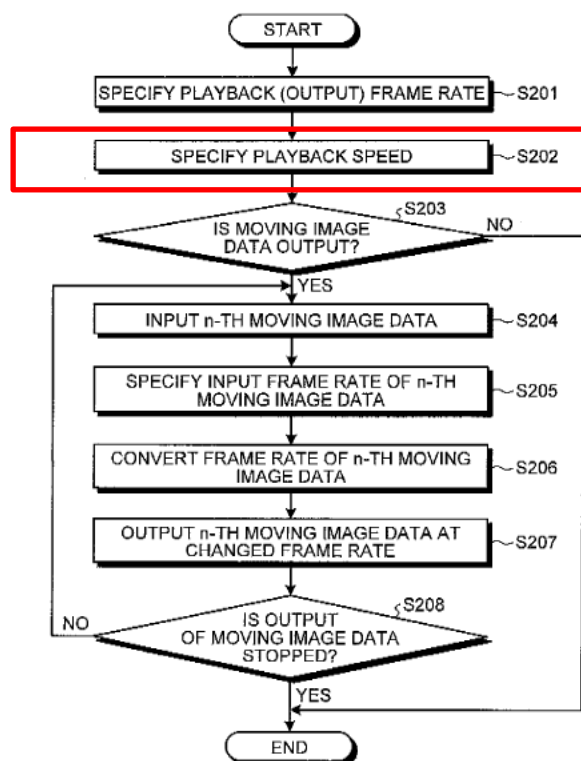
’041 Patent, 8:58-9:17; 13:4-62, 14:24-15:26, 17:15-48. 18:36-19:43, FIGS. 1, 6, 8,

9.

59. A person of ordinary skill in the art would understand the structure of the playback speed specification unit to be a software algorithm. The patent specification describes an exemplary embodiment where the playback speed specification unit can specify the playback speed based on selection by the user through generating an “instruction” to the user to select a playback speed. Ex. 1001, 13:31-38 (“The playback speed specification unit 305 can specify the playback speed based on selection by the user from the high speed, equal speed, and low speed. When an instruction to the effect to select the playback speed of the moving image data to be output is input via the operating unit 209, the audio/image processing unit 204 generates such an image G81 that prompts the user to select the playback speed as illustrated in FIG. 8.”). A person of ordinary skill in the art would recognize a generated instruction to the user in order to specify a playback speed as the result of a software algorithm.

60. Each of the algorithm steps is disclosed explicitly in FIG. 6 of the '041 Patent which shows receiving “SPECIFY PLAYBACK SPEED” from Step 202 and transmitting the specified playback speed of Step 202 to the frame rate conversion unit to “CONVERT FRAME RATE OF n-TH MOVING IMAGE DATA” in Step 206.

FIG.6



Ex. 1001, FIG. 6.

61. A person of ordinary skill in the art would further understand based on the '041 patent specification, that the specifying step of the algorithm can be programmed in several ways to specify, such as based on user selection or a predetermined playback speed. *See Id.*, 8:58-9:31 (“The user can select/set the playback speed using the button 209b and the dial 209d which are illustrated in FIG. 2A. In other words, if the user presses button 209b, an image for selecting the playback speed is displayed on the monitor 207. The user rotates the dial 209d to move a cursor image contained in the image, and selects and sets a desired playback speed. The playback speed specification unit 305 specifies the playback speed of the

moving image data to be output based on this setting. Moreover, a predetermined playback speed (for example, only the equal speed), for example, only equal-speed playback, may be used. In this case, the playback speed specification unit 305 specifies the predetermined playback speed as the playback speed of the moving image data to be output.”).

62. A person of ordinary skill in the art would also understand that the specified playback speed would be transmitted to the frame rate conversion unit because “the frame rate conversion unit 306 changes the frame rate of the input moving image data based on the input frame rate, the output frame rate, and the playback speed.” *Id.* at 14:32-60 (“**Assuming** the specified input frame rate is F_{in} , the output frame rate is F_{out} , and **the multiplier of the playback speed relative to the equal speed is M** , a change multiplier x of the total number of frames of the input moving image data has a relationship expressed in the following equation (1). $x = F_{out}/M \cdot F_{in}$ (1). Therefore, for example, if the output frame rate is specified as 60 fps in step S201, **the playback speed as the equal speed in step S202**, and the input frame rate of the first moving image data input in step S204 as 600 fps, **the frame rate conversion unit 306 sets the total number of frames of moving image data to be output as one tenth of the total number of frames of the input moving image data**...In other words, the frame rate conversion unit 306 changes the frame rate of the input moving image data based on the input frame rate, the output frame rate, and

the playback speed.”).

63. A person of ordinary skill in the art would find the function of the “playback speed specification unit” to be apparent from the claim language of Claim 2, which states that the “a playback speed specification unit [is] configured to *specify a same playback speed for the first moving image data and the second moving image data.*” Ex. 1001, Claim 1.

E. “a frame rate conversion unit configured to change a frame rate of the first moving image data based on the first frame rate, the output frame rate, and the playback speed, and change a frame rate of the second moving image data based on the second frame rate, the output frame rate, and the playback speed”

64. A person of ordinary skill in the art would find no specific structure disclosed in “a frame rate conversion unit configured to change a frame rate of the first moving image data based on the first frame rate, the output frame rate, and the playback speed, and change a frame rate of the second moving image data based on the second frame rate, the output frame rate, and the playback speed” or the rest of the claim, but rather a number of different ways that a person of ordinary skill in the art would understand to build the functionality that is disclosed in this claim limitation. Ex. 2004, at 37:1-11 (“A person of normally -- of ordinary skill in the art would understand multiple ways to build this functionality.”).

65. A person of ordinary skill in the art would understand “a frame rate conversion unit configured to change a frame rate of the first moving image data based on the

first frame rate, the output frame rate, and the playback speed, and change a frame rate of the second moving image data based on the second frame rate, the output frame rate, and the playback speed” to be subject to 35 U.S.C. 112 ¶ 6 with the following Structure and Function.

Structure: Software algorithm that performs the steps of:

- Receiving specified input frame rate and specified output frame rate for each of the first and second moving image data and receiving specified playback speed for both the first and second moving image data
- Converting input frame rate to a frame rate that is output, for each of the first moving image data and second moving image data, based on the received specified input frame rates, specified output frame rates, and specified playback speed
- Transmitting converted frame rate(s) to the moving image data output unit, for each of the first moving image data and second moving image data, to be output at the converted frame rate(s)

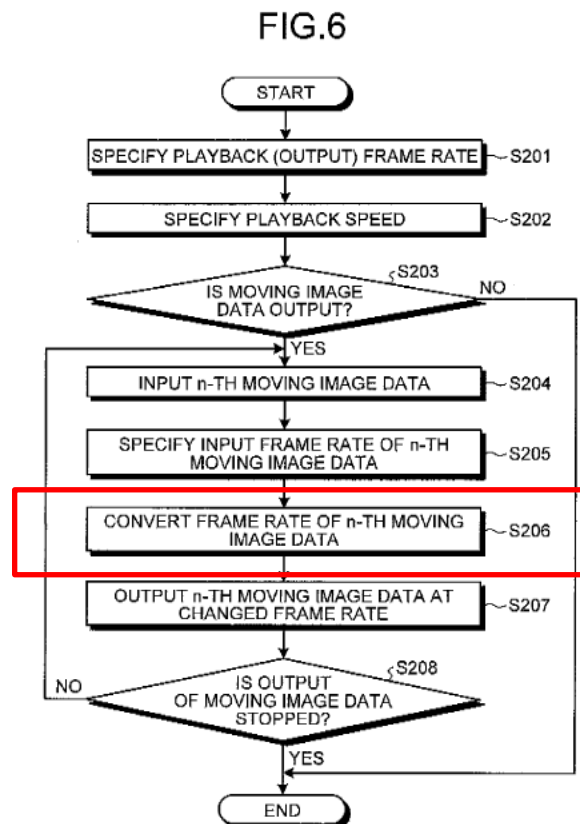
Function: change a frame rate of the first moving image data based on the first frame rate, the output frame rate, and the playback speed, and change a frame rate of the second moving image data based on the second frame rate, the output frame rate, and the playback speed

’041 Patent, 9:18-26, 13:4-30, 14:23-15:26, FIGS. 1, 6.

66. A person of ordinary skill in the art would understand the structure of the frame rate conversion unit to be a software algorithm. The patent specification describes such a software algorithm as a “method” based on various inputs. Ex. 1001, 9:18-27 (“The frame rate conversion unit 305 converts the frame rate of the input moving image data based on the specified output frame rate and playback speed. The conversion of the frame rate is performed based on a known *method* such

as interpolation in addition to decimation described in the above-mentioned example.”)

67. Each of the algorithm steps is disclosed explicitly in FIG. 6 of the '041 Patent which shows receiving “SPECIF[IED] PLAYBACK (OUTPUT) FRAME RATE” from Step 201, “SPECIFY PLAYBACK SPEED” from Step 202, and “SPECIFY INPUT FRAME RATE OF n-TH MOVING IMAGE DATA” from Step 205, performing the “CONVERT FRAME RATE OF n-TH MOVING IMAGE DATA” in Step 206, and transmitting the converted frame rates of Step 206 to the moving image data output unit to “OUTPUT n-TH MOVIN IMAGE DATA AT CHANGED FRAME RATE” in Step 207.



Ex. 1001, FIG. 6.

68. A person of ordinary skill in the art would also understand that the specified output frame rate, specified input frame rate, and the specified playback speed would be received by the frame rate conversion unit because “the frame rate conversion unit 306 changes the frame rate of the input moving image data based on the input frame rate, the output frame rate, and the playback speed.” *Id.* at 14:32-60 (“Assuming the specified input frame rate is F_{in} , the output frame rate is F_{out} , and the multiplier of the playback speed relative to the equal speed is M , a change multiplier x of the total number of frames of the input moving image data has a relationship expressed in the following equation (1). $x = F_{out}/M \cdot F_{in}$ (1). Therefore, for example, if the output frame rate is specified as 60 fps in step S201, the playback speed as the equal speed in step S202, and the input frame rate of the first moving image data input in step S204 as 600 fps, the frame rate conversion unit 306 sets the total number of frames of moving image data to be output as one tenth of the total number of frames of the input moving image data...In other words, the frame rate conversion unit 306 changes the frame rate of the input moving image data based on the input frame rate, the output frame rate, and the playback speed.”).

69. A person of ordinary skill in the art would further understand based on the '041 patent specification, that the converting step of the algorithm can be programmed in several ways, such as based on decimation and interpolation to adjust

the total number of frames for each of the first moving image data and second moving image data. *See Id.*, 9:18-27 (“The conversion of the frame rate is performed based on a known method such as interpolation in addition to decimation described in the above-mentioned example.”); 13:14-30 (“In contrast, a speed, at which the imaging data generated spending 10 minutes from the start time to the end time is played back for five minutes, is the high speed. In this case, the decimation process described below is performed by the frame rate conversion unit 306 in a manner of reducing the total number of frames of the imaging data to a half. For example, the moving image data whose frame rate has been converted to 30 fps is output/played back at an output frame rate of 60 fps for five minutes. Moreover, the imaging data generated spending 10 minutes from the start time to the end time is played back at a speed spending 20 minutes, of which speed is a low-speed frame; and in this case, the total number of frames of the imaging data is interpolated to be doubled by the frame rate conversion unit. For example, the moving image data whose frame rate has been converted to 120 fps is output/played back at the output frame rate of 60 fps for 20 minutes.”); 15:57-62 (“As described above, with the imaging apparatus 1 according to the present invention, the frame rates of a plurality of moving images generated at different frame rates are respectively converted to output the plurality of moving images. Moreover, at this point, frame decimation and interpolation are performed based on a preset playback speed.”).

70. A person of ordinary skill in the art would also understand that the algorithm for the frame rate conversion unit would include transmitting converted frame rates, to the moving image data output unit, for each of the first moving image data and second moving image data, to be output at the converted frame rate(s). *Id.* at 3:39-42 (“moving image data output unit that outputs the first and second moving image data whose frame rates have been converted by the frame rate conversion unit.”); Fig. 6 (“OUTPUT n-TH MOVING IMAGE DATA AT CHANGED FRAME RATE”).

71. Because the claim language and the portions of the specification cited above state that the converted output frame rates of the first and second moving image data is based, at least in part, on the specified output frame rates of the first and second moving image data, a person of ordinary skill in the art would understand that the converted output frame rates is not necessarily the same as the specified output frame rates. *See Id.* at Claim 1 (“***change a frame rate*** of the first moving image data ***based on*** the first frame rate, ***the output frame rate***, and the playback speed.”), 9:18-26, 13:4-30, 14:23-15:26. A person of ordinary skill in the art would understand this distinction through the mathematical relationship provided in the patent specification:

$$x = F_{out} / M * F_{in}$$

Ex. 1001, 14:36-38.

72. The “specified input frame rate is F_{in} , the [specified] output frame rate is F_{out} , and the multiplier of the playback speed relative to the equal speed is M .” The “equal speed” is the specified playback speed from the playback specification unit that is desired to be “equal” or “same” for both the first and second moving image data while the “playback speed” is the moving image data input’s original playback speed. *Id.* at 14:32-60. “ x ” is a “change multiplier” of the total number of frames of the input moving image data, which is what the frame conversion unit uses to decimate or interpolate frames for each of the first and second moving image data. *Id.* A person of ordinary skill in the art would understand that such decimation or interpolation of frames would result in a changed output frame rate, distinct from the specified output frame rate from the output specification unit.

73. A person of ordinary skill in the art would find the function of the “frame rate conversion unit” to be apparent from the claim language of Claim 1, which states that the “a frame rate conversion unit [is] configured to *change a frame rate of the first moving image data based on the first frame rate, the output frame rate, and the playback speed, and change a frame rate of the second moving image data based on the second frame rate, the output frame rate, and the playback speed.*” Ex. 1001, Claim 1.

F. “operating unit”

74. A person of ordinary skill in the art would find no specific structure disclosed

in “operating unit” or the rest of the claim, but rather a number of different ways that a person of ordinary skill in the art would understand to build the functionality that is disclosed in this claim limitation.

75. A person of ordinary skill in the art would understand “operating unit” to be subject to 35 U.S.C. 112 ¶ 6 with the following Structure and Function.

Structure: Buttons, dials, or equivalents thereof for accepting various inputs related to the moving image data

Function: accept [an] input[s]

See ’041 Patent, 6:20-44; 8:20-39, 9:38-10:53, 11:3-38, 11:61-12:29, 13:31-62, 15:11-50, 17:24-19:5, FIGS. 1-4C, 6.

76. A person of ordinary skill in the art would understand the structure of the “operating unit” to be “buttons, dials, or equivalents thereof for accepting various inputs related to the moving image data.”

77. The specification of the ’041 patent describes that the “operating unit 209 is constituted by a release button 209a, buttons 209b and 209c, and dials 209d and 209e which are illustrated in the exterior view of FIGS. 2A and 2B; and an unillustrated operation key, cross key, lever, or touch panel superimposed on the monitor 207, and the like.” Ex. 1001, at 6:32-38. A person of ordinary skill in the art would understand “equivalents thereof” in the proposed construction to include any equivalent physical interface from which to receive a user input, such as the disclosed “operation key, cross key, lever, or touch panel superimposed on the

monitor 207, and the like.” *Id.*

78. A person of ordinary skill in the art would find the function of the “operating unit” to be apparent from the claim language of Claim 2, which states that the “operating unit” is configured to “*accept an input* to specify the playback speed.” Ex. 1001, Claim 2. As noted elsewhere in the ’041 patent specification, the operating unit can accept multiple inputs other than the playback speed, which is why the function should not be improperly narrowed to only accepting playback speed inputs: “The operating unit 209 accepts the user’s various operation inputs into the imaging apparatus 1, including the start and end of image capture, inputs related to the settings, or the like. The user can change/set the frame rate and the like of moving image data upon image capture and playback at the imaging apparatus 1, using the button 209b and the dial 209d forming the operating unit 209.” *Id.* at 6:36-43.

VI. Ground 1A: Morikawa Does Not Render Claims 1-6 Obvious

A. Morikawa Does Not Disclose “a moving image data input unit configured to be input of first moving image data generated at a first frame rate and second image data generated at a second frame rate that is different from the first frame rate” as Required by Claim 1 or “inputting first moving image data generated at a first frame rate and second image data generated at a second frame rate that is different from the first frame rate” as Required by Claim 6

79. Petitioner incorrectly cites to Morikawa’s multi-frame rate contents as disclosing this limitation. However, a person of ordinary skill in the art would not

understand a multi-frame rate content to be multiple moving image data inputs. Morikawa explains that a multi-frame rate content is one piece of content where a certain portion of the content is one frame rate and another portion of the same content is another frame rate. Ex. 1004, at [0024] (“The multi-frame rate contents are composed of a high frame-rate portion (second portion) of a high frame rate (second frame rate) and an ordinary frame rate portion (first portion) of an ordinary frame rate (first frame rate”), Fig. 5 (“START PLAYBACK OF *CONTENT*” and “HAS PLAYBACK OF *CONTENT* ENDED?”). That there is only one piece of content renders Morikawa inapposite to the teachings of the ’041 Patent.

B. Morikawa Does Not Disclose “an input frame rate specification unit configured to specify the first frame rate of the first moving image data and the second frame rate of the second moving image data, the first and second moving image data having been input into the moving image data input unit” as Required by Claim 1 or “specifying the first frame rate of the first moving image data and the second frame rate of the second moving image data” as Required by Claim 6

80. In my opinion, Morikawa cannot disclose the “input frame rate specification unit” claim limitation or “specifying the first frame rate of the first moving image data and the second frame rate of the second moving image data,” which requires “first moving image data” and “second moving image data.”

81. In my opinion, Morikawa also does not disclose “transmitting specified input frame rate to frame rate conversion unit” or the “frame rate conversion unit,” which is required by the software algorithm structure of the “input frame rate

specification unit.”

C. Morikawa Does Not Disclose “an output frame rate specification unit configured to specify output frame rate of the first moving image data and output frame rate of the second moving image data that have been input into the moving image data input unit” as required by Claim 1 and 4 or “specifying output frame rate of the first moving image data and output frame rate of the second moving image data that have been input” as Required by Claim 6

82. In my opinion, Morikawa cannot disclose the “output frame rate specification unit” claim limitation or “specifying output frame rate of the first moving image data and output frame rate of the second moving image data,” which requires “first moving image data” and “second moving image data.”

83. In my opinion, Morikawa also does not disclose “transmitting specified output frame rates to frame rate conversion unit,” which is required by the software algorithm structure of the “output frame rate specification unit.”

84. Claims 1 and 6 of the '041 Patent require the specification of the output frame rate of the moving image data, either by a user or other means.

85. The Petition states that Morikawa’s “rate analysis unit” calculates a “first playback time . . . based on a predetermined playback frame rate” and that Morikawa explains that the “playback frame rate is set based on the display frame rate of the display device.” Pet. at 16. Morikawa discloses that:

[W]hen the display frame rate is 60 Hz, 120 Hz, 240 Hz,
the payback [sic] frame rate is set to 60 Hz.

Ex. 1004, [0026]. Nowhere does Morikawa disclose setting the output frame rate to any other value other than 60, even when the required display frame rate is a multiple of 60. Thus, like Iwata, Morikawa's output frame rate is *fixed* rather than variable.

86. The Petition does not cite to any output frame rate other than 60 Hz, nor does Petitioner's expert argue that another output frame rate is disclosed or rendered obvious by Morikawa. Ex. 1003, ¶¶ 37-38. Morikawa states that the output frame rate is "set based on a display frame rate of a display device," (Ex. 1004, [0025]), but does not explain how, or why, multiple output frame rates are possible or necessary when the very next sentence notes that the playback frame rate is set to 60 Hz regardless of the frame rate required by the display. *Id.*, [0026]. Therefore, the Petition fails to show that Morikawa renders obvious the specification of a playback frame rate for the output video data as required by the claims.

D. Morikawa Does Not Disclose "a playback speed specification unit configured to specify a same playback speed for the first moving image data and the second moving image data" as required by Claim 1 and 2 or "specifying a same playback speed for the first moving image data and the second moving image data" as required by Claim 6

87. In my opinion, Morikawa cannot disclose the "playback speed specification unit" claim limitation or "specifying a same playback speed for the first moving image data and the second moving image data," which requires "first moving image data" and "second moving image data."

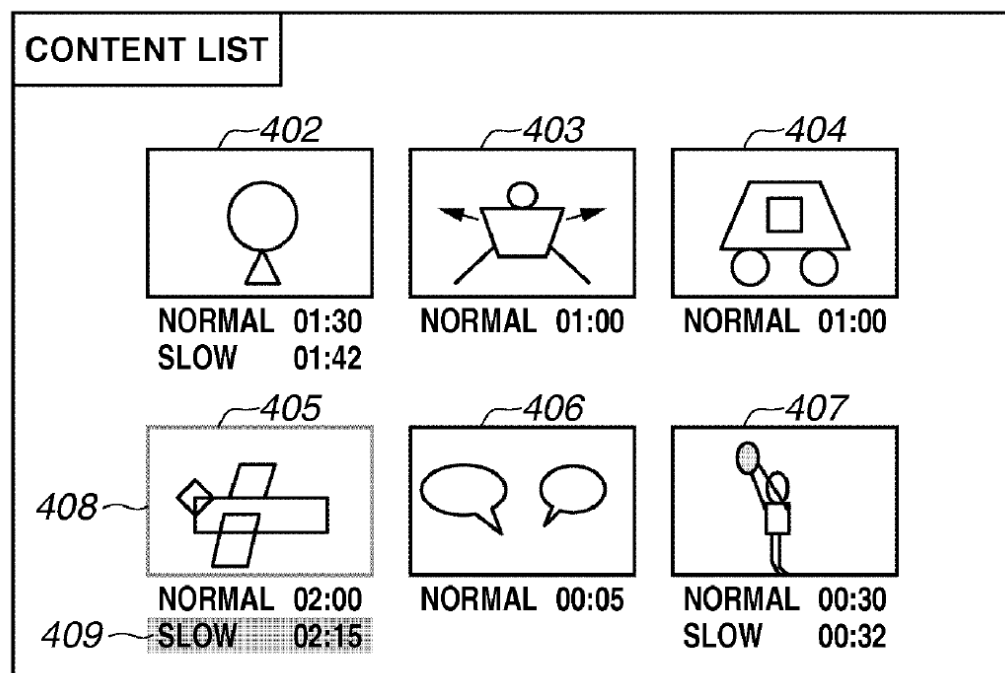
88. Morikawa cannot teach this software algorithm, particularly the step of

“transmitting the specified playback speed to the frame rate conversion unit” because it is directed toward offering the user the choice to specify the playback speed of a singular multi-frame rate content *after* any alleged frame rate conversion occurs. Ex. 1004, [0036]-[0038], Fig. 4.

89. The benefit to which the '041 patent is directed is sequentially or continuously playing back multiple moving image data so as to have a same playback speed between the first and second moving image data despite being generated at different frame rates. Ex. 1001, 15:11-19 (“[I]f the moving image data generated at different frame rates...are sequentially/continuously played back, the frame rate conversion unit can convert the frame rate of each piece of the moving image data so as to have a predetermined output frame rate and the same playback speed between the first and second moving image data.”). Contrast this with Morikawa, where, because there is only one content, the end result is a choice provided to the user: a “Normal” playback time applied to the entire content based on the normal or slower frame rate portion of the content or a “Slow” playback time applied to the entire content based on the faster or “high frame-rate portion.” Ex. 1004, [0036]-[0038] (“In step S304, *when there is the high frame-rate portion, a total playback time in a case where the entire contents are played back at a slow speed is calculated*. Further, in step S305, the total playback time in a case where the entire contents are played back at a normal speed is calculated. In step S305,

when there is not the high frame-rate portion, only the normal playback time is calculated. ... As to the multi-frame rate contents, a normal playback time is displayed on a right side of 'Normal' and a slow playback time is displayed on the right side of 'Slow'. These playback times are displayed in parallel or side by side on a screen.”). Fig. 4 of Morikawa also demonstrates how for each piece of multi-frame rate content, there are two options for playback speed: “Normal” and “Slow.”

FIG.4



Ex. 1004, Fig. 4.

90. In my opinion, Morikawa also does not disclose a “frame rate conversion unit,” which is required by the software algorithm structure of the “playback speed specification unit.”

E. Morikawa Does Not Disclose “a frame rate conversion unit configured to change a frame rate of the first moving image data based on the first frame rate, the output frame rate, and the playback speed, and change a frame rate of the second moving image data based on the second frame rate, the output frame rate, and the playback speed” as Required by Claim 1 or “changing a frame rate of the first moving image data based on the first frame rate, the output frame rate, and the playback speed, and changing a frame rate of the second moving image data based on the second frame rate, the output frame rate, and the playback speed” as Required by Claim 6

91. In my opinion, Morikawa cannot disclose the “frame rate conversion unit” claim limitation or “changing a frame rate of the first moving image data ...and changing a frame rate of the second moving image data,” which requires “first moving image data” and “second moving image data.”

92. Moreover, neither the software algorithm structure of the “frame rate conversion unit” which requires “receiving specified playback speed for both the first and second moving image data” and “converting input frame rate to a frame rate that is output, for each of the first moving image data and second moving image data, based on the ...specified playback speed” nor the corresponding function of “changing a frame rate...based on the...playback speed” is disclosed by Morikawa because a person of ordinary skill in the art would understand that any alleged specification of the playback speed in Morikawa is made *after* Petitioner’s alleged frame rate conversion, as I explained above in Section VI.D. with respect to the playback speed specification unit.

93. In my opinion, the changed frame rates of the first and second moving image data in the Challenged Claims are based, at least in part, on the specified output frame rates of the first and second moving image data. Therefore, a person of ordinary skill in the art would understand that the changed output frame rates are not necessarily the same as the specified output frame rates. *See Id.* at Claim 1 (“***change a frame rate*** of the first moving image data ***based on*** the first frame rate, ***the output frame rate***, and the playback speed.”). No such distinction is present in Morikawa, which merely states: “the playback frame rate is set based on a display frame rate of a display device. More specifically, when the display frame rate is 60 Hz, 120 Hz, 240 Hz, the payback frame rate is set to 60 Hz.” Ex. 1004, [0025]-[0026]. As a result these claim limitations cannot be obviated by Morikawa, which at best, just changes the multiple input frame rates of a single piece of content into changed output frame rates.

VII. Ground 1B: Morikawa, Alone or in Combination with Takabe, Does Not Render Claim 3 Obvious

A. Takabe Does Not Disclose “The moving image data processing apparatus according to claim 1, further comprising a display unit, wherein the operating unit accepts the inputs continuously, and the moving image data output unit makes the display unit display the first frame rate, second frame rate, or the playback speed thereon arranged in a circular ring shape, makes the display unit display the circular ring shape of the first frame rate, second frame rate, or the playback speed in a rotating manner in accordance with the input of the operating unit, and specifies the first frame rate, the second frame rate, or the playback speed” as Required by Claim 3

94. In my opinion, Takabe is silent regarding displaying input frame rates, output frame rates, or playback speeds on its circular display.

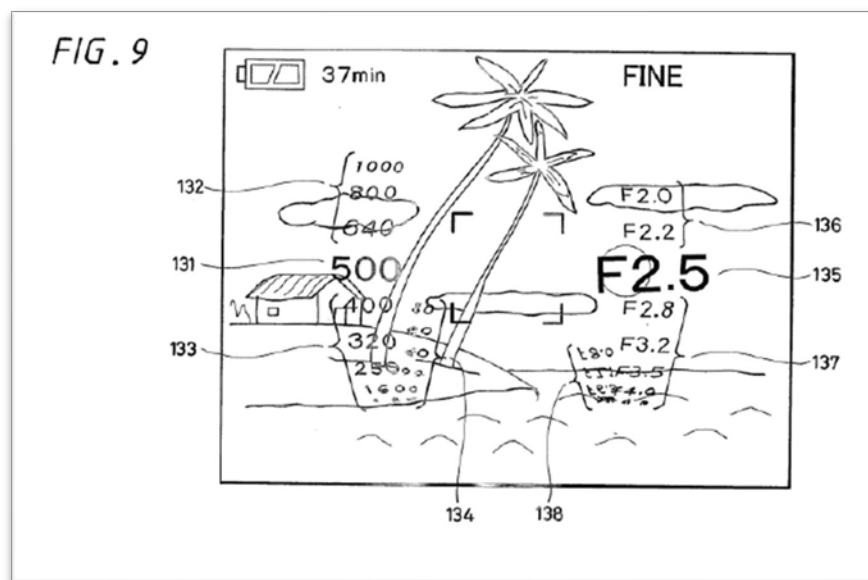
95. Claim 3 also requires a “first frame rate” and a “second frame rate” along with a “playback speed” for both the first and second moving image data. Takabe is merely directed towards “set values for the shutter speed and aperture on a digital camera” to capture input and therefore cannot disclose a circular display for features like frame rate and playback speed. Ex. 1005, 1:4-7. Moreover, a person of ordinary skill in the art would understand that Takabe is only directed to, at best, set values for a given image or video, whereas the claimed limitation requires “the playback speed” which is shared between two moving image data inputs. *Id.*

B. Petitioner Does Not Show That a Person of Ordinary Skill in the Art Would Be Motivated to Combine Morikawa with Takabe

96. The Petitioner argues that Claim 3 is rendered obvious over a

combination of Morikawa with Takabe's circular digital camera display. Pet. at 29-31. I disagree.

97. Takabe discloses a “display method and display device” for displaying set values where multiple levels of set values exist, “such as the set values for the shutter speed and aperture on a digital camera, for example.” Ex. 1005, 1:6-7. It discloses that “values and items for states that can be selected in multiple stages are positioned in order in designated places within a virtually set section of a circle or ellipse on the display panel.” *Id.*, Summary. Figure 9 of Takabe is shown below:



98. In my opinion, a person of skill in the art would not have looked to combine Morikawa, which deals with multi-frame rate content and the digital camera or video camera of Takabe (Ex. 1005, at 1:10-13) in order to pick one of the two alleged playback speeds of Morikawa (“Normal” or “Slow”) in a circular

display. A person of skill in the art would not find the technical combination feasible because Takabe's video camera would not likely be able to manipulate multi-frame rate content after it has already been received. For example, even if the multi-frame content were uploaded through a memory card, the specification of Takabe is unclear on how it would provide a user the capability to change the playback speed.

99. A person of ordinary skill in the art would understand the description of Takabe to be directed towards a user specifying metrics in which to capture content at the input, not manipulate input content by adjusting playback speed.

VIII. Ground 1C: Morikawa, Alone or in Combination with Walpole, Does Not Render Claims 5 Obvious

A. Walpole Does Not Disclose "The moving image data processing apparatus according to claim 1, wherein the output frame rate specification unit is configured to specify the output frame rate based on network band information of an external device receiving the moving image data output by the moving image data output unit," as Required by Claim 5

100. Claim 5 requires both the software algorithm structure and function of the claimed "output frame rate specification." Walpole is silent on the algorithm steps of "specifying variable frame rates for each of different moving image data" and "transmitting specified output frame rates to frame rate conversion unit" as well as the function of "specify[ing] variable output frame rate of the first moving image data and variable output frame rate of the second moving image data that have been input into the moving image data input unit."

101. Walpole is silent on being able to specify a first and second output frame rates of two different moving image data inputs based on currently available network bandwidth, for example.

102. Both Petitioner and the Board also ignore Claim 5's language that "the output frame rate [is] based on network band information of an external device receiving the moving image data." Pet. at 35; Inst. at 18-19. The '041 patent describes how, when the claim describes an external device, "[a]ssumed is a tablet PC or a smartphone, for example, as the external device that supports wireless network communication likewise and includes a display monitor." Ex. 1001, 16:55-17:14. A person of ordinary skill in the art would understand such an "external device" to be a "device other than the imaging apparatus" that is claimed. *Id.* at 7:61-65; *see also id.* at 12:30-55. A person of ordinary skill in the art would understand Walpole to only disclose, at most, specifying the output frame rate based on network band information on the device from which the moving image data output originated or in ***real-time streaming*** from remote servers. Ex. 1006, at 13 ("This paper has described the architecture of a distributed multimedia player that integrates support for advanced adaptive QoS control, complex presentations, and real-time transmission of continuous media streams from multiple remote servers.").

B. Petitioner Does Not Show That a Person of Ordinary Skill in the Art Would Be Motivated to Combine Morikawa with Walpole

103. Claims 1 and 6 require a “first moving image data generated at a first frame rate and a second image data generated at a second frame rate.”

104. Walpole is a conference publication that describes an “adaptive Internet-based video and audio player.” Ex. 1006 at 3. Walpole is a real-time system, and proposes an *adaptive* application that attempts to “preserve presentation quality in one dimension” by allowing quality to vary in response to available network bandwidth. *Id.* The Petition states that it would have been obvious to combine Walpole with Morikawa because “Morikawa describes its video processing system as network-enabled.” Pet. at 33.

105. A person of ordinary skill in the art would not have been motivated to combine Morikawa and Walpole to reach the invention of Claim 5. Morikawa only describes that it is network-enabled on the input side: “an input unit 102 is an input interface of video contents. Input sources include . . . a server via a network.” Ex. 1004, [0023]. Claim 5 requires altering the *output frame rate* based on network band information of an external device *receiving* the output. But Morikawa has no need for the teachings of Walpole because it does not output data over a network. The only disclosure of a display device in Morikawa is “a liquid crystal display device or plasma display device” that displays the display data on a screen. Ex. 1004, ¶

[0033]. Because there is no disclosure of the system in Morikawa outputting information over a network, there would have been no need for the person of ordinary skill in the art to look to the rate-limiting disclosure in Walpole to solve the non-existent problem of fluctuating network bandwidth.

IX. Ground 2A: Suzuki Does Not Render Claims 1 and 6 Obvious

A. Suzuki Does Not Disclose “a moving image data input unit configured to be input of first moving image data generated at a first frame rate and second image data generated at a second frame rate that is different from the first frame rate” as Required by Claim 1 or “inputting first moving image data generated at a first frame rate and second image data generated at a second frame rate that is different from the first frame rate” as Required by Claim 6

106. Claims 1 and 6 require a “first moving image data generated at a first frame rate and a second image data generated at a second frame rate.”

107. Petitioner incorrectly cites to Suzuki’s multi-frame rate contents as disclosing this limitation. See Ex. 1007, Fig. 8 (showing the frame rate for as singular moving image data changing over time).

B. Suzuki Does Not Disclose “an input frame rate specification unit configured to specify the first frame rate of the first moving image data and the second frame rate of the second moving image data, the first and second moving image data having been input into the moving image data input unit” as Required by Claim 1 or “specifying the first frame rate of the first moving image data and the second frame rate of the second moving image data” as Required by Claim 6

108. In my opinion, Suzuki cannot disclose the “input frame rate specification unit” claim limitation or “specifying the first frame rate of the first

moving image data and the second frame rate of the second moving image data,” which requires “first moving image data” and “second moving image data.”

109. In my opinion, Suzuki does not disclose “transmitting specified input frame rate to frame rate conversion unit” or the “frame rate conversion unit,” which is required by the software algorithm structure of the “input frame rate specification unit.”

C. Suzuki Does Not Disclose “an output frame rate specification unit configured to specify output frame rate of the first moving image data and output frame rate of the second moving image data that have been input into the moving image data input unit” as required by Claim 1 and 4 or “specifying output frame rate of the first moving image data and output frame rate of the second moving image data that have been input” as Required by Claim 6

110. In my opinion, Suzuki cannot disclose the “output frame rate specification unit” claim limitation or “specifying output frame rate of the first moving image data and output frame rate of the second moving image data,” which requires “first moving image data” and “second moving image data.”

111. In my opinion, Suzuki does not disclose “transmitting specified output frame rates to frame rate conversion unit” or the “frame rate conversion unit,” which is required by the software algorithm structure of the “output frame rate specification unit.”

D. Suzuki Does Not Disclose “a playback speed specification unit configured to specify a same playback speed for the first moving image data and the second moving image data” as required by Claim 1 or “specifying a same playback speed for the first moving image data and the second moving image data” as required by Claim 6

112. In my opinion, Suzuki cannot disclose the “playback speed specification unit” claim limitation or “specifying a same playback speed for the first moving image data and the second moving image data,” which requires “first moving image data” and “second moving image data.”

113. Suzuki does not and cannot disclose the “playback speed specification unit” claim limitation or “specifying a same playback speed for the first moving image data and the second moving image data.” If at all, Suzuki sets a “reproduction speed” for only one moving image data, and not a first moving image data and the second moving image data, as required by Claims 1 and 6. Ex. 1007 at [0087]-[0089]. Petitioner cites to Fig. 8, object 801 for showing allegedly a same playback speed for multiple moving image data. Pet. at 40-41. However, Suzuki itself contradicts that, and states: “FIG. 8 illustrates moving image data that is captured and recorded as described above. Moving image data 801 includes a 60-fps moving image in the period from T0 to T1, a 240-fps moving image in the period from T1 to T2, and a 120-fps moving image in the period from T2 to T3.” Ex. 1007, [0044]. In other words, a person of ordinary skill in the art would understand object 801 in Fig. 8 of Suzuki to be one multi-frame rate data, similar to that of Morikawa.

114. In my opinion, Morikawa also does not disclose a “frame rate conversion unit,” which is required by the software algorithm structure of the “playback speed specification unit.”

E. Suzuki Does Not Disclose “a frame rate conversion unit configured to change a frame rate of the first moving image data based on the first frame rate, the output frame rate, and the playback speed, and change a frame rate of the second moving image data based on the second frame rate, the output frame rate, and the playback speed” as Required by Claim 1 or “changing a frame rate of the first moving image data based on the first frame rate, the output frame rate, and the playback speed, and changing a frame rate of the second moving image data based on the second frame rate, the output frame rate, and the playback speed” as Required by Claim 6

115. In my opinion, Suzuki cannot disclose the “frame rate conversion unit” claim limitation or “changing a frame rate of the first moving image data ...and changing a frame rate of the second moving image data,” which requires “first moving image data” and “second moving image data.”

116. Moreover, neither the software algorithm structure of the “frame rate conversion unit” which requires “receiving specified playback speed for both the first and second moving image data” and “converting input frame rate to a frame rate that is output, for each of the first moving image data and second moving image data, based on the ...specified playback speed” nor the corresponding function of “changing a frame rate...based on the...playback speed” is disclosed by Morikawa.

117. In my opinion, the changed frame rates of the first and second moving

image data in the Challenged Claims are based, at least in part, on the specified output frame rates of the first and second moving image data. Therefore, a person of ordinary skill in the art would understand that the changed output frame rates are not necessarily the same as the specified output frame rates. *See Id.* at Claim 1 (“***change a frame rate*** of the first moving image data ***based on*** the first frame rate, ***the output frame rate***, and the playback speed.”). No such distinction is present in Suzuki, which merely states: “In step S701, the control unit 107 sets the interval of frames to be displayed to FR/60xM according to the reproduction speed in high-speed reproduction and the frame rate of the moving image.” Ex. 1007, [0087]. As a result these claim limitations cannot be obviated by Morikawa, which at best, just changes the multiple input frame rates of a single piece of content into changed output frame rates.

X. Ground 2B: Suzuki, Alone or in Combination with Takabe Does Not Render Claims 3 Obvious

A. Takabe Does Not Disclose “The moving image data processing apparatus according to claim 1, further comprising a display unit, wherein the operating unit accepts the inputs continuously, and the moving image data output unit makes the display unit display the first frame rate, second frame rate, or the playback speed thereon arranged in a circular ring shape, makes the display unit display the circular ring shape of the first frame rate, second frame rate, or the playback speed in a rotating manner in accordance with the input of the operating unit, and specifies the first frame rate, the second frame rate, or the playback speed” as Required by Claim 3

118. In my opinion, the combination of Suzuki and Takabe does not obviate

Claim 3 for the same reasons that the combination of Morikawa and Takabe does not.

B. Petitioner Does Not Show That a Person of Ordinary Skill in the Art Would Be Motivated to Combine Suzuki with Takabe

119. The Petitioner argues that Claim 3 is rendered obvious over a combination of Suzuki with Takabe’s circular digital camera display. Pet. at 47-50.

120. Petitioner’s obviousness arguments are predicated on the idea that “[i]t would have been obvious [] to use Takabe’s circular ring shape interface component to display and enable a user to specify the moving image parameters described in the apparatus of Suzuki, such as the first frame rate [], second frame rate [], or the playback speed [].” Pet. at 47.

121. In my opinion, Petitioner’s motivations to combine, predicated on Takabe’s statements that the circular display is “easy to understand,” (*id.*) does not provide sufficient motivation to combine, absent impermissible hindsight.

XI. Ground 2C: Suzuki, Alone or in Combination with Sekiguchi Does Not Render Claim 4 Obvious

A. Sekiguchi Does Not Disclose “The moving image data processing apparatus according to claim 1, wherein the output frame rate specification unit is configured to specify the output frame rate based on information of an external device receiving the moving image data output by the moving image data output unit,” as Required by Claim 4

122. Claim 4 requires both the software algorithm structure and function of the claimed “output frame rate specification.” Sekiguchi is silent on the algorithm

steps of “specifying variable frame rates for each of different moving image data” and “transmitting specified output frame rates to frame rate conversion unit” as well as the function of “specify[ing] variable output frame rate of the first moving image data and variable output frame rate of the second moving image data that have been input into the moving image data input unit.”

123. Sekiguchi is silent on being able to specify a first and second output frame rates of two different moving image data inputs based on information of an external device, for example.

124. Petitioner ignores Claim 4’s language that “the output frame rate [is] based on information of an external device receiving the moving image data” and merely calls a “display panel” the information of an external device. Pet. at 52. The ’041 patent describes how, when the claim describes an external device, “[a]ssumed is a tablet PC or a smartphone, for example, as the external device that supports wireless network communication likewise and includes a display monitor.” Ex. 1001, 16:55-17:14. A person of ordinary skill in the art would understand such an “external device” to be a “device other than the imaging apparatus” that is claimed. *Id.* at 7:61-65; *see also id.* at 12:30-55. A person of ordinary skill in the art would understand Sekiguchi to only disclose, at most, specifying the output frame rate based on a “frame rate [that] is synchronized with the refresh rate of a display panel.” Pet. at 52. However a person of ordinary skill in the art would understand that is the

display panel of the device receiving the moving image data, and therefore does not meet this claim limitation.

B. Petitioner Does Not Show That a Person of Ordinary Skill in the Art Would Be Motivated to Combine Suzuki with Sekiguchi

125. In my opinion, Ground 2C regarding combining Suzuki with Sekiguchi to reach the invention of Claim 4 fails because a person of ordinary skill in the art would not have been motivated to combine Sekiguchi, which discloses modifying a frame rate in response to network conditions, with Suzuki, which only discloses a fixed frame rate on a playback device without network capability.

126. Suzuki describes a video camera recording system which possesses the capability to play video. The videos recorded with Suzuki's video camera functionality are played back at a later time. Sekiguchi presents a video playback system, such as a TV or a set top box, that plays video from a source, such as broadcast TV input. While Suzuki and Sekiguchi are both directed to the field of digital video, Suzuki deals with video camera devices without any network capability and Sekiguchi is only a broadcast video playback device.

127. Sekiguchi also discloses "control[ling] the frame rate of the video data in units of frames to 60 fps so that the frame rate is synchronized with the refresh rate of the panel." Ex. 1008, [0031]. However, as discussed above, Suzuki only discloses a fixed output frame rate. Therefore, the combination of Sekiguchi with Suzuki is not technically possible, nor would a person of ordinary skill in the art

have been motivated to make this combination.

128. The Petition merely states in a single sentence that a person of ordinary skill in the art “would have been motivated to modify Suzuki to specify the output frame rate of a display device, as taught by Sekiguchi, in order to avoid . . . anomalies.” Pet. at 50-51. Neither the Petition nor the identical expert declaration explain how Suzuki would have been modified based on the teachings of Sekiguchi. There is no description, for example, of how the modified system would detect the frame rate required by the display device. There is also no description of how the modified frame rate would impact playback speed. And there is no description or discussion of the steps that a person of ordinary skill in the art would take to make the proposed combination. Even ignoring that the references are not combinable, the Petition does not sufficiently articulate a motivation to combine, and therefore Ground 2C should be denied.

XII. Ground 2D: Suzuki, Alone or in Combination with Walpole Does Not Render Claim 5 Obvious

A. Walpole Does Not Disclose “The moving image data processing apparatus according to claim 1, wherein the output frame rate specification unit is configured to specify the output frame rate based on network band information of an external device receiving the moving image data output by the moving image data output unit,” as Required by Claim 5

129. In my opinion, the combination of Suzuki and Walpole does not obviate Claim 5 for the same reasons that the combination of Morikawa and Walpole does

not.

B. Petitioner Does Not Show That a Person of Ordinary Skill in the Art Would Be Motivated to Combine Suzuki with Walpole

130. Ground 2D combines Suzuki and Walpole to attempt to render Claim 5 obvious. Claim 5 requires configuring the output frame rate specification unit to specify the output frame rate based on network band information of an external device.

131. Walpole is a conference publication that describes an “adaptive Internet-based video and audio player.” Ex. 1006 at 3. Walpole is a real-time system, and proposes an *adaptive* application that attempts to “preserve presentation quality in one dimension” by allowing quality to vary in response to available network bandwidth. *Id.* Aside from leading to a “better user experience” (Pet. at 53), the Petition does not state a motivation to combine Suzuki and Walpole, nor does it state how a person of ordinary skill in the art would have done so. Therefore, a person of ordinary skill in the art would not have been motivated to combine Suzuki and Walpole to reach the invention of Claim 5.

132. Suzuki does not disclose that any portion of the system is connected to the internet, instead disclosing a closed system including an image capturing unit, display unit, operation unit, and recording medium. Ex. 1007, Fig. 1. Because there is no disclosure of the system in Suzuki outputting information over a network, there would have been no need for the person of ordinary skill in the art to look to the rate-

limiting disclosure in Walpole to solve the non-existent problem of fluctuating network bandwidth except through the impermissible application of hindsight.

133. Specifically, Walpole teaches a streaming server that uses MPEG compressed video for streaming. The frame rate at the server is adaptively reduced by dropping compressed video frames. That means the frame rate of Walpole can only be reduced and not increased. The frame rate reduction in Walpole's system is limited by the frame dependencies and the structure of the group of pictures while the delays in the network are used to estimate the frame rate reduction in the compressed video streamed by the server. The playback device of Walpole decodes the compressed video and plays the video at normal speed. The purpose of this system is to adaptively reduce the framerate at the server so that the receiver does not have to do any adaptation.

134. Suzuki's invention teaches a playback device that plays a locally stored file. Any frame rate conversion in Suzuki is performed on an uncompressed video obtained by processing the multi-frame rate input video data (which may have to be decoded if the input video is compressed).

135. In my opinion, a person of ordinary skill in the art working with Suzuki's invention that deals with multi-frame rate input video data would not have been motivated to combine Walpole's compressed domain video adaptation in a real-time streaming solution. The systems are not similar and there is no motivation

to combine because the combination of Suzuki and Walpole would not yield the result of the claimed invention predictably without changing the respective functions of Suzuki and Walpole (*e.g.*, the compressed domain video adaptation in a real-time streaming solution).

XIII. SUMMARY OF OPINIONS

136. It is my opinion that the Board should confirm the validity of the challenged claims. I reserve the right to supplement my opinions in response to any additional contentions by Petitioner or opinions by David Lett, and as the Board permits.

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

Executed on July 5, 2023 at Delray Beach, FL.



Hari Kalva, Ph.D.

EXHIBIT A

Curriculum Vitae

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A. Education

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M.S.C.E., Master of Science in Computer Engineering

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N.B.K.R. Institute of Science and Technology, S. V. University, Tirupati, India

B.Tech., Electronics and Communications Engineering

May 1991

B. Employment History

Florida Atlantic University, Boca Raton, FL, USA

Aug 2014 – present

Professor, Dept. of Computer & Electrical Engineering and Computer Science

Florida Atlantic University, Boca Raton, FL, USA

Aug 2014 – present

Associate Chair, Dept. of Computer & Electrical Engineering and Computer Science

Videopura, Inc.

Jan 2016 – present

a video streaming company, Founder and CEO

Florida Atlantic University, Boca Raton, FL, USA

Jul 2008 – Jul 2014

Associate Professor, Dept. of Computer & Electrical Engineering and Computer Science

Florida Atlantic University, Boca Raton, FL, USA

Aug 2003 – Jun 2008

Assistant Professor, Dept. of Computer Science and Engineering

Mitsubishi Electric Research Labs, Murray Hill, NJ, USA

Nov 2001 – Aug 2003

Consultant, Video Processing Group

Flavor Software, New York, NY, USA
V.P. of Engineering and Co-founder

Jan 2000 – Oct 2001

I.B.M. T.J. Watson Research Center, Yorktown Heights, NY, USA
Summer Internship, Image and Video Communications Group

May 1998 – Aug 1998

Columbia University, New York, NY, USA
Research Staff Associate, Image and Advanced Television Laboratory

Jan 1995 – Aug 1996

Florida Atlantic University, Boca Raton, FL, USA
Teaching Assistant, Dept. of Computer Science and Engineering

Aug 1993 – Dec 1994

C. Awards and Honors

- 1 **Fellow of the National Academy of Inventors.** The NAI Fellows Selection Committee inducts those who “*have demonstrated a highly prolific spirit of innovation in creating or facilitating outstanding inventions that have made a tangible impact on the quality of life, economic development, and welfare of society.*”
- 2 **Inventor of patented technology essential for the implementation of the Versatile Video Coding (VVC/H.266).** patents essential to the VVC/H.266 standard are part of the Access Advance license pool. VVC based products are expected to see wider distribution in digital TVs, smart phones, and streaming services starting in 2023.
- 3 **Inventor of patented technology essential for the implementation of ATSC digital TV broadcast, Blu-ray, and MPEG AVC/H.264.** patents essential to these standards are part of multiple license pools licensed to manufacturers of digital TVs, smart phones, tablets, Bluray players, and cable set-top-boxes.
- 4 **Technology transfer:** Founder of Videopura, a technology startup commercializing research innovations in the area of perceptually optimized video compression.
- 5 **NSF I/UCRC Technology Breakthroughs 2014,** PI “Automated Asset Management in Data Centers” this project has been included in a National Science Foundation (NSF) publication on breakthrough technologies – *2014 Industry-Nominated Technology Breakthroughs of NSF Industry/University Cooperative Research Centers*
- 6 **NSF I/UCRC Technology Breakthroughs 2012,** FAU Lead, “Distributed Cloud Computing Study: 3-D Visualization Services for Climate Data on Demand” this project has been included in a National Science Foundation (NSF) publication on breakthrough technologies – *2012 Industry-Nominated Technology Breakthroughs of NSF Industry/University Cooperative Research Centers*
- 7 **MPEG Standards Development** (1/97 – 12/99, 1/08 – 12/10): US delegate to the ISO (MPEG, SC29/WG11) standards committees and contributed to the development MPEG-4 Systems and MPEG-7 Visual Signature standards.
- 8 **Digital Audio Visual Council (DAVIC) Standards** (3/95 – 12/96): Made contributions to the DAVIC standards development with technical proposals, chairing sessions, and e-mail discussions. Participated in the Systems and Interoperability sub-group of DAVIC.
- 9 FAU 2008 Researcher of the Year (Asst. Professor)
- 10 ASEE Southeastern Section, 2009 New Faculty Research Award (2nd Place)
- 11 **Best Student Papers Supervised**

- (i) Bhatt J., Pappusetty, D., Kalva, H., and Naik, M. (2016). “Image Retargeting for Wearable Devices” *In 2016 IEEE International Conference on Consumer Electronics (ICCE)*, pp.xx-xx, Jan. 2016. **Best Student Paper Award.**
- (ii) Adzic, V., Hock, H. S., & Kalva, H. (2014, February). Visually lossless coding based on temporal masking in human vision. In *IS&T/SPIE Electronic Imaging* (pp. 90141C-90141C). International Society for Optics and Photonics. **Best Student Paper Award.**
- (iii) Van Leuven S, Kalva H, Van Wallendael G, De Cock J and Van de Walle R (2013). “Joint complexity and rate optimization for 3DTV depth map encoding” *In 2013 IEEE International Conference on Consumer Electronics (ICCE)*. **Special Merit Award.**
- 12 Lead Guest Editor, Multimedia Tools and Applications, Nov 2015 **special issue on Visual Information Processing and Perception**
- 13 Lead Guest Editor, IEEE Transactions on Special Topics in Signal Processing, June 2014 **special issue on Perception inspired Video processing**
- 14 Chair and Organizer of special session on Perception Inspired Video Processing at Human Vision and Electronic Imaging (HEVI), SPIE Electronic Imaging, Feb 2014
- 15 Chair and Organizer of Workshop on Perception Inspired Video Processing, collocated with ACM Multimedia 2014, Orlando, FL, November 2014.

D. Peer Refereed Publications in Print

D.1 Articles (Journals)

1. Parikh, S. and Kalva, H. (2020). Feature Weighted Linguistics Classifier for Predicting Learning Difficulty Using Eye Tracking. *ACM Transactions on Applied Perception*, Volume 17 Issue 2, May 2020 Article No.: 5pp 1–25<https://doi.org/10.1145/3380877>
2. Parikh, S. S., Ruiz, D., Kalva, H., Fernández-Escribano, G., & Adzic, V. (2018). High bit-depth medical image compression with HEVC. *IEEE journal of biomedical and health informatics*, 22(2), 552-560.
3. Prabhakaran, B., Jiang, Y. G., Kalva, H., & Chang, S. F. (2018). Editorial IEEE Transactions on Multimedia Special Section on Video Analytics: Challenges, Algorithms, and Applications. *IEEE Transactions on Multimedia*, 20(5), 1037-1037.
4. Pappusetty, D., Kalva, H., & Hock, H. S. (2017). Pupil response to quality and content transitions in videos. *IEEE Transactions on Consumer Electronics*, 63(4), 410-418.
5. Ruiz, D., Fernández-Escribano, G., Adzic, V., Kalva, H., Martínez, J. L., & Cuenca, P. (2017). Fast CU partitioning algorithm for HEVC intra coding using data mining. *Multimedia Tools and Applications*, 76(1), 861-894.
6. Garcia, R.; Adzic, V.; Kalva, H., (2017). Adapting Low Bit Rate Skip Mode in Mobile Environment, *Circuits and Systems for Video Technology, IEEE Transactions on*, Vol. 27, No. 2, pp. 352-365, doi: 10.1109/TCSVT.2014.2365653.
7. Kalva, H., Chen, H., Adzic, V., & Fernández-Escribano, G. (2015). Guest Editorial: Visual Information Processing and Perception. *Multimedia Tools and Applications*, 74(22), 10053-10056.
8. Pantoja, M., Ling, N., Kalva, H., & Lee, J. B. (2015). An efficient VC-1 to H. 264 IPB-picture transcoder with pixel domain processing. *Multidimensional Systems and Signal Processing*, 26(3), 555-574.
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14. Adzic V, Kalva H and Furht B (2011). "A survey of multimedia content adaptation for mobile devices" *Multimedia Tools and Applications*. January, 2011. 51(1), 379-396.
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D.3 Books

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D.4 Book Chapters

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D.5 US Patents (Granted)

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| 2 | US 6092107 A | System and method for interfacing MPEG-coded audiovisual objects permitting adaptive control |
| 3 | US 6292805 B1 | System and method for processing object-based audiovisual information |
| 4 | US 6751623 B1 | Flexible interchange of coded multimedia facilitating access and streaming |
| 5 | US 7149770 B1 | Method and system for client-server interaction in interactive communications using server routes |
| 6 | US 7199836 B1 | Object-based audio-visual terminal and bitstream structure |
| 7 | US 7428547 B2 | System and method of organizing data to facilitate access and streaming |
| 8 | US 8046338 B2 | System and method of organizing data to facilitate access and streaming |
| 9 | US 8115873 B2 | Object-based audio-visual terminal and bitstream structure |
| 10 | US 8189664 B2 | Methods for encrypting and compressing video |
| 11 | US 8363716 B2 | Systems and methods for video/multimedia rendering, composition, and user interactivity |
| 12 | US 8421923 B2 | Object-based audio-visual terminal and bitstream structure |
| 13 | US 8531608 B2 | Object-based audio-visual terminal and bitstream structure |
| 14 | US 8782713 B2 | Systems and methods for encoding multimedia content |
| 15 | US 8854552 B2 | Object-based audio-visual terminal and bitstream structure |
| 16 | US 8917357 B2 | Object-based audio-visual terminal and bitstream structure |
| 17 | US 8922717 B2 | Object-based audio-visual terminal and bitstream structure |
| 18 | US 8948250 B2 | Systems and methods for video/multimedia rendering, composition, and user-interactivity |
| 19 | US 9235917 B2 | Systems and methods for video/multimedia rendering, composition, and user-interactivity |
| 20 | US 9870801 B2 | Systems and methods for encoding multimedia content |
| 21 | US 10210907 B2 | Systems and methods for adding content to video/multimedia based on metadata |
| 22 | US-11006132-B1 | Methods and systems for adaptive cropping |
| 23 | US-11055437-B2 | Systems and methods for ensuring privacy in online information sharing applications |
| 24 | US-11102498-B2 | Block-based adaptive resolution management |
| 25 | US-11178416-B2 | Global motion models for motion vector inter prediction |

26	US-11252433-B2	Signaling of global motion vector in picture header
27	US-11259014-B2	Inter prediction in geometric partitioning with an adaptive number of regions
28	US-11265566-B2	Signaling of global motion relative to available reference frames
29	US-11284104-B2	Global motion constrained motion vector in inter prediction
30	US-11284100-B2	Candidates in frames with global motion
31	US-11356660-B2	Methods and systems of video coding using reference regions
32	US-11375183-B2	Methods and systems for combined lossless and lossy coding
33	US-11438594-B2	Block-based picture fusion for contextual segmentation and processing
34	US-11438603-B2	Methods and systems for adaptive cropping
35	US-11438604-B2	Methods and systems for adaptive cropping
36	US-11438620-B2	Efficient coding of global motion vectors
37	US-11451800-B2	Methods and systems for adaptive cropping
38	US-11451810-B2	Merge candidate reorder based on global motion vector
39	US-11477469-B2	Adaptive resolution management prediction rescaling
40	US-11516502-B2	Selective motion vector prediction candidates in frames with global motion
41	US-11546597-B2	Block-based spatial activity measures for pictures

D.6 Foreign Patents (Granted)

- 1 CA 2257577 C System and method for interfacing mpeg-coded audiovisual objects permitting adaptive control
- 2 CA 2257578 C System and method for processing object-based audiovisual information
- 3 CA 2281538 C Object-based audio-visual terminal and bitstream structure
- 4 DE 69835039 D1 Object-based audiovisual terminal and corresponding bitstream structure
- 5 DE 69835039 T2 Object-based audiovisual terminal and corresponding bitstream structure
- 6 EP 1209915 B1 Object-based audio-visual terminal and corresponding bitstream structure
- 7 EP 2338278 B1 Method for presenting an interactive video/multimedia application using content-aware metadata
- 8 ES 2266396 T3 Audio terminal – visual based on objects and flow structure of corresponding bits
- 9 JP 4393591B2 Object-based audio-visual terminal and corresponding bitstream structure
- 10 JP 4194240 Method and system for client-server interaction in conversational communication
- 11 LI 1209915 Object-based audio-visual terminal and corresponding bitstream structure
- 12 SE 1209915 Object-based audio-visual terminal and corresponding bitstream structure
- 13 IT 1209915 Object-based audio-visual terminal and corresponding bitstream structure
- 14 GB 1209915 Object-based audio-visual terminal and corresponding bitstream structure
- 15 FR 1209915 Object-based audio-visual terminal and corresponding bitstream structure
- 16 FI 1209915 Object-based audio-visual terminal and corresponding bitstream structure
- 17 CH 1209915 Object-based audio-visual terminal and corresponding bitstream structure
- 18 EP-2338278-B1 Method for presenting an interactive video/multimedia application using content-aware metadata

D.7 Patent application sold to Mitsubishi Electric

1. 055205-504P01US (62/694,524) Multi-level Bi-directional Prediction
2. 1163-1691PW01 Video Encoder, Video Decoder, Video Encoding Method, Video Decoding Method, H. Kalva, B. Furht

D.8 Contributions to International Standards Development (Un-refereed)

- 1 H. Kalva, A.Eleftheriadis, S.-F. Chang, and C. Judice, "Interoperability Experiments to Validate STU-VASP Interface," DAVIC contribution DAVIC/SYS/Interop/95/03/06, March 1995, London, United Kingdom.
- 2 H. Kalva, S.-F. Chang, A.Eleftheriadis, "Configuration of Columbia's Video on Demand Testbed," DAVIC contribution DAVIC/SYS/Interop/95/09/11, September 1995, Beverly Hills, CA, USA..
- 3 H. Kalva, S.-F. Chang, A.Eleftheriadis, and L. Ulbricht, "Response to the Second Call for Interoperability Test Plans," DAVIC contribution DAVIC/SYS/Interop/95/12/11, December 1995, Berlin, Germany.
- 4 H. Kalva, S.-F. Chang, A.Eleftheriadis, "Proposal and Plans for New York Interoperability Experiments," DAVIC contribution DAVIC/SYS/Interop/96/03/08, March 1996, Seoul, Korea.
- 5 H. Kalva et. al., "Configuration and Test Scenarios for Interop Experiments," DAVIC/SYS/Interop/96/06/17, June 1996.
- 6 H. Kalva, "DAVIC New York Interoperability Experiments: Report and Results," DAVIC Contribution No. DAVIC/TC/SYS/96/09/008, Geneva, Switzerland, 1996.
- 7 A. Eleftheriadis and H. Kalva, "A Proposed Architecture for an Object-Based Audio-Visual Bitstream and Terminal", Contribution ISO-IEC JTC1/SC29/WG11 MPEG97/1619, February 1997, Seville, Spain (38th MPEG meeting).
- 8 H. Kalva, A. Eleftheriadis, A. Puri, and R. Schmidt, "Stored File Format for MPEG-4", Contribution ISO-IEC JTC1/SC29/WG11 MPEG97/2062, April 1997, Bristol, UK (39th MPEG meeting).
- 9 A. Puri, R. Schmidt, A. Eleftheriadis, H. Kalva, and Y. Fang, "APIs for MPEG-4 Systems", Contribution ISO-IEC JTC1/SC29/WG11 MPEG97/2133, April 1997, Bristol, UK (39th MPEG meeting).
- 10 A. Eleftheriadis, H. Kalva, A. Puri, and R. Schmidt, "Stored File Format for MPEG-4 (Rev. 2.0)", Contribution ISO-IEC JTC1/SC29/WG11 MPEG97/2536, July 1997, Stockholm, Sweden (40th MPEG meeting).
- 11 H. Kalva, A. Eleftheriadis, A. Basso, R. Schmidt, and A. Puri, "File Format for MPEG-4 (Rev. 3.0)", Contribution ISO-IEC JTC1/SC29/WG11 MPEG97/2873, October 1997, Fribourg, Switzerland (41st MPEG meeting).
- 12 H. Kalva and A. Eleftheriadis, "Requirements for MPEG-4 File Format", Contribution ISO-IEC JTC1/SC29/WG11 MPEG97/2886, October 1997, Fribourg, Switzerland (41st MPEG meeting).
- 13 H. Kalva and A. Eleftheriadis, "MPEG-4 Interaction Model and Required Normative Support", Contribution ISO-IEC JTC1/SC29/WG11 MPEG97/2888, October 1997, Fribourg, Switzerland (41st MPEG meeting).
- 14 A. Basso, A. Eleftheriadis, R. L. Schmidt, H. Kalva, and A. Puri, "MPEG-4 Integrated Intermedia Format (IIF): Basic Specification", Contribution ISO-IEC JTC1/SC29/WG11 MPEG98/2978, February 1998, San Jose, CA (42nd MPEG meeting).
- 15 A. Basso, A. Eleftheriadis, A. Puri, R. L. Schmidt, and H. Kalva, "Flexible-IIF: A Conceptual Framework for Intermedia Development in MPEG-4", Contribution ISO-IEC JTC1/SC29/WG11 MPEG98/2979, February 1998, San Jose, CA (42nd MPEG meeting).
- 16 H. Kalva and A. Eleftheriadis, "AL Packetized Elementary Stream Format", Contribution ISO-IEC JTC1/SC29/WG11 MPEG98/3188, February 1998, San Jose, CA (42nd MPEG meeting).
- 17 H. Kalva and A. Eleftheriadis, "Syntax and Semantics of Control Messages for User Interaction", Contribution ISO-IEC JTC1/SC29/WG11 MPEG98/3189, February 1998, San Jose, CA (42nd MPEG meeting).

- 18 H. Kalva and A. Eleftheriadis, “Software Implementation of the MPEG-4 Intermedia Format Proposal from Columbia University and AT&T Research,” Contribution ISO-IEC JTC1/SC29/WG11 MPEG98/3190, February 1998, San Jose, CA (42nd MPEG meeting).
- 19 A. Eleftheriadis, A. Basso, H. Kalva, A. Puri, and R. L. Schmidt, “Input for Development of MP4 File Format”, Contribution ISO-IEC JTC1/SC29/WG11 MPEG98/3455, March 1998, Tokyo, Japan (43rd MPEG meeting).
- 20 A. Eleftheriadis and H. Kalva, “Use of CommandDescriptors and CommandROUTEs to Support User Interaction”, Contribution ISO-IEC JTC1/SC29/WG11 MPEG98/3506, March 1998, Tokyo, Japan (43rd MPEG meeting).
- 21 J. Zamora, L.-T. Cheok, A. Eleftheriadis, H. Kalva, and L. Tang, “MPEG-4 Remote Application through IP Networks: Demonstration Outline”, Contribution ISO-IEC JTC1/SC29/WG11 MPEG98/4092, October 1998, Atlantic City, New Jersey (45th MPEG meeting).
- 22 H. Kalva and A. Eleftheriadis, “Using Command Descriptors”, Contribution ISO-IEC JTC1/SC29/WG11 MPEG98/4269, December 1998, Rome, Italy (46th MPEG meeting).
- 23 H. Kalva, L.-T. Cheok, A. Akhtar, J. Zamora, and A. Eleftheriadis, “Implementation/Demonstration of Command Descriptor Framework”, Contribution ISO-IEC JTC1/SC29/WG11 MPGE98/4270, December 1998, Rome, Italy (46th MPEG meeting).
- 24 A. Akhtar, H. Kalva, and A. Eleftheriadis, “Implementation of CommandDescriptor and CommandDescriptorNode”, Contribution ISO-IEC JTC1/SC29/WG11 MGE99/4431, March 1999, Seoul, Korea (47th MPEG meeting).
- 25 A. Akhtar, H. Kalva, and A. Eleftheriadis, “Command Node Implementation “, Contribution ISO-IEC JTC1/SC29/WG11 MGE99/4905, July 1999, Vancouver, Canada (48th MPEG meeting).
- 26 A. Akhtar, H. Kalva, and A. Eleftheriadis, “Command Node Implementation in the IM1 Framework”, Contribution ISO-IEC JTC1/SC29/WG11 MGE00/5687, March 2000, Noordwijkerhout, Netherlands (51st MPEG meeting).

E. Litigation Consulting

1. Samsung (petitioner) vs. M&K Holdings (patent owner), IPR2018-00696, IPR2018-00697, IPR2018-00698, Oct 2018
 - a. Expert witness for the patent owner
 - b. Patent owner’s counsel: Mintz, Levin, Cohn, Ferris, Glovsky and Popeo, P.C.
 - c. Provided expert testimony and was deposed
2. Unified Patents vs Korean Broadcasting System (“KBS”) and Korea Advanced Institute of Science and Technology (“KAIST”) (patent owners), May 2019
 - a. expert witness for the patent owners
3. Harman vs DivX, July 2022 – present
 - a. Expert witness for Harman International Industries, Inc., represented by Jenner & Block LLP

F. Grants

Sponsor	Project Title
	Grants as PI
OP Solutions	Developing Technology Improvements for the next generation compression standards, 2018-2023
NSF CAKE	Deep Learning for Multimedia Big Data on HPCC 2016

Comcast	Perceptually Optimized Video Encoding 2015-2016
Intel	HEVC Video Codec Adaptation 2014-2015
NSF CAKE	Innovative Utility Programs for Window-based Systems 2014
NSF CAKE	Video Quality Evaluation Tools, 2013
COET	Automating Aerial Survey of Marine Mammals, 2010-2012
Avocent	FAU Image Recognition and Asset Tag Identification, 2012
Avocent	Image Recognition and Asset Tags, 2012
Real Networks	Video Pre Processing Tools, 2009-2011
Real Networks	Video Codec Optimization, 2009 -2011
Real Networks	Encoder Optimization, 2008-2009
FAU RC	GAP Funding Video Identification, 2009
Real Networks	Meta Data Development for Video Encoding, 2008-2010
Real Networks	Advanced Coding Tools, 2008 - 2009
FAU RC	RealtimeH.264 Encoder for Mobile Devices, 2008-2009
Real Networks	Real Media Decoder Design Specification, 2007-2008
Real Networks	Real Video Decoder Design Specification, 2007-2008
FAU RC	Development of MPEG-2 to H.264 Video Transcoder Using IPP, 2007-2008
FAU Research	Low Complexity Video Encoding Using Machine Learning, 2007-2008
On2 Tech.	H.263 to VP6 Transcoding, 2007-2008
Real Networks	H.264 video Transcoding, 2006-2007
	Grants as Co-PI
NSF	NSF Center for Advanced Knowledge Enablement, 2015-2020
NSF	Modeling Ebola Spread, 2015
NSF	NSF Center for Advanced Knowledge Enablement, 2015-2020
NSF CAKE	Mobile Visual Search , 2011-2012
NSF	Data Correlation and Fusion for Medical Monitoring, 2012-2014
	Participation in Grants as an Investigator
NSF CAKE	Innovative Technologies (PI: Dr. Dani Raviv), 2012-2014 <i>Role: PI for the project on parking occupancy automation, supervised two graduate students with partial summer support.</i>
ONR	ONR/Federal Earmark Grant on “Center for Coastline Security Technologies”, 2004-2007. <i>Role: Investigator for the project on Video and Image Processing Techniques (PI: Dr. Borko Furht), Supervised one graduate student with partial summer support.</i>
DoD	DoD/Federal Earmark Grant on “Secure Telecommunications”, 2004-07. <i>Role: Investigator for the project on Information Security (PI: Dr. Spyros Magliveras), received partial summer support.</i>
Motorola	One Pass to Production, 2005-2009 <i>Role: Investigator for the project on Multimedia Modeling (PI: Dr. Ravi</i>

	<i>Shankar), Supervised one graduate and one undergraduate student with partial summer support.</i>
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G. Graduate Student Supervision

G.1 Ph.D. Dissertations Supervised to Completion

- 1 Parikh, S (2017). “Predicting Levels of Learning with Eye Tracking”. *Dissertation at: Florida Atlantic University. United States – Florida*
- 2 Pappusetty, D (2017). “Analysis of Eye Response to Video Quality and Structure”. *Dissertation at: Florida Atlantic University. United States – Florida*
- 3 Adzic, V (2014). “Perceptual Methods for Video Coding”. *Dissertation at: Florida Atlantic University. United States – Florida*
- 4 Garcia, R. (2014). “HEVC Optimization in Mobile Environments”. *Dissertation at: Florida Atlantic University. United States – Florida*
- 5 Jillani RM (2011). “Low complexity Scalable Video Encoding”. *Dissertation at: Florida Atlantic University. United States – Florida*
- 6 Sanigepalli P (2005). “Innovative video error resilient techniques for MBMS systems”. *Dissertation at: Florida Atlantic University. United States -- Florida*

G.2 Ph.D. Dissertations Currently Supervising

- 1 Eimran Eimon
- 2 Aishan Perera

G.3 M.S. Theses Supervised to Completion

- 1 Chinta, V. (2017). “Multimedia Big Data Processing Using HPCC Systems”. *Thesis at: Florida Atlantic University. United States -- Florida*
- 2 Escudero, A (2014). “People counting and density estimation using public cameras”. *Thesis at: Florida Atlantic University. United States -- Florida*
- 3 Justo F (2013). “Automatic parking lot occupancy calculations using motion tracking”. *Thesis at: Florida Atlantic University. United States -- Florida*
- 4 Torres F (2013). “Exploiting audio-visual attention for video coding”. *Thesis at: Florida Atlantic University. United States -- Florida*
- 5 Friedel RU (2012). “Asset identification using image descriptors”. *Thesis at: Florida Atlantic University. United States -- Florida*
- 6 Aghera S (2011). “Design and development of video acquisition system for aerial surveys of marine animals”. *Thesis at: Florida Atlantic University. United States -- Florida*
- 7 Castellanos Jimenez RA (2010). “Event detection in surveillance video”. *Thesis at: Florida Atlantic University. United States -- Florida*
- 8 Possos Medellin S (2010). “Signature system for video identification”. *Thesis at: Florida Atlantic University. United States -- Florida*
- 9 Reza W (2010). “Remote gaming on resource constrained devices”. *Thesis at: Florida Atlantic University. United States -- Florida*
- 10 Carrillo P (2008). “Low complexity H.264 video encoder design using machine learning techniques”. *Thesis at: Florida Atlantic University. United States -- Florida*
- 11 Holder C (2008). “Video transcoding using machine learning”. *Thesis at: Florida Atlantic University. United States -- Florida*

- 12 Leon GA (2008). "Content identification using video tomography". *Thesis at: Florida Atlantic University. United States -- Florida*

G.4 Advisor to Visiting Scholars

- 1 Gerardo Fernandez, University of Castilla La Mancha, Albacete, Spain, Sept. 2005 to Nov. 2006.
- 2 Jose Luis Martinez, University of Castilla La Mancha, Albacete, Spain, Aug. 2007 to May. 2008.
- 3 Chunyan Dou, Beijing University of Post and Telecommunications, Beijing, China, Oct. 2007 to April 2008.
- 4 Trushal Thakar, Nirma University, Ahmadabad, India, Sept. 2007 to May 2008.
- 5 Sebastian Van Leuven, University of Ghent, Belgium, Sept to Dec 2011.
- 6 Damian Ruiz Coll, University of Castilla La Mancha, Spain, June to Sept 2012
- 7 Damian Ruiz Coll, University of Castilla La Mancha, Spain, June to Sept 2012
- 8 Georgia Elfoudi, University of Starthclyde, Glasgow, Scotland, Sept to Dec 2014
- 9 Antonio Jesus Diaz Honrubia, University of Castilla La Mancha, Spain, Sept to Dec 2015

G.5 Member of Ph.D. Committees

- 1 Edin Muharemagic (Nov 2004)
- 2 Nyeongkyu Kwon (External examiner, Aug 2005, University of Victoria, Victoria, Canada)
- 3 Daniel Socek (Aug 2006)
- 4 Hyun-Ho Jeon (External examiner, June 2007, University of Victoria, Victoria, Canada)
- 5 Liam Mayron (May 2008)
- 6 Branko Petljanski (May 2010)
- 7 Ivana Ilic (Nov 2010, Dept. of Mathematical Sciences, Florida Atlantic University)
- 8 Amy Mihnea (Dec 2011, Dept. of Mathematical Sciences, Florida Atlantic University)
- 9 Diego Pava (May 2015)
- 10 David Jaramillo (Dec 2014)
- 11 Joel Gibson (May 2015)
- 12 Esfandiar Zolghadr
- 13 Gary Croucher
- 14 Walter Britton
- 15 Carlos Garrafa
- 16 Oscar Lopez (Dept. of Mathematical Sciences, FAU)

G.6 Member of MS Thesis Committees

- 1 Pierre Baillargeon (Aug 2005)
- 2 Chetan Thakker (Aug 2005)
- 3 Joel Gibson (Dec 2008)
- 4 Jens Mangs (Dec 2008)
- 5 Chris Thoman (June 2009)
- 6 Adriana Garcia (July 2010)
- 7 Francisco Amador (July 2010)

H. Professional Service

H.1 Conference and Workshop Organization

- 1 Chair, Special Session on Perception Inspired Video Processing, Human Vision and Electronic Imaging Conference, SPIE Electronic Imaging, Feb 2014.
- 2 Chair, *Image and Video Codecs track, International Conference on Consumer Electronics (ICCE)*, Las Vegas, NV, USA, Jan 2010.
- 3 Finance Chair, *International Workshop on Multimedia Signal Processing (MMSP)*, Rio de Janeiro, Brazil, Oct. 2009.
- 4 Co-chair, *Image and Video Codecs track, International Conference on Consumer Electronics (ICCE)*, Las Vegas, NV, USA, Jan 2009.
- 5 Co-chair, *Image and Video Codecs track, International Conference on Consumer Electronics (ICCE)*, Las Vegas, NV, USA, Jan 2008.
- 6 Finance Co-chair, *International Workshop on Multimedia Signal Processing (MMSP)*, Crete, Greece, Oct 2007.
- 7 Co-chair, *Image and Video Codecs track, International Conference on Consumer Electronics (ICCE)*, Las Vegas, NV, USA, Jan 2007.
- 8 Program Vice Co-Chair, *Image and Video Processing Track, IEEE International Symposium on Multimedia (ISM)*, San Diego, CA, USA, Dec 2006.
- 9 Chair, *Special Session on X to H.264 Transcoding, International Conference on Multimedia and Expo (ICME)* 2006, Toronto, Canada, Jul 2006.
- 10 Co-chair, Image and Video Processing track, *International Conference on Consumer Electronics (ICCE)*, Las Vegas, NV, USA, January 2006 .
- 11 Tutorials Chair, *Image and Video Processing Track, IEEE International Symposium on Multimedia (ISM)*, Irvine, CA, USA, Dec 2005.
- 12 Co-chair, *Workshop on Mobile Multimedia*, collocated with the *Sixth International Symposium on Multimedia Software Engineering*, Miami, FL, USA, Dec 2004.
- 13 Co-Organizer, *The First DAVIC Interoperability Event*, Columbia University, New York, NY, USA, Jun 1996.
- 14 Demos chair, *Workshop on Video On Demand Systems*, Columbia University, New York, NY, USA, Jun 1996.

H.2 Editorship of Journals and Books

- 1 Lead Guest Editor, *Multimedia Tools and Applications*, Nov 2015 ***special issue on Visual Information Processing and Perception***
- 2 Lead Guest Editor, *IEEE Journal on Selected Topics in Signal Processing*, Special Issue on Perception Inspired Video Processing.
- 3 Member of the Editorial Board, *Multimedia Tools and Applications Journal* (Springer), 2009 - present.
- 4 Member of the Editorial Board of Hindawi's *Advances in Multimedia* Oct. 2008 – 2018.
- 5 Member of the Editorial Board of Elsevier's *Signal Processing: Image Communication* journal Oct. 2006 – 2010.
- 6 Member of the Editorial Board of *Recent Patents on Electrical Engineering*, Bentham Science Publishers Ltd. Aug 2007 – 2018.
- 7 Guest Editor, Special Issue on H.264 Transcoding, *Multimedia Tools and Applications Journal* (Springer), 2007.

- 8 Member of the Editorial Board of *Encyclopedia of Multimedia*, Springer, 2006.
- 9 Member of the Editorial Board, *Journal of Multimedia*, Academy Publishers, 2006 - present.
- 10 Guest Editor, Special Issue on Mobile Multimedia, *Multimedia Tools and Applications Journal* (Springer), 2006.
- 11 Member of the Editorial Board of the *Communications Interactive*, the online publication of the IEEE Communication Society. 1999-2000.

H.3 Member of Technical Program Committee of Conferences

- 1 IEEE International Conference on Consumer Electronics (ICCE), 2003-present
- 2 SIGMAP 2009, the International Conference on Signal Processing and Multimedia Applications
- 3 MUE 2009, The 3rd International Conference on Multimedia and Ubiquitous Engineering
- 4 UNESST 2008, First International Conference on u- and e- Service, Science and Technology, December 13 ~ 15, 2008, Hainan Island, China.
- 5 SIGMAP 2008, the International Conference on Signal Processing and Multimedia Applications
- 6 MUE 2008, The 2nd International Conference on Multimedia and Ubiquitous Engineering
- 7 SIGMAP 2007, the International Conference on Signal Processing and Multimedia Applications
- 8 First International Workshop on Multimedia Analysis and Processing (IMAP 2007)
- 9 IEEE International Conference on Multimedia and Expo (ICME), 2000 – 2010
- 10 IEEE Consumer Communications and Networking Conference (CCNC), 2004 – 2006
- 11 IEEE International Conference on Communications (ICC), 2004-2005
- 12 IEEE International Conference on Image Processing (ICIP), 2003 – 2005
- 13 IEEE International Symposium on Multimedia (ISM), 2005-2008.
- 14 Workshop on Parallel and Distributed Multimedia (PDM), 2007.
- 15 IEEE INFOCOM, 2004 – 2005.
- 16 IEEE GLOBECOM 2007.

H.4 Referee of Journal Papers

- 1 ACM Transactions on Multimedia Computing, Communications and Applications, ACM/Springer Verlag Multimedia Systems Journal, ETRI Journal, EURASIP Image Communications Journal, EURASIP Journal on Advances in Signal Processing, IEEE Communications Magazine, IEEE Journal on Selected Areas in Communications, IEEE Transactions on Circuits and Systems for Video Technology, IEEE Transactions on Multimedia, IEEE Transactions on Image Processing, International Journal of Computers and Applications, Journal of Communications and Networks, Journal of Multimedia Tools and Applications, Journal of the Indian Institute of Science, Journal of Information Science and Engineering

H.5 Membership of and Service to Professional Organizations

- 1 Chair, IEEE Palm Beach Section, 2015-Present
- 2 Chair of the IEEE Communications Society Chapter, Palm Beach Section, 2004 - present
- 3 Membership Development Officer, IEEE Palm Beach Section, 2010 - 2015
- 4 Member of the Multimedia Technical Committee of the IEEE Communications Society
- 5 Senior Member of the IEEE
- 6 Member of Vision Sciences Society (VSS)

- 7 Member of IEEE Circuits and Systems Society
- 8 Member of the IEEE Communications Society
- 9 Member of the IEEE Consumer Electronics Society
- 10 Member of the IEEE Signal Processing Society
- 11 Member of the ACM

I. University Service

I.1 University Committees

- | | | |
|---|---|----------------------|
| 1 | Academic Planning and Budget Committee | 2021-2023 |
| 2 | Senator, University Faculty Senate | 2012-2014; 2020-2022 |
| 3 | College Representative, Faculty Advisory Committee, OIT | 2012 –2015 |
| 4 | Senate Steering Committee Member, University Faculty Senate | 2013-2015 |

I.2 College Committees

- | | | |
|---|--|-----------|
| 1 | Member of the College Research Committee | 2012-2015 |
|---|--|-----------|

I.3 Departmental Committees

- | | | |
|---|--|------------------|
| 1 | Chair of the Computer Engineering undergraduate committee | 2012-2013 |
| 2 | Member of the Dept. Research Committee | 2011-2014 |
| 3 | Member of the Personnel Committee | 2009-2010, 2012- |
| 4 | Member of the Ad-hoc Committee to Create Department's Bylaws | 2009-2010 |
| 5 | Member of the Computer Engineering undergraduate committee | 2003-2014 |
| 6 | Member of the TA/GA Selection Committee | 2008- 2009 |

I.4 Other University Service

- 1 Co-organizer MakeFAU Annual Hackathon, 2016-present
- 2 Co-Organizer, CEECS Department Open House, 2012
- 3 Organizing an annual IEEE sponsored research poster competition for the graduate students in the Dept. of Electrical Engineering and the Dept. of Computer Science and Engineering, 2005 and 2006.
- 4 Faculty advisor to the FAU IEEE Student Branch
- 5 Faculty advisor to the Novel Engineering Research and Development Society